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Master's Thesis
Academic Year 2021

Companion: Tangible Object to Reduce Anxiety towards Fear Triggered in Virtual Horror Experience

Keio University
Graduate School of Media Design

Jie Lu

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

Jie Lu

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Abstract of Master's Thesis of Academic Year 2021

Companion: Tangible Object to Reduce Anxiety towards Fear Triggered in Virtual Horror Experience

Category: Design

Summary

Virtual horror experience dedicated to induce fear emotion is popular among large group of people, with virtual threats which rarely appear in daily life that drive thrills and cause physiological and behavioral fear reactions. Though many people enjoy virtual horror experience, some people who are interested in it are too scared to try out the experience or bothered by anxiety caused by fear. This study proposes the design of "Companion", a comfort object with soft texture, attached light breathing guidance, heating pad and steady heartbeat sound. Its purpose is to help users reduce their anxiety level by providing guidance in deep breathing, thermal feedback and comforting experience. A user test conducted revealed that the prototype of "Companion" had significant effect in reducing state anxiety level when participants used it while playing a short horror game. The appearance and functions were positive in helping people calm down after their fear emotion was triggered.

Keywords:

fear, horror game, comfort object, anxiety, human computer interaction

Keio University Graduate School of Media Design

Jie Lu

Contents

List of Figures

List of Tables

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Chapter 1
Introduction

1.1. Research Background

"Aaaaaaaaaaaah, don't come closer to me! I can't do this anymore!" When encountering a jump scare or a monster in a horror game, many of my friends react intensely even when they are aware that they are facing virtual threats. Horror games, along with horror movies and shows, are media genre dedicated to induce fear emotion. Their popularity among the world is driven by thrills that people feel when they experience fear, which rarely appears in people's daily life. The acceleration of breath and heart rate, goosebumps on the skin, nightmares and "butterflies in the belly" are various responses triggered when we have frightening experience. Yet many enjoy this kind of experience, some people feel uncomfortable and refuse to make more progress on the experience after several trials. Players who consider horror games are too frightening would prefer to watch online streaming or play-through than experiencing horror games by themselves.

Many previous studies of fear emotion and virtual horror focused on seeking possible approaches to create more intense, scarier experience in video games, horror movies and other virtual horror media. Taking the approach from another angle, I propose this design to help people reduce their anxiety caused by fear.

1.2. Motivation

With the design of this comfort object, I want to help people to reduce their anxiety level caused by fear triggered in mediated environments, especially jump scares. I also want to make horror media more accessible for people to help them gain increased capacity to fear, so they can react and cope more effectively to fear.

1.3. Concept

The concept of "Companion" is a soft and huggable comfort object, equipped with LED lights emitting in a pattern with speed of deep breathing, heating pad serving as thermal-feedback and ambient sound of steady heartbeat. The goal of my concept is to create a non-intrusive, comforting experience for users during virtual horror experience.

Figure 1.1 Companion

1.4. Contributions

1.4.1 Pre-study

In the early stage of this study, a pre-study was conducted to explore the relationship between people's eye blink rate and fear emotion among 8 subjects. This study indicated that their eye blink rates were higher when they felt scared when watching a horror game play-through. Individual differences in fear reactions were

also discovered. Some people were very scared and they closed or covered their eyes, while some others enjoyed it a lot and smiled (Figure 1.2).

Figure 1.2 Pre-Study

In the current study, a prototype of "Companion" was applied in a user study involving 8 participants. It was tested to be effective in reducing users' state anxiety level when they played a short horror game.

1.4.2 Main Contributions

This study's main contributions are listed as follow:

- Present potentially effective stimuli to trigger fear emotion in mediated environments
- Explore people's physiological and behavioral responses during virtual horror experience
- Present the approach of a comfort object with breathing guidance and thermal-feedback functions for people to cope with fear

- Test the feasibility and effects of this design for users to reduce their anxiety level during virtual horror experience

Chapter 2
Related Works

2.1. Fear

2.1.1 Fear in Real Environment and Mediated Environment

Our emotions prepare us for action. Fear is an emotion induced by perceived danger or threat from environment. It has a strong function that elicits a distinctive physiological and psychological response. The physiological reaction elicited by fear can be defined as "fight or flight" response, including the acceleration of respiratory rate and heart rate, increase of muscle intensity and sweating. In addition to real environment, similar reactions towards danger and threat are also found in mediated environment. Psychological research has discovered that analogous stimuli in mass media contents will evoke similar but less intense reactions than real stimuli, which is defined as stimulus generalization [1]. Fright experience can be depicted as stimulus-evoked experience.

2.1.2 Fear Stimuli

Fear stimuli in virtual horror environment can trigger fear emotion, in horror media like horror games and horror movies, they usually appear as visual or audio forms. Fear stimuli may differ for each individual, some are more sensitive to certain fear stimuli while some others may not find it scary. But common fear stimuli were identified in some fear related studies. Darkness, disfigured humans, zombies are top mentioned fear stimuli in a report of 265 students [2].

2.1.3 Fear Induction in Video Games

Under the mediated context, contemporary entertainment media forms have been effective in inducing fear with visual and auditory stimuli in high fidelity [3]. Movies, video games and virtual reality are three most common media that can simulate real life events and present unnatural life-like events to elicit horror experience. The fear experience induced by these three types of media differs based on the level of interactivity. In horror movies, audience are exposed to stimuli from a limited, third-person point of view, and experience fear in a character alike way, resulting an indirect fear response. While in video games, players have control over their virtual character and engage in the story on their own. A study of fear experience in horror game indicated that interactivity is a prominent factor correlating with fear in video games [2]. Besides engagement, VR provides immersive simulated experience by covering players' vision with headsets. By examining the fear of place illusion (PI) and the plausibility illusion (PSI) in VR, a study showed that VR can provide effective approach to simulate close-range threats that induce fear and determine how people react and cope with such stimuli [4]. The therapeutic use of VR has also been applied in exposure therapy for phobias by exposing subjects to fear-inducing stimuli [5].

2.2. State Anxiety

2.2.1 State Anxiety and Fear

State anxiety can be defined as a temporary emotional state of intense and nervous feelings, and physiological reactions such as an increased heart rate or respiration [6]. Fear about a particular situation or activity can be characterized as state anxiety. Fear and anxiety are relevant in arousal body state [7].

2.2.2 Measurement Tool for Fear and Anxiety

There are many validated scales and standard questionnaires regarding fear in psychological researches, such as Fear Questionnaire (FQ) and the MPQ - Harm Avoidance Scale. However, most of the scales and questionnaires are related to

fear in long-term situations and trait fear such as phobia, or concerns with mental health studies on social disorder.

Since this study's focus is on short-term fear induced at the present time, FQ and MPQ will not be applicable for measuring fear level in this case. Thus, in order to evaluate fear as an emotion state, a validated scale related to state will be introduced.

The Spielberger State-Trait Anxiety Inventory (STAI) is one of the most commonly used measures for state and trait anxiety in many applied psychological researches. The original STAI was developed by Charles Spielberger, R.L. Gorsuch, and R.E. Lushene, and was tested valid and reliable. The main objective was to develop a scale to distinguish between state anxiety and trait anxiety. The standard STAI contains two questionnaires with 40 items in total, which assess state and trait anxiety separately. The State-anxiety scale will only measure state anxiety (temporary mental state influenced by the current situation, the respondent reports feelings at the moment); while Trait-anxiety scale will only measure trait anxiety (general tendency of anxiety, the respondent reports general feelings). Each scale has 20 items based on a 4-point Likert scale. The scoring of each scale ranges from 20 to 80, and higher scores relate with higher level of anxiety.

2.3. Deep Breathing

2.3.1 Breathe to Ease Anxiety

Deep breathing has been widely adopted as a method of reducing stress and anxiety [8], especially in the cases of panic attacks. It can stimulate the vagus nerve and help reduce the "fight or flight" response, which is the fright response caused by fear. Deep breathing can also reduce heart rate and blood pressure and help achieve a reduced anxiety state.

2.3.2 Breathing Patterns

Deep breathing can be executed in many kinds of techniques, aiming to reduce anxiety level to help people fall asleep or concentrate better. It is also applied in mindfulness meditation to focus on breathing [9]. The deep breathing technique

this study adopted is box breathing, or square breathing. It requires breathing in for 4 seconds, then holding breath for 4 seconds, and slowly breathe out for 4 seconds[1](Figure 2.1).

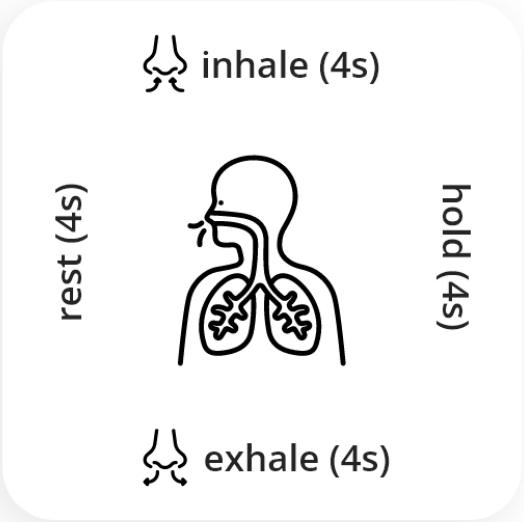


Figure 2.1 Box Breathing

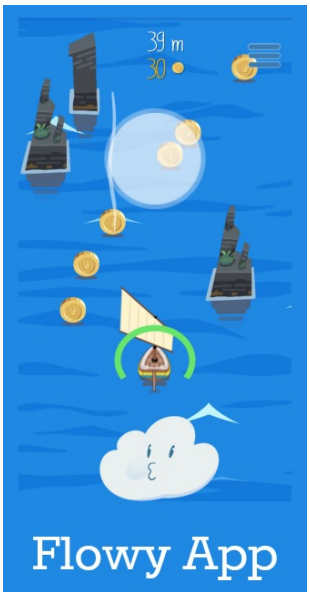
2.3.3 Breathing Guidance Examples

Deep breathing guidance are commonly provided as visual and audio guidance in the form of picture, animations, white noise with voice-over, interactive applications, and games, etc.

