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Master's Thesis  
Academic Year 2022

Project Corvus: A Virtual Reality Horror Tool  
for Improving Self-efficacy



Keio University  
Graduate School of Media Design

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A Master's Thesis  
submitted to Keio University Graduate School of Media Design  
in partial fulfillment of the requirements for the degree of  
Master of Media Design

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Abstract of Master's Thesis of Academic Year 2022

## Project Corvus: A Virtual Reality Horror Tool for Improving Self-efficacy

Category: Design

### Summary

Throughout our history, horror is often associated with a negative connotation. But in today's popular culture, the beneficial qualities of fright and thrills have become such an engaging topic. Interestingly, people's engagement with darker materials is not merely a result of scare-seeking curiosity but as a way to regulate stress and anxiety. Self-efficacy is another important term in this study. The role of self-efficacy has been studied by various researchers in the aspects of academic performance, physical activities, and more general – daily tasks. There are various ways of aiding individuals to develop self-efficacy including exposure therapy. However, exposure therapy practices are still at the clinical and organizational level, and most of immersive horror experiences are still aimed at user engagement than psychological treatments. There is yet a commercial-level program that focuses on how horror can be leveraged to promote self-efficacy. This work presents Project Corvus, an assistive virtual reality tool to help people build self-efficacy. With this prototype, we explore the possibilities to leverage designed horror experiences to help people develop self-efficacy. Through a designed program of short horror experiences in VR, the user will achieve small goals in the horror environment that will potentially help the user to build confidence. The concept is evaluated by comparing the participants in the non-horror-induced environment and the Corvus environment with the same tasks. Then the results are presented and compared for differences and effects. The contributions of this work are threefold: 1) We propose Project Corvus, a horror-themed assistive program to help users develop self-efficacy and better control of their emotions, 2) we ran an initial study to evaluate our system in terms of self-reported self-efficacy

and physiological response, and 3) we found that there was an indication that self-efficacy can be improved.

**Keywords:**

horror, morbid curiosity, exposure therapy, recreational fear, self-efficacy, immersive virtual reality

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*“In ordinary life, we hardly realize that we receive a great deal more than we give and that it is only with gratitude that life becomes rich.”*

# Chapter 1

## Introduction

### 1.1. Background

Analytics<sup>1</sup> indicates the demand for the walking dead, a horror thriller series made by HBO is still popular around the world after its debut almost 10 years ago. Lin et al. [1] described a system that looked at developing a VR horror system for self-efficacy [2].

Why are so many people attracted to frightening experiences? Can this experience offer more than just entertainment? This project is inspired by the context of horror related to people's morbid curiosity. Throughout our history, horror is often associated with a negative connotation. But in today's popular culture, the beneficial qualities of fright and thrills have become such an engaging topic. Interestingly, people's engagement with darker materials is not merely a result of scare-seeking curiosity but as a way to regulate stress and anxiety. Self-efficacy is another Important term in this study. The role of self-efficacy has been studied by various researchers in the aspects of academic performance, physical activities, and more general – daily tasks. There are various ways of aiding individuals to develop self-efficacy including exposure therapy. In this paper, we explore how to use a designed horror experience to achieve the effect of exposure therapy to develop self-efficacy.

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<sup>1</sup> <https://www.parrotanalytics.com/insights/the-global-demand-for-the-horror-genre/>



(Source: Parrot Analytics )

Figure 1.1 The global demand for the Walking Dead

## 1.2. Goals and Contribution

Utilizing the immersive nature of VR, This research aims to leverage people's response to horror to explore the possibilities of using assistive horror experiences to help people build mental resilience. We propose an assistive horror system that can be used for people who are intrigued by horror entertainment to not only enjoy the content but also develop self-efficacy in various aspects of life that will help them achieve more. The contributions of this work are therefore the following:

- Explore the psycho-educational opportunities in this horror-themed direction of biofeedback system
- Design a horror-themed assistive program that can help the participants develop their skills in controlling their emotions even when facing real crises in the future
- Introduce a novel application of horror entertainment to help people develop self-efficacy

## 1.3. Thesis Structure

This thesis consists of 5 chapters described as follows:

- Chapter 1 describes the background and motivation of this research. Based on the problem statement, this chapter also explains the novelty of the study.
- Chapter 2 examines related research and previous works on the key topics of the thesis. Key concepts are extracted to display relevance and connections.
- Chapter 3 reflects the design process and iterations of the studies from the concepts developed. Insights towards the proof of concepts were obtained through user interviews and experiments.
- Chapter 4 presents the final experiment of the prototype system developed from Chapter 3. Results are analyzed for the conclusion.
- Chapter 5 summarizes the outcome of the thesis including the objectives and hypothesis. In addition, the conclusion elaborates on result, limitations and future research opportunities.

# Chapter 2

## Literature Review

This chapter will discuss the related literature relevant to the thesis topic. The explanation will elaborate on the definitions of morbid curiosity as an inherent psychological trait, exposure therapy in modern day practices and its effect in treating phobias and mental resilience, definition of self-efficacy [2] and the importance of its development for an individual's well-being and lastly, the application of virtual reality in its effect to shape behaviors. As discussed in the first chapter, the development of novel applications in horror entertainment is expanding outside of recreational purposes. This section will also touch upon the possibility of using the techniques in virtual reality to help individuals build self-efficacy [2] in a horror context.

### 2.1. Morbid Curiosity

#### 2.1.1 What is morbid curiosity?

Morbid curiosity [3] is often described as an interest in subjects about unpleasant and negative things, especially death. According to Scrivner et al [4], individuals are inherently attracted to particular aspects of the world such as faces, people and negatively dangerous phenomena. Just as personalities and other psychological traits, a study from Coltan Scrivner [4] showed that morbid curiosity can be measured. Through a scale developed by Scrivner, individual differences in morbid curiosity can be predicted for other research implications and assessment.





(Source: Watanaba Lab, Tokyo Tech<sup>1</sup> )

Figure 2.1 Examples of how horror tales are transformed into digital experiences

### 2.1.2 Why is morbid curiosity relevant?

One social phenomenon that can be associated with morbid curiosity [5] is the booming popularity of horror entertainment. Haunted houses are an essential attraction in theme parks that people voluntarily seek out. Horror movies and festivities like halloween are popular worldwide regardless of culture differences nowadays. There are many reasons why people consume horror entertainment aside from just the pursuit of thrills. First of all, clearly one reason is that people enjoy the experience of simulation. According to Recreational Fear Lab<sup>2</sup>, when exposed to threat in a safe situation [6], people can often find excitement. Neuroscientist, psychologist, movie and game makers are constantly studying the audiences responses to fear. Another reason people seek horror entertainment is to gain novel experiences. People want to experience a portrayed or imagined situation to simulate responses and live an alternate reality. This can be seen recently as the pandemic broke out, Scrivner et al. [7] reported that people who watch apocalyptic movies feel mentally more prepared than those who don't. Lastly, horror content offers the chance for people to safely explore their curiosity about the dark side of the human psyche. Allowing people to study and develop their interest towards morbid interests. As one of the common psychological traits of humans – morbid curiosity can reflect and shape one's behavior in everyday life.

## 2.2. Exposure Therapy

### 2.2.1 What is exposure therapy?

Exposure Therapy is a developed method in psychology to help people confront their fears [8, 9], and many times used to treat Post traumatic stress disorder (PTSD)<sup>3</sup>. Studies show that when people encounter danger or fear, fight or flight response is triggered. Although the avoidance of fear might induce less stress to the individual in the short term, it is proven that continuous avoidance can result

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2 <https://cc.au.dk/en/recreational-fear-lab>

3 <https://www.apa.org/ptsd-guideline/patients-and-families/exposure-therapy>

in the fear evolving into worse experiences. Through exposure therapy, the individual is often reintroduced to the specific fear factor in a safe environment [10]. Therefore the individual feels in control and therefore can slowly build resilience to the stimulus [11]. There are many methods used in exposure therapy such as in vivo exposure which directly face the fear object in reality. Imaginal exposure instructs the individual to recall a certain event or situation which they are afraid of. Interoceptive exposure will artificially mimic the physical sensation that the individual might experience during the feared experience in order for them to safely build familiarity.

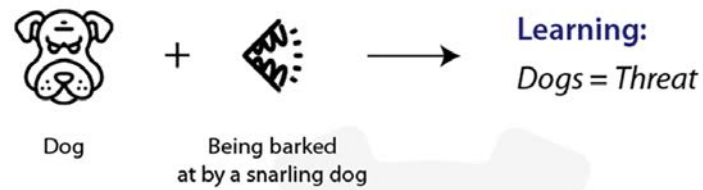
### 2.2.2 How is exposure therapy applied?

As discussed in the previous section, exposure therapy is applied in many fields of study and experiments. It has been proven to be an effective way to treat an array of mental problems such as panic disorders, phobias, post-traumatic stress disorders [12]. Aside from the various means of conducting exposure therapy, there are also ways to pace the program. The most commonly used is to apply graded exposure - to apply a fear exposure hierarchy. By using various combinations of fear elements, the program administrator can rank the fear level of the program to slowly introduce the user from most mild experience to more stimulating experience. The administrator can also reverse the order by using the flooding technique to overwhelm the user with the most difficult tasks and go down the pyramid. In other cases, exposures can be combined with relaxation exercises to make it more manageable for the users. It is called Systematic desensitization<sup>4</sup>. Regardless of how exposure therapies are conducted, it is important to know that it has been proven to be helpful in aiding people to confront their fears and build self-efficacy.

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<sup>4</sup> <https://www.webmd.com/anxiety-panic/what-to-know-systematic-desensitization-therapy>

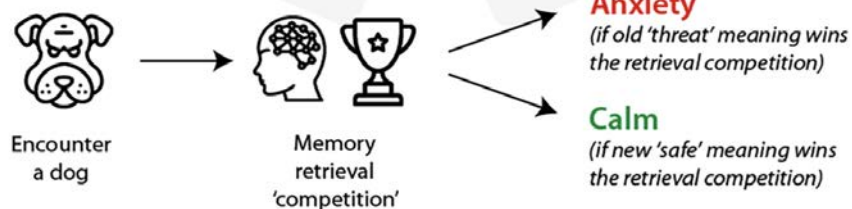
### How the fear is learned (fear acquisition)



### Exposure therapy (fear extinction)



### Later on



(Source: Psychology Tools )

Figure 2.2 An illustration of inhibitory learning theory

## 2.3. Self-efficacy (SE)

### 2.3.1 What is self-efficacy

Self-efficacy (SE) [13] refers to one's belief in their ability to cope with life situations. It poses a significant role in our lives as it can affect our ability to unlock our potentials to build confidence and develop mental resilience. Self-efficacy is important for individuals to be aware of and when properly developed it can aid one in building stronger resilience against psychological stress. Based on Bandura's social-cognitive theory [2], he points out that there are four major sources of self-efficacy (i.e., anxiety coping, modeling, mental practice, and effort feedback). Huang and Mayer [14] further investigated the effectiveness of various strategies to help individual develop their SE level. The most significant source of SSE is through mastery of an experience.

