



Faculty of Science and Technology

BSc (Hons) Games Design
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*Creating an Immersive Horror
Puzzle Game in Virtual Reality*

By

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Abstract

When creating a horror game, it is very important that certain aspects of the game are correctly designed, this includes level design, lighting, sound and post-processing, this is key in creating the right atmosphere for players to give a fear response.

Additionally, it's important to see if these conditions excel in a virtual reality environment as this full immerses the player within the game, whether it's sight, sound or even being able to interact with the world using their hands.

This led to the creation of a game in Unity called Umbra which was designed to give the player a feeling of unease while they traverse a haunted mansion while escape room style puzzles. The virtual reality has been utilized to allow the player to directly interact with doors, drawers, buttons, dials and various other miscellaneous objects.

A study was undertaken with three participants using a Polar H9 heartrate sensor and recorded with an application that exports the data as raw RR intervals. Unfortunately, due to complications the data was not reliable and as such no conclusions regarding horror games could be drawn from this data. The qualitative study suggests that the game created a fear response using a combination of the lighting, sound, post-processing effects. Additional information also suggests that virtual reality enhanced the experience for the player.

Overall, this suggests that the game was effective in creating a horror experience, however, to obtain meaningful physiologic data better heartrate equipment would need to be utilized. Additionally, an increased number of participants in the study would be required to obtain significant results.

1. Introduction and Background

1.1 Introduction

Virtual reality (VR) headsets are constantly gaining popularity and becoming more mainstream. Each year the virtual reality market grows exponentially, with the global virtual reality market predicted to be worth \$5.1 billion by 2023. This would represent an almost doubling the size of the virtual reality market since 2018. (Consumer virtual reality (VR) market size worldwide 2023 | Statista, 2022)

With virtual reality games, a new variety of design challenges are introduced, as the game is no longer limited to a monitor, the player is now inside of the game's environment. This helps the player become more immersed in the game itself, becoming one with the atmosphere.

Virtual reality has a variety of different genres such as sports, racing, puzzle and visual novels, however games utilizing elements of the horror genre stand out in virtual reality game design. This is partly because with modern virtual reality, all of your senses are immersed within the game's environment. However, despite being considered scary, it is still very popular genre among some players of virtual reality games, though it is not the most popular genre of game (Foxman, Leith, Beyea, Klebig, Chen, Ratan 2020, P. 239). The horror genre still has a dedicated fanbase in virtual reality gaming with new horror virtual reality titles being released on a regular basis.

A very interesting point to be made is that horror games are paradoxical in nature as the player is finding enjoyment from being scared, which in turn creates a positive emotion out of something that would normally be considered something fairly negative. The one feeling that gets the most attention from horror games is fear and with the games being inside virtual reality, the player is now in a first-person position, this in turn increases the fear. (BANTINAKI, 2012, cited in Lin, Wu and Tao, 2017)

The primary goal of this study is to find out what it takes for a game to invoke a fear response. Various conventional elements of horror games will be looked at when developing this game, including map sizing and layout, lighting, audio and a perceivable threat. The study will identify whether the game is considered scary and suggest what could be done to improve it. Additional research will also help determine whether any additional elements need to be added to the game and how they should be implemented.

The project, called Umbra is a psychological horror that attempts to use the environment and scripted events in an attempt to provoke a fear response from the player. Following the completion of Umbra, a qualitative study will be performed in a broader audience. This research will test various people to determine whether the study was successful in helping implement the horror elements. This will be accomplished by asking the participant to play through the game while they have a heartrate sensor attached to their body. Their heartrate will be monitored through the entire duration of the gameplay and will be compared to a screen recording of their session so the footage can be analysed and compared to the other data that has been recorded for the study. After the playthrough, they will be questioned about their experience. This can help answer some questions and gain additional insight that cannot be obtained through the gameplay recordings or heartrate data. If the game fail to create an adequate fear response, then the feedback can be used to find out why.

This will allow several questions to be addressed including; whether the game fits within the horror genre by creating fear for the player, how players cope under the pressure of having to solve escape room style puzzles and whether being in virtual reality enhances the experience and makes the game scarier.

Several limitations will also have to be considered, one of which will be the reliability of the Polar H9 heartrate monitor, which may have some discrepancies in the heart rate variability data due to the accuracy of the device. However, one thing that will be worth noting is the average heartrate of the player throughout the game and their heartrate at the end of the play session.

Something else to consider is how much experience the player has with both virtual reality and horror games. More experienced players may find themselves more adept with virtual reality games, resulting in a quicker overall time completing the puzzles, while other players may have had more exposure to horror games, leaving them less startled by the environment, this must be considered when picking the candidates as not only can their experience with horror games affect their

perception, but it can also affect enjoyability and immersion. (Armanto, Anthony and Pickerling, 2021)

1.2 Background

The earliest example of the development of the horror genre dates to 1972 when Sega released Killer Shark which was designed for use on arcade cabinets (Sega, 1972). This was followed by the release of such games as Haunted House for the Atari 2600 (Atari, 1982) and Halloween for the Atari 2600 (Atari, 1983). However, Horror games still remain mainstream to this day, with several popular releases such as Resident Evil Village (Capcom, 2021), Phasmophobia (Kinetic Games, 2020) and Dying Light 2 (Techland, 2022) occurring in recent years.

Virtual reality was chosen for this study because the player experiences a higher level of immersion while playing a game on a virtual reality headset. Not only does the use of virtual reality provide a higher level of challenge compared to a non-virtual reality system but it also has a higher positive effect on the player as a whole, creating a much more enjoyable experience. (Christensen et al., 2018) Virtual Reality being more immersive is due to great advancements with the hardware and software over the past decade, including 3D visual, auditory and haptic displays, position tracking systems and input devices. (Bowman and McMahan, 2007)

Games that present the player with a first-person view are ideal for the horror genre as this gives the player less spatial awareness of the environment around them. Giving the player a reduced field of view is a large influencing fact as this leaves them in a more vulnerable position due to the fact that the player's vision has now become limited (Gordon, 2022). This factor played an important role in the decision to develop the game in virtual reality, as this environment places the player in first person on a literal level.

In addition to the limitations virtual reality provides to a player's field of view, it also limits and reduces their movement. Playing a game in virtual reality means that the player is limited to a slower paced style of game, this is because faster movement such as sprinting could cause the player to become motion sick or disoriented (Motion Sickness in VR: Why it happens and how to minimise it, 2022). This can work as an advantage however, as the player must spend longer in this unsettling environment feeling much more vulnerable to the hostile nature of the game.

2. Related Work

The inspiration for this work comes from a prior study that proposed a similar premise utilizing aspects of the game (Misztal, Carbonell, Zander and Schild, 2020). This study investigated the role of visual effects on the fear of a player using a variety of effects such as vignetting, grain, chromatic aberration, colour grading and blurring. This study found that a combination of all of the listed effects can increase stress perception for the player, while simultaneously avoiding negative effects on the player's presence and also avoiding motion sickness.

Additionally, a previous study had examined a number of factors to measure the enjoyability of games within virtual reality. (Christensen et al., 2018) This study tested these factors in full virtual reality, which used a headset and two tracked VR controllers, simple virtual reality, which used a headset and Xbox controller and non-VR which used just a mouse and keyboard. This study showed that full VR had a positive impact on the immersion, flow and behavioural involvement of the player, whereas simple virtual reality had greater values for competence, tension and challenge. Non-VR

was simply beaten out by either full VR or Simple VR, this made the decision to use full-VR very easy as the study would benefit from an increased level of immersion. Although full-VR had a lower tension rate, it was decided that it wouldn't impact the game on a huge scale as the tension wasn't non-existent. Overall, the paper shows that virtual reality can positively influence the playthrough of a video game in various areas, such as the immersion, flow and behavioural involvement.

Another research goal that this research paper aims to answer is whether ambient sound can affect the player. Using ambient sound for this effect is ideal, because it can instil unconscious emotions onto the player without the need of stopping the player for story development (Spittle, 2011). The goal is to mostly stick to diegetic sound, while occasionally playing some non-diegetic sound, this is because it is easier to trigger a fear response using diegetic sound as it is more lifelike and natural where non-diegetic sound is mostly background music.

These papers gave way to the idea that there are key elements to horror games that must be included for a game to be considered scary. However, they also leave unaddressed the question of which of these features are required. So far it has been established that post-processing effects can affect the player (Misztal, Carbonell, Zander and Schild, 2020) as well as ambient sound (Spittle, 2011). This paper aims to find out which of these features are important when creating an immersive horror experience through research into similar papers and backing this up with qualitative study to either confirm or deny whether these features have any effect on the player's fear perception.

Alongside these research papers, inspiration was also taken from games of the same genre. The first game that was used as inspiration for this is Phasmophobia (Kinetic Games, 2020). The goal of Phasmophobia is to identify which ghost is haunting the building, this is done by using a variety of tools to deduce the ghost. However, there's also added danger as the ghost can enter hunting mode to try and kill the player, if they player is unable to escape from the ghost or hide on time, then the player is killed.

Phasmophobia has a very dark and sombre atmosphere, using mostly cold colours, dimly lit areas and empty buildings as a way to set the tone and attempt to create a fear response in the player as shown in Figure 1.



Figure 1. Phasmophobia (Kinetic Games, 2020) Image credit (PCGamesN, 2020)

Phasmophobia also makes use of ambient soundscapes to make the play feel a level of unease, this includes sounds such as rain, white noise, radio sounds and fluorescent lighting.

Another game that inspired the creation of Umbra is Resident Evil Village (Capcom, 2021). The gameplay was not chosen for the gameplay as this differs greatly from my intended gameplay functionality, however it does take inspiration from the art style of the game, especially the Victorian themed mansion which can be seen in Figure 2.



Figure 2. Resident Evil Village (Capcom, 2021), image credit (Green Man Gaming, 2021)

This Victorian gothic aspect specifically inspired the creation of the haunted mansion for Umbra. This aspect was chosen because the unwelcoming architecture attempts to instil fear into the player by using the design of the mansion.

3. Research, Development and Implementation

Unity was chosen for this project as it has built in virtual reality software development tools alongside an asset store that offers a large library of free and paid scripts and assets. The initial idea was to use Unity's built in VR toolkit by Sysdia Solutions LTD; however, this was abandoned in favour of the VRTK toolkit as it provides a greater variety of useful virtual reality development tools. The project is running on Unity 2019.4.23f1 as this is an officially supported version of Unity.

The doors in the project are activated by the player putting their hand over the door handle and activating it with the trigger button, this is called a controllable. This causes the door to play an animation and swing open, however if a key is required for the door, the door will not open until the player has brought the correct key to the door.