For example, Flowy is a mobile game application aims to help people achieve immediate relaxation by breathing exercise. Its breathing speed can be customized

1 Box Breathing
`https://www.healthline.com/health/box-breathing`

to suit individual needs(Figure 2.2)[2].



(Source: "Flowy Beta." One Mind PsyberGuide)

Figure 2.2 Flowy App

2.4. Comfort Object

Comfort object is an item used to provide psychological comfort [10], especially in unique situations. It is commonly used by children in the form of teddy bears or security blankets. Adults use comfort objects, too. They can give psychological strength and help with people's capacity to be alone.

2 "Flowy Beta" One Mind PsyberGuide
`https://onemindpsyberguide.org/apps/flowy/`

Chapter 3
Design and Methodology

3.1. Design Proposal of Companion: Overview and Concept

Driven by my motivation to reduce people's anxiety level when fear emotion is triggered, and help people cope with fear in virtual horror media environment, I propose the design of "Companion". "Companion" is an interactive comfort object with round shape and soft texture, equipped with visual and audio breathing guidance to assist people adjust their breathing rhythm to a more steady and calm pattern, and uses thermal-feedback to comfort people when they have chilly feel due to fear.

The concept of the name "Companion" is inspired by a description shared by many of my friends who consider themselves "weak" at virtual horror experience. They would prefer to try out this genre of contents only when someone is around, because the existence of someone's company gives them a sense of safety. It also derives from the context of social distancing during the Covid-19 pandemic. People spend more time at home nowadays than before, which leads to more cases of experiencing media contents alone. When close social contact is becoming less accessible, a comfort object can serve the role as a companion to soothe people's nerves during a virtual journey of perceived dangers.

3.2. Target Users

The target user group of this design are people who have interests in virtual fear experience, but can't participate or make more progress in the journey because they are too scared. Especially when they are alone, "Companion" can accompany

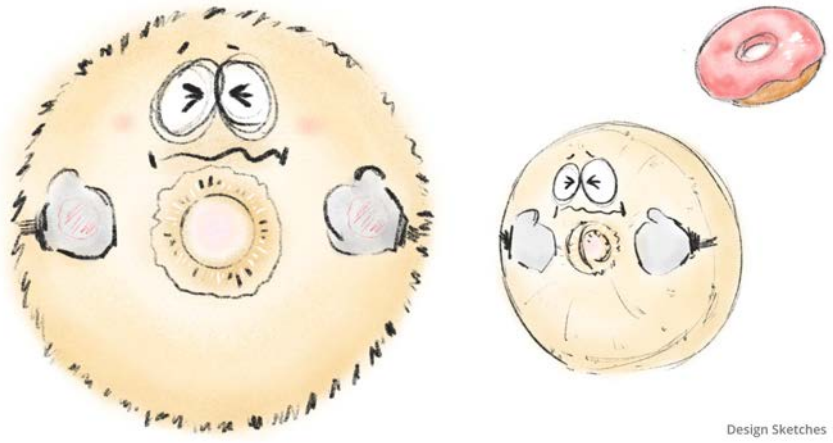


Figure 3.1 Design Sketches

them when they are scared.

3.3. Prototype

The design prototype of “Companion” is a cushion with donut alike shape that can fully fit in an adult’s arms. It supports visual breathing guidance and thermal-feedback, and it is powered by USB(5V) through cables and activated by an attached switch.

3.3.1 Aesthetic Design

Since ”Companion” is a comfort object that will have close body contact with users, the design of its overall appearance is crucial to establish emotional comfort for users and create smooth user experience. The objective is to design features that can help generate positive emotional responses and ease negative emotions.

Earlier Concept

The earlier concept of the appearance of "Companion" is a heart-shaped pink plush that can be held easily in people's arms when they are playing video games or watching videos. It has eyes to resemble human-like appearance and two arms equipped with sensors.

The final prototype resembles and keeps main traits of from this early concept, and is modified in appearance and functions to suit in real-life situations better.

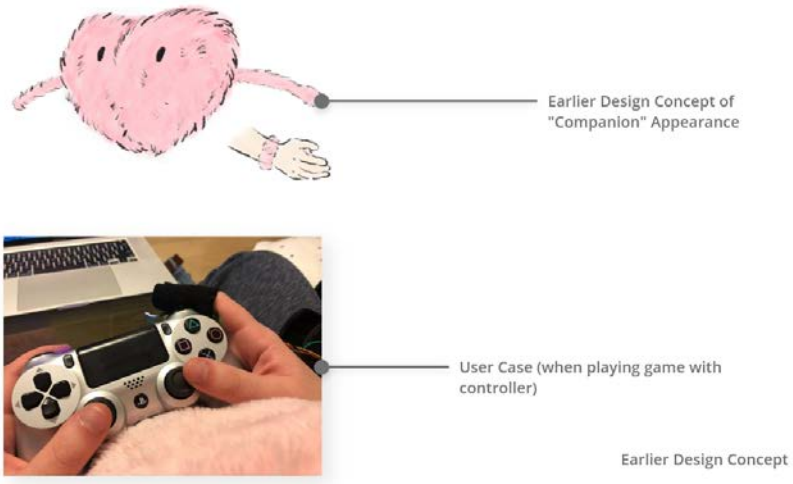


Figure 3.2 Earlier Design Proposal 1

Design for Touch: Shape, Size, Texture and Color

In psychological studies, simple geometric shapes were discovered to convey emotional meanings. Round, curvy lines and shapes tend to be associated with positive and pleasant emotions [11]. Apart from visual perception, the shape of a design object also affects the way users physically interact with the object. Thus, a rounded, circle shape is proposed to associate the experience with the sense of harmony and protection, and to be held in human arms in a smooth way. The diameter of outer circle of the prototype is around 45 centimeters(Figure 3.6).

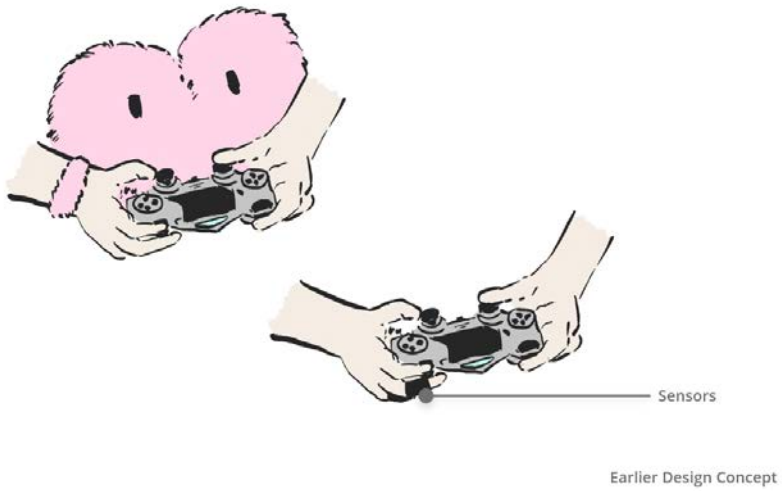


Figure 3.3 Earlier Design Proposal 2

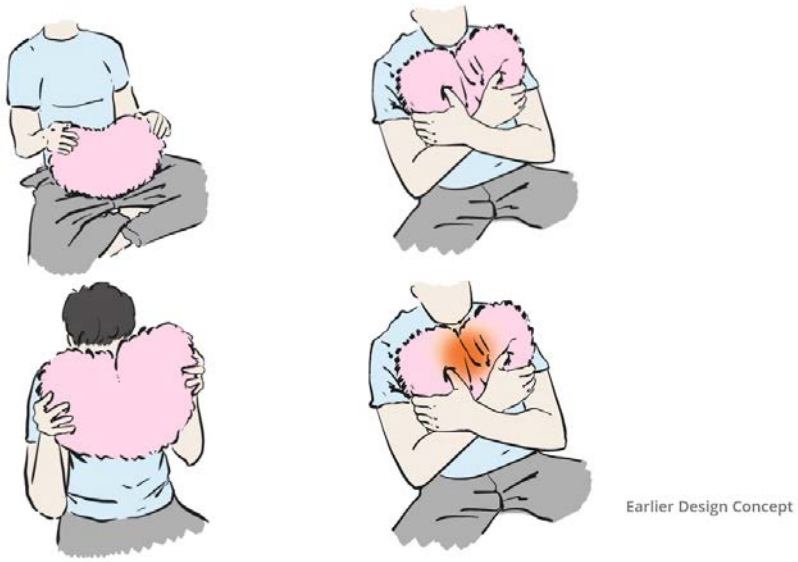


Figure 3.4 Earlier Design Proposal 3

Figure 3.5 Curvy Shape of Companion (3D render)

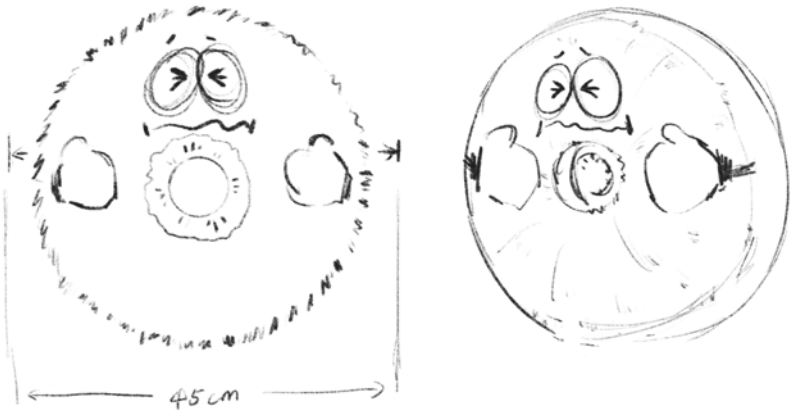


Figure 3.6 Shape and Size of Companion

The prototype's texture is determined from a series samples of texture materials (Figure 3.7). The ideal texture would be described as soft, fluffy and comfortable to grab, and it is expected to be associated with warmth.