### 2.3.2 How to measure self-efficacy?

There are many validated scales developed to measure one's level of self-efficacy. The original self-efficacy scale (SGSE) was developed in 1982 by Sherer et al. However, the New General Self-Efficacy Scale developed by Chen, Gully, and Eden (2001) [15] states a more recent and updated evaluation of the process. According to the study, the New General Self-Efficacy Scale (NGSE) has stronger

<i>Variable</i>	<i>Mean</i>	<i>SD</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
1. NGSE (T1)	4.14	0.48	(.85)					
2. SGSE (T1)	4.06	0.46	.78	(.88)				
3. Leadership SSE (T1)	4.15	0.34	.68	.68	(.92)			
4. NGSE (T2)	4.16	0.41	.86	.77	.70	(.86)		
5. SGSE (T2)	4.08	0.48	.73	.90	.68	.75	(.91)	
6. Leadership SSE (T2)	4.14	0.34	.73	.69	.90	.75	.70	(.94)

*Note.*  $N = 42$  to  $48$  for the correlations. Reliability coefficients (alpha) are on the diagonal. NGSE = New General Self-Efficacy Scale, SGSE = Sherer et al. (1982) General Self-Efficacy Scale, SSE = specific self-efficacy, T1 = Time 1, T2 = Time 2. All correlations are significant ( $p < .01$ ).

(Source: Validation of a New General Self-Efficacy Scale [15] )

Figure 2.3 Descriptive Statistics, Reliability Coefficients, and Intercorrelations construct validity than the previous SGSE scale based on studies conducted in

two countries. The NGSE scale displayed good reliability, predicted specific SE for a variety of tasks in varied circumstances, and was shorter than the SGSE scale. It is also the scale used in this thesis to observe SE change throughout the study.

### **2.3.3 Benefits of stronger self-efficacy**

According to Panc et al. [16] SE is an important coping capacity for psychological stress. The construct discusses the role of SE in the various aspects of our life such as professional, social, educational, etc. Bandura's social-cognitive theory [2] indicated that with stronger self-efficacy people can perceive challenges to be more accomplishable; develop a deeper interest in daily activities and recover faster from setbacks and failures in situations. While people with low self-efficacy tend to avoid challenges and perceived far-reaching obstacles; have a higher focus on negative outcomes and exhibit a faster drop in confidence when experiencing challenges. Therefore it is meaningful to examine and explore ways to develop SE for individual well-being.

## **2.4. Immersive Experience in Virtual Reality**

### **2.4.1 Virtual Reality Applications**

Virtual reality exposure is often adopted for its effectiveness in recreating an environment that can be hard to simulate. As it was predominantly used in entertainment. It has been adopted in many other areas for its capacity to customize and prototype [17]. According to studies on the effect of immersive VR experience [18] tailored virtual content can be complementary to conventional treatment for mental disorders. Moreover, Wenk et al. [19] also showed effective VR application in motor training for cognitively impaired patients.

### 2.4.2 Gamification in non-gaming context

In Human-Computer Interaction(HCI), gamification has been a long-discussed topic. It is a term not only pertaining to game design but all digital system experiences. According to Deterding et al. [20], more researchers attempt to employ the elements of game design to enhance user engagement and user experience in non-gaming contexts. On another note, psychophysiological research methods [18] have gained much traction in the gaming industry to study and measure players' engagement, emotions, and other facets of the user experience. Easily deployable tools such as electrodermal activity (EDA) and heart rate sensing devices are used to collect users' physiological data during gameplay. Leveraging the theories and psychophysiological research methods can potentially inform the development of psychological treatments such as building self-efficacy. Other studies, researchers also explored biofeedback-enhanced game experiences to train users in stress management [21]. Biofeedback games can potentially be adapted to a deeply personal experience by linking the virtual gaming world to each player's physiological state. In the game Nevermind [22], the developers argue for its potential to help players to train emotion regulation skills. While much gaming research focuses on player engagement, assistive therapy programs are still absent.

### 2.4.3 Physiological data in virtual reality

On another note, psychophysiological research methods [18] have gained much traction in the gaming industry to study and measure players' engagement, emotions, and other facets of the user experience. Easily deployable tools such as electrodermal activity (EDA) and heart rate sensing devices are used to collect players' physiological data during VR. Leveraging the theories and psychophysiological research methods [19] can potentially inform the development of psychological treatments such as building self-efficacy [1].

## 2.5. Summary

From investigating related works, it can be inferred that there are lots of works focusing only on user engagement in VR and Horror entertainment but yet to

have dedicated research on clinical applications of horror. Exposure therapy does employ VR but mainly for clinical and organizational use, there is yet to be a novel application of horror entertainment to help people develop self-efficacy at a commercial level.



# Chapter 3

## Concept Design

### 3.1. Design Proposal

#### 3.1.1 Overview

The project is called project Corvus. The name “Corvus” is conceived from the Native American Northwest mythology<sup>1</sup>. In their culture, the raven is a powerful figure who transforms the world. Raven stole lights and lit up the world for people. In this design concept, the assistive program will be designed around



(Source: American Museum of Natural History )

Figure 3.1 Raven the Trickster

the idea of shifting between two opposite “worlds” so that the user can use the

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<sup>1</sup> <https://www.amnh.org/exhibitions/totems-to-turquoise/native-american-cosmology/raven-the-trickster>

experience to confront fear hence enhancing their self-efficacy [23]. When we set out to design the prototype, the initial goal was to rebuild a positive image of horror to expand its audience. But as the study proceeded, the goal shifted from changing to embracing the image of perceived horror as we discovered that horror is not a niche but a popular demand. Therefore, we aim to design an effective program that can help people enjoy horror while building stronger mental health in this fast-paced society.

### **3.1.2 Target Audience**

The target user group for this study is not specifically restricted to a specific demographic but to the general mass with an emphasis on people who are evaluated to be more morbidly curious. As discussed in the previous sessions, people who are innately drawn to the topic might have more potential to benefit from the results predicted in the hypothesis. In this case, people who want to safely challenge themselves in a scary experience might achieve a higher sense of accomplishment.

## **3.2. Workshop and Preliminary Survey**

### **3.2.1 Workshop to find out about peoples fear**

When we set out to design the prototype, the goal of the workshop is to 1) Look for culture, and gender influence as well as interests towards horror 2) Discover more specific fear elements of individuals 3) Gauge interest in the concept.

#### **Insights**

The workshop was conducted in a 40-minute session guided by group discussion. Participants were asked a question to find out about their background and elaborate on their experience and preferences for horror. Participants responded strongly to audio stimuli compared to visual stimuli. Even though some participants reacted to specific sounds that resonated with them more, all of them responded that audio stimulus is the most effective way to trigger arousal in their emotions towards fear. As for visual stimulus, it was particularly relevant to the participants' cultural backgrounds. For example, East Asian participants



Figure 3.2 Fear Workshop

reacted strongly to the images representing Asian horror tales while feeling indifferent about images of gothic church buildings. Western catholic participants felt strongly towards pictures of Maria and religious representations as there are implied associations to demons and possessions while being less responsive to Asian legends. Few participants reacted to blood and gore images as well as grotesque characters such as zombies or werewolves. Most participants found abstract and human-like images more horrifying. The general mysterious environment and realistic photos were also scary to most participants.

### 3.2.2 Preliminary Survey

A two-part preliminary survey was used to discover the potential user demographic, their opinion, and preference towards fear. The survey was about 3 minutes in length and consisted of 15 questions. It was conducted online with 21 collected responses from university students to working professionals.

Part 1 - Demographic Questionnaire: Basic questions were designed to collect the

demographic and background information of the target group.

Part 2 - Interest and Experience in Horror: Further inquired people's interest in horror entertainment and their specific preferences. Some insights including participants' expected level of fear, what genre scares them the most were presented.

## Insights

In terms of demographics, 87.5 percent of the participants were Asian and the rest were Caucasian, Black and Latino. 62.5 percent of the answers collected were from

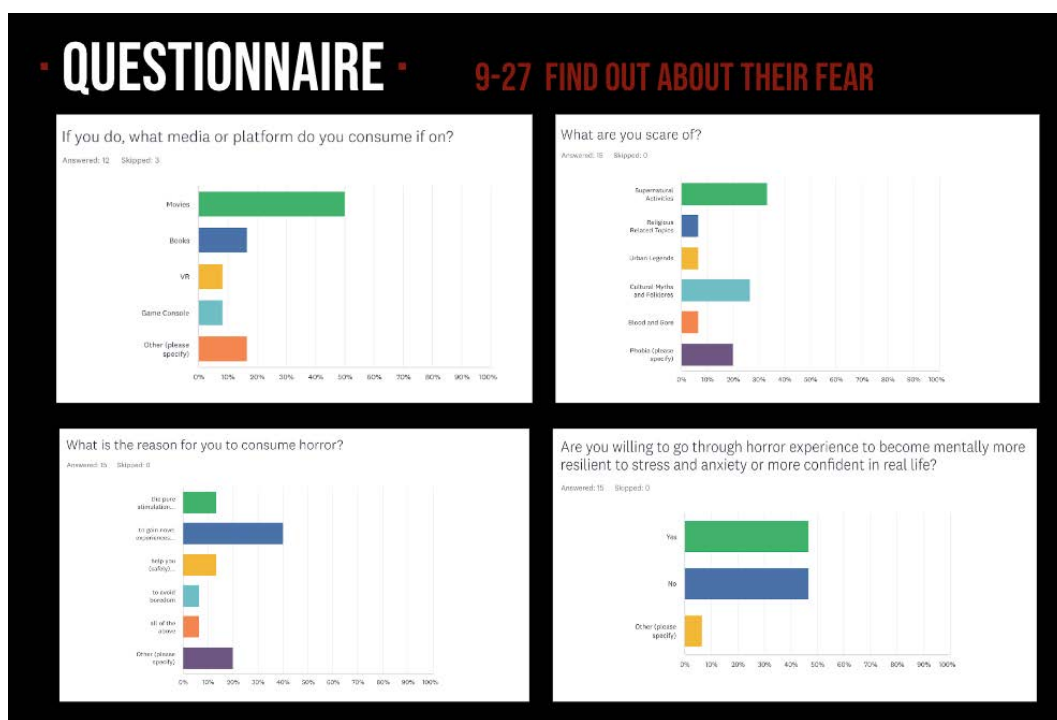


Figure 3.3 Preliminary Survey Results

female participants. While 37.5 percent of the participants indicated that they are very empathetic, all of them indicated that they have some level of empathy towards others. As for horror preferences, about 50 percent of the participants consume horror from movies, while the rest are scattered amongst VR, gaming consoles, and books. As to what they are most scared of, it was an even split between supernatural activities, cultural myths and folklore, and specific phobias.