The drawers in the level are also a controllable and have a little bit more interaction where the player has to pull the drawer open with their hands, as they would with a real drawer. This was done by using a linear drive façade and a linear joint drive. Unfortunately, this turned out to be problematic as the drawers ended up having various collision issues with the other drawers and the items inside of them. Instead of utilizing these for gameplay, it was decided to keep them in for interactivity, but not much else.

There are various objects scattered around the level which players can pick up and interact with, these are called interactables, this includes books, cassette players, keys and miscellaneous household objects. This was restricted to small items to keep the game realistic. This was easily accomplished by giving the items an interactable façade, the rest of the code is handled by VRTK.

3.1 Designing the Aesthetic

An important part of creating a horror game is the aesthetic, the right atmosphere is an essential component of designing the player's experience. This is why I chose a haunted mansion as this would allow me to build an old, dirty and dilapidated structure in an attempt to fit with the horror aesthetic. To provide the appropriate atmosphere and the right feel two haunted mansion asset packs were used from the Unity asset store. This was to allow for additional resources to be placed into other essential elements of game design required to provide the overall experience, this would have been limited if these asset packs were not used as the asset creation process is quite time consuming.

The first pack that was used is the Classic Mansion Pack by Anil Isbilir. This pack has a semi-realistic look, while these models don't have very high polygon count or highest texture resolution, they still look fairly realistic with the right lighting. I purposefully chose not to use high realism props as these limit options when it comes to finding props, as there aren't too many affordable realistic props on the asset store.

It was also important that these models didn't have too high of a polygon count as this could affect the framerate inside the virtual reality space. An additional optimisation method that was also included with these models was the use of level of detail (LODs). The use of LODs allows the game to save resources as the polygon count of the model reduces automatically the further the player gets

from it.

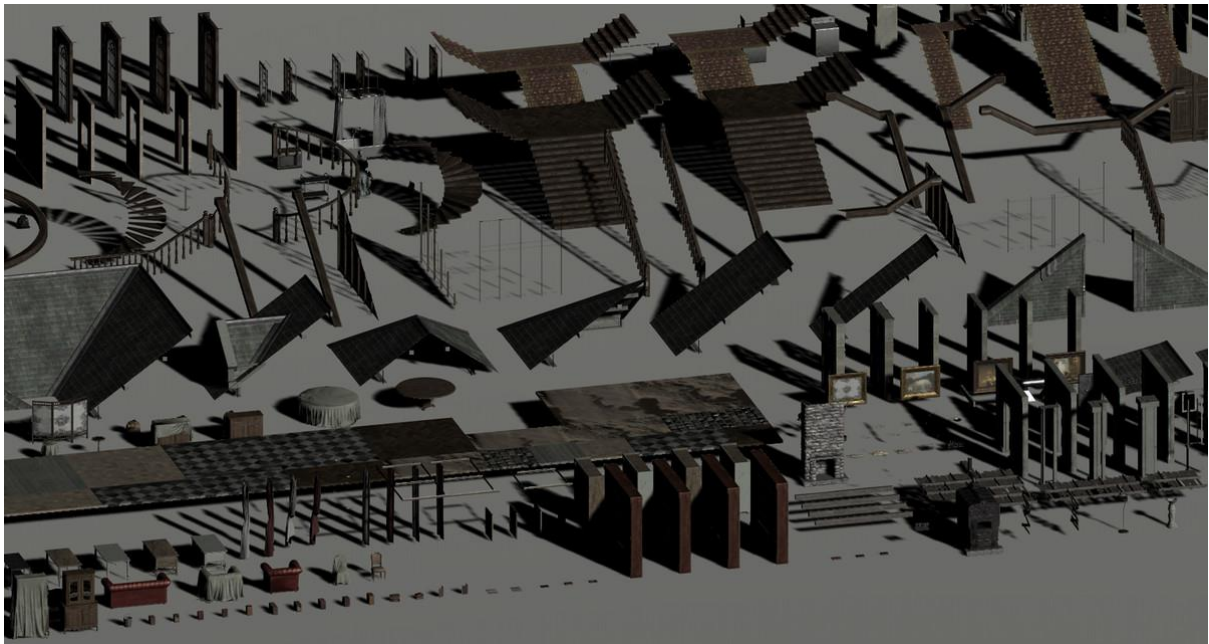


Figure 3. The Classic Mansion Pack by Anil Isbilir on the Unity Asset Store

The modular assets included in the Classic Mansion Pack allowed the creation of the house's layout with ease. By providing each floor and wall section with standardized dimensions, they are compatible with other addons which may include similar modular assets as seen in Figure 3.

These assets however were not enough to create a detailed environment, while this prop pack contained a wide number of useful props for walls, floors and stairs, additional furniture props were required. To resolve this, the Mansion SET by Tres Dimensiones as seen in Figure 4. was also used in the development of the game.

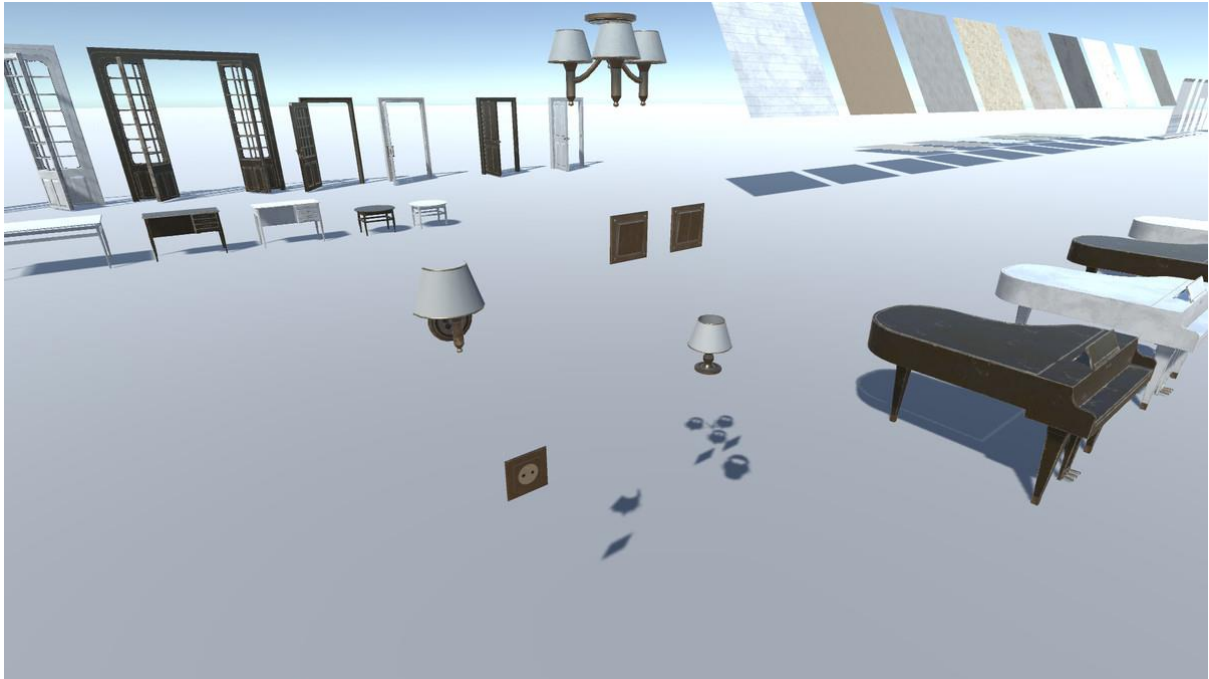


Figure 4. The Mansion SET by Tres Dimensiones on the Unity Asset Store

This mansion pack proved to be useful as it provided a variety of additional furniture assets that could be used in the mansion. Additionally, the aesthetic of the mansion pack preserved the established aesthetic of the game's initial design, which allowed for a consistent experience between the different elements.

3.2 Designing the Mansion Layout and Puzzles

When designing the layout of the mansion, it was very important to keep the design process for the puzzle in mind as this would streamline development of the level itself. Several real-world examples of both well-kept and derelict mansions as well as video game locations were used to gain an idea of how the layout and art style could be achieved realistically. Mood boards were created to help with this process, allowing the design process to become much quicker as seen in Figure 5.

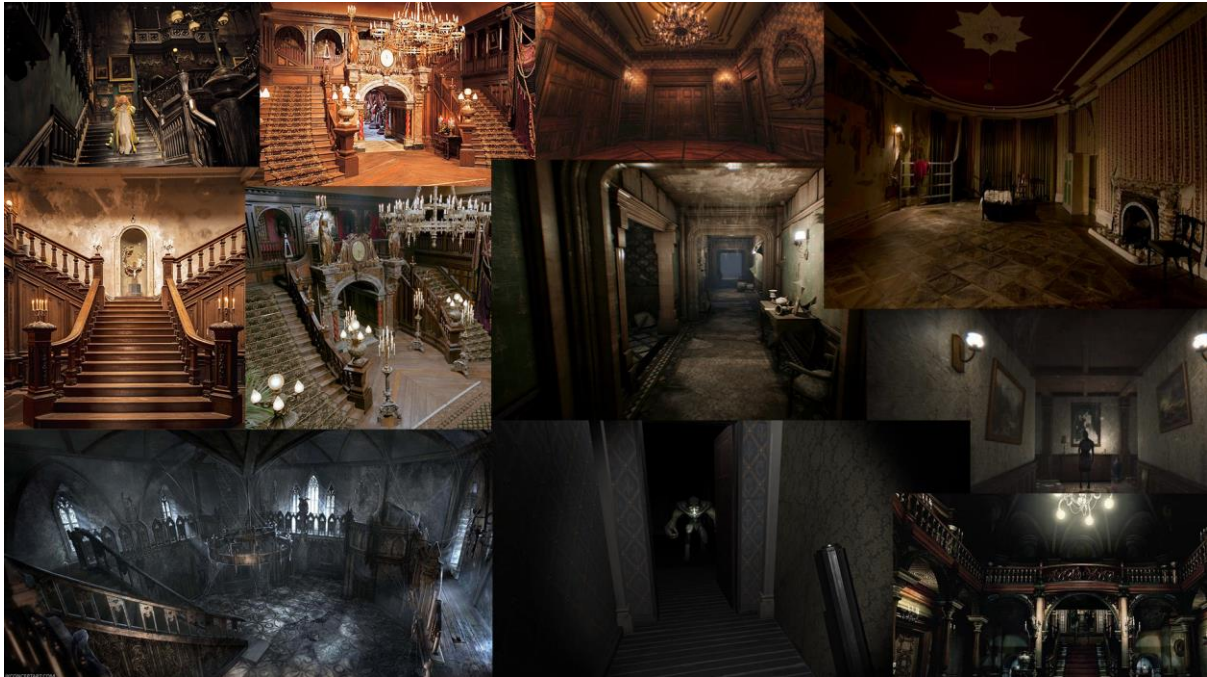


Figure 5. A collection of reference images put together as a mood board

When putting all of these images together it became apparent that all of these mansions had one thing in common, the lack of vibrant colours. Most of these mansions use muted colours, mostly because this is the aesthetic of most old homes, however some of these images also make use of dim, gloomy and cold lighting to set the atmosphere of the different mansions.

