Designing Compassionate Technology for Mental Health

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Abstract

This project focuses on understanding how to design compassionate technology for mental health. More specifically the project aims to understand how compassionate care could be provided to individuals who are feeling symptoms of anxiety utilising technology. Background research was then conducted which helped understand the different characteristics of generalised anxiety disorder patients and further helped understand the concept of compassion and compassionate technology. Based on the background research, a total of 12 concepts were developed and through a selection criteria, the final concept of a Connection Lamp was achieved. The Connection Lamp is a lamp which allows the users to conduct a breathing exercise while also encouraging them to become mindful of their emotions and situation by determining their own anxiety level and requesting help from their loved one; who also has a lamp of their own.

The first prototype of the concept was then created specifications and requirements which were proposed. This prototype was then used to conduct a usability test to further gain insight into how technology could be used to provide compassionate care for generalised anxiety disorder patients. A total of 6 participants took part in the evaluation by completing a usability test followed by a semi structured interview. The evaluation helps shed light into the difference of providing compassion and receiving while also highlighting the importance of human connection and a strong emotional bond in communicating successful compassionate interactions. It was concluded that the Connection Lamp has the potential to help mitigate the symptoms of generalised anxiety disorder through a mindfulness based approach while also allowing them to connect with their loved ones. Compassionate technology could be used as a mediator of compassion to provide compassionate care for individuals who struggle with generalized anxiety disorder.

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Introduction

Anxiety is considered to be one of the common mental health disorders. Anxiety is associated with disproportionate feelings of worrying or intrusive thoughts. More so, the abundance of novel technologies aimed to solve anxiety continues to rise. This brings about an important question regarding how effective and compassionate these forms of technologies are. Does it only provide a solution towards anxiety or does it solve it in a way that shows empathy and compassion for the user. The aim of this thesis is to develop compassionate technology for anxiety.

1.1 Situation

According to the National Institute for Health and Care Excellence, anxiety disorders are one of the most common mental health issues faced today ("Common mental health problems"). Anxiety disorders are often accompanied by feelings of tension, irritability, stress and a sense of danger. Symptoms of anxiety could often be a first warning sign or hints into an individual suffering other illness such as PTSD, OCD, depression, etc (Tyrer et al, 2157).

Remedies such as cognitive behavioral therapy, drug treatment and self-help options are available for individuals who suffer from anxiety disorders. Technologies such as e-health solutions have recently emerged and became popular due to their constant availability and convenience; however, most of these technological solutions lack one important key aspect which could be offered in the more traditional methods of treating anxiety such as therapy. As suggested by the National Institute of Mental Health, this key aspect is the lack of human connection within these solutions ("Technology and the Future of Mental Health Treatment").

The question then arises on how technology could be used to provide compassionate care to individuals who suffer from anxiety, while also providing the sense of compassion provided through human connection. In the research article, *What is compassion and how can we measure it*, Straus et al collected and discussed different definitions of compassion from different sources. These definitions could be found below:

> *"Being moved by another's suffering and wanting to help" (Lazarus, 1991, p.289)*
>
> *"Genuine compassion must have both wisdom and loving kindness. That is to say, one must understand the nature of the suffering from which we wish to free others (this is wisdom), and one must experience deep intimacy and empathy with other sentient beings (this is loving kindness)"* (Dalai Lama, 2005)
>
> *"feeling that arises in witnessing another's suffering and that motivates a subsequent desire to help"* (Goetz et al., 2010, p.351)
>
> (Stauss et al., 18)

Based on different definitions provided in literature, compassion could be defined in this project as understanding and empathizing on the emotional, physical and mental needs of the individual. Thus compassionate technology could be described as technology which takes into account the user's comfort and experiences. Furthermore, focusing on the emotion, physical and mental needs of the user, with the user being the basis for the design of the prototype.

The target users of this research are individuals who experience symptoms of the different anxiety disorders. Both clinically diagnosed and self diagnosed users are considered as the primary users within this research. More so, it has been determined that mental healthcare institutions and specialists are the secondary users as it is hoped that the proposed technological solution could be of high societal readiness in aiding these institutions in treating these different anxiety disorders.

1.2 Challenges

The main challenge of this research is to firstly understand what compassionate technology is. Upon understanding and creating a definition of compassionate technology, the next challenge is to design and create a prototype aimed at providing this compassionate care for people who are currently experiencing symptoms of anxiety, further easing the symptoms. This prototype must be able to take into account the individual's physical, mental and emotional well being. More so, it is prefered that it could provide or mediate a sense human connection, not only as a tool that is used by the individual (ie. such as a medical drug).

The development of the prototype will also be a challenge. The results and evaluation of user study from both target users and stakeholders will greatly influence the form and shape in which the prototype will take. Some already existing possibilities are a physical prototype or an e-health solution or a hybrid between both. This prototype might also change and be iterated a number of times depending on the feedback provided by target users within an interim evaluation study. This will help create a prototype which is not only tailored towards the user group but also ensure the factor of inclusivity.