As for the reason to consume horror, 40 percent indicated that they want to gain novel experiences from the viewing while the rest answered from stimulating curiosity to peer pressure. Surprisingly, more than half of the participants indicated that they are willing to try out an immersive horror experience but less than half expressed that they think it might help them build higher self-efficacy/confidence.

### 3.3. Pilot Study

The pilot study was conducted under the premise of testing out the initial setup of the system. It was conducted to 1) collect individual's reaction to fear 2) test the validity of physiological data sensing 3) further define the experience

#### 3.3.1 Participants

Three graduate school students (1 Male and 2 Females) were selected to participate in the pilot study. Their age ranged from 24-28. One of them is very familiar with VR experience and the other two have previously used VR a few times. All participants are university students who are interested in the topics of horror as leisure entertainment.

#### 3.3.2 Methods

##### Apparatus

*Meta Quest 2*<sup>2</sup> As one of the most updated VR systems for the time being, The Oculus 2 was selected for its developer adaptability and high quality rendering of the content.

*Noise-Canceling earbuds* In order to create a more immersive experience and avoid the distraction of the experiment environment. Noise-canceling headphones were applied for the participants.

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<sup>2</sup> <https://www.meta.com/jp/en/quest/products/quest-2/>

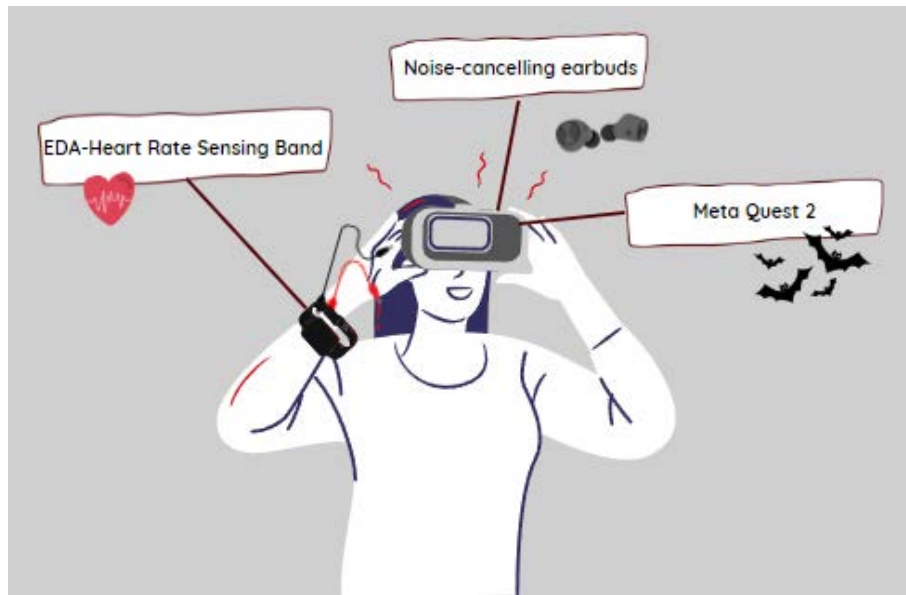


Figure 3.4 The Corvus Device Setup

*EDA + Heart Rate Apparatus* also included the physiological sensing device developed by the Geist Lab at KMD for recording electrodermal activity and heart rate data. It was applied to monitor the arousal and anxiety level of the participant during the experiment.

*Horror Virtual Reality Video from Within* Within is an online platform that distributes high quality 360-degree video, AR, and VR experiences for non-commercial use. A five minute long horror VR video was selected to stream for the participants to observe their reaction as well as to investigate their scare factors. were captured as well as a premade commercial horror short video was streamed as the stimulus for the user.

*Testing Environment* A comfortable and a relatively sound isolated environment was reserved for the study. Ample moving space was provided along with the presence of the administrator in case of assistance or withdrawal.

## Experiment Design

The study aimed at collecting participants' responses to immersive VR horror material. The participant was first introduced to the system. Then the participants were asked to view a short 4 minutes 7 seconds 360-degree VR film streamed from the Within<sup>3</sup> platform. The narrative is about the protagonist waking up in a dungeon not knowing what was happening and eventually being attacked by an unknown monster figure. During the experience, the participants can freely view

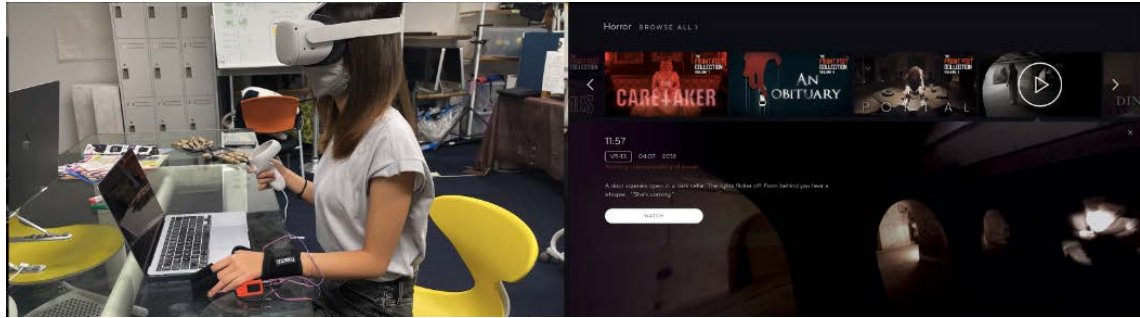


Figure 3.5 Pilot Study

the surroundings while watching the story progression. Physiological data were captured and participants' view was cast throughout the viewing. At the end of the viewing, an interview was conducted to discover the participants' responses to the experience.

### 3.3.3 Results

Because there was no interaction and conscious decision required during the experience, the participant was feeling more passive than engaged. All of the participants reported that they were somewhat unsettled by the content. They all reacted strongly to the main jump scare halfway into the video. One participant even vocally expressed the emotion. The most significant response was that two of the participants specifically mentioned that the low visibility of the environment and the anticipation towards the horror were the most unsettling and scary throughout the viewing experience. This feedback responds to the previously

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3 <https://www.with.in/>

mentioned technique in Horror movie-making. “Suspense building is the scariest experience”. One participant also mentioned that due to the immersiveness of the experience, it was stressful at times as the participant cannot evade the horror by covering their eyes or muffling their hearing. The participants also reflected that the length of the viewing was enjoyable as VR can cause motion sickness when inexperienced. Heart rate was monitored during the experiment, there was a slight increase in heart rate towards the main jump scare for all participants, but overall, the heart rate stabilized after the jump scare.

## **3.4. Design of the VR System “The Corvus”**

### **3.4.1 System Description**

After the initial research and pilot study. Fear factors were selected to build the virtual experience. The Corvus can be defined as an experience of two “worlds”. The basic system included three main scenes for design. 1. Tutorial scene - for users to familiarize with the interaction mechanic of the program 2. Safe environment (Safe World) - for baseline study and fallback from the scary environment 3. Horror environment (Horror World) - for horror stimulus to observe the users behavior and reaction.

### **3.4.2 Interaction Mechanics**

The interaction mechanic is the core of the experience. After learning about the participants’ request to control their exposure to the horror environment. The fundamental idea was to retain the power of decision-making in the users’ hands so that the user can feel in control. Figure While in a short experience like The Corvus, an elaborate interaction system might not be as designed as a fully-commercial product, we aim to develop the mechanics to be simple yet effective.

#### **“Experience Goal”**

Simple item retrieval - The user goal is simply designed so the user can focus more on the immersive experience of exploring the virtual space. Based on the narrative, the user is asked to retrieve a virtual key in order to save the innocent



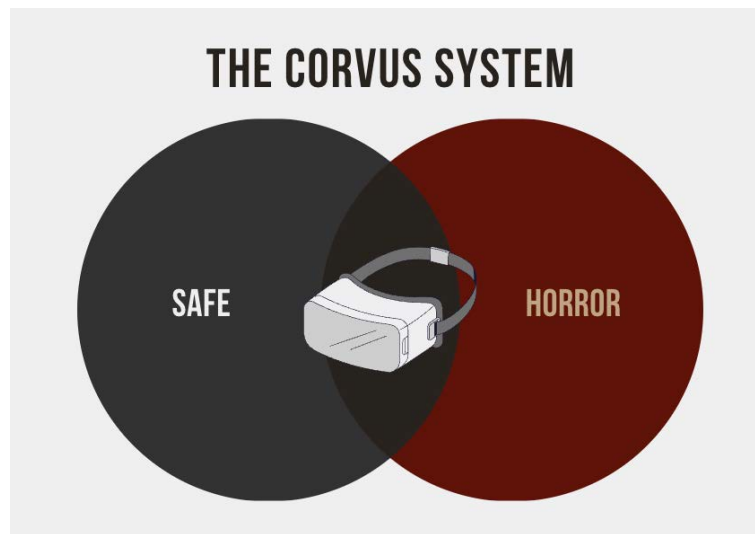


Figure 3.6 System diagram

child in distress in the fictional context. The goal is designed to be simple to eliminate the learning curve for new users and people who have less experience using VR.

#### **“Movements”**

Pathfinding -The movement in the game can be described as the main pathfinding. The user will use one controller to control the camera - character in the program. The direction of the camera will be controlled by the VR headset with actual head-turning [24] for directions. By using the controller for movement, we avoid the limitation of actual operating space. The user can either stand or sit to enjoy the experience as long as they can turn the headset. Figure photo of VR The reason to use pathfinding [25] as the core movement is because, in the preliminary interviews, most users indicated that they prefer to actively explore when it comes to immersive experience rather than passively viewing. Although it is desirable to build in more interactive objects for the virtual experience in future iterations, elaborated interactions are not necessary to validate the construct of the thesis.

#### **“World toggle”**

The world toggle is the switch between the “safe environment” and the “horror



Figure 3.7 Experience Diagram

environment” in the experience. The safe environment is a basic space with no threat of any scare elements while the horror environment is tailored and filled with scare elements that will spook the participants. The interaction mechanic to switch between the worlds is bound to the user’s movement. So when the user moves in the experience, the horror environment referred to as the horror world will be present, and by stopping moving the user can switch back to the safe world. Therefore the user decides to evaluate how long and how frequently they will confront the fear.