Similarly, the color of the prototype is cream white, in accordance with the design theme of forming a comfortable experience.

Figure 3.7 Texture of Prototype

Design for Visual: Anthropomorphic Appearance

On top of the main cushion structure, a cartoon style facial expression is attached, which conveys the virtual character of "Companion". The face consists of downward eyebrows, closed bubble eyes and a wave-shaped mouth. It is associated with the facial expression people make when they experience fear: they feel intense and close or cover their eyes to avoid seeing the scary contents(Figure 3.9).

The eyes of "Companion" are designed in a cartoon style because they have less details than realistic style of eyes, which is widely used in animations(Figure 3.3.1)[1].

1 CARTOONY EYES – HOW TO Olivier Ladeuix
http://www.olivier-ladeuix.com/blog/2016/10/19/cartoony-eyes-how-to/

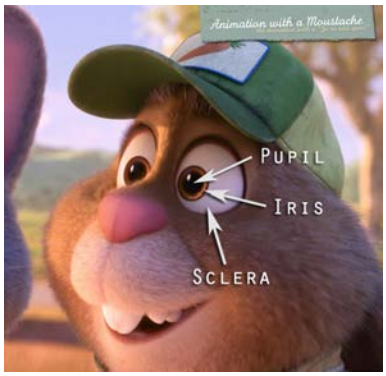


Figure 3.8 Cartoony Eyes Design Reference: Zootopia Character Eye Anatomy
(Source: CARTOONY EYES – HOW TO by Olivier Ladeuix)

Figure 3.9 Comparison of Companion with Screenshot of Facial Expression During My Previous Experiment of Fear When Viewing Horror Game Play-through

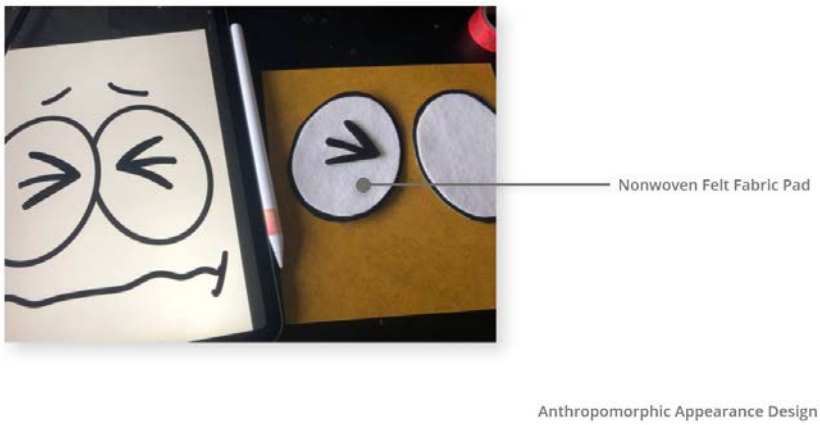


Figure 3.10 Anthropomorphic Appearance Design

3.3.2 Function Design

Earlier Concept of Breathing Guidance

In the early stage of this study, the concept of an on-screen, pop-up breathing guidance was developed. When the user is playing a game or watching a video, if he/she experienced scary contents such as jump scare, the fear emotion is induced and the reading of the user's heart rate goes up or has significant changes, a visual breathing guidance will appear on the screen, overlapping the media contents. The user can follow the animation of a lung to adjust their breathing. The demonstration of this function was simulated in a play-through of a survival horror game *Outlast 2*(Figure 3.12).

Figure 3.11 Screenshot from Survival Horror Game *Outlast 2*: Jump Scare

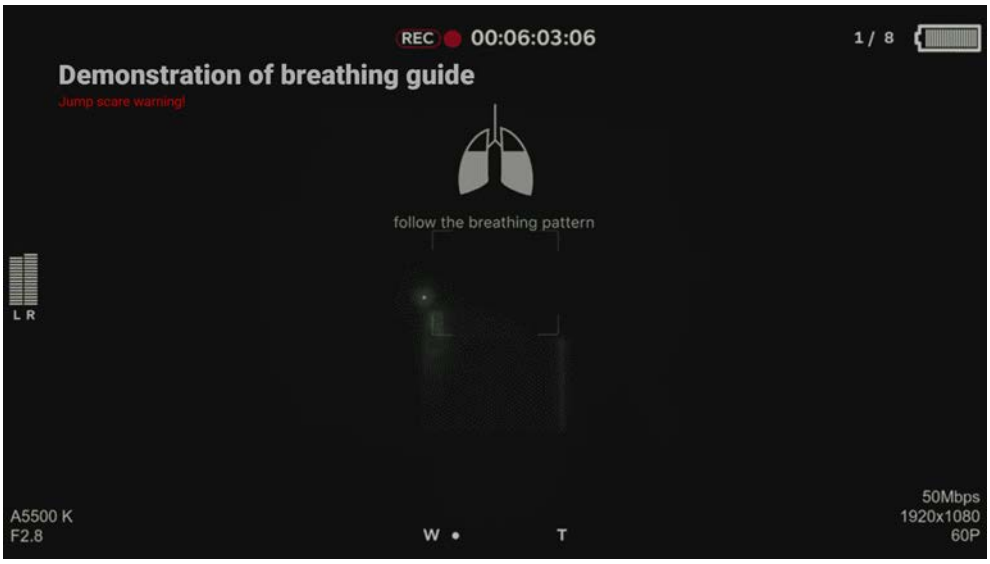
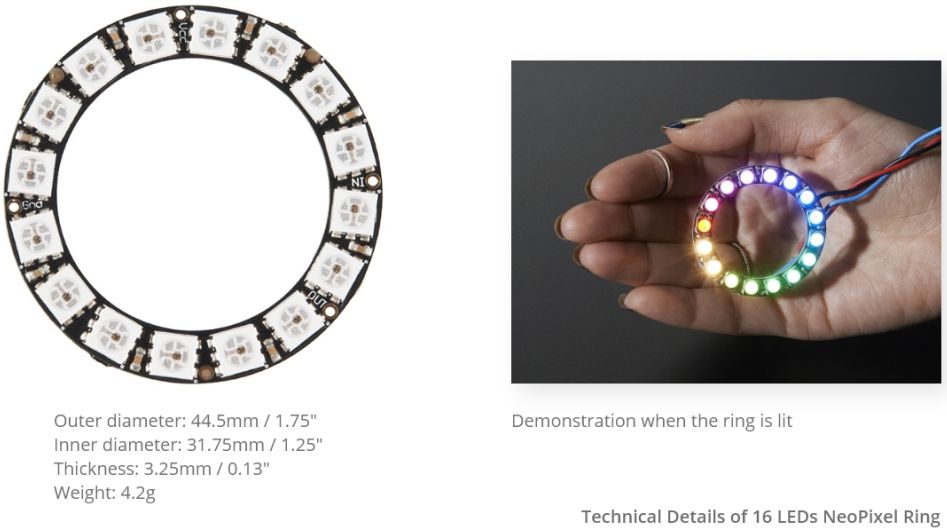


Figure 3.12 Visual Breathing Guidance Proposed in Earlier Concept

Breathing Rhythm Guidance: LED

A 16-LED NeoPixel ring[2] is placed in the center of "Companion" prototype as a visual breathing guidance. When it is activated, the LEDs will glow one by one in the ring circle in a counterclockwise manner, and with an 180-ms interval delay of transition. After every LED is lit, the LEDs will be turned off one by one at the same speed. The whole cycle will repeat until it is switched off(Figure 3.14).



(Source: NEOPIXEL RING - 16 X 5050 RGBW LEDS W/ INTEGRATED DRIVERS Descriptions from Adafruit Website)

Figure 3.13 Technical Details of 16 LEDs NeoPixel Ring Used As Breathing Guidance

The glowing process serves as visual guidance for users to take in and hold breath, while the off process is associated with breathing out. The speed setting

2 NeoPixel Ring - 16 x 5050 RGBW LEDs w/ Integrated Drivers - Natural White `https://www.adafruit.com/product/2855`

is based on the square breathing pattern, creating a simulation of breathing effect with light.