The prototype must not only adhere to the overall wellbeing of the individual but also a successful method of intervention which could be utilized in the professional field. As professionals are still questioning the effectiveness and success of technological intervention in improving mental health, the next challenge would be on how the developed solution could be ready for use in the field of mental healthcare.

New challenges and objectives might and will be determined and identified as the user research and evaluations are conducted. These will be taken into consideration when designing and creating the prototype and if determined, will be discussed on the latter stages of this paper.

1.3 Research Question

Main research question

How can compassionate care be provided to individuals who are experiencing symptoms of anxiety disorders using technology?

Sub Research Questions
Knowledge Questions

- What is compassion? What is the difference between showing and giving someone compassion? How can it be given to ourselves?
- What are some general characteristics and challenges of individuals who face anxiety disorders?

Design Questions

- What type of sensory feedback would increase the sense of compassion within the prototype? How will this be measured?
- How can empathy and emotions be implemented into mental healthcare interventions and technology?
- What form of innovation would prove most compassionate for the end users? Physical, digital, a mix of both?

Evaluation Questions

- How has the prototype provided compassionate care towards the user?

1.4 Limitations

Due to the time limit of the project, no longitudinal study will be conducted, thus evaluating the prototype will be determined through the use of short usability tests on the primary users. The method utilized for the user testing evaluation would also depend on the form of the prototype. A digital and a physical device would have different approaches. In the event that there are not enough primary users to conduct the evaluation, proxy users could also be utilized for the research. The specific numbers required for evaluation will further be discussed in the latter part of this paper.

1.5 Thesis Outline

This thesis includes a number of different chapters. First the thesis will continue with a Background Research chapter in which different theories and concepts revolving the study such as anxiety, compassion and compassionate technology will be explored. More so, examples of compassionate technology will be provided. Second, the Ideation chapter will discuss how the ideation process was conducted to achieve one final concept. Next, in the Specification chapter, the previously developed concept will then be specified further in terms of hardware, software, design, and user requirements in order to provide a blueprint for the prototype. Then, the Realisation chapter will discuss the process of developing the first functional prototype which will be used in the evaluation. The Evaluation chapter will then discuss how the prototype was used to evaluate and conduct user testing to further understand the research questions being explored. This is then followed by a Discussion chapter which focuses on discussing the main research questions which were proposed in section 1.3. The thesis will then be closed through the Conclusion chapter where the main findings of the research will be iterated. The different appendixes and sources utilised within the study will also be included at the end of the study.

2 Background Research

The chapter will be divided into three parts which include anxiety, compassion, and state of the art research on compassionate technology aimed for anxiety. The research into anxiety is aimed to create a better understanding of the disorder while also providing an overview of the symptoms and struggles faced by the individuals. Interventions for anxiety will only be discussed briefly and will primarily focus on its relevance to the scope of the study.

Research into compassion is aimed to understand the different definitions and aspects of compassion. Based on the results, a definition of compassion which is relevant to the scope of the study could be proposed. This definition will then serve as the basis on proposing a definition of compassionate technology. This could then serve as a framework in the ideation phase of the project when designing the compassionate technology solution for anxiety. This section will also research on how compassion could be provided to further understand how compassion could be integrated into the solution.

Finally, the state of the art research will primarily focus on technological solutions which combat anxiety and could be considered within the proposed definition of compassionate technology. Based on this it is aimed that a better understanding of the different solutions and their similarities could be found and used in the creation of the solution of this project.

2.1 Anxiety

2.1.1 Generalised Anxiety Disorder

Anxiety could come in the form of different disorders, one of these being generalised anxiety disorder. Generalised anxiety disorder (GAD) is a common mental health issue and could manifest itself in different ways, becoming more noticeable during the early days of adulthood (Tyrer et al., 2163). Frequently, generalised anxiety disorder could be caused by traumatizing life events. More so, poor mental and physical health has also been deemed as a cause of GAD (Allgulander, 104).

A study by Tyrer et al suggests that GAD has a lifetime prevalence of 4.3-5.9% in Europe (Tyrer et al., 2158). Moreso, it has been argued that GAD has a lifetime morbidity of 9.0% (American Psychiatric Association, 223). GAD is considered an uncommon disorder for individuals under the age of 25. Moreso, studies suggest that GAD is twice as common for women than men (Allgulander, 103).

Individuals who suffer from GAD often have struggles reporting that they are suffering from the disorder. More so, a study suggested that “only two out of five patients seek treatment for their disorders” (Tyrer et al., 2158). Furthermore it was also seen that “individuals from developed countries are more likely than individuals from non developed countries to report that they have experienced symptoms that meet criteria for generalized anxiety disorder in their lifetime" (American Psychiatric Association, 223).

Generalised anxiety disorder could be identified through a number of key symptoms. According to the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5),* generalised anxiety disorder is primarily identified with an excessive amount of anxiety and worrying which could last from days to even months. Individuals who suffer from GAD often struggle to take control of these different worrying thoughts (American Psychiatric Association., 222).