Once enough inspiration had been gathered to design the layout and art style of the house, the next step was to create a low fidelity prototype of the overall mansion layout, this went through several revisions as the game was developed, however the base layout of the house mostly remained the same throughout.

The first version was much bigger than what was eventually built as seen in Figure 6, this was because at the time there was less understanding of specific puzzle elements at the time of designing this rough draft.



Figure 6. Early low fidelity prototypes for the upstairs and downstairs sections of the mansion

Eventually the design was fleshed out and improved with the puzzle in mind, this is when more detailed and colour coded low-fidelity sketches were made of the mansion layout which is presented in Figure 7. and Figure 8.

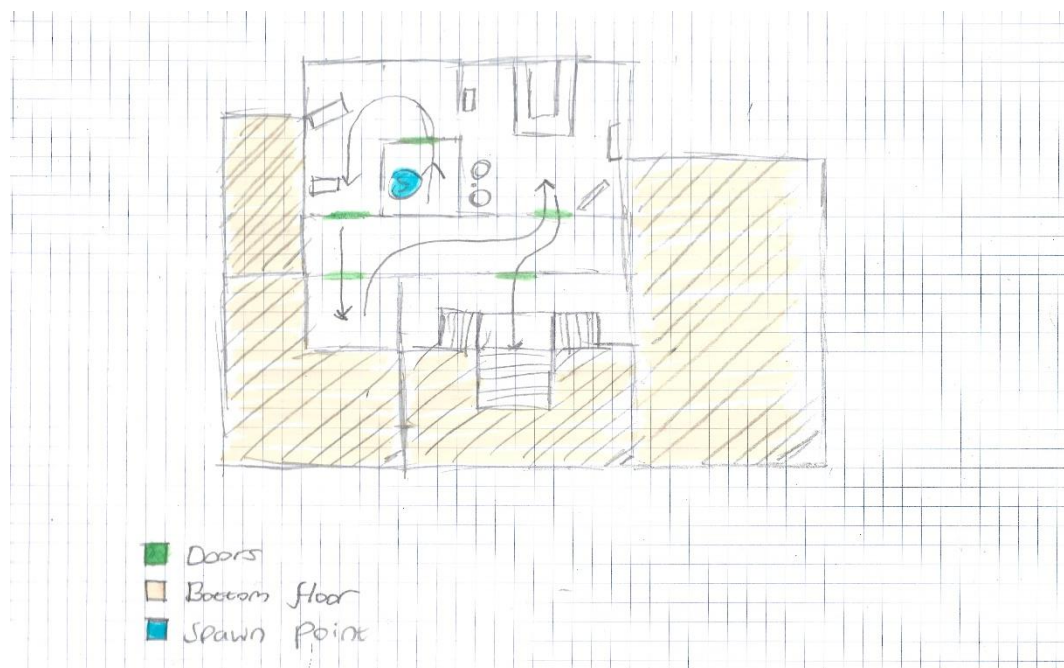


Figure 7. The final low-fidelity layout for the mansion top floor

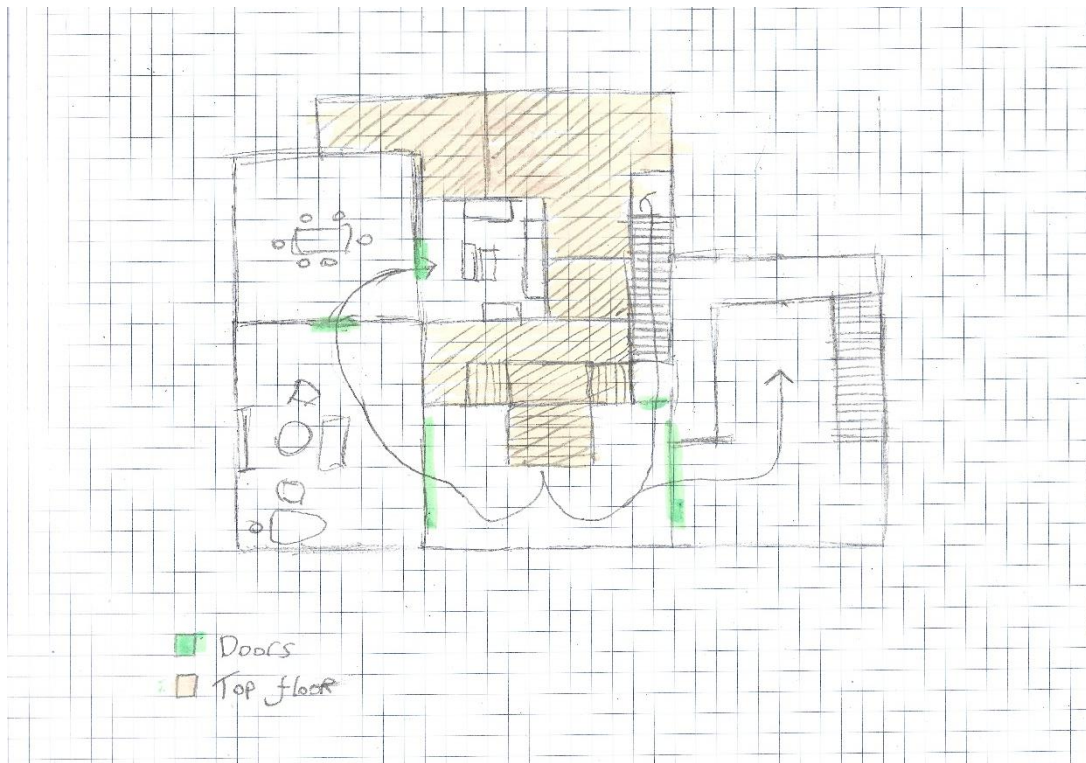


Figure 8. The final low-fidelity layout for the mansion bottom floor

From early on it was planned that the gameplay elements would be similar to that of an escape room, where the player has to complete various objectives to complete the goal of leaving the haunted mansion. One of the main elements of the puzzles involved using keys to unlock various doors around the mansion. Each of the keys requires a different challenge to progress to the next area of the house, eventually with the last key leading the player to escape from the haunted mansion.

Another idea identified during the development process was to keep some areas of the game dark, relying on the use of a torch to navigate through the various rooms. This was implemented because it allows the player to navigate dark rooms, but with a limited field of view, which aims to make the player more susceptible to the scripted events that aim to create a state of fear.

The game was designed in such a way to teach the player how to play the game without directly telling them, making the experience as smooth and user-friendly as possible without relying on a separate tutorial. The player starts in a small well-lit room which they can't leave until they find the key. This key is found in a drawer with a tape recorder and a torch. This teaches the player that they can interact with drawers and key objects, while progressing the main narrative of the story as the tape recorder includes the setup for why the player is in the mansion and what they need to do. By placing these essential objects with the key, it means that the player can't miss them before leaving the room.

Once the player has left this room, they are presented with a bigger more dimly lit room, at this point in the game they are not given the key, they have to solve the puzzle to unlock the door. They are given multiple keys which are all red herrings, while the true door key is attached to the plant pot which is on the same table, this was done to teach the player to not only think outside of the box but also that the world can be interacted with on a deeper level.

When the player leaves this room, they are met with a hallway, which is brightly lit on one end and completely dark on the other end, this is to symbolise the player's transition from light rooms to dark rooms and from this point forward, the player will have to rely on their torch increasingly more to see what they are doing.

Opposite the twin bedroom is the bathroom, which is the players next destination. When they enter the bathroom, they will be presented with dials that open the bathroom cabinet upon completing this puzzle they will get a key for the master bedroom. Once the player completes the rotating picture puzzle for the master bedroom, they are given a hammer which can smash the glass case with the key inside of it. When the player unlocks the final upstairs door, they are introduced to the downstairs area of the mansion, which includes the foyer, the library, the lounge, the dining room and the kitchen. The only locked door in this area is for the basement as the player must now take everything they've learned from the upstairs section of the house and apply it to the downstairs section; it is the ultimate test. In the library there is a safe that the player can enter four digits into, each digit has a corresponding colour, and their numbers are hidden around the house. The first number is hidden to the left of the safe, the second number is where the bricked-up entrance to the house is, the third number is hidden inside the fireplace and the fourth number is obtained by completing the mannequin puzzle in the dining room. Eventually the player will open the safe with the code "0647". Inside the safe is the key to the basement, which is the final area of the game.

Finally when the player reaches the basement, they are presented with a small maze that they must navigate through to finally escape the house, once they reach the end of the basement, they are presented with the exit, which they can leave the house through. As they are leaving the house the game fades to white and ends. Initially the basement was going to have an encounter with the ghoul where it would chase the player around, but this had to be scrapped due to time constraints and the complexity of the programming required.

3.3 Scripted Events

As this is a horror game, the easiest course of option was to establish a threat to the player, as the environment is a haunted house, it seemed fitting to the aesthetic that the threat was a ghost. This ghost needed to scare the player, which is why the model seen in figure 9 was chosen. Threats that look supernatural while containing humanoid elements are perceived to be scarier by the player, therefore increasing the fear levels each time the threat is encountered. (Carr, D., Campbell, D. and Ellwood, 2006 as cited in Spittle, 2011, p. 314)



Figure 9. Ghoulish-zombie asset from the Unity Asset Store

The initial idea was to have the ghost free roaming around the house where the player would have to avoid it, however this came with a number of interesting challenges. One of the main priorities is keeping the game immersive and that would've been fairly difficult with an enemy that roams around, it would've been possible by creating complex code, however there wasn't any script on the Unity Asset store within the budget range that met these criteria, and it wasn't worth creating a script to achieve the desired effect due to a lack of programming knowledge to make it believable and due to time restraints.

However, an enemy was needed, this meant that an alternate solution was needed as the game could not have an invisible threat as the player would eventually catch on to this and would not be afraid of their surroundings. (Garner, Grimshaw and Nabi, 2010, p. 9)

It was eventually decided that the presence of a visible threat could be achieved through scripted events that the player would encounter throughout the game. One of the first examples is when the player leaves the twin bedroom and enters the hallway, the player can hear a soft heartbeat sound, alerting them of a danger that they cannot see. The door behind them slams, trapping the player in the hallway. At this point a ghoul hidden in the shadows charges at the player while emitting a loud screech, without giving them enough time to react. Once the ghoul collides with the player, it lets out an even louder screech. Once it has done this, the mesh is disabled and all that is left is the sound of a heartbeat.