### 3.4.3 Environment and Sound Design

Based on the concepts of “World toggle”. The environment design is essential to the experience. The environment is designed and developed in Unity<sup>4</sup>, a cross-platform developer engine for building experiences in 2D and 3D. In order to build

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<sup>4</sup> <https://unity.com/ja>

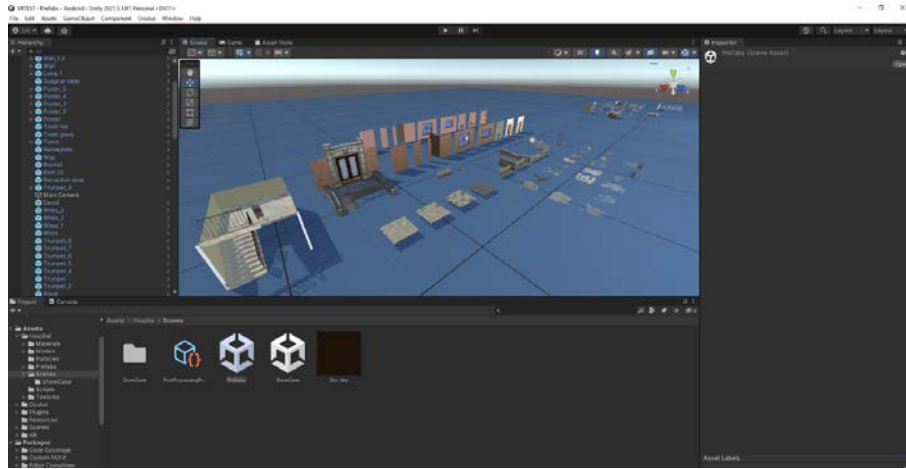


Figure 3.8 Unity Prefab Components for customisations

the environment effectively [26, 27], pre-made assets<sup>5</sup> were selected in the Unity Asset store for customization. The following figure displays the prefab components used to build the scenes.

“Safe world” - For the safe environment, it is important to keep it sterile and generic so the user can feel a sense of safety. It is designed as the fallback space if the user found the horror world too much to confront. Soothing ambient music was purposely inserted as well as bright lighting for clear visibility and warmth [27]. As shown in the figure below, a generic interior design is implemented for minimal distraction and provides the user with a sense of familiarity. No furniture was inserted to avoid associations to any specific environment so that the user does not have previous associations.

“Horror world” - On the other hand, the horror world is designed to induce fear. It aims to build pressure, anxiety, and insecurity. Therefore based on the data gathered from the previous rounds of a quantitative and qualitative study of fear, the following three aspects were enhanced.

#### a. “Building the suspense”

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<sup>5</sup> <https://assetstore.unity.com/packages/3d/environments/urban/horror-hospital-138042>

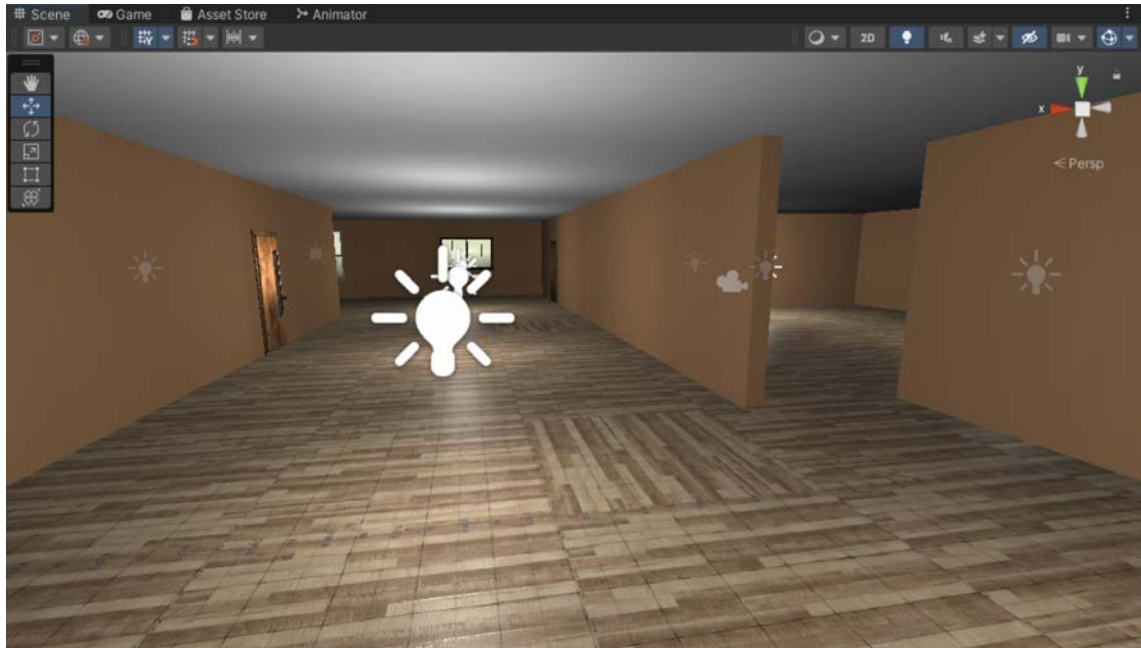


Figure 3.9 Safe World Scene Design

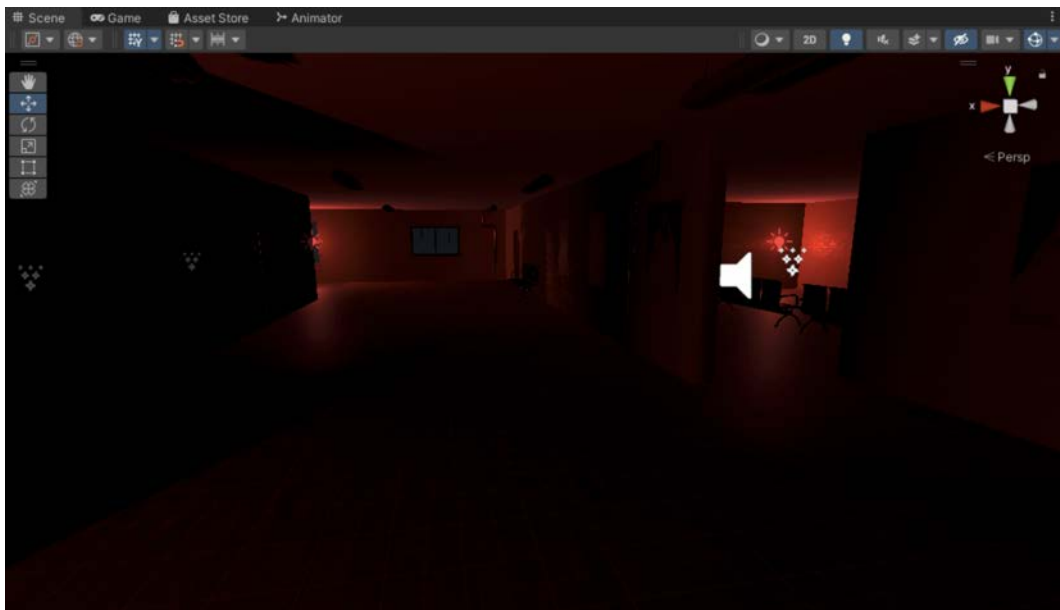


Figure 3.10 Horror World Scene Design

As mentioned in the earlier sections, participants feel most scared when they are anticipating an unknown threat. To build the suspense [28], the environment employed various point light techniques that only lit up part of the environment, the rest of the way was dimmed to extremely low visibility with fog effect for the dynamic and mystery of the experience. Other threat simulations including longer hallways and sharp corners are also purposely designed to ensure the participant only has limited visual distance at any given time [29]. The map and environment are designed to induce the feeling that anything could happen anywhere at any time.

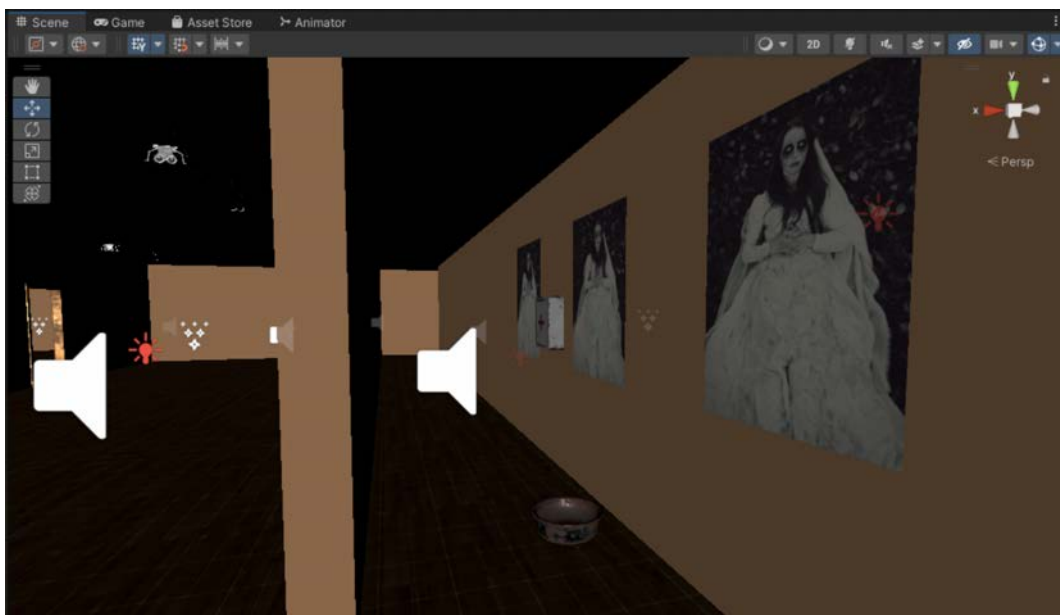


Figure 3.11 Long hall way with unknown ends

#### b. “Non-linear sounds<sup>6</sup> ”

Non-linear sounds are many times considered the secret ingredient of any horror movie. It refers to audio frequencies that are outside of the typical musical range of a voice, an instrument, or an animal. The cries of children, the distress calls of wild animals, and the abrupt and unpredictably changing frequency changes

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<sup>6</sup> <https://nevadafilm.com/production-notes-non-linear-sounds/>

of acoustic instruments are all examples of non-linear noises. Human brains have a natural aversion to distressful sounds. From a study conducted by UCLA [30], Participants were asked to listen to two different groups of original music. One included film soundtracks that are emotionally neutral. The other one had non-linear sounds. The study’s findings demonstrated that the music with nonlinear sounds stimulated emotions to a much greater extent and produced more negative feelings. Combined with the results from the preliminary studies, an array of non-linear sound triggers were placed along the explorational journey of the participants in the Corvus program. The goal is to use the number and intensity of these non-linear audio stimuli to control the fear level of the environment.