In addition to continual and disproportionate anxiety, GAD is often accompanied with other psychological and somatic symptoms (Tyrer et al., 2156). Patients with GAD have been said to have “a wide variety of somatic symptoms…which range in severity” (Allgulander, 105). These symptoms include sweating, nausea, an increased flight-or-fight response, muscle tension and trembling. Although not as prevalent in GAD, patients also have been reported to have experienced dizziness, an accelerated heart rate, stress, and also shortness of breath **(**American Psychiatric Association, 223).

These individuals’ anxiety and worrying causes significant stress which does not only affect themselves but all aspects of their lives, including social and occupational. Moreso, DSM-5 further states that, "The anxiety and worry are accompanied by at least three of the following additional symptoms: restlessness or feeling keyed up or on edge, being easily fatigued, difficulty concentrating or mind going blank, irritability, muscle tension, and disturbed sleep" (American Psychiatric Association, 223).

2.1.2 Understanding the user group

This project aims to assist individuals who are suffering from symptoms of anxiety, thus the primary user group of this project has been identified as the GAD patients themselves. They will be the main users of the intervention which will be designed, thus are considered the primary stakeholder (and usergroup). It is aimed that the compassionate technology developed could further assist these individuals reduce the intensity of their symptoms. More so, mental health experts have been considered as the secondary stakeholders as they will further play a crucial role in providing important input and feedback regarding the design of the prototype.

Moreso, the success of this project would ultimately determine the effectiveness of design in aiding symptoms of GAD, further utilized and supported by mental health experts as a technological intervention which they could truthfully prescribe to their patients who are suffering from anxiety.

Primary stakeholder - Generalised anxiety disorder patients

It is important that before designing the prototype, user research is conducted to further understand the primary user group. As mentioned in the previous section, generalised anxiety disorder is twice as common in women than men. Moreso, it has been suggested that it is an uncommon disorder for individuals under the age of 25 years of age (Allgulander, 103). However, Risa Weisberg argues that, “European studies have found that GAD prevalence increases from young adulthood through the mid-50s” (Weisberg, 4). This further indicates that despite being an uncommon disorder for young adults, generalised anxiety disorder could begin during early adulthood.

Generalised anxiety disorder could affect an individual in many different ways. Individuals often struggle to perform daily activities, further influencing their physical and mental well being and quality of life (Allgulander, 104). This struggle of constant anxiety and overwhelming worrying has a major strain on the individuals themselves. As stated in DSM-5,

> *"Excessive worrying impairs the individual's capacity to do things quickly and efficiently, whether at home or at work. The worrying takes time and energy; the associated symptoms of muscle tension and feeling keyed up or on edge, tiredness, difficulty concentrating, and disturbed sleep contribute to the impairment. Importantly the excessive worrying may impair the ability of individuals with generalized anxiety disorder to encourage confidence in their children" (DSM-5, 225).*

Treatment for GAD often also raises concerns and struggles for these individuals. Because of the chronic nature of generalised anxiety disorder, the costs of treatment are expensive (Tyrer et al, 2159). This poses an important aspect which needs to be considered within the project. The question thus also arises on how technology could be used to not only aid with the symptoms of anxiety but also reduce the price for this treatment.

Based on the user research it could be seen that individuals who suffer from generalised anxiety disorder struggle mainly to reduce their feelings of anxiety. More so, the constant worrying often hinders them from staying focused and productive. Thus, it is important that the compassionate technology which will be designed focuses on how it could help the user stay focused and also alleviate their feelings of anxiety.

2.1.3 Interventions for Anxiety

There are numerous traditional and conventional treatments commonly used to treat anxiety. These treatments have been used over the years to combat generalised anxiety disorders and are still being used conventionally today. These treatments include cognitive based therapy (CBT), drug treatment, self help, and meditation and mindfulness based approaches.

Cognitive based therapy is one of the most common and well studied interventions used today for generalised anxiety disorder. Cognitive based therapy focuses on, "an assumption that affective disorders are mediated by cognitive factors" (Bolognesi et al., 112). CBT works by modifying the cognitive perception of the situation that causes distress in belief that this would be reflected in the external reality of the individual. Further changing their outlook on the situation and their behaviour towards it.

As the name suggests, drug treatment utilizes the intake of medical drugs to further combat the symptoms of generalised anxiety disorder. Although common intervention studies suggest that the use of drugs such as antidepressants are only effective in short and medium term treatments. Drug treatment is often also utilized in parallel to a different form of treatment such as CBT (Tyrer et al., 2159).

Self help is another form of treatment method which is used in combatting. Self help could either be aided with the assistance of an expert or be done completely alone by utilizing different mediums which are already available such as natural remedies, self-help manuals, or technological solutions which are available today. However experts are still doubtful regarding the efficacy of using this form of treatment due to factors such as the lack of medical trials (Tyrer et al., 2162).

Meditation and mindfulness based approaches have been growing in popularity over the years and now have been regarded as a promising treatment for generalised anxiety disorder. Meditation and mindfulness focuses on paying attention consciously and with awareness to the present moment. “Formal mindfulness exercises include the bodyscan, namely sitting meditation with awareness of breath; mindful movement and informal practice involve mindful attention to selected routine, day-to-day activities” (Bolognesi et al., 115).