It was vital that the same scripted events were not repeated as this would become predictable to the player, so some lengths were taken to add variety to the scripted events. One example of this is when the player enters the foyer for the first time, the piano in the lounge will start playing Fur Elise by Beethoven and when the player approaches the piano, the keys slam in an attempt to startle them. Not only was it important to have the right types of scripted events, but it was also important that they were not too common within the level, so they would catch the player by surprise whenever they happened.

3.5 Lighting and Post-Processing Effects

As discussed before in the related work section, lighting and post processing effects are some of the most vital elements when it comes to creating an immersive horror experience. The difference in tone that can be established through lighting and post processing effects can create a very noticeable difference in the players experience.

When creating the lighting, the initial idea was to have the entire house covered in darkness, to make the game more challenging by making the player rely of their torch, giving them a limited field of view. One of the reasons that this was quickly scrapped with fears that this would make the game far too difficult, another is that the opportunity would be lost to use Unity's lighting system to create atmospheric effects as seen in figure 10 and figure 11.



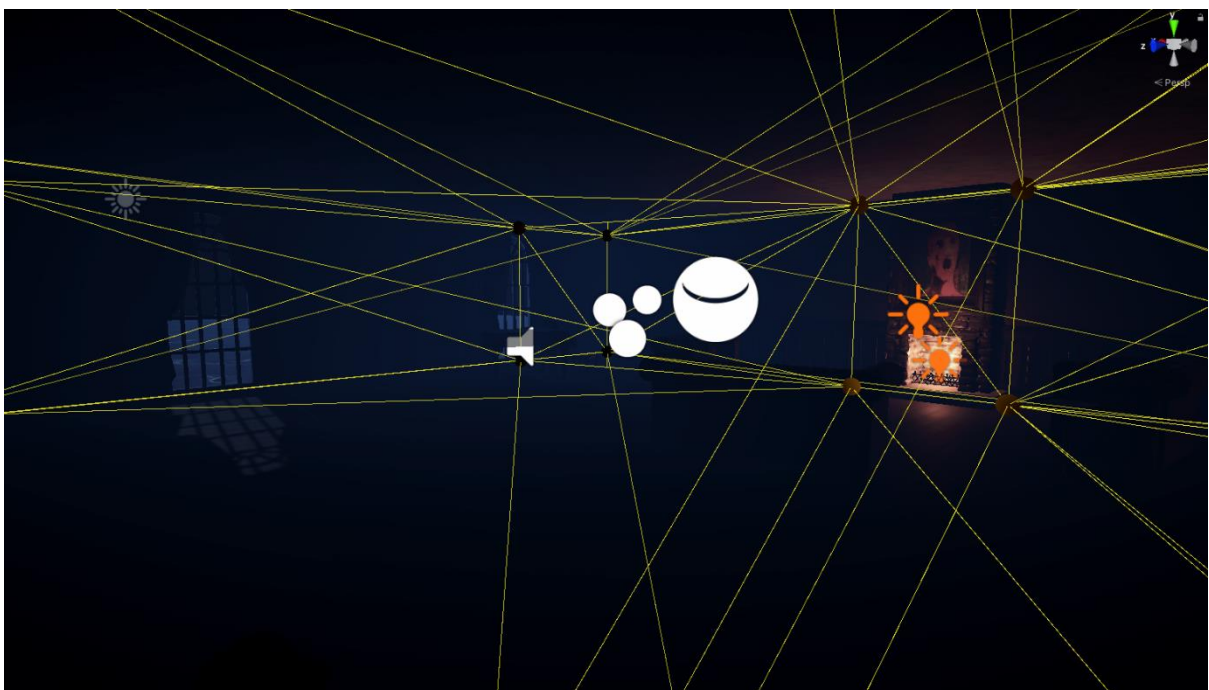
Figure 10. The fireplace in the lounge casting an orange light



Figure 11. The dimly lit hallway becoming darker the further down it goes.

To achieve this kind of lighting in the Universal Render Pipeline, several steps had to be taken to ensure the lighting looked believable but also was optimised to keep the immersion. As the universal render pipeline does not support real time lighting on point lights, baked lighting was chosen to illuminate the level. This is also ideal for virtual reality as real time lighting calculations can be expensive causing the frames per second to drop.

When implementing the lighting, the creation of light probes was vital, otherwise the lighting would not be able to bake into the UV maps of the level or cast accurate lighting on dynamically lit objects. Creating the light probes was not difficult, however they had to be tweaked properly, otherwise dynamic objects would have the wrong lighting which would risk breaking the immersion of the



game. The light probes allow the light mapper to cast accurate data about the light bounces of the object where it stores them, allowing for that data to be retained, as seen in Figure 12.

Figure 12. The light probes for the Lounge.

Alongside the light probes, reflection probes were required to provide accurate reflections within the level. As seen in Figure 13.

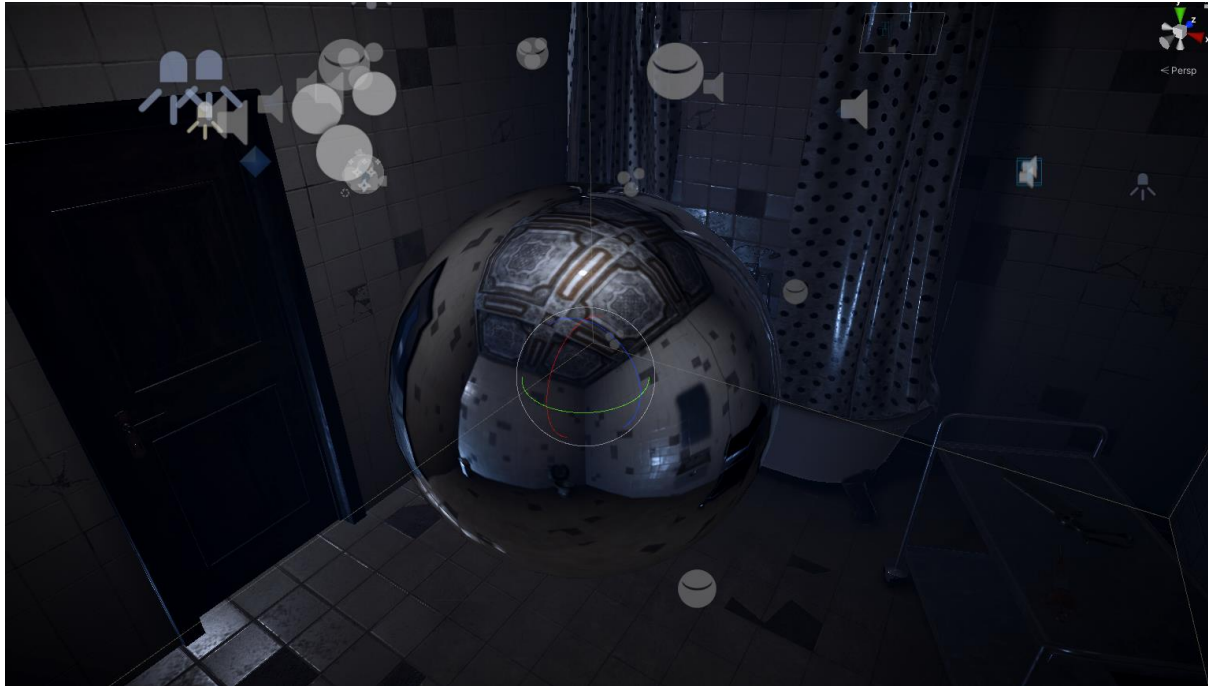


Figure 13. A reflection probe casting reflections onto the Bathroom

Once again, this is a very similar process to creating the reflection probes, where a box is defined for the room and the reflections are baked as a cube map. This was the best option as screen space reflections are too expensive on the frame rate and are not available for the Universal Render Pipeline.

The lighting alone could not achieve a believable horror atmosphere for Umbra, as stated before, the use of appropriate post processing effects is very important to achieve a fear response from the player. (Misztal, Carbonell, Zander and Schild, 2020)

The aim for the post processing effects was to create a dark and cold environment that would be considered unpleasant by the player, this was achieved by creating a post process volume as seen in Figure 14.

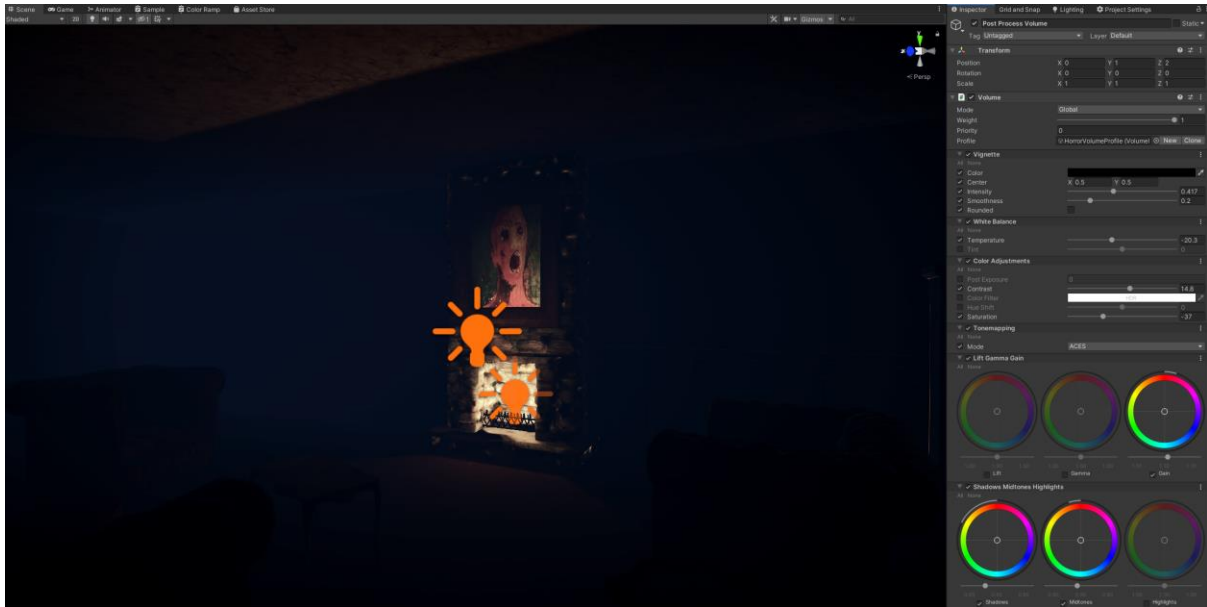


Figure 14. The post processing volume effects in the inspector

A vignette effect was added as this darkens the player's peripheral vision, this was done in an attempt to give them less special awareness to make them more susceptible to elements of the level that aim to incite fear.