### c. “Element of surprise”

The last aspect is the element of surprise. It is a technique commonly used in

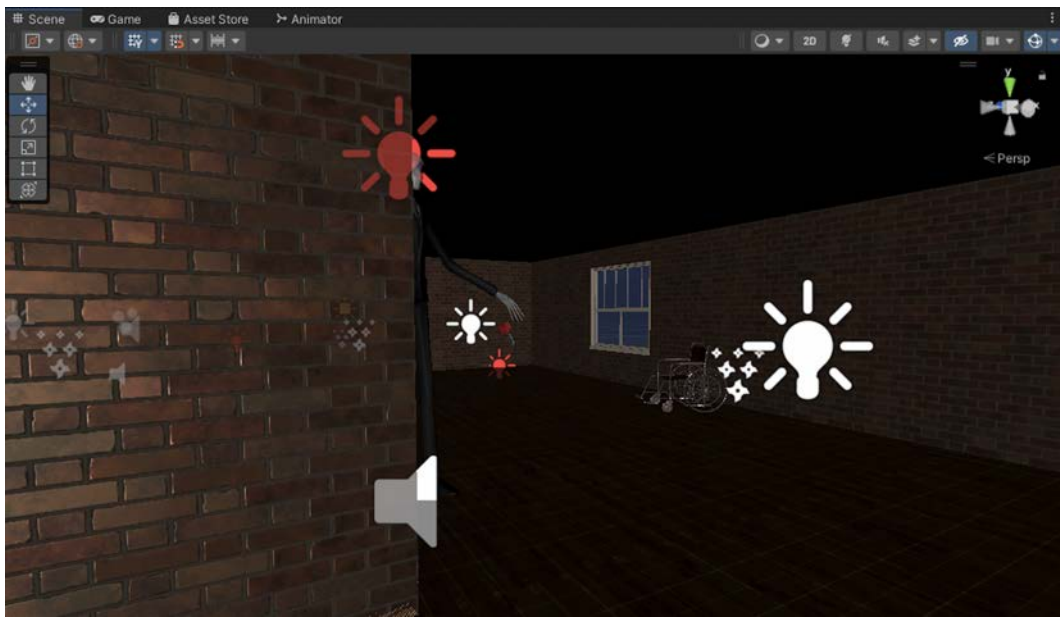


Figure 3.12 Surprise scare factor before the finish point

film-making and storytelling [31]. In this design concept, the element of surprise is applied as some animated figures at intentionally designed locations. For example, blind-spots right before the participants can retrieve the key. Individuals tend to relax their awareness when they are closer to the goal. By exploiting this pattern,

the scary figures can function as an element of surprise to shock the participants in the experience if not noticed.

### 3.4.4 Level Design

To offer the appropriate program for the participants and adopt the concept of fear hierarchy from exposure therapy practices [32]. The experience is designed to various horror levels based on the amount of the scare factors employed in the system [33]. There are three levels of scariness Beginner, Seasoned, and Die-Hard. The participants can select the one they feel best fitting for their tolerance level of horror as a way to provide a more tailored experience.

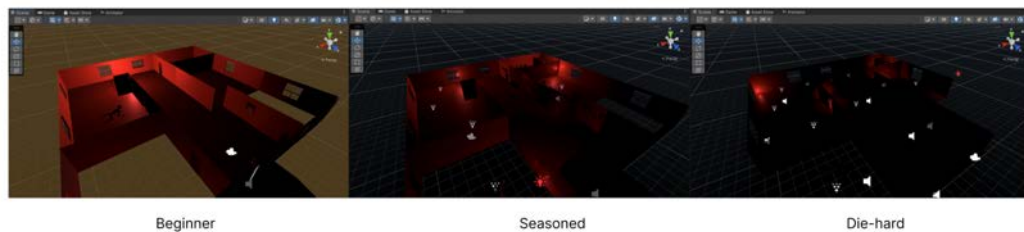


Figure 3.13 Levels from Beginner to Die-hard

### 3.4.5 Map Design

To collect multiple sessions of data and observe the experiment. The participants will be spawned on different maps. The differences in the map are necessary to minimize habituation to the task. The overall space and the distance between the spawn area to the goal area are kept approximately the same while the specific routes in each map [34] are altered as well as the scare elements are swapped for variations.

## 3.5. Iteration of The Corvus

Another iteration study was administered to validate the effectiveness of the interaction mechanic and the environment design of the system. Based on the design





Figure 3.14 Examples of the various maps

decisions mentioned above. The updated prototype was employed to 1) identify the preference of scary level for the participants 2) test the reaction to specific horror elements 3) discover areas for experience enhancements

### 3.5.1 Participants

Six graduate school students (2 Males and 4 Females) were selected to participate in the second study. Their age ranged from 24-28. Two of them are very familiar with VR experience and the other have previously used VR a few times. All participants are from a University.

### 3.5.2 Methods

The methods and apparatus are kept the same as the previous pilot study besides the content presented to the participants. During the pilot study, we used a pre-made non-interactive video. In the iteration, the following aspects of the programs are tested to inform future proof of concept.

#### Scare Elements Study



**1. Movements** The movement was mainly studied for the ideal moving speed of the participant in the program. The speed was differentiated into three different levels from slow to fast. The participant was asked to move from point A to point B and report their response to the interaction smoothness.

**2. Lighting - Intensity** The lighting was also differentiated based on color and intensity. For intensity, neutral point light was used to light up the virtual space. Three levels of brightness were defined from low intensity to high. To find out the more horror-inducing intensity. The participants were asked to report their responses when immersed in the environment.

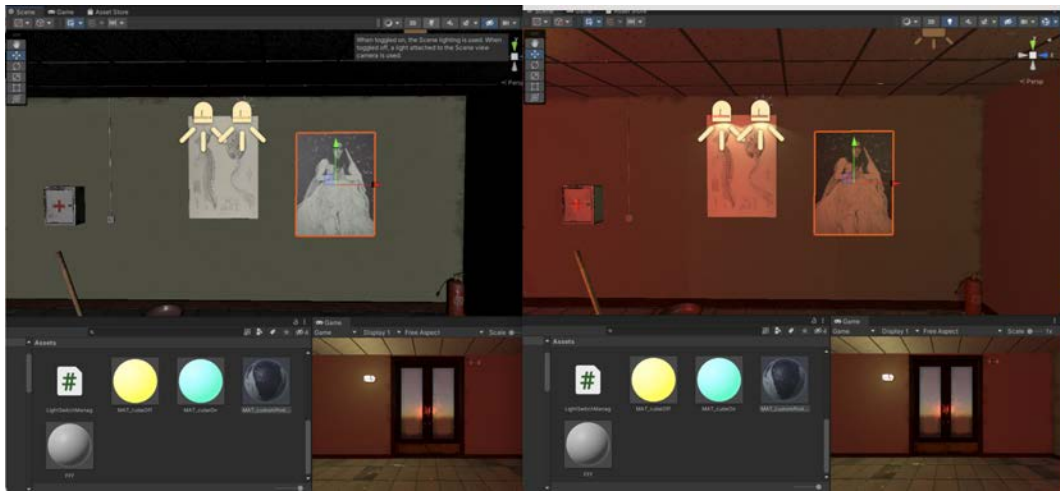


Figure 3.15 Iteration process of wall lighting

**3. Lighting - Color** For color, point light was used to light up the virtual space. Three primary colors with two secondary colors were selected at the same intensity. The participants were asked to report their responses from most scary to least scary when immersed in the environment.

**4. Sound Effects** For sound effects, a list of various nonlinear sound samples was selected for testing. Samples from baby-crying, men's coughing sounds, women whispering, cat screeching, wood cracking, etc. The participants were asked to report how uncomfortable they feel when hearing the sounds in the environment.

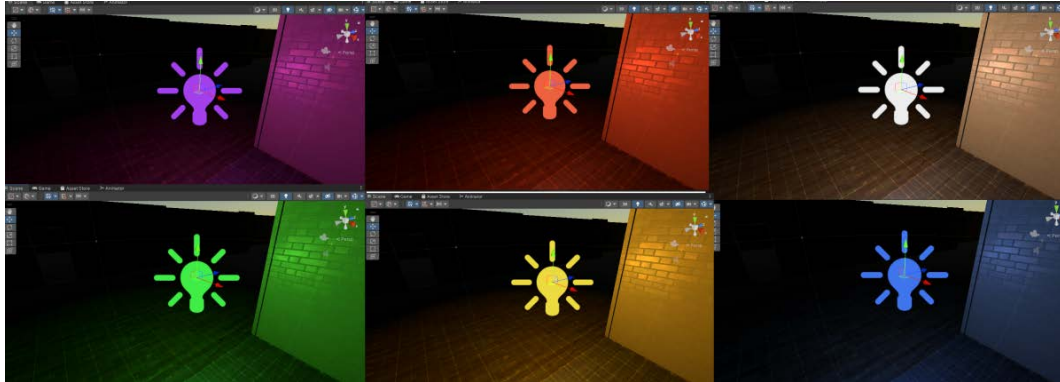


Figure 3.16 Light Color Experiments

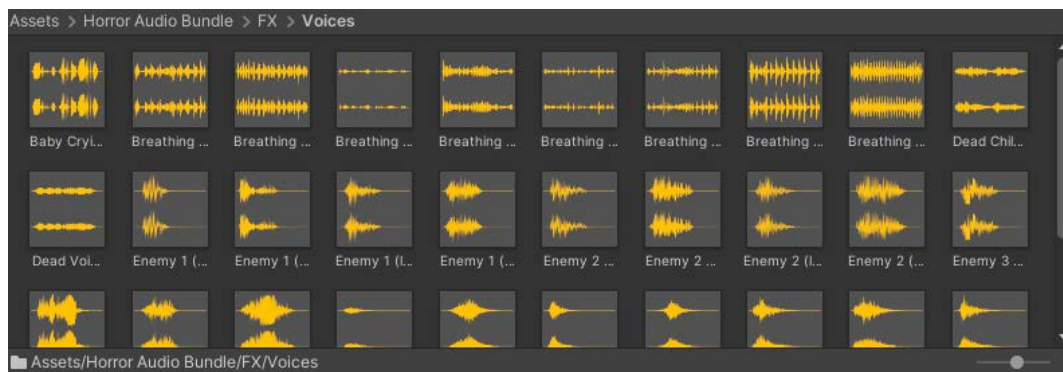


Figure 3.17 Sound Effects Library

**5. Scary figures** For scary figures, a list of designed and pre-made characters<sup>7</sup> from Unity Asset store was shown. The participants were asked to report how scary they feel when encountering the figures in the scene.