By having a basic understanding of the different conventional approaches to treating GAD, it will be easier to spot which technologies utilize which approach to combat GAD. This does not only narrow down the treatment approach utilised in the technological solutions but provides insight to which treatment is most popularly used and integrated within these solutions. This further provides an idea to which approach is most effective due to its popularity. Furthermore, it would present the opportunities possible in the field through the use of these different approaches.

2.2 Compassion

2.2.1 Understanding Compassion

There is no one definition that could be used to describe compassion. Many experts have different opinions and definitions of compassion, thus defining compassion itself could be seen as a challenge on its own. Compassion plays an important role in everyday life and could be said to be the foundations of some of humanity's core beliefs. It has been argued compassion is an important foundation of religions, to ethics, education and even care (Strauss et al.,16).

In the paper *What is Compassion and how can we measure it? A review of definitions and measures,* Strauss et al provided different definitions which have been proposed by different authors. Taken directly from their work, Strauss et al has provided a set of definitions listed in a table which could be used to further create an understanding of compassion. The table of their work could be seen below.

Number	Definition
1	Being moved by another’s suffering and wanting to help (Lazarus, 1991, p.289)
2	An openness to the suffering of others with a commitment to relieve it (Dalai Lama, 1995). Buddhist conceptualizations also highlight cognitive components (e.g. the ability to imagine and reason about a person’s experience) and approaching those who are suffering with tolerance and non-judgement.
3	“Being touched by the suffering of others, opening one's awareness to others' pain

	and not avoiding or disconnecting from it, so that feelings of kindness towards others and the desire to alleviate their suffering emerge. It also involves offering non-judgmental understanding to those who fail or do wrong" (Neff, 2003a, p. 86–87).
4	Compassion consists of three facets: Noticing, feeling, and responding (Kanov et al., 2006).
5	A deep awareness of the suffering of another coupled with the wish to relieve it (Gilbert, 2009, p. 13). Compassion consists of six 'attributes': Sensitivity, Sympathy, Empathy, Motivation/Caring, Distress Tolerance, and Non-Judgement.
6	The feeling that arises in witnessing another's suffering and that motivates a subsequent desire to help (Goetz et al., 2010, p. 351)
7	An orientation of mind that recognises pain and the universality of pain in human experience and the capacity to meet that pain with kindness, empathy, equanimity and patience" (Feldman & Kuyken, 2011, p. 145).
8	Compassion involves three elements: Kindness, mindfulness, and common humanity (Pommier, 2010).
(Strauss et al., 18)	

Table 1: Table of different definitions of compassion by Strauss et al (For more information see table 1 of their work; page 18).

Based on the collected definitions by Strauss et al, it could be seen that there are emphasis on two important similarities amongst all of the provided definitions. First, there is an emphasis on understanding an individuals' situation and struggle. Further emphasizing on what the other individual is experiencing. Next, it also puts emphasis on the willingness to provide assistance towards the struggling individual. This puts forward the notion that in order to be compassionate towards another, one must understand the struggle of the other and is motivated to assist. These two similarities make it possible to create a solid definition of compassion which could be used within the scope of this project.

Based on this research and the different interpretations and definitions of compassion provided by the various authors, a definition of compassion could be provided. For the scope of this project, compassion is defined as the ability of an individual to recognize, understand and empathize with the physical, mental, and emotional struggles and needs of another who is suffering, which creates a motivation to provide help. This definition of compassion will serve as a guideline and framework to the design of the solution which will be developed in this project.

2.2.2 Providing compassion

Providing care which could be considered compassionate based on the previously defined compassion could prove to be a difficult task. Understanding the concept of compassion is not enough to further understand the different requirements needed to further be able to provide compassionate care. Thus, it is crucial to explore the different ways compassion could be

provided towards another and oneself. By understanding how compassion could be provided, it is possible to identify different factors which could be used to further create a compassionate technology to combat anxiety.

There is debate within literature that compassion could be differentiated from self-compassion as it is two different concepts. However some argue that as humans who all share a common desire of intimate connection, it is false to view self-compassion as a different concept from compassion (Barnard et al, 289). Thus, this research will follow the concept that providing compassion towards another would be like providing compassion towards oneself.

There are several factors which should be considered when providing compassion to oneself. One of these factors is self-talk. Often, individuals could create certain judgements towards others which have been considered as a common activity. Thus, it has been argued that individuals are often unaware of how one speaks towards themselves.

Depending on this self-talk, an individual could either affect themselves positively or negatively depending on if they engage in talks of self-kindness or self-judgement (Barnard et al, 290). Thus, engaging in an undermining and negative self-talk will ultimately create a negative impact on the individual and their own wellbeing. A solution which promotes self-kindness talks will ultimately increase a sense of compassion within an individual.