Colour grading was also implemented as this allowed for colder colours to be more dominant over warmer colours in the level, this was finely tuned to get the right atmosphere. The white balance specifically removes warmer colours such as reds, oranges and yellows from the scene making them less noticeable while making colder colours pop out more, such as the blues, purples and greens.

ACES tone mapping was applied to the post processing, this helped to make the shadows darker with more precise blacks and darkening the whites in the scene, making them greyer in colour, this in turn makes the scene look more cinematic. (ACES Filmic Tone Mapping Curve, 2022)

Additional adjustments were then made to the lift, gain, shadows and midtones. Once again this was applied to make the lighting on the level pop out a bit more, making the shadows darker and making certain lit areas of map brighter. This was used a substitution to using exposure settings as the universal render pipeline doesn't support dynamic exposure natively.

Finally, fog was added to reduce visibility within the level, while also giving off an ominous atmospheric effect. It was given a blue hue and thickness of 0.07. This may seem fairly small, however larger fog values were too much and made it impossible to see anything in the level, so this was adjusted accordingly to reduce the player's vision without blinding them completely which is represented in Figure 15.



Figure 15. Left, no fog, Middle fog value of 0.07, Right fog value of 0.5

Not only does fog create an atmospheric effect, but it also is great for reducing motion sickness as brightness changes can confuse the brain, therefore this creates a smoother lighting transition which is ideal for the participants when playing the game. (Ae Ryu and Yoo, 2020)

The difference between the game with and without post processing is incredibly vast as seen in figure 16, with the post processing effects making the level darker and colder.



Figure 16. Left Post processing and fog enabled. Right Post processing and fog disabled.

Chromatic aberration was considered to be used to give the game a more distorted look, however this was ruled out as chromatic aberration can cause nausea within virtual reality. It was also

important to avoid effects such as depth-of-field and motion blurring as it is not possible to predict where the eye is looking to adjust this according, which also can cause motion sickness. (Ae Ryu and Yoo, 2020)

3.6 Music and Ambient Soundscapes

Designing the music and ambient soundscapes of the levels is just as important as the lighting design and post-processing. This is because the way the player perceives sound can change the way the game is viewed; this is known as the cognitive theory of emotions. (Cornelius, 1998 as cited in Toprac and Abdel-Meguid, n.d.). This shows that the player can either become scared of the sounds around them or see them as a joke depending on how well they have been implemented. The three main sound properties that are often used in horror games are volume, timing and source which can be used to impact players through diegetic sound effect. In some games these sound effects may include ambient and environmental sounds (Toprac and Abdel-Meguid, n.d.).

When designing the sound for this game, two types of diegetic sound were kept in mind which were ambient soundscapes which can be heard at all times, depending on which room the player is in and sounds that are paired with moments of surprise. Additionally, non-diegetic sound has also been used such as an opening musical score.

The work by Toprac and Abdel-Meguid demonstrated that players showed more fear when over loud sounds, so this was used for the moments that were designed to incite fear into the player. For the ambient soundscapes, quiet and calm sounds were used, this contrasts quite well compared to the loud sounds for the scripted events and this was intentional. It is vital that the sounds implemented in an attempt to surprise the player are significantly louder than the ambient soundscapes. (Toprac and Abdel-Meguid, n.d.) Some of the sounds that were chosen for the ambient soundscape included rain outside of the house, white noise inside the rooms and some specific rooms had sounds such as the creaking of floorboards, the ticking of a clock or the expansion of pipes in the walls.

To implement ambient soundscapes a system was used called "Ambient Sounds - Interactive Soundscapes" by Procedural Worlds. This was chosen over Unity's default sound system as this expands on the features in a useful way such as specifying whole areas to play sounds and allowing sounds to be played randomly in some rooms.

The random sound events were used on a few occasions, such as the creaking of floorboards and the expansion of pipes in the bathroom and kitchen as various different sounds play randomly. One of the more notable sounds that uses this same system is hearing footsteps from the floor above, this makes the house feel livelier and reaffirms to the player that they are not alone.

3.7 Limitations Within VR

The initial idea for this project was to use the high-definition render pipeline to give the game stunning visuals to attempt to increase the immersion, however this proved to be problematic as the high-definition render pipeline proved to be too resource intensive within virtual reality, causing the framerate to fluctuate between 30 and 50 frames per second.



Figure 17. The game using the high-definition render pipeline, making use of the volumetric lighting effects

Early builds of the game made use of many of the high-definition render pipeline features, such as volumetric fog, a HDRi sky, mixed baked and real-time lighting and automatic exposure as shown in Figure 17. While this look visually appealing, a decision was made to prioritise the framerate of the game as the framerate being below 90 frames per second could cause disorientation, nausea and various other side effects to anybody that plays the game. The lower the frame rate, the worse this effect gets. (The Importance of Frame Rates, n.d., Ae Ryu and Yoo, 2020)

To resolve the issue with the low framerate, the rendering pipeline was downgraded to the universal rendering pipeline. While it is not as visually pleasing, this still achieves the intended atmospheric effect using the lighting settings provided with the render pipeline. The framerate while running the game in virtual reality in the universal render pipeline is now anywhere between 90 – 120 frames per second.

Attempts were made to restore the volumetric fog in the universal render pipeline as the volumetric fog allowed for more atmospheric horror effect, while the Universal Render Pipeline doesn't have built in volumetrics, it was possible to achieve a similar effect using a script from the Unity Asset Store. However, when it came to testing the lighting in virtual reality, the effects were less than desirable and were ultimately scrapped as they did not look as refined as expected. Eventually the volumetric fog was replaced with the standard universal render pipeline fog as seen in Figure 18.



Figure 18. The game using the Universal Render Pipeline standard fog and lighting.

Due to the way Unity handles doors and drawers inside VR there were some major difficulties that were faced when developing Umbra. In VR a player's controller is a fixed point in space, matching its location in the physical world.

This causes no issues with interactable objects as they can move freely within the player's hand and travel with them, but it create a large issue when paired with objects that have to stay fixed in one position. The only way of keeping an object fixed in place is doing so with Unity's configurable joints, while they offer a variety of configurability, they only offer a narrow range of motion which makes them incredibly easy to break. Even a joint with infinite break and torque force breaks when pulled outside of its hinge range.

The only solution was to use doors with box colliders on the handles that triggers an open animation when the player presses the grab button, they were the best choice for maintaining immersion and interactivity without sacrificing too much time, as this bug in particular had already taken quite a lot of development time to fix.

The drawers themselves weren't quite as easy to fix, so they were left in the level as a decoration and don't serve much of a practical function.

4. Participant Study

For the participant study, it was not vital to get large numbers of data, the main goal was to reaffirm the research done to see if this was implemented into the game correctly. Due to the nature of the study, it was decided that the study would be performed with three participants to reaffirm the

implementation of the identified elements of VR horror games.

In order to identify a player's response to the horror elements of the game the study would be performed by utilizing a Polar H9 heartrate sensor to monitor the players heart rate data alongside a screen recording of their gameplay session. Once they had finished the game, a qualitative questionnaire was presented to them to get additional insight into their game play experience and different elements of their experience with the horror elements of the game that could not be provided through other means.

All ethics guidelines under the Bournemouth University Ethics Checklist have been followed with approval obtain from the Bournemouth University ethics board and this research complies with Bournemouth University's Code of Good Research Practice. Each participant has signed a participant agreement form and read a participant information sheet with all of the necessary vital information on it.

It has been agreed that each participant will be kept anonymous for this study, so no real names have been used, each participant will simply be referred to as Participant 1 (P1), Participant 2 (P2) and Participant 3 (P3).

Each participant was asked to refrain from participating in any activity that may elevate their heartrate for a minimum of one hour before this study, this is so accurate readings of their resting heartrate can be taken at the start of the study.

Due to a limited number of heartrate apps made for Windows 10 on the PC, a Samsung Galaxy S20 was used in an attempt to record the heartrate data. The software that was chosen is called EliteHRV which was one of the only apps that could be found with the option to export data, however this data turned out to be not useful as it only exported the data as raw RR intervals, which would be difficult to convert to HRV without knowledge of biology.

It didn't matter too much in the end that the data did not export as there were massive discrepancies in the data itself. Unfortunately, it seems that the accuracy of the Polar H9 isn't ideal for this study as the readings of the device are sub-par, as they do not provide any useful data. To begin with the data that was taken isn't reliable as there are major fluctuations within the player's heart rate as shown in Figure 19. with it randomly spiking up and down, this could be due to a number of factors such as the reliability of the device, the Bluetooth connectivity or the accuracy of the software used to take in the readings.

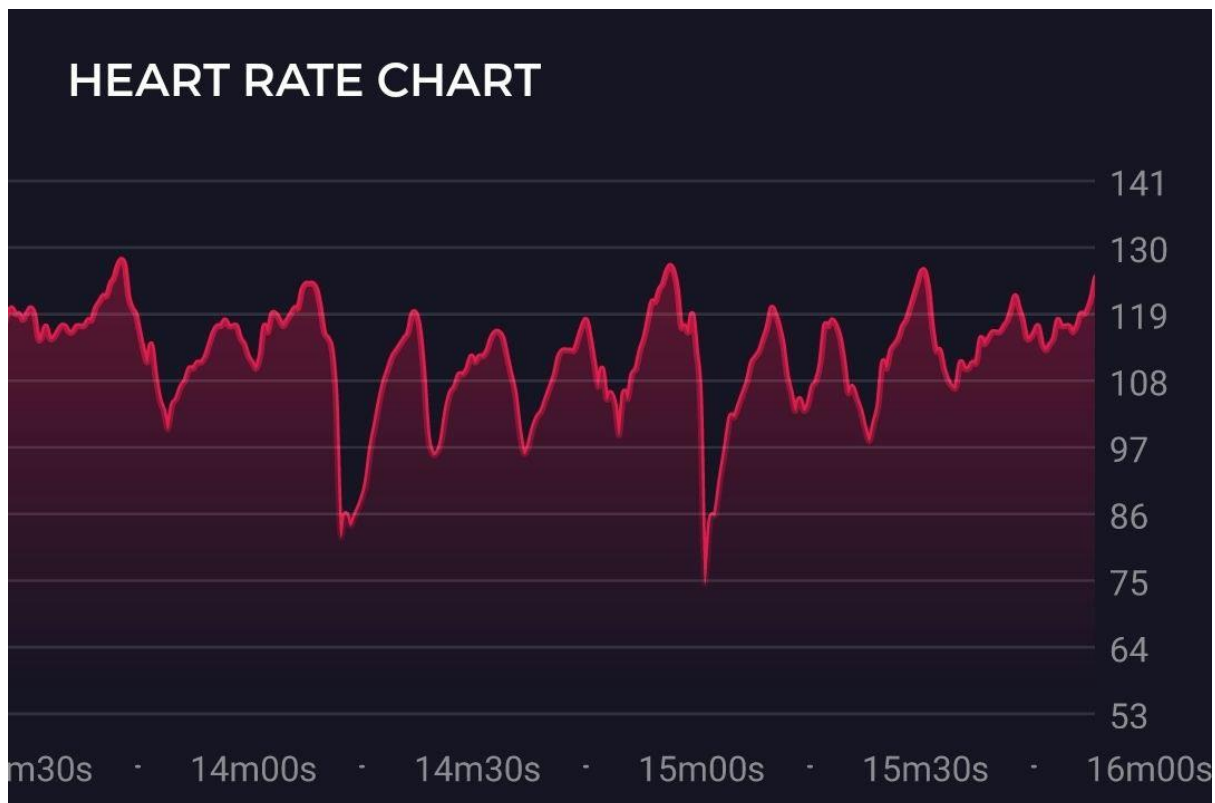


Figure 19. The heartrate chart on the EliteHRV app with major fluctuations over a two minute and thirty second period.