While the original concept is to use the LED ring to perform a visual guidance similar to a circular progress bar, so that users can recognize the pattern more intuitively. However, the brightness of the LED ring is quite strong that it might cause eye fatigue. In this case, a thin layer of white polyester fabric is attached above the LED ring to soften the light, which creates a sense of gentleness both in visual and touch.

Figure 3.14 LED Breathing Guidance Demonstration

Thermal-feedback: Heating Pads

The second primary function of "Companion" is providing thermal-feedback. When the user's fear emotion is triggered, he/she is perceived to experience a feeling of "chill in the spine" or coldness, this function can provide a warm touch when human skin is in contact with the surface of the heating pad areas.

There are two areas of the prototype that can release thermal-feedback, which consist of two parts: heating pads powered by USB (5V) and two layers of non-woven felt fabric pads. The heating pads are modified from heating gloves for mo-

tor bikes, and can be heated up within 30 seconds to one minute when connected to a power source. If the heating pads are not covered, the direct contact between human skin and heating pad might cause low-temperature burns due to low heat contact (40-60℃) in a period of time. In order to prevent low-temperature burns, two layers of non-woven felt fabric pads are attached to the surface of the heating pads to avoid direct heat contact.

The placements of the heating pads are on the front side of "Companion", positioned symmetrically on left and right sides of the donut-like shape structure (Figure 3.16). The purpose behind the positions is to enable users to reach the heating areas with their palms or skin on forearms without extra efforts.

Figure 3.15 Thermal-feedback Prototype

Audio Ambient Guidance: Heartbeat Sound

An audio track of steady human heartbeat (60bpm) will be played from speakers to create an ambient environment for users to calm down.

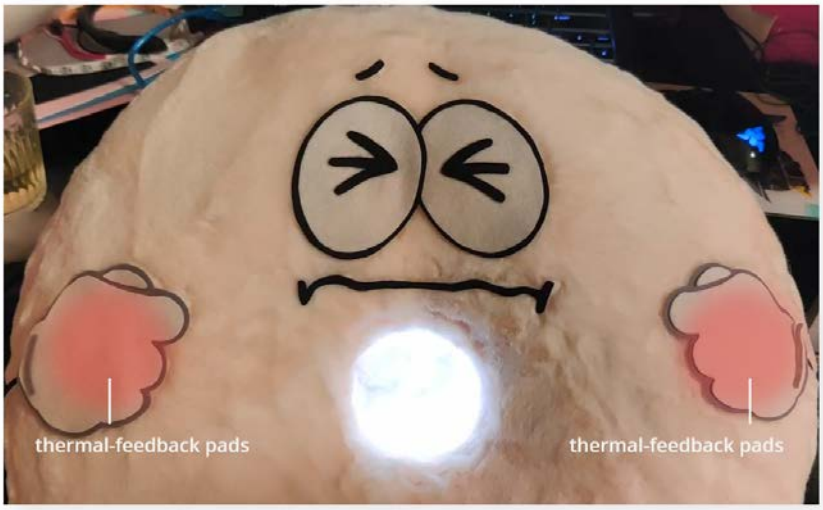


Figure 3.16 Position of Thermal-feedback Pads

Activation

In earlier concept, the activation of breathing guidance and thermal feedback will be triggered by a detected significant rise of heart rate(Figure 3.17), based on observation of correlation of heart rate increase and fear in related studies. However, the heart rate variability and sensitivity to fear stimuli differ a lot from each individual, thus leading to difficulty of normalizing the average heart rate and heart rate increase. At current stage, a switch to turn on and off the functions of "Companion" is adopted as activation.

3.3.3 User Cases

"Companion" can be placed in different positions depending on users' needs, and it can be used in various contexts of virtual horror media environment. In most cases, the user is presumed to use "Companion" while he/she is sitting, since in most of the virtual horror experience, players or viewers interact with the media while they are sitting.

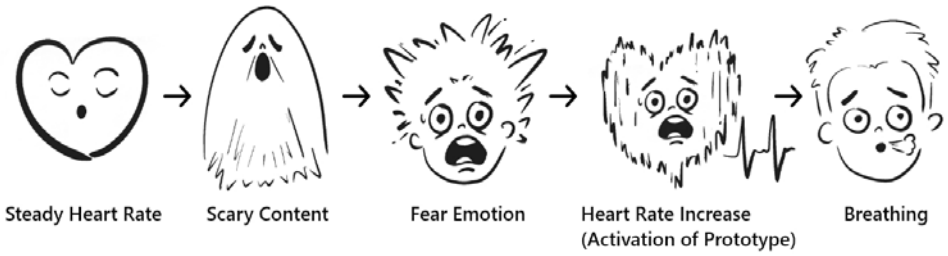


Figure 3.17 Earlier Activation Explained

When the user is playing a horror game, on one hand, he/she can hold "Companion" under arms, with arm's skin touching heat pad and LED breathing guidance in sight; on the other hand, the "Companion" can be wrapped around by the user's arms, the user can grab or squeeze "Companion" when they feel scared. The use of "Companion" can cover most of the game-control contexts, including keyboard and mouse, game console controllers and Virtual Reality controllers. When the user is playing game in Virtual Reality, even though the visual guidance is blocked due to the VR headset, the breathing guidance will still be available through audio, and he/she can feel the physical touch of the "Companion". However, the use of "Companion" is not applicable in some Virtual Reality gaming contexts when the user is required to stand and hold the controllers in both hands during gameplay, because the physical interaction with "Companion" is not available in this situation.

When the user is watching horror movies, series or any similar video media format, "Companion" can be held in the user's arms in more ways, since the user's hands are not occupied by other tasks like holding the controllers. The user can lift up "Companion" to cover their eyes when he/she sees scary contents, and the user can grab the soft surface of "Companion" when their intense emotion is triggered, especially during suspense and jump scare situations.

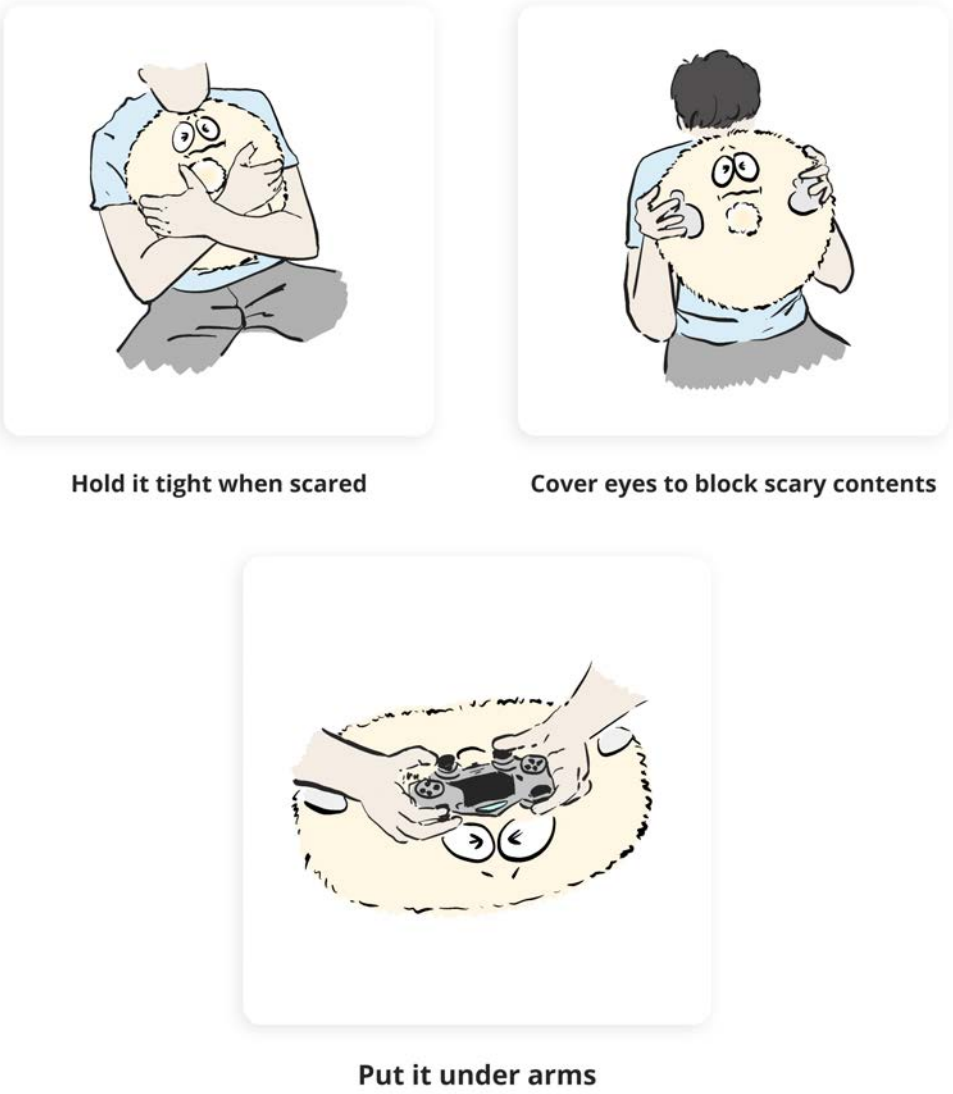


Figure 3.18 User Cases

Figure 3.19 Demonstrations

3.4. User Test

A user test is conducted to test the performance of "Companion" and collect feedback on user experience. The purposes and setup are listed as follows.