Another factor which should be considered in procrastination. Studies suggest that procrastination has been associated with low self-compassion (Barnard et al, 296). In reference to the previous section of anxiety, it was seen that GAD directly interferes with an individual's ability to conduct daily tasks and be productive. This might further suggest that this lack of productivity might lead towards procrastination and vice versa. Tackling the problem of procrastination within the solution might ultimately lead to a better sense of self-compassion which could also indirectly help solve or mediate the symptoms of anxiety itself.

Finally another important factor to be considered is mindfulness. Overinclusive ruminating about the future creates a sense of tunnel vision that might create painful thoughts to be emphasized. This unrealistic expectation of the future ruins the individual's ability to be able to stay focused on the present (Barnard et al, 290). More so, it was also discussed that mindfulness has been used as a promising intervention for anxiety. By incorporating mindfulness based approaches within the compassionate technology, it could be hypothesized that it will not only further help reduce symptoms of anxiety but further increase a sense of self-compassion for the individual.

2.2.3 Compassionate Technology

Based on the definition of compassion discussed in the previous section, a definition of compassionate technology could be proposed. As discussed previously compassion is defined as the ability of an individual to understand and empathize with the physical, mental, and emotional struggles and needs of another who is suffering. Thus, a compassionate technology should be able to consider how it affects the user physically mentally and emotionally. In addition, it should also be able to emphasize with the user, further striving to understand what

the user is experiencing. More so, it should also be able to provide a sense of human connection through different means of communication in order for the user to feel connected.

Compassionate technology is a technology which takes into account the user's comfort and experience. It does not only understand the physical, emotional, and mental aspect separately but also considers all three aspects interconnectedly in the design process. More so, compassionate technology tries to provide a sense of human connection.

Based on this definition, compassionate technology could be divided into 4 criterias.

1. Considers Overall wellbeing - Design of the technology takes into account the mental, physical, and emotional wellbeing of the user
2. Provides Human Connection - Strives to provides a sense of human connection
3. Empathizing - The solution must be able to sense, record, or keep track of the user's state
4. Understanding - The solution must make sense of the current state of the user

There are a number of compassionate technologies which could be used as examples for this project. Two different examples have been identified, and although they do not relate to mental disorders, each one provides an acceptable example of compassionate technology as defined in this project.

Liftware

Liftware is a spoon which is capable of auto stabilizing and leveling its handle to further assist individuals with parkinson's disease and hand tremors. It's main function is to ease the struggle for these individuals when they try to eat. More so, this technology not only further assists individuals struggling with parkinsons but also increases a sense of independence and also confidence by being able to independently take care of themselves ("Liftware"). Hence, it could be seen that Liftware does not only increase the physical wellbeing of the individual but takes into account the emotional and mental impact of the product for their users, this could be seen as a perfect example of a compassionate technology.

Vital Beat

Next, Vital Beat is a Netherlands based company which specialises in the creation of body shields for individuals who have implantable devices such as pacemakers and ICDs. Living with an implantable device could cause numerous issues especially when it comes to the protection of the device itself. Individuals often have to take extra precautions from dangerous situations such as contact sports, have accessories that cover the chest with the implantable, or even riding a car or a motorcycle. The shield provides an extra layer of protection which could further aid the individual physically but provides mental comfort knowing that the individual feels *protected*. Again, this is an example of technology which not only takes into account the user's physical but also mental well being ("Vitabeat").

2.3 State of the Art

Based on the research conducted in the previous two sections, it is possible to identify a number of different state of the art solutions. There are two criterias which have been used to determine the different state of the art solutions included. First the technology must be aimed to solve anxiety (in any form). Solutions which are not only specifically aimed to solve anxiety are also considered (eg. solutions which tackles anxiety and other mental disorders). Secondly, the solution must be considered a compassionate technology based on the criterias defined in the previous section. A compassionate solution could be considered if it adheres to at least two of these criterias.

2.3.1 Sanvello

Sanvello is a mobile application that primarily focuses on anxiety and depression. The application hosts a number of great features which are available to the users. Sanvello provides a wide range of features for self care which include mood tracking, guided meditations and therapies, coping tools such as health tracking, goal tracking, hope and reflection journals. In addition to this, Sanvello also provides peer support through social groups, coaching, and also the possibility of therapy from experts (“Sanvello”).

It could be seen that Sanvello tries to consider the different aspects of well being (ie. emotional, physical, mental) within their application. Sanvello was able to tackle this by utilizing guided meditation techniques combined with a mood and activity tracker thus further showing and signifying the importance of the different aspects of wellbeing for the individual. More so, with the addition of the social groups and therapy session, Sanvello was able to further reinforce the feeling of human connection which as discussed, is an important factor which is lacking in a great number of solutions for mental health today.

2.3.2 Calm

Similar to Sanvello, Calm is another mobile application which is used to tackle anxiety and stress. The application focuses on different mindfulness exercises while also provided different guided meditations and different body scan meditations within the application. Calm also features a mood journal to keep track of the user's mood. In addition to that, Calm also provides a reflection journal in which users keep track of their thoughts, feelings while also adding a daily gratitude entry. In addition, Calm continuously provides new content with famous public figures while also integrating different positive quotes which could be read to boost an individual’s mood. (“Calm”).