It was decided to not use this data in the study as it was too unreliable to be used in an accurate study. The second playthrough with P2 and P3 has the same situation where the heartrate data has too many anomalies, therefore can't provide accurate information as to whether the gameplay affected the heartrate of the player or not.

Due to the inconsistencies with the heartrate data, it was difficult to use the footage to an advantage, however this data was used to analyse the gameplay patterns of the player which could be used in a capacity to improve the level design and horror experience of the game. In all three of the studies the players ignored the drawers in the rooms, this is because they were not given much of a chance to interact with them, so they were ignored in most parts of the level.

Another thing that was noted is that all three participants excelled at the mannequin puzzle, this is likely because the puzzle in itself wasn't difficult, but instead required the player to explore around the room to find the parts of each mannequin.

With the qualitative questionnaire each participant was asked the same ten questions each, this was to get a better understanding of what Umbra did well and what could be improved, with information that could not be obtained by the heartrate data readings.

The first two questions asked whether the player was familiar with horror games and VR games. All three participants were familiar with VR as they have used it before but don't own a headset. However, P1 was not familiar with horror games as they do not play them often, whereas P2 and P3 have played them regularly, with both of them sharing interest in the game Phasmophobia and P3 showing a particular interest in Dead by Daylight.

Next the participants were asked if there were any parts of the game that they found particularly scared, another trend among the players was that the mannequins made them feel particularly

uneasy, for P3 this way due to the uncanny valley elements of the mannequins as talked about before in (Carr, D., Campbell, D. and Ellwood, 2006 as cited in Spittle, 2011, p. 314) and for P1 this was because it tied into the environment story elements with the player encountering the skeleton before the mannequins, leading them to believe that the souls of the victims had become trapped within the mannequins. Additional comments were made by P1 and P2 about the ambient soundscapes making them feel uneasy as it made the house feel empty and isolated.

Each player was then asked to rate the game based on two things, the first being how uneasy they felt during the game, with 1 being comfortable and 10 being incredibly uneasy. The results are shown directly on Table 1.

Participant	Score (Out of 10)
Participant 1	8
Participant 2	7
Participant 3	8
Average	7.75/10

Table 1. A score of how uneasy the player felt of a scale of 1 – 10

The second thing they were asked to rate is how challenge the game was on a scale of 1-10 with 1 being easy and 10 being incredibly difficult, the ratings they gave are shown on Table 2.

Participant	Score (Out of 10)
Participant 1	8
Participant 2	5
Participant 3	10
Average	7.6/10

Table 2. A score of how difficult Umbra was on a scale of 1 – 10

Afterwards the participants were asked why they provided this score, P1 and P3 both answered because they haven't played too many puzzle games, so they struggled on where to look, whereas P2 has played them quite regularly, so it was easier to know where to look.

Finally, the player was asked three questions about the immersion of the game, what did they find immersive about the game, if anything broke the immersion and whether VR helped to create a more immersive experience for them. Each participant praised the game saying that they all felt very immersed because of the level design, sound design and lighting of the level. Specific comments about the lighting that were made by P2 and P3 is that they preferred the dark environment inside VR as being able to navigate with the torch was a lot of fun. Whereas P1 explained that being in the VR space was "almost hypnotic". Each player agreed the VR made for a more realistic and enjoyable horror experience.

5. Conclusion and Reflection

5.1 Critical Reflection

Developing this project and undertaking in a participant study has taught me a lot about not just Unity, but also game design as a whole. The main question that I asked when starting this paper was what makes a horror game scary and whether VR enhances the immersive horror experience.

In part it was a difficult design process as the project was plagued with various issues with Unity's engine from the start. I have come to conclusion that although Unity has an openly available VR

toolkit that can be used on most mainstream VR platforms, the functions of the toolkit are still lacking. Even with VRTK installed, the functions were still not up to my expectations due to the issues I had with drawers, doors and some of the interactable puzzles. If research like this was done again it was more fitting to use an engine such as Source 2 to streamline the process as the software development kit is specifically tailored with VR in mind.

While developing the project, the use of ambient soundscapes and atmospheric lighting was a moderate success. I believe this was due to the fact that a lot of time and care was taken to ensure that the lighting was as well as the soundscapes. This showed in the feedback of the participant study as each of the participants complimented these design choices.

Unfortunately, due to the performance issues that I had with the high-definition render pipeline, the realistic volumetric lighting was unavailable; Fortunately, the project still came out with a similar atmosphere to what I had envisioned. Although it was difficult having to sacrifice the volumetric lighting, I would always pick performance over visuals any day, especially with VR involved. It ended up being a case of having to learn the hard way that the HDRP wasn't well optimised for VR as there wasn't many framerate issues until about midway through the project where great lengths had to be taken to convert the project to use the universal render pipeline. Luckily the universal render pipeline allowed me to use almost all of the effects that were in the high-definition render pipeline, with the exception of volumetric fog, mixed baked and real-time lighting, as well as automatic exposure.

The light mapper for the universal render pipeline has its issues too, unfortunately there are lighting artefacts on some of the objects when baking the lighting. This was mostly resolved in the high-definition render pipeline as it allowed for double sided global illumination which improved the texel validity, however this option is not in the universal render pipeline.

Despite the problems that I had with Unity, some parts of the process were incredibly streamlined, this was mostly because of the Unity asset store. The asset store allowed me to get the props I needed for my level at a very cheap price, with some of them even being free. The scripts that were provided on the asset store also proved to be incredibly helpful.

5.2 Future Work

Ultimately gameplay could be revised if this was to be undertaken in a similar capacity again, as the participants all found the puzzles difficult and sometimes a bit clunky, this was also weighed down by the limitations of Unity's engine, so if this was to be undertaken again, it would either need to be done in an engine more tailored for VR or additional programming knowledge would be required. Some additional research would also likely be required to ensure that this is done correctly.

In retrospect, the study was inadequately powered, and an increased number of participants would be required to derive significant conclusions. If this was to be carried out again, it would likely benefit from having a minimum of 20 subjects enrolled.

Also using a the Polar H9 was ineffective in obtaining reliable heartrate data for the study. This is likely because the Polar H9 is a commercial heartrate tracker used for exercise, a medical heartrate monitor would have provided increased accuracy to the heartrate data collected and allowed for more meaningful interpretation of that data. While an improved heartrate sensor would have been ideal, this kind of equipment is difficult to obtain in a non-medical setting. Possible reasons that the heartrate sensor didn't function as intended include the limited Bluetooth connectivity, the software

used to record the data, and the limitation inherent to a fitness-based heartrate tracker. These limitations would need to be explored further in future studies to ensure that valid heart rate data is obtainable.

The study has found that VR is excellent for improving immersion, this could likely be expanded on in a large study, which in turn leads to a more favourable horror experience.

5.3 Conclusion

To conclude, the questions asked in this paper was what creates an immersive VR horror experience. It has been found that virtual reality creates a much more enjoyable horror experience by combining the interactivity of the VR system and well though out level design, lighting design, post-processing design and sound design.

It would've been ideal to be able to find more information from the study, but unfortunately the readings were not reliable enough to provide concrete evidence that the game created a fear response using heartrate data. Fortunately, the data taken from the qualitative study allowed some insight to be gained into what was done right within the design process.

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Mansion Set - <https://assetstore.unity.com/packages/3d/props/furniture/mansion-set-150953>

Old Kitchen Assets - <https://assetstore.unity.com/packages/3d/props/old-kitchen-assets-71374>

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AllSky Free – 10 Sky / Skybox Set - <https://assetstore.unity.com/packages/2d/textures-materials/sky/allsky-free-10-sky-skybox-set-146014>

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Ambient Sounds – Interactive Soundscapes - <https://assetstore.unity.com/packages/tools/audio/ambient-sounds-interactive-soundscapes-142132>

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Skeleton – Low Poly - <https://assetstore.unity.com/packages/3d/characters/humanoids/skeleton-low-poly-202176>

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Arkham Horror Card Game Symbols - https://www.kindpng.com/imgv/imTwJR_arkham-horror-card-game-symbols-hd-png-download/

Safe 3D Model - <https://free3d.com/3d-model/-floor-safe-v2--405612.html>

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Sound Effect and Music Library - <https://elements.envato.com/>

Beethoven – Dark Fur Elise - https://www.youtube.com/watch?v=aKPqxo_UnLw

Voice Acting – Corey Hendricks

Key 3D Model - <https://blendswap.com/blend/20439>

Flashlight - <https://assetstore.unity.com/packages/3d/props/electronics/flashlight-18972>

Horror Starter Pack FREE - <https://assetstore.unity.com/packages/3d/props/horror-starter-pack-free-178413>

Medical Saw - <https://assetstore.unity.com/packages/3d/props/tools/medical-saw-110165>

Appendices

Questionnaire – Participant #1

Participant – Participant #1

Question 1. Do you have experience with Horror games?

No

Question 2. Do you have experience with VR?

No

Question 3. What was the scariest part of the game?

The environment and the unevenness of the game which plays into the mannequins and the statues. The dismembered mannequins were a big one. The statues in the dark in the foyer, approaching them instilled some fear. The monster that appeared in the upstairs area was also a big one.

Question 4. On a scale of 1-10 how scary was it?

8/10

Question 5. Why did you find this part of the game scary?

You see the skeleton before seeing the mannequins which made them think that they are somehow related that the souls of the victims were in these dismembered mannequins, not knowing was also a big part in this as you don't know what's going to happen next.

Question 6. To what degree did you find the game challenging?