### 3.5.3 Results

1. Movements - All participants selected the medium speed as the most comfortable speed. 4 out of the 6 participants indicated that the slower the camera speed, the more unsettling and uncomfortable it was. It can be inferred that in general, the slower the movement, the scarier it is for the participant.
2. Lighting intensity - Although most of the participants reported being scared by medium-intensity light. They all expressed that dimmer lights induced more fear as lower visibility communicated uncertainty and danger.
3. Lighting color - When asked to rank the color of light in the environment from least scary to most scary, all participants' answers varied. 2 participants indicated the green light as the scariest, and 1 participant indicated the blue light to be the scariest. 2 indicated the red light to be the scariest and 1 indicated the neutral light to be scarier.
4. Sound effects - As for sound effects, people also ranked different sounds to be scarier with no specific patterns. As discussed in the previous section, fear is also directly related to people's experiences and personality.
5. Scare figures - the scare figures resulted in various results as well. Only 2 participants indicated the human-like children figure as the scariest. 4 out of 6 participants reported that they think the monster-like crawler figure as scarier.

## 3.6. Discussion

In addition to the insights acquired from the iteration studies mentioned above, ambient enhancements were also made based on the study from Byrne [35] that otherworldly and spooky feelings can also be exerted from the unfamiliar interaction of daily tasks. the final prototype should render a more effective system

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<sup>7</sup> <https://assetstore.unity.com/packages/3d/characters/humanoids/horror-creatures-97865>

to build anticipation of the suspense, to leverage audio stimulus which can exponentially intensify the experience, and to give the user more holistic control of the experience. By achieving the goals mentioned above, the Corvus system could attempt to link the horror interests of individuals to the development of self-efficacy.

# Chapter 4

## Proof of Concept

### 4.1. Final Prototype

For the final prototype, the experiment apparatus was kept the same as in previous studies aside from an updated version of the virtual experience design. The experiment was adjusted to a more soundproofing and spacious media studio with adjustable environment lights. This is chosen for better immersion in the study.

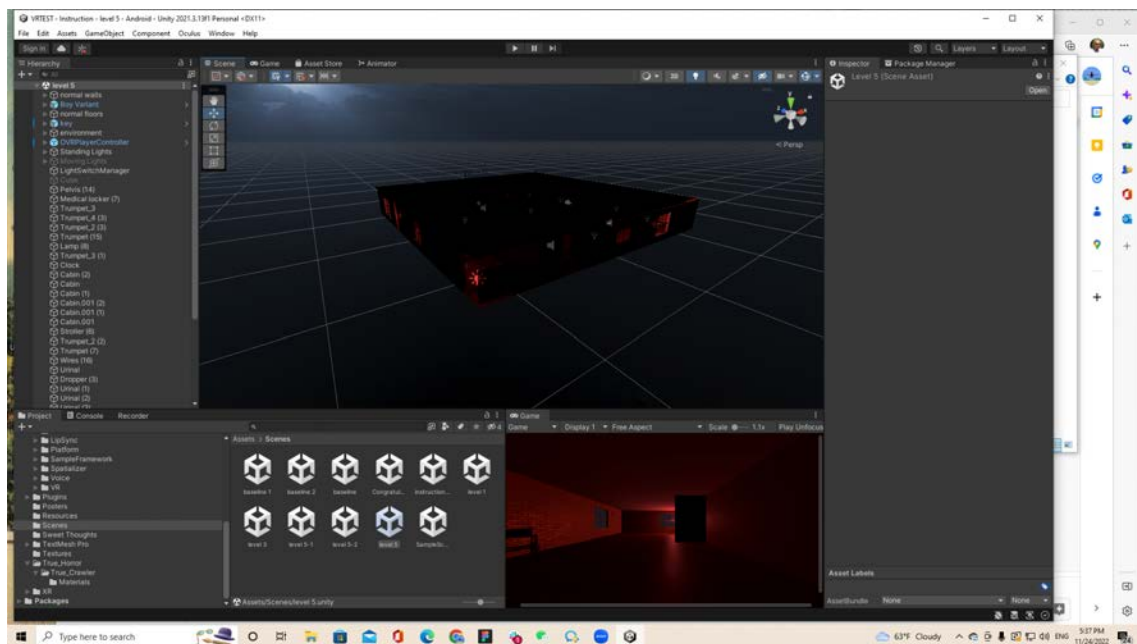


Figure 4.1 Bird-eye view of the prototype

### Apparatus

Meta Oculus 2 , Noise-Canceling earbuds, EDA + Heart Rate Sensing wristbands

### VR Program

Based on the feedback collected from the previous iteration, the final program had several enhancements in the following aspects. **Interaction mechanic, sound design and visual effects.** In terms of interaction mechanics, the biggest change is that compared to the unlimited move/stop decision toggle in the previous version. The number that the user can switch between the Safe World and the Horror World will be limited to five times. This enhancement was made based on the observed behavior of the participants in the previous study. One participant was stopped very frequently to escape from the horror environment while making progress toward the goal. The interrupted experience broke the flow of the intended design of the program. To avoid the exploitation of the interaction and encourage the user to make more thoughtful decisions on when to shift and move between the world, this design decision was made for the final study. The second area of enhancement was the sound design. Sound effects that mimic footsteps and heartbeats were incorporated to offer a more immersive experience. This can reflect a higher sense of agency for the user when controlling the camera/character in the program. The last area is the animation trigger of the scary figures. As reported in the previous study, a higher sense of urgency and life threat can induce more fear. More threatening and intense movements such as attacks and running are attached to the figures in the program. to the participants. The final prototype also included three different map designs to avoid user prediction in the study. In the experiment, in every session the participant will spawn and navigate a new space for the key.

## 4.2. Field Study 1 - Quantitative

Field Study 1 focuses on observing the instant effect of the program. The goal of the quantitative study is to 1) find out about the average response of the participants to the experience 2) seek insights

### 4.2.1 Participants

Fourteen graduate school students (6 Male and 8 Females) were selected to participate in the field study. Their age ranged from 24-34. Four of them are relatively familiar with VR experience, eight had some experience using VR and the other two have no experience using VR entertainment. All participants are from universities.

### 4.2.2 Experiment

The experiment was a tailored training session based on the individual's fear context. The participants will be immersed in a VR session to accomplish a key retrieval task. The experience should last approximately one to three minutes for each session. The participant will be informed of a context that a fictional child is in distress, and they require a key to rescue the child. The participant should attempt to locate the key in the designed space. However, the space will go to the horror world setting as soon as it detects motion (the participant starts moving). The scare elements in the horror world will vary in each session. To stay in the safe world the participant needs to stay still. Therefore, it is the participants' choice to decide how and when to overcome the horror and reach for the key.

#### Data Collection

The result will be evaluated based on the three types of data recorded. 1. Performance data- Completion time of the experiment sessions 2. Self-reported data - scoring of The New General Self-efficacy scale (NGSE) and The Self-Assessment Manikin (SAM) after each session. 3. Physiological data - feedback of Electrodermal Activities and Heart-rate variability to reflect participants' emotional condition during the experiment. The reason these three types of data are selected is that the compilation time of the task is a factual reflection of the participants' ability to change in each session. The physiological data is a widely used method to monitor the passive change of arousal in experiments. The self-reported data is subjective feedback on the direct influence of the experiment.

#### Baseline Experience vs. Experimental Experience

In order to carry out the effect of the assistive program. Three sessions of test-

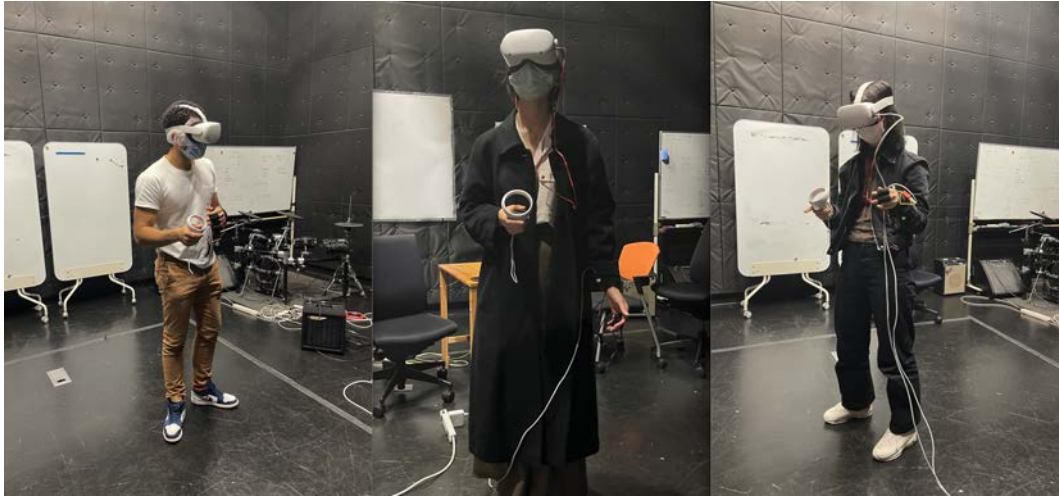


Figure 4.2 Participants in the study

ing are carried out to simulate the repetition in exposure therapy design. The participant will be instructed to complete a simple tutorial session designed to understand the movement and mechanics of the program without any added horror effects. Then the participants will be asked to complete three sessions of key retrieval without the safe/horror world mechanic as baseline observation and three sessions with the safe/horror mechanic as experimental observation. The order of the designed experiences will be randomized in each experiment session to avoid order bias [36] The assumption is that the participants will gain a higher level of confidence after going through the experimental experiences.

### 4.2.3 Performance Results

Performance results are measured from the completion time of the sessions. It starts from the moment the participant initiates movement in the program and finishes when the participant reaches the goal in each session. It is intended to measure if the participants' ability to complete the task develops over repetitions of the program. Faster speed could be an indication that the participants are gaining the capacity to overcome the fear situations induced in virtual reality. As



we can see from table 4.1, in the three experimental rounds with horror elements, 50 percent of the participants recorded a shorter completion time in the end. Excluding the outlier data due to special incidents such as loss in the maze and control troubles. The result does not show a significant difference between the baseline environment and the experimental environment.