Calm could be considered as another example of compassionate technology. Similar to Sanvello, by utilizing different features, Calm is able to adhere to the improvement of the overall wellbeing of the user. Unlike Sanvello, Calm does not provide a sense of human connection through the use of support groups or therapy. Instead, content from relatable public figures and motivational quotes could help in increasing a sense of familiarity for the users. This further promotes a sense of empathy for the application, further showing that the application could be seen to understand and empathize with the struggle of the individual.

2.3.3 Muse

Muse is an EEG Powered wearable headband which passively senses brain activity when being used. Although it does not provide any physical or haptic feedback towards the user, the user could still receive real time feedback regarding their brain activity when they are doing and performing certain tasks. In addition to this, Muse's application further has a meditation option which allows users to wind down when stressed, anxious, or simply want to relax. Users will be able to have a better understanding of how their own mind works, understanding their own unique patterns and activities ("Muse").

Despite not being able to provide physical feedback towards the user, its sensing (empathizing) capabilities allows Muse to be able to further sense the current situation and state of the individual. More so, it is able to keep record and provide real time feedback regarding the current activity of the individuals' mind, further providing insight towards themselves.

2.3.4 XRHealth

XRHealth is a virtual clinical therapy which combines conventional therapy with virtual reality technology. The company could treat a number of mental disorders which include anxiety disorders. With the help of dedicated XRHealth therapists, it is possible to create a sense of human connection while aiding the individual from a distance ("XRHealth").

The use of VR technology allows for the measurement of physical data and quantities to further track the progress of the individual's physical wellbeing, further showing its consideration to the overall wellbeing of the individual. More so, XRHealth is able to provide the necessary human connection through its dedicated therapists which work closely in aiding the patients.

2.3.5 Apollo Neuro

Apollo Neuro is a wearable technology which keeps track of an individual's heart rate. The device primarily looks for variations and changes in the individual's heart rate which are activated by sympathetic nervous response due to factors such as anxiety or stress. Based on this variation, Apollo Neuro then uses touch therapy and creates light haptic vibrations which could urge the user to calm down, further providing external reminders towards the user to be aware that they are currently feeling stressed, anxious, or in a fight or flight mode. The device has been seen to assist users to focus, sleep, increase physical recovery, and calm down better ("Apollo Neuro")

The sensing capabilities Apollo Neuro allows this wearable to be able to recognize the current state of the individual. This provides a sense of understanding and empathy by the wearable towards the individual further showing a sense of *compassion*. This is further shown by its ability to provide haptic feedback to remind the user regarding their current mental state. This further shows how Apollo Neuro utilizes physical signals to determine the user's mental state which shows how the different aspects of wellbeing are interconnected and was taken into consideration in the design process.

2.3.6 Other Digital Health Solutions

A literature review (see Appendix A) on digital health solutions for anxiety was previously conducted. The results of the literature review discovered that although digital health interventions were becoming more popular, the lack of medical trials and a standard evaluation method made it difficult to determine the efficacy of these interventions. More so, it was also identified that users were often hesitant to try digital interventions, either due to reasons such as lack of trust, or incorrectly self diagnosing.

2.4 Discussion of Research Findings

Based on the research conducted it could be seen that generalised anxiety disorder is a mental disorder which could affect an individual in many different ways. This includes the decrease in focus and productivity of daily tasks due to constant worrying and anxiety. Individuals also struggle to alleviate their own feelings of anxiety. Thus it is crucial that a solution could be derived to try and help tackle these two issues for individuals who suffer from generalised anxiety disorder.

In regards to compassion, it was discussed how there was no definition of compassion. Thus based on the different definitions provided by experts, the definition of compassion for this study was stated as the ability of an individual to recognize, understand and empathize with the physical, mental, and emotional struggles and needs of another who is suffering, which creates a motivation to provide help. Compassionate technology was then defined as a technology which takes into account the user's comfort and experience. It does not only understand the physical, emotional, and mental aspect separately but also considers all three aspects interconnectedly in the design process.More so, different criterias essential for compassionate technology was also introduced. When a solution could achieve at least two of these criterias, then the solution could be considered as a compassionate technology.

It was seen that identifying technological interventions which could be considered compassionate technology based on the definition proposed by this study proved to be a difficult task. This further provides support to the argument that there is a lack of compassionate technology being utilized today in order to assist in aiding anxiety.

Furthermore it was seen that the interventions that fit the criterias of compassionate technology mostly focused on the utilization of the mindfulness based approach and meditation techniques utilized in conventional anxiety therapy. This further provides insight that these two treatments could be integrated into these technological solutions with ease. More so, it further provides recognition which shows that these two treatments in fact work well when integrated with these technological solutions based on the number of technologies found to utilise these treatment methods.

As a result of the findings of this research, this project will try to create a solution that focuses on alleviating the feelings of anxiety while also aiming to provide a sense of human connection as it was seen that this component was missing in a great number of current mental health technological solutions. More so, the solution will aim to tackle and achieve at least two criterias

of the previously defined criterions for compassionate technology. And finally, the solution will primarily be focusing on integrating the meditation and mindfulness based approach and technique within the technology.