3.4.1 Purposes

- Learn about what will induce user's fear emotion and when will fear be induced
- Observe how users will interact with the prototype
- Test if the prototype is effective in reducing state anxiety and which parts of the prototype are effective
- Learn about the possible improvement of this design

3.4.2 Setup

Prepared Documents

- Research Participation Agreement
- Control Guidance for Gameplay
- Pre-gameplay Questionnaire
- Post-test Questionnaires (STAI-6)
- Semi-structured Interview Questions

Devices

- Laptop for filling out questionnaires and playing the game
- Laptop for collecting physiological data
- Heart Rate sensors
- Prototype

- Timer
- Camera

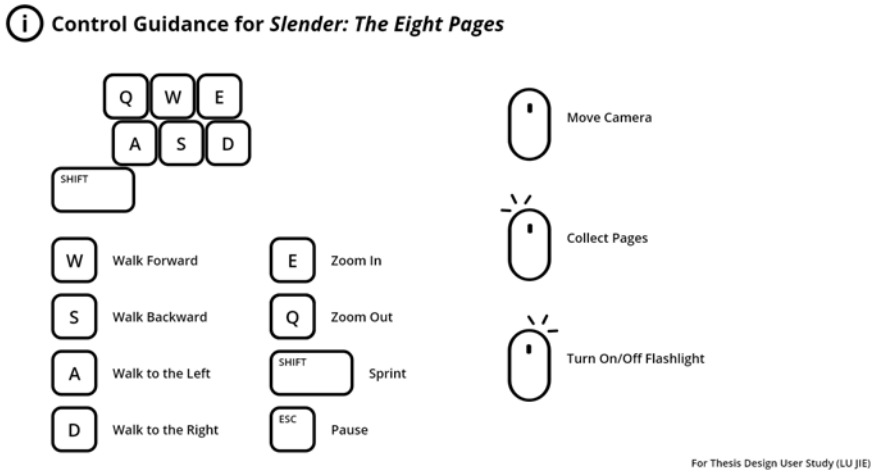


Figure 3.20 Control Guidance Provided in the User Test for the Game: *Slender: The Eight Pages*

3.4.3 Process

1. The user will be given a brief description of the user test process and contents, fill out the Research Participation Agreement to provide their agreement to participate in this user test and understand the potential risks of this test. The user is also notified that he/she can pause or stop the gameplay or terminate the test process if he/she feels uncomfortable.

2. The user will fill out a pre-gameplay questionnaire to provide basic information (name, age, gender, etc.) and report past video game experience and virtual horror experiences.

3. The user will be given a brief introduction of the game and a keyboard and mouse control guidance for the gameplay. At the same time, the user will

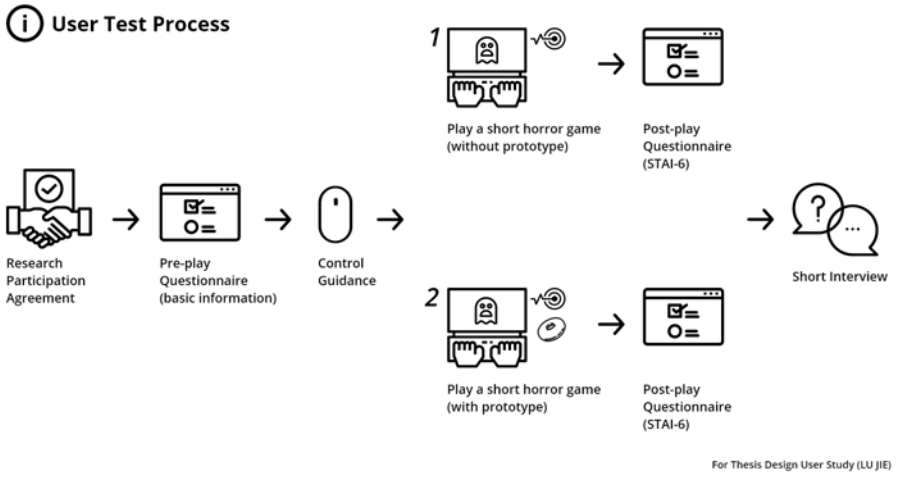


Figure 3.21 Process of User Test Explained in a Chart

wear the sensors and be checked if the data is synced. A one-minute break will be taken before playing the game.

4. The user will play a short horror game called *Slender: The Eight Pages* while wearing the sensing device to record and monitor heartbeat. The time of gameplay will depend on the user's decision. If the user feels the game is too scary to continue, the gameplay can be stopped.

5. After playing the game for the first time, the user will fill out a post-gameplay questionnaire (STAI-6) to report their current emotion state. Then the user will take a 5-minute break.

6. After the break, the user will be given the prototype and a brief introduction on how this prototype works. The user will play *Slender: The Eight Pages* again while wearing the sensing device, and holding the prototype at the same time. The time of gameplay will depend on the user's decision. If the user feels the game is too scary to continue, the gameplay can be stopped.

7. After playing the game for the second time while using the prototype, the user will fill out a post-gameplay questionnaire (STAI-6) to report their

current emotion state.

8. In the end, the user will take a short semi-structured interview (around 10 questions) to report their experience and feedback on using the prototype.

Furthermore, the order of Step 4 and Step 6 (Condition 1 and Condition 2 in the process chart) in the user test process will be reversed for half of the participants, in order to avoid the order effects in the user test.

3.4.4 Description of Contents and Methods Used in the User Test

Slender: The Eight Pages

Slender: The Eight Pages is a short first person perspective horror game released in 2012. It is developed by Parsec Productions with Unity engine. The game is set in a forest at night, and the player's objective is to collect eight pages scattered in the forest without being caught by Slender Man, a scary character(Figure 3.23). As the game proceeds, Slender Man will creep closer to the player and cause a static on display with a loud eerie sound, which combined together will cause a jump scare. The player only has a flashlight as equipment, which can be turned off and on through mouse.

Slender: The Eight Pages is chosen to be the horror game for this user test because it is a non-linear structure, which allows the player to explore the game without repeating the same content every time. It has a relatively short game flow and a small map, and the background setting of the game is simple which does not require long introduction beforehand. Despite its short story, it contains several stimuli that can induce fear emotion in players, one of the major fear stimuli is jump scare, along with scary contents reported by people in previous virtual fear researches [2], such as darkness, eerie sound, music and disfigure humans.

Six-item State-Trait Anxiety Inventory (STAI-6)

This study will adopt the State-anxiety scale in STAI to assess state anxiety, which is co-related with state fear. However, instead of using the current 20-item scale, this study will apply a standardized short-form of STAI, which is known as

Figure 3.22 Screenshot of the environment in *Slender: The Eight Pages*

Figure 3.23 Screenshot of Slender Man in *Slender: The Eight Pages*

Six-item State-Trait Anxiety Inventory (STAI-6). It was developed by Theresa M. Marteau and Hilary Bekker, with six items chosen for reliability and validity, and it produces similar scores compared with those in full 20-item STAI State-anxiety Scale. With this brief scale, the response rate increased and response errors were reduced, as well as the time consumed in taking the questionnaire [12].

306 *Theresa M. Marteau and Hilary Bekker*

Appendix A: Self-evaluation questionnaire (Y-6 item)

Name ..... **Date** .....
A number of statements which people have used to describe themselves are given below. Read each statement and then circle the most appropriate number to the right of the statement to indicate how you feel right now, at this moment. *There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.*

	Not at all	Somewhat	Moderately	Very much
1. I feel calm	1	2	3	4
2. I am tense	1	2	3	4
3. I feel upset	1	2	3	4
4. I am relaxed	1	2	3	4
5. I feel content	1	2	3	4
6. I am worried	1	2	3	4

Please make sure that you have answered *all* the questions.

(Source: The development of a six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory (STAI) [12])

Figure 3.24 A six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory (STAI) developed by Theresa M. Marteau and Hilary Bekker

Latin Square Design and Order Effect

Latin Square Design is adopted in this user test setup as a research methodology. It is often applied in experiments in which a researcher has two sources of variation in a research to control [13]. Test subjects are given conditions over a certain time period where time is considered to have a major effect on the experimental result [14].

Table 3.1 Application of Latin Square Design in User Test Process by Chaning the Order of Two Conditions for Each Participant

Participants	**First Order**	**Second Order**
1	Condition 1	Condition 2
2	Condition 2	Condition 1
3	Condition 1	Condition 2
4	Condition 2	Condition 1
5	Condition 1	Condition 2
6	Condition 2	Condition 1
7	Condition 1	Condition 2
8	Condition 2	Condition 1

In this user study, participants will go through the short horror game under two conditions, as shown in the *User Test Process Chart* (Figure 3.21): Condition one, the user play the horror game without using the prototype; and Condition two, the user play the horror game while using the prototype.

If all users are allocated with the same order of these two conditions, their answers on the post-play questionnaire (STAI-6) might be affected by the order of the conditions. This is referred to as "order effect" in researches, where the responses of users might be influenced by the order of the questions or experimental materials presented to them. For instance, if Question A received a different answer when it is placed in a reversed order with Question B, in this case, it might be possible that the order of the questions presented were controlled by the researcher [15].