Participant	B1	B2	B3	E1	E2	E3
1	35.5	35.4	35.3	60.0	103.1	59.1
2	46.7	43.2	44.3	88.2	90.2	80.4
3	70.1	35.4	50.3	49.4	51.6	50.2
4	36.7	29.3	35.3	61.3	55.2	52.5
5	34.7	30.3	36.2	68.3	65.1	62.3
6	39.3	37.38	38.3	57.4	55.4	52.2
7	42.5	46.4	55.4	60.1	59.9	64.1
8	40.5	20.06	40.1	42.5	120.2	56.3
9	49.5	46.5	55.6	47.7	55.4	90
10	42.3	36.1	36.5	96.8	90.1	90.0
11	150.1	22.4	34.3	135.1	38.1	83.2
12	32.3	33.3	43.5	55.2	47.1	92.0
13	38.3	23.3	21.5	43.5	38.8	60.1
14	49.3	31.2	29.5	63.2	60.1	59.5

Table 4.1 Completion time of the sessions in seconds

#### 4.2.4 Self-Reported Results

##### NGSE Scoring

SE data was collected at three main times for comparison with the NGSE scale. For each participant, the initial score is taken one day before the study as the initial baseline score. On the day of the study, the scale is handed out 6 times after each completed session of the experiment yielding 3 scores under the non-horror baseline environment and 3 scores under the horror experimental environment for comparison of the changes of SE. The last score is taken approximately 2 days after the study to observe the lingering effects of the experiment observed

in Field Study 2 of this thesis. In this section, we will compare the individual SE

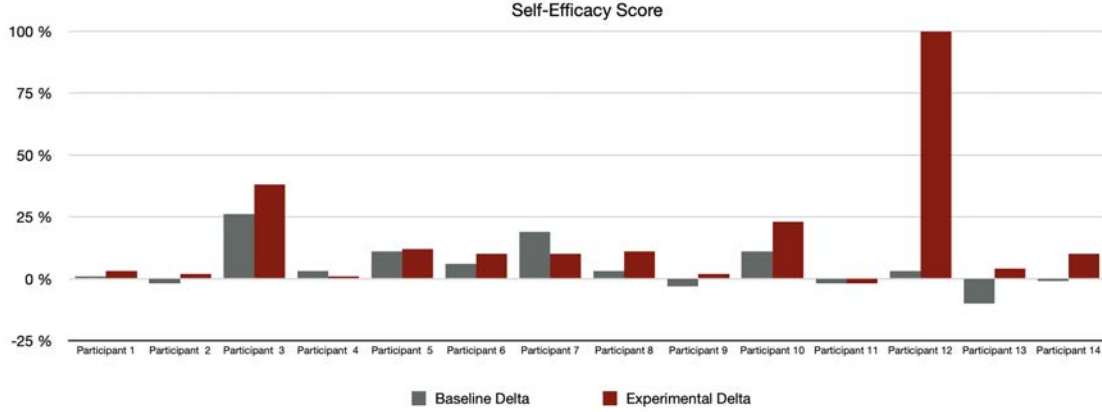


Figure 4.3 SE Score Delta of all participants

score before and after the experiments, we will also compare the effect between the baseline environment and the experimental environment. As indicated in the chart below, the graph shows that in the 6 selected participants out of 14. Their overall self-efficacy score increased after the experience whether it included the horror elements or not. In addition, when comparing the effect of the baseline environment and the experimental environment, the experimental environment with the horror mechanic displayed higher scores in the reported SE scale. In the second chart, we compiled all 14 participants' SE scores and calculated the average increase in the relative delta. Even though the chart showed differences in the changes in SE score, and 3 participants showed reversed results, 11 out of the 14 participants' results aligned with the hypothesis that the prototype helps provide the individuals with an immediate self-efficacy boost.

### SAM Scoring

Self-Assessment Manikin (SAM) [37] is a pictorial representation tool for assessing pleasure, arousal, and dominance to controlled stimulus. In this experiment, the tool is used to assess the emotions of the participants during the experiment and examined for a potential relationship between dominance level and self-efficacy score. SAM scores were recorded twice during the study from 14 participants.

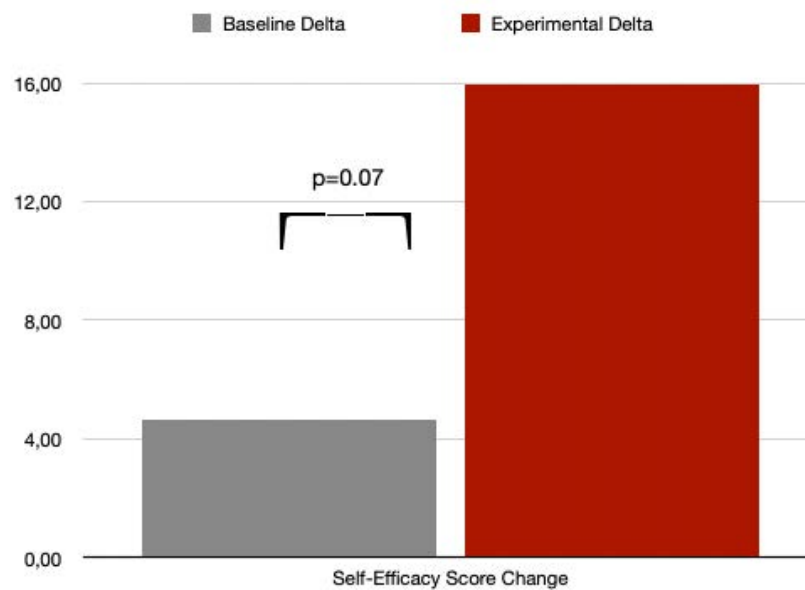


Figure 4.4 SE Score Change

Once after the 3 sessions of baseline study and once at the end of the experimental study with stimulus. From the results, we can see that, after the baseline study, participants indicated very scattered arousal levels from the experience ranging from extremely excited to very calm. For dominance level, a pattern can be seen that 13 out of 14 participants showed they felt in control of the situation with only 1 outlier data. In the experimental study with horror stimuli, the arousal level reported by the participants were more consistent. As we can see from Figure 4.5, the clutter shows that most participants were excited during the experience. Compared with the dominance level of the baseline study, the results indicated an average decrease in dominance, which means the scare-induced environment caused the participants to feel out of control.

### Morbid Curiosity Scoring

Morbid Curiosity score was also taken in the beginning of the experiment to investigate if morbid curiosity score of the individual attribute to the development of SE after the program. As an inherent personality trait, the assumption was that

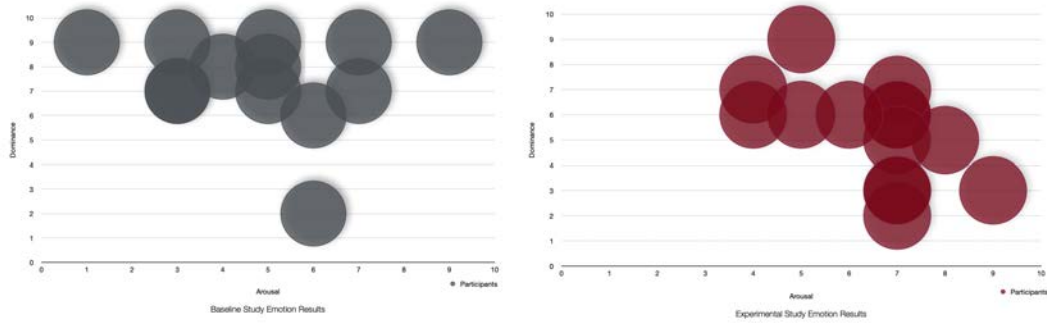


Figure 4.5 SAM distribution of all participants

more morbidly curious individuals might have more significant development in SE after the participation in the horror experience. But after comparing the result of the morbid curiosity score to the SE delta change after the experiment, there was no indication of a strong relationship between the two data sets.

### 4.2.5 Physiological Results

#### Heart rate variability (HRV)

Tracking heart-rate variability can be informative in reflecting an individual's autonomic nervous system (ANS) [38] as it regulates our physical conditions such as blood pressure and heart rate. One sub-category of ANS system named

sympathetic system (SNS) is directly linked to our fight-or-flight response under crisis or stress. In the experiment, Heart rate data was captured in each session as HRV and heartbeats per minute (BPM) <sup>1</sup>. For analysis, the HRV data was selected as it was more effective in reflecting the stress level over time of the participant. Out of the 14 participants, 50 percent of the results showed noticeable linear progression of HRV results after the final session of using the Corvus. The progression in the data can be an indicator that after the three sessions of experience, the participants can regulate their emotions better as they become calmer

<sup>1</sup> <https://elitehrv.com/heart-rate-variability-vs-heart-rate>

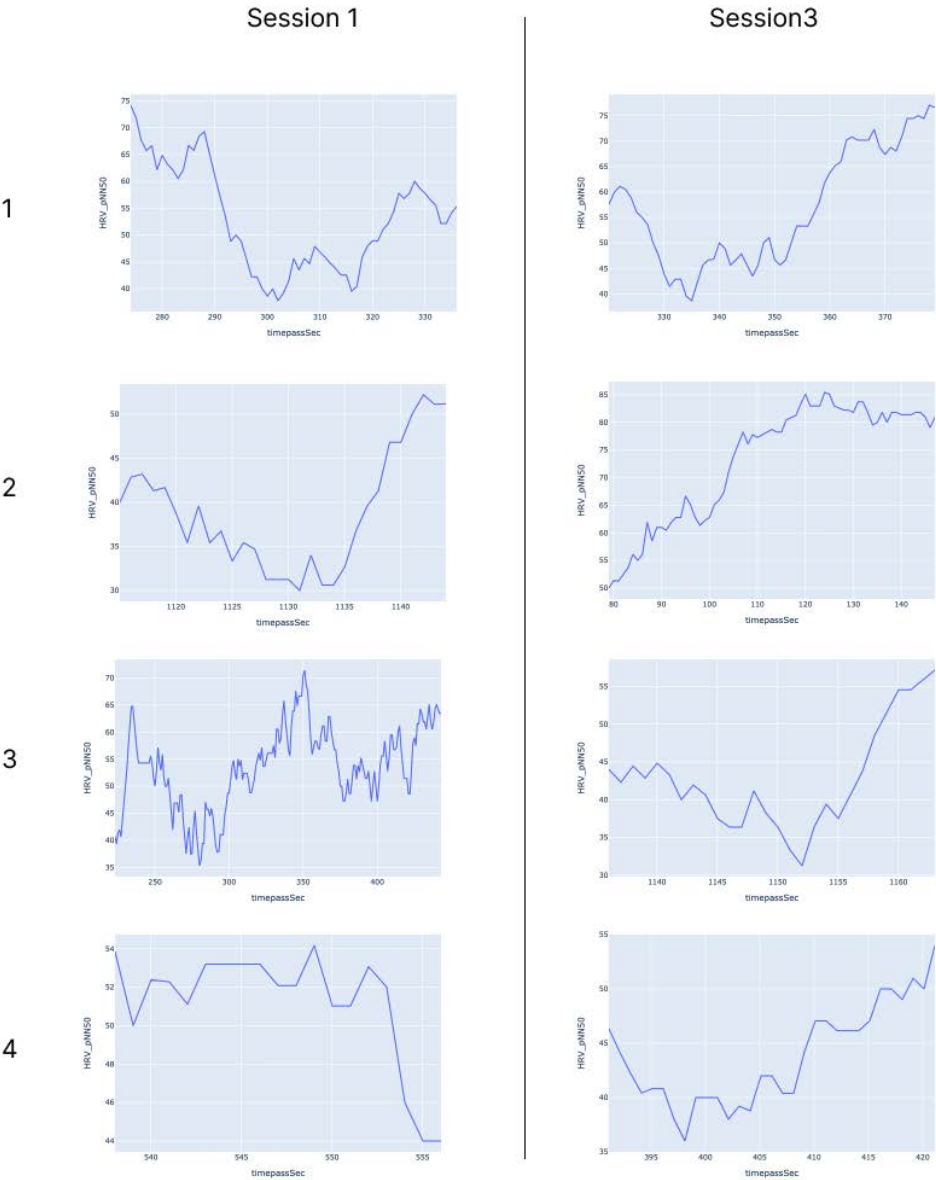


Figure 4.6 HRV Recording Comparison Between Initial Session and Final Session under The Corvus