3 Ideation

This chapter will focus on developing different concepts which will try to meet the needs of the user group. It will explain the ideation process and further visualise how the final concept was made. A number of concepts were initially developed based on the theory which was discussed in the previous section. Initial mind maps were developed to further explore the different aspects of the theory and possible forms of solutions. Then ideation matrices were made in order to produce a synthesis of different ideas based on the different key words and factors which are considered. This was followed by an in depth description of the different ideas made. Finally, the different ideas were passed through a number of different elimination criterias in order to obtain the final concept.

3.1 Iteration 1

To initially begin the ideation process two mind maps of the senses were developed. The first mind map focuses on the different keywords which could be associated with the different senses of taste, sight, smell, touch, and hearing. Thus, based on the first mind map, it was possible to create a secondary mind map which focuses on the different forms that the innovation or technology can take.

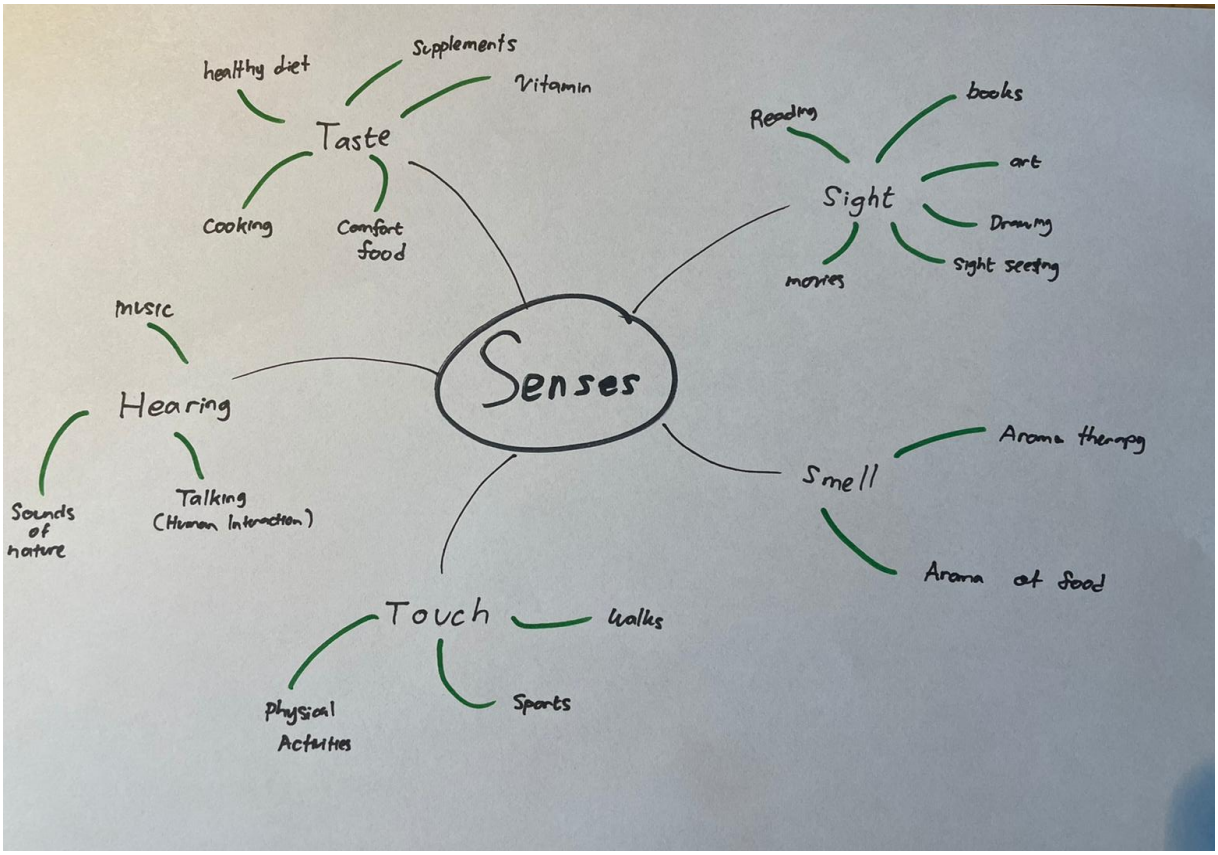

Figure 1: Mindmap of Senses

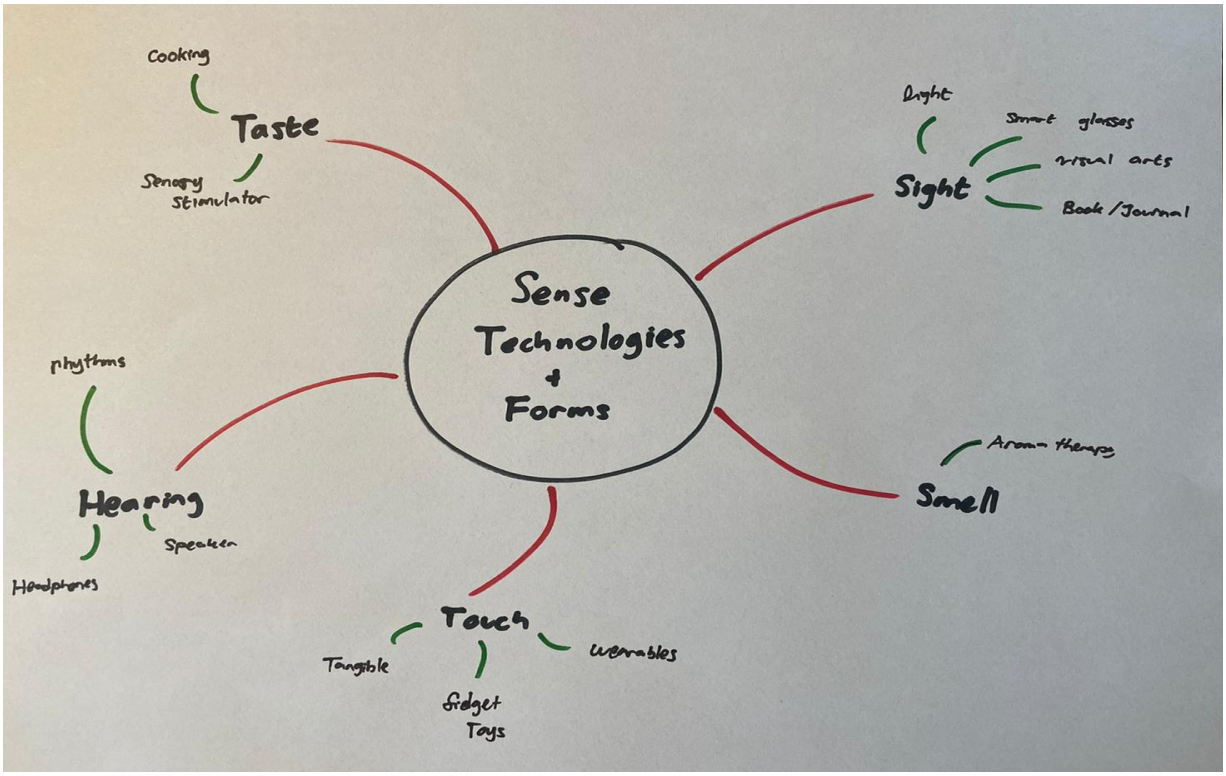

Figure 2: Mindmap of Sense Technologies and forms

Based on the different forms of innovation found it was possible to create an ideation matrix to generate a number of different ideas. The form of innovation was synthesized with the four different criterias of compassionate technology. The table is as follows.

	Overall Wellbeing	Human Connection	Empathizing (sensing)	Understanding
Lights	**x**	Lamp that respond to anxiousness utilizing messages sent by loved ones	**x**	Light that provides/sets mood depending on emotional input of individual
Book/Journal	Workbook to keep track of daily mental physical and emotional wellbeing	**x**	**x**	**x**
pictures	**x**	**x**	**x**	**x**
Glasses	Smart glasses that provide daily reminders/tasks	**x**	**x**	**x**

	to accomplish			
Bracelet	**x**	Panic button bracelet which automatically connects individuals to loved ones (letting them know they need help)	Watch/bracelet that tracks activity of individual	Bracelet that reminds individuals when it is time to relax