8

Question 7. If so, what made you pick this?

required some brain power to solve the puzzles. However, there wasn't a need to rush things, but there was a constant unnerving feeling of not knowing what was going to happen next.

Question 8. Did you find the game immersive?

The environment the well set up and to scale. Really liked the setup of the skeleton and tape recorder leading into the mannequins. Wouldn't have worked as well without it adding tragedy, ultimately increasing immersion.

Question 9. Is there anything within the game that broke your immersion?

A few minor bugs here and there.

Question 10. Did you find that being inside virtual reality helped with the overall immersion? Yes, as you are actually inside the environment where you can directly interact with items and collect them. It almost “hypnotises you in a way”, mostly about perspective.

Questionnaire – Participant #2

Question 1. Do you have experience with Horror games?

Yes, games such as Phasmophobia, Dead by Daylight and Friday the 13th

Question 2. Do you have experience with VR?

Played it before, but don't own a headset.

Question 3. What was the scariest part of the game?

Being charged at down the hallway was very unexpected and me them jump. Also, the mannequins made them feel a bit uncomfortable.

Question 4. On a scale of 1-10 how scary was it?

8

Question 5. Why did you find this part of the game scary?

The sounds of the game are a bit jarring; it makes the situation feel very real along with being inside VR, it feels like you're in the real empty and abandoned haunted mansion, it almost makes you feel isolated. The hard to see lighting and torch also made it a bit scarier as you didn't know what would jump out at you.

Question 6. To what degree did you find the game challenging?

5

Question 7. If so, what made you pick this?

There were some well-designed puzzles, but they are used to puzzle games, so it was fairly easy to pick up.

Question 8. Did you find the game immersive?

Yes. The use of lighting and sound really helped make it feel realistic

Question 9. Is there anything within the game that broke your immersion?

The broken LODs didn't help, but in terms of gameplay design there should've been more use of the drawers.

Question 10. Did you find that being inside virtual reality helped with the overall immersion?

Yes. Interacting with the environment directly was the best part of VR, it made it feel much more real.

Questionnaire – Participant #3

Research Questionnaire

Question: Do you have experience with Horror games?

Yes, Phasmophobia and Dead by Daylight

Question: Do you have experience with VR?

Don't own headset but have played VR before.

Question 1. What was the scariest part of the game?

Putting on the mannequin arms.

Question 2. On a scale of 1-10 how scary was it?

7

Question 3. Why did you find this part of the game scary?

It uses the primary horror goals with the mannequins which are fairly creepy and the fact that it was hard to see in the game. The mannequins are very uncanny valley.

Question 4. To what degree did you find the game challenging?

10

Question 5. If so, what made you pick this?

not used to puzzle games

Question 6. Did you find the game immersive?

Yes. There wasn't a primary goal, everything kind of aligns itself where you weren't really told what to do.

Question 7. Is there anything within the game that broke your immersion?

Nothing that comes to mind.

Question 8. Did you find that being inside virtual reality helped with the overall immersion?
Yes. Being able to walk around in the dark and interaction with the environment, wouldn't have had the same experience without VR.

Ref & Version: 2.0
Ethics ID number: 42595
Date: 14/03/2022



Participant Agreement Form

Full title of project: Creating an Immersive Horror Puzzle Game in VR

Name, position and contact details of researcher: Joseph Marks-Chadwick, Researcher – s5071292@bournemouth.ac.uk

Name, position and contact details of supervisor: Vedad Hulusic, Supervisor – Vhulusic@bournemouth.ac.uk

To be completed prior to data collection activity

Section A: Agreement to participate in the study

You should only agree to participate in the study if you agree with all of the statements in this table and accept that participating will involve the listed activities.

I have read and understood the Participant Information Sheet (Ref – 42595, Version 1) and have been given access to the BU Research Participant Privacy Notice which sets out how we collect and use personal information (https://www1.bournemouth.ac.uk/about/governance/access-information/data-protection-privacy).

I have had an opportunity to ask questions.

I understand that my participation is voluntary. I can stop participating in research activities at any time without giving a reason and I am free to decline to answer any particular question(s).

I understand that taking part in the research will include the following activities as part of the research:
--

- | |
|---|
| <ul style="list-style-type: none">• Playing a scary virtual reality horror game to complete the puzzle and given objectives which may startle me or make me feel some levels of discomfort• Having my heartrate recorded through the use of a heartrate monitor• Have a screen recording of my gameplay session, which will not include my face, voice or any information that will be able to identify me as an individual.• Answering a questionnaire once the playtesting period has been completed. |
|---|

- That the information recorded from this session is anonymous and will be used as a part of the research project

I understand that, if I withdraw from the study, I will also be able to withdraw my data from further use in the study **except** where my data has been anonymised (as I cannot be identified) or it will be harmful to the project to have my data removed.

I understand that my data may be used in an anonymised form by the research team to support other research projects in the future, including future publications, reports or presentations.

	Initial box to agree
I consent to take part in the project on the basis set out above (Section A)	



Participant Information Sheet

The title of the research project

Creating an Immersive Horror Puzzle Game in VR

Invitation to take part

You are being invited to take part in a research project. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the project?

The purpose of this project is to create an immersive horror puzzle game within virtual reality. To do this research must be undertaken, the key question is how to make the game scary, however additional research needs to be done to ensure that the game has an unsettling environment.

Why have I been chosen?

This study will analyse five different participants playing the same copy of the same game. You have been chosen as you meet the criteria, this includes being over the age of 18 and not having any existing mental trauma which may cause stress while playing and any physical conditions which may put you in danger with this project.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a participant agreement form. We

want you to understand what participation involves, before you make a decision on whether to participate.

If you or any family member have an on-going relationship with BU or the research team, e.g. as a member of staff, as student or other service user, your decision on whether to take part (or continue to take part) will not affect this relationship in any way.

Can I change my mind about taking part?

Yes, you can stop participating in study activities at any time and without giving a reason.

If I change my mind, what happens to my information?

After you decide to withdraw from the study, we will not collect any further information from or about you.

As regards information we have already collected before this point, your rights to access, change or move that information are limited. This is because we need to manage your information in specific ways in order for the research to be reliable and accurate. Further explanation about this is in the Personal Information section below.

Due to the data in the study being completely anonymous, if you request for your data to be deleted more than 24 hours after the study, then this may not be possible due to the fact that it would not be possible to know which the correct data is to delete.

What would taking part involve?

You will be playing a puzzle horror game within virtual reality. You will be asked to wear a heartrate monitor while playing, this is so we can see the changes to your heartrate while you play the game.

You will be asked to wear a virtual reality headset where you will be surrounded by your environments, you will be left to figure out the game for yourself, this includes navigation and the puzzles.

During the game, you may encounter scary elements, however if you become too startled by the game, you are allowed to stop playing or take a break at any time. Please note that the game may include elements such as loud startling noises, jump scares, mild gore such as blood and dark enclosed areas.

While you are playing the game, your gameplay will be screen recorded, so it can be compared to the other participants, however in line with keeping you anonymous, your face or voice will not be recorded in any way whatsoever.

Afterwards, you will be asked a series of questions on your experience with the game, we ask that you answer these as truthfully as possible to aid with the research.

Will I be reimbursed for taking part?

You will not be reimbursed for taking part in this study, your involvement is purely voluntary and neither myself or Bournemouth University will be obligated to reimburse you at any time before, during or after the study.

What are the advantages and possible disadvantages or risks of taking part?

Whilst there are no immediate benefits for those people participating in the project, it is hoped that this work will allow me to get a better understanding of how people react to virtual reality horror games and will also allow me to improve and refine the experience for my final dissertation submission.

Whilst we do anticipate any risks to you in taking part in this study, you may experience feelings of discomfort while playing the virtual reality game as this is the intended result. The game you will be playing has been designed in such a way to startle you and leave you feeling uneasy; however, you do not have to play the whole game if you feel uncomfortable, you have the right to withdraw at any time.

We ask if you have any physical or psychological conditions that you have not made aware to the researchers, then please mention them immediately, this is for your own safety. This includes anxiety disorders such as generalized anxiety disorder, post-traumatic stress disorder, panic disorder and any phobias that may be relevant such as a fear of blood, the dark and being in enclosed spaces.

Physical disorders may include anything that hinders your ability to move about freely, heart conditions, neck or back conditions and photo sensitive epilepsy. We also ask that if you are pregnant, that you don't take part in this experiment.

However, it is not possible to list all of these conditions, so if you believe you have a condition that might put you in danger, please speak to the researcher, even if you're unsure and then a decision can be made about whether it's safe to continue. If you choose not to mention anything that might put you in danger, then you can be held liable for any damage that occurs.

What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?

The information collected from you will include your heartrate activity from a heartrate monitor, a screen recording of your gameplay and a questionnaire at the end of the play session. This will allow us to compare the data with the other participants where we will be able to look for correlating data and trends.

This will allow us to align this with the gameplay footage to see which parts caused more of a reaction from you and see if this is the same for all participants. Once we have this information, it will allow us to see if the objective of making a horror game has been met and whether and additional changes to the game need to be made.

Will I be recorded, and how will the recorded media be used?

The screen recordings of your activities made during this research will be used only for analysis and the transcription of the recording(s) for illustration in conference presentations and lectures. No other use will be made of them without your written permission, and no one outside the project will be allowed access to the original recordings.

You will not be recorded but a screen recording will be captured to compare to the heartrate sensor data to obtain additional data. Your face or voice will not be recorded under any circumstance.

How will my information be managed?

Bournemouth University (BU) is the organisation with overall responsibility for this study and the Data Controller of your personal information, which means that we are responsible for looking after your information and using it appropriately. Research is a task that we perform in the public interest, as part of our core function as a university.

Undertaking this research study involves collecting and/or generating information about you. We manage research data strictly in accordance with:

- Ethical requirements; and
- Current data protection laws. These control use of information about identifiable individuals, but do not apply to anonymous research data: “anonymous” means that we have either removed or not collected any pieces of data or links to other data which identify a specific person as the subject or source of a research result.

BU’s Research Participant Privacy Notice sets out more information about how we fulfil our responsibilities as a data controller and about your rights as an individual under the data protection legislation. We ask you to read this Notice so that you can fully understand the basis on which we will process your personal information.

Research data will be used only for the purposes of the study or related uses identified in the Privacy Notice or this Information Sheet. To safeguard your rights in relation to your personal

information, we will use the minimum personally-identifiable information possible and control access to that data as described below.

Publication

You will not be able to be identified in any external reports or publications about the research without your specific consent. Otherwise, your information will only be included in these materials in an anonymous form, i.e. you will not be identifiable.

Research results will be published at the end of the academic term when the dissertation has been completed.

Security and access controls

BU will hold the information we collect about you in hard copy in a secure location and on a BU password protected secure network where held electronically.