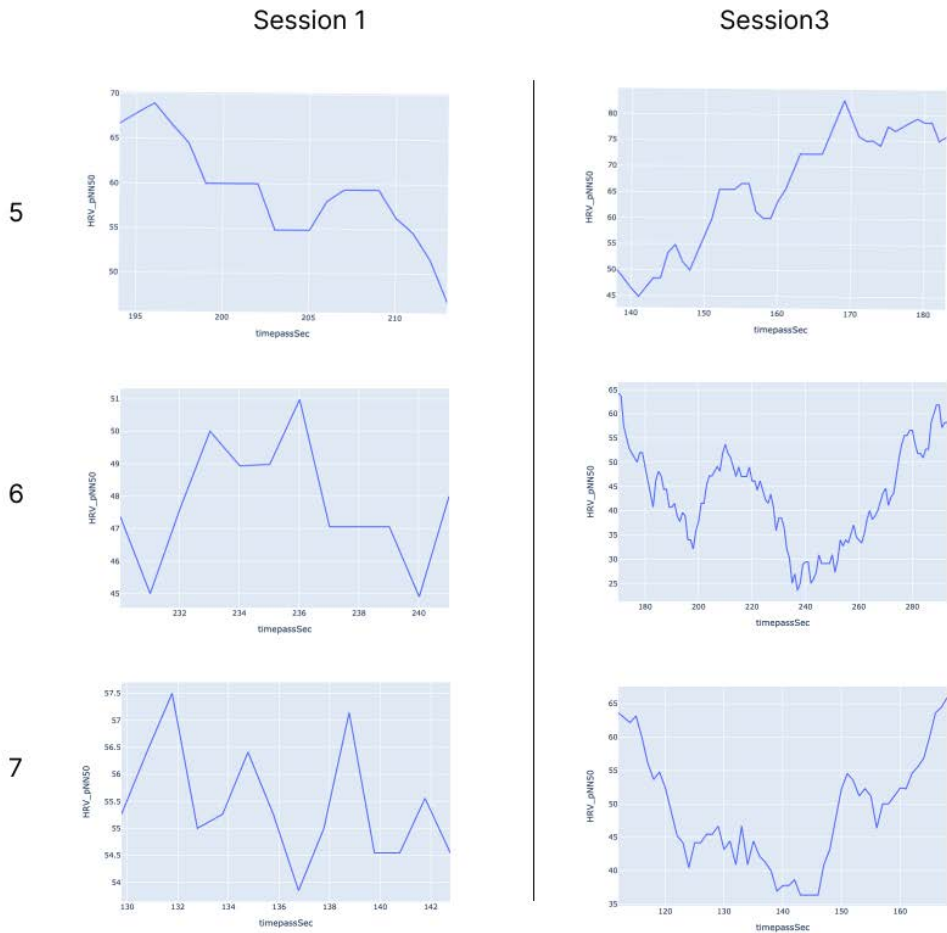


Figure 4.7 HRV Recording Comparison Between Initial Session and Final Session under The Corvus Continued

towards the end. **Electrodermal activity (EDA)** From the captured EDA data, tonic EDA was extracted for analysis. The data displayed no significant or informative pattern. Possible sensor malfunction could be present rendering this data irrelevant to the study.

## 4.3. Field Study 2 - Qualitative

Field Study 2 focuses on open discussion with the participants in the previous study. The goal of the qualitative study is to 1) find out about the lingering effect of the program 2) Allow the participants to share their experiences with each other for further insights

### 4.3.1 Participants

Same participants were asked to participate in the second field study.

### 4.3.2 The Study

The study consists of two parts. Discussion and data collection. The discussion is conducted in small groups consisting of three to four participants. It is a semi-structured open discussion regarding a) the overall perception of their self-efficacy development over the years b) sources of self-efficacy for each individual c) experiences with the Corvus d) willingness to participate in similar programs. In addition, the same NGSE scoring was taken for approximately 2 days for all participants again to observe if there is a lingering effect of the experiment.

### 4.3.3 Results

From the discussions, several participants' reports aligned with Bandura's theory [2] that self-efficacy can come from the mastery of an experience. Most of the participants shared that they felt a big confidence boost when they became better at doing a task. One specific participant used the example of weight-lifting as an example when he lifted much higher weights than expected. However, participants also expressed the difference of perceived self-efficacy being drastically



Figure 4.8 Open discussion of the participants



different in various scenarios. Several of them agreed that they have a self-efficacy boost when the scenario is associated with a rewarding purpose. When discussing their experience of the Corvus, one participant specifically mentioned that the experience was scary but it was also empowering as the scary element gave the power to go through the experience. Another insight was that Several participants mentioned that the scariest part of the environment was the audio stimulus. Especially a male coughing sound effect triggered a strong fear response in most of the participants. 10 out of the 14 participants also expressed that they are willing to try a higher level of horror than they believe they can endure if the experience would yield an increase in self-efficacy. When asked if they are interested in participating in similar programs. The participants all showed interest except for one participant not believing the experience would help in self-efficacy development.

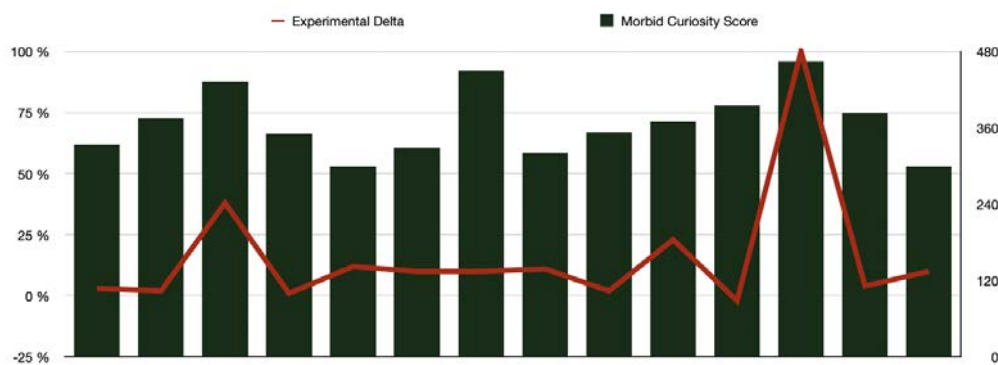


Figure 4.9 Comparison of Morbid Curiosity Score to Self-Efficacy Change

In addition, as we can see from the scoring of the NGSE, the answers showed noticeable improvements in 8 self-perceived self-efficacy levels compared to the immediate score after the experiment. However, it could be due to other events that might have contributed to the increase in the score.

## 4.4. Discussion

From the overall gathered results from all the studies, we compiled all 14 participants' SE scores and calculated the average increase in the relative delta. The result showed differences in the changes in SE score, positively, 11 out of the 14 participants' results displayed various levels of increase in SE score. After performing a T-test, the participants demonstrated no significantly better self-efficacy scores,  $t(14)=-1.52$ ,  $p=0.07$ . The result is not significant at  $p < 0.05$ . The main takeaway from the qualitative research is that fear could be a driving force for people to overcome perceived mental obstacles. Participants also indicated potential rewards such as self-efficacy boosts can increase their tolerance for the level of horror they are willing to go through. Therefore, with a higher fidelity of the system and a larger sample of participants observed over a longer period. Potential VR applications can be developed for commercial download and use at home for audiences who are interested in building self-efficacy and self-development.

# Chapter 5

## Conclusion

The final prototype of the Corvus presents an attempt to use horror virtual reality to assist individuals in developing their self-efficacy for daily life. How individuals process and respond to cues of a novel threat in their environment can be related to their level of self-efficacy, the hypothesis is that systematic exposure to such controlled threat in virtual reality can increase self-efficacy capacity. Through designing a system of horror experiences in VR, the effect of such a hypothesis was tested at a relatively small scale.

From the combined results in the previous section, the system has displayed some level of potential to aid the individual's development in self-efficacy. But there are still factors to be considered to validate the hypothesis. For example, the capacity of self-efficacy is still situation specific. The tool can only assist to a certain extent in general SE development but can still be limiting in specific situations.

### Future Work

Due to the limited time and resources, there are still vast opportunities and challenges to be explored. Interesting directions can be taken in the future to expand the study of this particular premise. There are three main directions of enhancements we would like to explore in future studies.

- Cross-modality stimulus

Now the horror stimulus most come from the built-in output of the VR headset. Visual and audio stimulus were incorporated for the experience. However, more sensory stimulus could be potentially influential for the effectiveness of the horror inducing tool. For example, haptic-thermal feedback could provide a more immersive environment for testing.

- Real-time biofeedback adjustments

As discussed in related works, real-time biofeedback can not only make the content more engaging, but also lead to a more tailored experience for the users. Physiological data feedback for the user can also affect the user's perception and emotions in the experience as possibilities opens up for more controlled condition of horror elements.

- Personalisation of experience

The last direction for future study is to build a more extensive horror component library for scenario building. The elements such map design, ambient effects, sound effects, horror figures can be developed based on various criteria for a more systematic way of constructing scenes therefore giving more progra variations based on participants personal preferences.

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