In order to reduce and avoid the order effect, Latin Square Design is applied in this user test process(Table 3.1). If Participant 1 plays the horror game under Condition 1 (without prototype) and then plays the horror game under Condition 2 (with prototype); the next Participant will be go through the process in reverse order: play the horror game under Condition 2 first and then play it under Condition 1.

Semi-structured Interview

The semi-structured interview is applied in this study as a method of collecting qualitative data. Since semi-structured interview contains open-ended questions, it can allow user test participants to provide on-site, subjective feedback on user experience. In the case of "Companion", it is a cushion-like object that will be used in direct body contact with users, so each user will have individualized experience when using it. By having a short semi-structured interview with each user right after the user test, it will provide each participant's reviews on interaction and feedback on functions and possible improvements.

Chapter 4
Evaluation and Findings

A total number of eight participants (age 23-26, one male, seven females) attended the user test for the prototype of "Companion". The test was conducted at Keio University's campus in a quiet classroom. All of the test participants have signed a research participation agreement and have been briefed about the user test process and contents before undergoing the user test. For each participant, a set of quantitative data were collected: bio-signal data, time spent on game-play and STAI-6 scores; and qualitative feedback was gathered through semi-structured interviews. Photos and videos were also recorded during the user test process under the consent of participants.

4.1. Past Game and Fear Experience

Before proceeding to the process of playing the horror game, each participant was required to fill out a short questionnaire to provide their basic information and reflect on their past gaming experience and virtual fear experience.

Among 8 participants, 6 people reported they play game frequently (every day or every week); 7 people do not play horror games; and 3 out of 8 participants have reported experience of fear during virtual horror experience (Figure 4.2).

Three participants who reported their fear experience selected fear stimuli that have triggered their fear during past experience. Darkness, enclosed environments, disfigured humans, eerie sounds are most mostly mentioned; the most common fear reactions are screaming, yelling, closing eyes and increase of heart rate (Figure 4.3).

It can be concluded that most participants have little fear experience before, and they are not frequent players or audiences of virtual horror media contents.

Figure 4.1 User Test

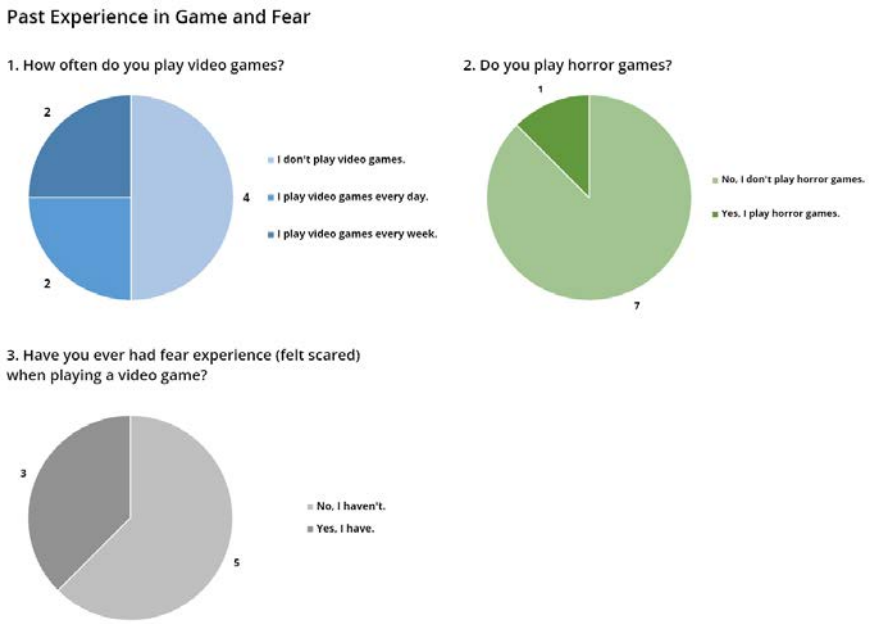


Figure 4.2 Past Experience Report

The fear stimuli result was similar to findings of previous fear studies [2] and [4], and their fear reactions were alike.

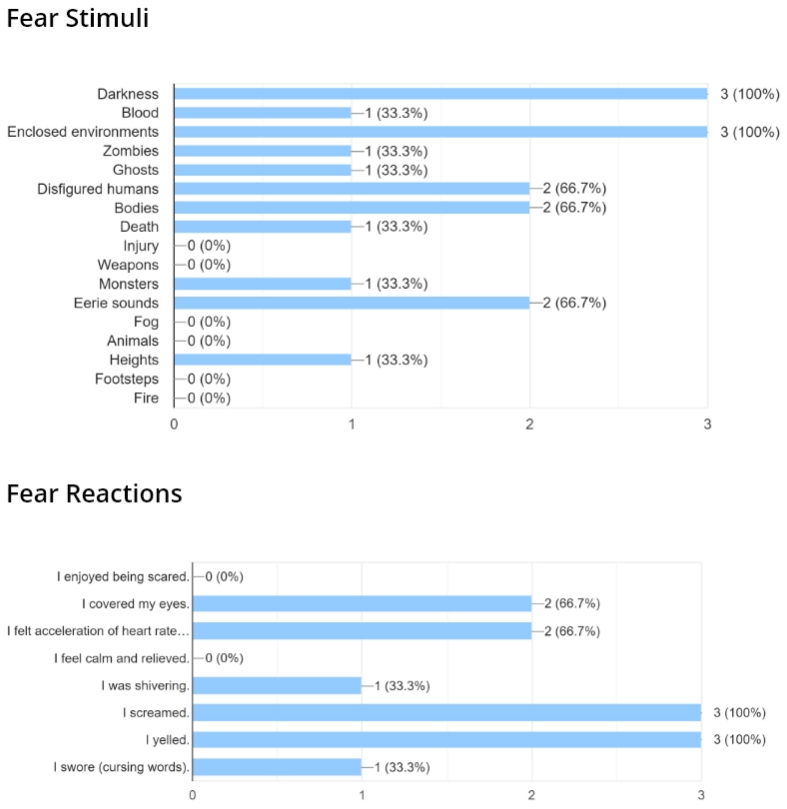


Figure 4.3 Fear Stimuli and Fear Reactions Report

4.2. Analysis on STAI-6 Scores

All 8 participants have filled out two STAI-6 questionnaires after playing the horror game without “Companion” and without “Companion”. The items in two

questionnaires are exactly the same and representing descriptions of feeling at the moment. In total, 16 questionnaire scores are obtained and analysed.

4.2.1 Scoring

The calculation of the STAI-6 total scores is based on the development research of short-form of original STAI-S scale [12]. The STAI-6 scale contains six items based on a 4-point Likert scale. The scores of positive, anxiety absent items (I feel calm; I am relaxed; I feel content) are calculated in a reversed manner (4=1, 3=2, 2=3, 1=4). The total score of the scale will be a sum-up of all six items (ranging from 6 to 24). The total score will be multiplied by 20/6 in order to gain scores comparable with the full 20-item STAI-S scale (ranging from 20 to 80). Referring to Spielberger's manual, the higher score indicates higher anxiety level. The commonly used cut score of the STAI scale is 39-40. Mean normative value for non-psychiatric population presented in the manual is 35 [16].

4.2.2 Normality Test and Results

A normality test is conducted to indicate if a parametric test can be applied to analyse the scores data.

A Sarpiro-Wilk's test ($p>.05$) [17] showed that both sets of STAI-6 scores attained after playing the horror game were approximately normally distributed under two conditions (without prototype and with prototype)(Figure 4.5), with a skewness of -0.210(SE=0.752) and a kurtosis of -1.483(SE=1.481) for the condition of playing the game without prototype; and a skewness of 0.461(SE=0.752) and a kurtosis of -1.793(SE=1.481)(Figure 4.4) [18].

4.2.3 Paired Samples T-Test and Results

A paired samples t-test was conducted to compare the scores of STAI-6 of a total number of 8 participants played the horror game without prototype and with prototype. Prior to conducting the paired samples t-test, the assumption of normally distribution of data was examined and considered satisfied.

The paired samles t-test has revealed that there was a significant difference in the scores for STAI-6. The scores of playing the horror game under without

Descriptives

Conditions				Statistic	Std. Error
Scores	With Prototype	Mean		37.5013	5.18531
		95% Confidence Interval for Mean	Lower Bound	25.2399	
			Upper Bound	49.7626	
		5% Trimmed Mean		37.4086	
		Median		31.6650	
		Variance		215.099	
		Std. Deviation		14.66626	
		Minimum		20.00	
		Maximum		56.67	
		Range		36.67	
		Interquartile Range		28.33	
		Skewness		0.461	0.752
		Kurtosis		-1.793	1.481
	Without Prototype	Mean		51.6688	4.54294
		95% Confidence Interval for Mean	Lower Bound	40.9264	
			Upper Bound	62.4111	
		5% Trimmed Mean		51.8542	
		Median		51.6700	
		Variance		165.106	
		Std. Deviation		12.84937	
		Minimum		33.33	
		Maximum		66.67	
		Range		33.34	
		Interquartile Range		25.83	
		Skewness		-0.210	0.752
		Kurtosis		-1.483	1.481

Figure 4.4 Normality Test: Descriptives

Tests of Normality

Conditions		Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Scores	With	0.237	8	.200*	0.858	8	0.116
	Without	0.151	8	.200*	0.917	8	0.409

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 4.5 Tests of Normality

prototype (M=51.67, SD=12.85) conditions are higher than the scores of playing the horror game under with prototype (M=37.50, SD=14.67) conditions; $t(7) = 5.06$, $p = .001$ (Figure 4.8).