Personal information which has not been anonymised will be accessed and used only by appropriate, authorised individuals and when this is necessary for the purposes of the research or another purpose identified in the Privacy Notice. This may include giving access to BU staff or others responsible for monitoring and/or audit of the study, who need to ensure that the research is complying with applicable regulations.

All data during this study will be completely anonymous from the minute it has been recorded. No personal data will be taken whatsoever.

All data will be stored on a password protected device where it will not be accessed by anybody apart from the main researcher. Any physical data will be destroyed once a digital copy has been made to the password protected device.

Sharing your personal information with third parties

As well as BU staff working on the research project, we may also need to share personal information in non-anonymised form with no other external parties.

Further use of your information

The information collected about you may be used in an anonymous form to support other research projects in the future and access to it in this form will not be restricted. It will not be possible for you to be identified from this data. Anonymised data will be added to BU's [this is](#) a central location where data is stored, which is accessible to the public.

Keeping your information if you withdraw from the study

If you withdraw from active participation in the study we will keep information which we have already collected from or about you, if this has on-going relevance or value to the study. This may include your personal identifiable information. As explained above, your legal rights to access, change, delete or move this information are limited as we need to manage your information in specific ways in order for the research to be reliable and accurate. However if you have concerns about how this will affect you personally, you can raise these with the research team when you withdraw from the study.

You can find out more about your rights in relation to your data and how to raise queries or complaints in our Privacy Notice.

Retention of research data

Project governance documentation, including copies of signed **participant agreements**: we keep this documentation for a long period after completion of the research, so that we have records of how we conducted the research and who took part. The only personal information in this documentation will be your name and signature, and we will not be able to link this to any anonymised research results.

Research results:

As described above, during the course of the study we will anonymise the information we have collected information about you as an individual. This means that we will not hold your personal information in identifiable form after we have completed the research activities.

You can find more specific information about retention periods for personal information in our Privacy Notice.

We keep anonymised research data indefinitely, so that it can be used for other research as described above.

Contact for further information

If you have any questions or would like further information, please contact –

Joseph Marks-Chadwick – s5071292@bournemouth.ac.uk

Primary Supervisor: Vedad Hulusic – Vhulusic@Bournemouth.ac.uk

Secondary Supervisor: Fred Charles – Fcharles@Bournemouth.ac.uk

In case of complaints

Any concerns about the study should be directed to Vedad Hulusic – Vhulusic@Bournemouth.ac.uk. If your concerns have not been answered by Vedad Hulusic, you should contact Professor Tiantian Zhang, Bournemouth University by email to researchgovernance@bournemouth.ac.uk.

Finally

If you decide to take part, you will be given a copy of the information sheet and a signed participant agreement form to keep.

Thank you for considering taking part in this research project.

About Your Checklist	
Ethics ID	42595
Date Created	25/02/2022 12:39:00
Status	Approved
Date Approved	25/03/2022 12:31:04
Date Submitted	14/03/2022 13:47:17
Risk	High

Researcher Details	
Name	Joe Marks-Chadwick
Faculty	Faculty of Science & Technology
Status	Undergraduate (BA, BSc)
Course	BSc (Hons) Games Design
Have you received funding to support this research project?	No

Project Details	
Title	Creating an Immersive Puzzle Horror Game in VR
Start Date of Project	11/02/2022
End Date of Project	20/05/2022
Proposed Start Date of Data Collection	13/03/2022

Original Supervisor	Vedad Hulusic
Approver	Ethics Programme Team
Summary - no more than 600 words (including detail on background methodology, sample, outcomes, etc.)	
<p>The purpose is to create a horror puzzle game within virtual reality by analysing the design elements that are vital to setting the correct atmosphere of the virtual environment. To get a better understanding of this, research will take place by gathering information from peer reviewed journals and various other additional sources.</p> <p>To ensure that this research has been applied properly, a user study will then be taken to see how each participant responds to the game and whether further adjustments need to be applied to ensure that the game is scary.</p> <p>During the study, the participant will be asked to wear a virtual reality headset where they will experience the game in first person, they will then have to solve a variety of different puzzles while experiencing mild discomfort from the unsettling environment around them.</p> <p>A heartrate monitor will be used to track their heartrate throughout the gameplay with accurate timestamps so the data can be matched to a screen recording on their gameplay. No face or voice recordings will be required.</p>	

Once the participant has played through the game, they will be asked to answer a questionnaire as truthfully as possible, to get some additional insight that neither the screen recording or heartrate monitor can provide.

Once this data has been recorded, it can then be used to determine whether the research undertaken has been useful to the development of the game and what could be done better.

Due to the nature of the game, certain elements may be upsetting for some participants. To reduce this risk, the study will be limited to people 18+ years only and the participant will be asked about any physical or mental conditions that they may have.

Filter Question: Does your study involve Human Participants?

Participants
Describe the number of participants and specify any inclusion/exclusion criteria to be used

Age isn't a key factor in this study, however, due to the mature themes of this game, absolutely no research will be undertaken on anybody under the age of 18, this is to ensure their safety.

Due to the nature of the study, gender, race and ethnicity aren't relevant to the research, therefore the participants can be any gender or from any race/ethnicity.

The participants health will be considered when undertaking this experiment. I will not be including any participants that are considered vulnerable or have any form of mental trauma, such as panic disorders, PTSD or severe anxiety. The participant will also be asked if they have any phobias which may put them in danger while playing this game, so far this includes, the dark, blood, insects and being trapped in an enclosed space (This is because some areas of the game may be in smaller locations)

For the physical health of the participant, it is important that they don't have a heart condition, epilepsy or are not pregnant.

The participants will be warned about potentially scary themes before participating in this research, they will then be asked if they are willing to continue or whether there might be something that would cause mental or physical trauma.

Do your participants include minors (under 16)?

No

Are your participants considered adults who are competent to give consent but considered vulnerable?

No

Is a Disclosure and Barring Service (DBS) check required for the research activity?

No

Recruitment

Please provide details on intended recruitment methods, include copies of any advertisements.

The recruitment will consist of friends, family and peers from the university course.

Do you need a Gatekeeper to access your participants?

No

Data Collection Activity

Will the research involve questionnaire/online survey? If yes, don't forget to attach a copy of the questionnaire/survey or sample of questions.

Yes

How do you intend to distribute the questionnaire?	
face to face	
Will the research involve interviews? If Yes, don't forget to attach a copy of the interview questions or sample of questions	Yes
Please provide details e.g. where will the interviews take place. Will you be conducting the interviews or someone else?	
The interviews will take place at my house, where I have easier access to the virtual reality and computing hardware. I will be conducting the interviews myself, in person. Nobody apart from myself and the participant will be present.	
Will the research involve a focus group? If yes, don't forget to attach a copy of the focus group questions or sample of questions.	No
Will the research involve the collection of audio materials?	No
Will your research involve the collection of photographic materials?	No
Will your research involve the collection of video materials/film?	Yes
Will any photographs, video recordings or film identify an individual?	No
Please provide details	
Screen recordings of the gameplay will be taken for further analysis, however nothing in these recordings can be used to identify the individual as their face or voice will not be included in the recording. The recordings will be used to compare how each participant played the game.	
Will any audio recordings (or non-anonymised transcript), photographs, video recordings or film be used in any outputs or otherwise made publicly available?	No
Will the study involve discussions of sensitive topics (e.g. sexual activity, drug use, criminal activity)?	No
Will any drugs, placebos or other substances (e.g. food substances, vitamins) be administered to the participants?	No
Will the study involve invasive, intrusive or potential harmful procedures of any kind?	No
Could your research induce psychological stress or anxiety, cause harm or have negative consequences for the participants or researchers (beyond the risks encountered in normal life)?	Yes
Please provide details and measures taken to minimise risks	

As mentioned before, each participant will be carefully selected to ensure they don't have a history of mental trauma, including anxiety disorders or phobias. This includes anxiety disorders such as generalized anxiety disorder, post-traumatic stress disorder, panic disorder and any phobias that may be relevant such as a fear of blood, the dark and being in enclosed spaces.

Due to not being able to list everything, a conversation will be had with the participant before the study begins to ensure that there is no psychological or physiological harm to them.

Each participant will be asked whether any of these apply to them before the research begins and whether anything in the game may risk injuring them.

Will your research involve prolonged or repetitive testing?

No

Consent

Describe the process that you will be using to obtain valid consent for participation in the research activities. If consent is not to be obtained explain why.

To obtain consent from the participants, they will be asked to read the participant information sheet which contains thorough information about how the study is carried and why it is being undertaken.

They will also be asked to sign a participant agreement form (both of which will be attached)

Do your participants include adults who lack/may lack capacity to give consent (at any point in the study)?

No

Will it be necessary for participants to take part in your study without their knowledge and consent?

No

Participant Withdrawal

At what point and how will it be possible for participants to exercise their rights to withdraw from the study?

The participant will be able to withdraw at any point before, during or after the study without giving a reason. They will be informed of this on the participant information sheet before the study commences.

If a participant withdraws from the study, what will be done with their data?

If the participant withdraws during the study, then their data will be destroyed completely and not used in any way. However, if the participant changes their mind about their data being used after the study has concluded, then it may not be possible to delete their data as all information is anonymous, so it would be very difficult to tell which is their data.

The participant will be made aware that they can have their data destroyed before the study commences, however they will also be informed about the limits of destroying the data.

Participant Compensation

Will participants receive financial compensation (or course credits) for their participation?	No
Will financial or other inducements (other than reasonable expenses) be offered to participants?	No

Research Data

Will identifiable personal information be collected, i.e. at an individualised level in a form that identifies or could enable identification of the participant?	No
Will research outputs include any identifiable personal information i.e. data at an individualised level in a form which identifies or could enable identification of the individual?	No

Storage, Access and Disposal of Research Data

Where will your research data be stored and who will have access during and after the study has finished.	
<p>All of the data will be kept on a password protected machine. Any physical data will be destroyed once it has been input on to a password protected machine.</p> <p>None of the data will have any personal information, the participants will be kept completely anonymous.</p> <p>Once the research has concluded and the paper has been completed, all data pertaining to this study will be destroyed.</p>	
Once your project completes, will any anonymised research data be stored on BU's Online Research Data Repository "BORDaR"?	No
Please explain why you do not intend to deposit your research data on BORDaR? E.g. do you intend to deposit your research data in another data repository (discipline or funder specific)? If so, please provide details.	
Undergraduate	

Final Review

Are there any other ethical considerations relating to your project which have not been covered above?

No

Risk Assessment

Have you undertaken an appropriate Risk Assessment?

Yes

Attached documents

Participant Agreement Form.docx - attached on 14/03/2022 13:46:39

Participant Information Sheet.docx - attached on 14/03/2022 13:46:44