These results suggested that when users used the prototype of "Companion" while playing a horror game, their state anxiety levels were significantly lower than under the condition of not using "Companion" when playing the horror game. Thus, "Companion" does have a positive effect on reducing the state anxiety level for users in virtual horror experience.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Without Prototype	51.6688	8	12.84937	4.54294
	With Prototype	37.5013	8	14.66626	5.18531

Figure 4.6 Paired Samples Statistics

Paired Samples Correlations

		N	Correlation	Significance One-Sided p	Significance Two-Sided p
Pair 1	Without Prototype & With Prototype	8	0.842	0.004	0.009

Figure 4.7 Paired Samples Correlations

Paired Samples Test

		Paired Differences					t	df	Significance One-Sided p	Significance Two-Sided p
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Lower	95% Confidence Upper				
Pair 1	Without Prototype - With Prototype	14.16750	7.91934	2.79991	7.54677	20.78823	5.060	7	<0.001	0.001

Figure 4.8 Paired Samples Test

4.3. Analysis on Differences of Time on Playing Horror Game

To check if there was any increase in the time that 8 participants spent on playing horror game under the conditions of with and without prototype, a Related-Samples Wilcoxon Signed Rank Test was conducted.

The test result indicated a non-significant result (z = -.676, p = .499). Thus, the time spent on playing horror game when playing with prototype was not statistically longer than time spent when playing without prototype (Figure 4.9).

Among 8 samples, compared with the time spent on playing game without prototype, the test showed that 5 participants played the game with a longer time when they used prototype; 2 participants played the game with a shorter time when they used prototype; 1 participant's time stayed the same under two conditions (Figure 4.10).

4.4. Analysis on Heart Rate Differences

The heart rates were very different among individuals. It showed increase of Mean Heart Rate among 5 users (User No.3, 4, 6, 7, 8), and decrease of among 3 users (User No.1, 2, 5) (Figure 4.11). This might be a result of several factors: lots of noises; random game contents; and differences in game play time.

4.5. Results of Interview and Observation

After finishing playing the horror game under two conditions, each participant was asked a set of open-ended questions to report their experience and reviews. The findings are listed as follow:

4.5.1 Game Experience: Mildly to Moderately Scary

All of 8 participants reported experience of fear when playing *Slender: The Eight Pages*, and they considered their game experience as scary. Most people rated their experience as mildly to moderately scary, some pointed out that in the beginning

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Without Prototype (Time)	8	7.1363	1.30724	6.00	9.30
With Prototype (Time)	8	8.6738	4.21728	5.58	18.73

Ranks

		N	Mean Rank	Sum of Ranks
With Prototype (Time) - Without Prototype (Time)	Negative Ranks	2[a]	5.00	10.00
	Positive Ranks	5[b]	3.60	18.00
	Ties	1[c]		
	Total	8		

a. With Prototype (Time) < Without Prototype (Time)

b. With Prototype (Time) > Without Prototype (Time)

c. With Prototype (Time) = Without Prototype (Time)

Test Statistics [a]

	With Prototype (Time) - Without Prototype (Time)
Z	-.676[b]
Asymp. Sig. (2-tailed)	0.499

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Figure 4.9 Wilcoxon Signed Rank Test Results

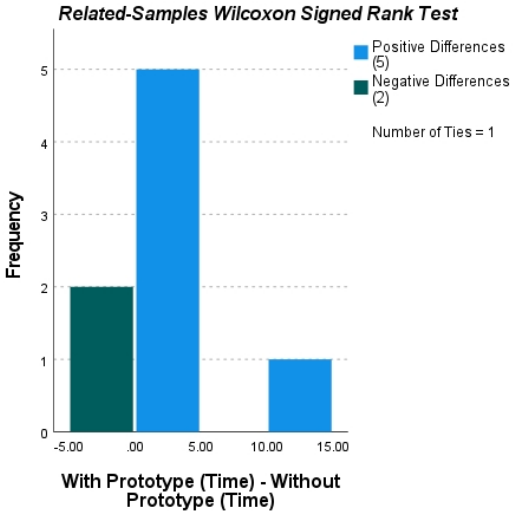


Figure 4.10 Wilcoxon Signed Rank Test: Differences

Descriptive Statistics

	Condition: Without Prototype			Condition: With Prototype		
Participant No.	Time (min)	Mean	SD	Time (min)	Mean	SD
1	9.3	62.74	22.03	9.35	66.91	17.41
2	6	61.48	17.46	6.5	63.33	22.91
3	6.18	96.21	33.40	18.73	79.63	30.60
4	6.98	57.31	13.40	6.98	56.51	16.12
5	6.1	125.73	22.72	8.05	130.80	15.93
6	9.05	71.61	29.46	6.65	52.30	15.96
7	6.73	60.18	20.84	5.58	58.92	16.45
8	6.75	94.47	29.55	7.55	82.59	27.77

Figure 4.11 Descriptive Statistics of Heart Rate Data

it was not very scary, yet as proceeding forward, the game experience became scarier; one participant considered the scary level of her experience as "strong", which might be a result of her having little or almost no experience of virtual fear in the past. All of the participants reported that jump scares in the game triggered their fear. Apart from jump scares, some participants pointed out that the disfigured face of Slender Man was scary; eerie sounds and music in the game were also mentioned to be fear stimuli. Some participants have also described about perceived fear, mentioning that the suspense before the appearance of jump scare was scary, because they were expecting horror event encounters.

4.5.2 Companion: Comfortable and Secure

All of 8 participants said they could understand that purpose and function of "Companion", and they gave positive feedback on its effect in reducing their anxiety and fear level. Some descriptive words frequently appeared in their comments: comfortable, secured, and reliable, which showed the overall impression of "Companion" on their experience. When describing the most helpful parts and functions of "Companion", most participants mentioned size, shape and texture (comfortable to touch); heating pads (warming feel); light guidance (calm and shifting of focus from scary contents). Some pointed out that the existence of "Companion" was very comforting, because they felt secured when they could hug or look at something cute.

Shape, Size, Texture and Color

The overall feedback of texture was positive, some suggested that it could be fluffier or softer. Most of people considered the shape and size were good, enabling them to hold "Companion" in arms and hug it in any angle. One mentioned that the size was very good because she could use it to cover her eyes when she felt scared. One person said that the size was a little big because he prefered to hold smaller cushions. Some participants suggested that the shape could be more "inclusive" to wrap themselves and feel more secured.

LED Breathing Guidance

Most participants considered the light breathing guidance was helpful for them to adjust their breathing rhythm and calming them down. The brightness of the LED was reported by all participants to be good. One mentioned that the surface felt like "cloud" and provided a sense of breathing. However, the reviews on the speed and purpose were mixed. Four people reported that the speed of the LED was too slow, making them unable to follow it very smoothly; and one person reported that she felt it was too fast for her. This might be the result of differences in people's individual breathing patterns. Three people considered the purpose of guidance to be clear, they could understand that lighting up meant breathing in and reverse was breathing out; while other participants felt that the purpose was confusing if they were not given introduction, they needed to observe patterns in the beginning, which cost focus and attention. Some suggested more intuitive presentation like air-flow to make an associative connection easier, and one suggested a presentation of progress of the lights.

Thermal Feedback

The reviews on heating pads were very positive, especially the temperature was rated as perfect among all participants. The warmth was considered to provide a sense of comfort and security. They have different opinions on the size and position of thermal-feedback areas. Some required that it should be bigger or in longer shapes so that forearm areas could be covered (Figure 4.12); while some said the position on top can be used as thermal-feedback area as well.

Heartbeat Sound

The reviews on heartbeat sound were mixed, too. Some reported it to be distracting, while some considered it to be better than breathing guidance because it's more intuitive.

4.5.3 Further Discussions: Using Companion in Other Contexts

All participants said they did not find the existence of "Companion" to be intrusive while they were playing the game, and they considered it might be useful in other cases such as watching horror movies. The current control of game was not very complicated, however, if more complex control (FPS games and action games) were needed, it might affect the experience. One mentioned that the need to hug something in such fear experience was very important.

When asked about the possible effects of "Companion" on motivation and interest of virtual fear experience, the opinions were mixed. Four people were positive that it would help them grow more interests to try more horror contents, because they had interested in such genre but they were scared to try out by themselves, if supported by "Companion", they could imagine making more progress. On one hand, it could enable them to take breaks and proceed again once they were calm; on the other hand, it could reduce fear that jump scares brought them. One mentioned that it would be better if functions like pre-warning of jump scare could be provided. Three users were not sure about the effect because they did not have interest in horror genre, nor they were sensitive to scary contents. One had negative review about this because her fear would exceed her interest in such contents.

All users expressed their willingness to try out products like "Companion". They explained the reasons that they wished to hug things when they were scared, and holding "Companion" made them feel comfortable. The appearance of "Companion" was also the reason because they considered it to be cute, which made them want to pat it. Some mentioned that the existence of "Companion" could provide them safety and even when they were alone, they felt accompanied.

Figure 4.12 Subjective Feedback in the Interview

Chapter 5
Conclusion and Discussion

5.1. Conclusion

This study presented a design of "Companion", a comfort object aiming to help people reduce state anxiety when they feel scared. A user study was conducted with 8 test subjects to test out the performance and possible effects of "Companion" during virtual horror experience. Most of the participants had little virtual fear media experience in the past, and their reports on fear stimuli were similar to results of previous studies on fear.

This study demonstrated that using prototype of "Companion" was effective in reducing people's state anxiety level when playing horror game. The STAI-6 scores of participants were significantly higher when they played the game without using the prototype, which correlated with higher anxiety level. No significant difference was found in the time users spent on the game under the conditions of with the prototype and without prototype, but most people have spent longer time on the game when they used the prototype. This might be a result of game contents and different individual purposes of gameplay, some participants insisted to find pages in the game. The interview revealed that all participants considered the game experience to be scary, and the reviews of "Companion" were very positive. It was helpful in calming them down after scary event encounters, and it was securing, comfortable and reliable. Specifically, the size, shape and texture of "Companion" received positive comments, and the thermal-feedback of "Companion" was comfortable. The LED breathing guidance was effective for guiding users to breathe calmly, but the comments on its rhythm and speed were mixed, highlighting future work on improving its pattern and form. It was also implied that the effects of "Companion" on people's motivation and interest of making more progress in horror media were very individualized, which might be

a result of differences in people's original interests in this genre. Those who were interested but scared would benefit from using "Companion" more, which would be the main target audience of this design. Future studies should explore more applications of "Companion" in other virtual fear contexts, such as amusements.

5.2. Discussion

In this study, there are several limitations that can be improved:

More Intuitive Breathing Guidance

Current design of breathing guidance were reported to be slow and not compatible with users' breathing speed. The purpose of this breathing guidance is to use the changing of light to guide users to do deep breathing, which is slower than normal breathing speed. The presentation of current breathing guidance was also reported by some users to be not intuitive, requiring observation to discover and focus on the pattern. Future improvements should be implemented to adjust the speed for individuals, such as applying adjustable speed options for users, and presentation of visual guidance can be improved as inflatable structures, or with sound guidance added.

Small Sample

The number of test subjects was eight. Small sample might cause the non-significant result of Wilcoxon Signed Rank Test conducted on analysing the time spent on game. Future studies should seek bigger number of test subjects.

Choice of Game used in User Test

The game *Slender: The Eight Pages* required players to find eight pages in the woods during the night. Players with strong purpose in finding the pages would play the game longer, which would affect test results. The environment in the game was very dark, which would distract users when they played it in a room with brighter environment.

Potential Malfunction Situation

The situation in which "Companion" might malfunction should also be considered. Whether users' anxiety level will rise or not under this situation is yet to be tested in the future. However, according to people participated in the user test, the existence of "Companion" itself could bring them feeling of comfort and security mainly because of its size and texture.

Chapter 6
Future Works

6.1. Adaptive Breathing Guidance

In future studies, the design of "Companion" can be improved by applying a more adaptive and intuitive breathing guidance. Current design of breathing guidance is a visual LED guidance with a emitting pattern simulating deep breathing, its speed and rhythm may be too slow or too fast due to individual differences of people's breathing rhythms. A learning curve and high attention are also required when following the current breathing guidance.

Possible approaches to improve this design will be:

1. A tangible design of adaptive, inflatable breathing guidance with soft materials, such as silicon or origami. It can demonstrate the breathing effect with its structure, making the visual guidance more intuitive.

2. A system controlling the speed and pattern of breathing guidance, which can be adjusted and customized by users according to their own breathing speed.

6.2. Activation

Current activation of the prototype of "Companion" depends on user's needs, the switch that triggers all functions will be turned on when the user is scared. Possible improvements of this design can be conducted in future studies:

1. The timing of the activation can be applied earlier than the scary event encounter as a pre-warning for users, this might work especially for jump scares.

2. A more intuitive switch can be applied as the forms of squeezable structure to make the experience more interesting. Users can squeeze on certain parts of "Companion" when they are scared, the action of squeezing might also be helpful for reducing anxiety.

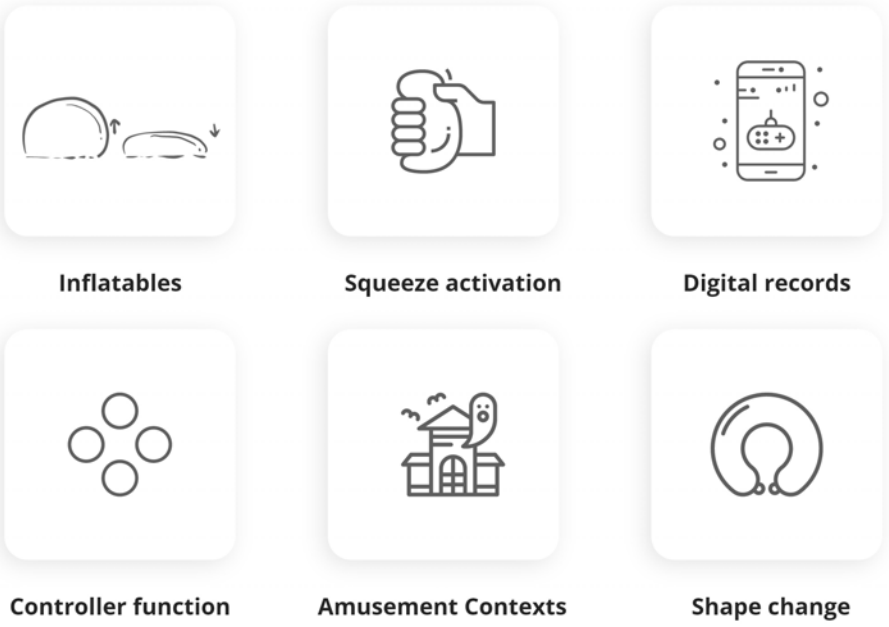


Figure 6.1 Directions of Future Studies

6.3. Personal Digital Records

An online digital platform or application can also be developed to keep the data of users' personal digital records, including their bio-signals during virtual horror experience and customized breathing patterns.

6.4. Controller Function

Another possible function for "Companion" will be using it as a controller for games, which can be realized by applying the mapping of buttons and controls on certain area of it. The controller function might be effective for distracting users' attention from scary contents to help them calm down.

6.5. Amusement Contexts

This design can possibly be applied in more virtual horror contexts, such as ghost houses and amusement parks. After having a ghost house experience, users can hold "Companion" in a public resting room and use it to help them calm down. It might be able to help prevent after-event horror reactions like nightmares.

6.6. Shape Change

The present shape of "Companion" is round, and the shape is fixed. As future improvement, the shape design could be turned into a more flexible and changeable structure, and adjustable to users' needs, such as a long cylinder that can be bent to wrap around human body.

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Appendices

A. Arduino Code for Breathing LED Guidance

Code for Arduino-controlled 16-LED NeoPixel Wheel to Perform Breathing Guidance

```
#include <Adafruit_NeoPixel.h>  // Library for NeoPixels

#define pinPix 6                // Pin driving NeoPixel Ring or String
#define numPix 21           // Number of NeoPixels in the Ring or Strip

// Setup NeoPixel Ring
// Parameter 1 = number of pixels in strip
// Parameter 2 = pin number driving the strip
// Parameter 3 = pixel type flags, add together as needed:
//   NEO_KHZ800  800 KHz bitstream (most NeoPixel products w/WS2812 LEDs)
//   NEO_KHZ400  400 KHz (classic 'v1' (not v2) FLORA pixels, WS2811 drivers)
//   NEO_GRB     Pixels are wired for GRB bitstream (most NeoPixel products)
//   NEO_RGB     Pixels are wired for RGB bitstream (v1 FLORA pixels, not v2)
Adafruit_NeoPixel myNeoPixels =
Adafruit_NeoPixel(numPix, pinPix, NEO_GRB + NEO_KHZ800);


void setup() {
  myNeoPixels.begin(); // Initialize the NeoPixel array in the Arduino's memory,
  myNeoPixels.show(); // turn all pixels off, and upload to ring or string

}

void loop() {
```

```
  letsDoIt(180, 80,80,80, 0,0,0);  // Pause; R,G,B foreground; R,G,B background
}


// Pause = delay between transitions
// Rf, Gf, Bf = RGB "Foreground" values
// Rb, Gb, Bb = RGB "Background" values
void letsDoIt(int pause, byte Rf, byte Gf, byte Bf, byte Rb, byte Gb, byte Bb) {

  for (int i=0; i<numPix; i++) {
    myNeoPixels.setPixelColor(i,Rf,Gf,Bf);
    myNeoPixels.show();
    delay(pause);
  }

  for (int i=0; i<numPix; i++) {
    myNeoPixels.setPixelColor(i,Rb,Gb,Bb);
    myNeoPixels.show();
    delay(pause);
  }
}
```

B. Six-item State-Trait Anxiety Inventory (STAI-6)

Self-evaluation questionnaire (Y-6 item)

NAME **DATE**

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the most appropriate number to the right of the statement to indicate how you feel right now, at this moment.

There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe yow present feelings best.

	Not at all	Somewhat	Moderately	Very much
1. I feel calm	1	2	3	4
2. I am tense	1	2	3	4
3. I feel upset	1	2	3	4
4. I am relaxed	1	2	3	4
5. I feel content	1	2	3	4
6. I am worried	1	2	3	4

Please make sure that you have answered all the questions.

Figure B.1 Six-item State-Trait Anxiety Inventory (STAI-6) Used in the User Test