Headband	**x**	**x**	**x**	**x**
Headphones/Speaker	**x**	**x**	Application/algorithm which checks/assumes your mood based on the music you have been currently listening to	Application which creates a playlist depending on your mood
Application	**x**	Connect Application (reference to other projects)	Journal application	Chat bot application

Table 2: Ideation Matrix of Iteration 1

After three days of ideation it was seen that ideas could not be easily synthesized. The ideation matrix was in fact able to be used to generate some ideas however it was seen that the initial factors which were included are not suited well enough to allow for more ideation. It was then concluded that the intervention form should be more generalised into categories instead of specific forms (ie. headband, glasses, etc). More so, it was decided that the criterias should not be used as factors as they would be used to determine whether a technology is considered compassionate. Hence, the criterias should function as a reflection tool for the ideation process to determine the compassion aspect of the ideas generated.

3.2 Iteration 2

The second iteration follows a similar structure to the first iteration by creating an ideation matrix. However the initial factors were changed to the form of the solution, versus the different factors involved or which wanted to be implemented within the solution.Instead of distinguishing between different everyday objects, different forms of solutions which could be utilised for anxiety were identified. These forms include wearable, application, physical devices, and mixed therapy. As discussed in the previous section, the solution would be to try to use a mindfulness based approach while also implementing a factor of human connection. More so, it was also identified that positive reinforcement is one beneficial aspect of providing compassion. Thus the included factors which were identified were human connection, mindfulness, and positive reinforcements. Based on this ideation matrix, a total of 12 concepts were identified.

	Human Connection	Positive Reinforcement	Mindfulness
Wearable	connection bracelet which stimulates the warmth of another individual	reminder/affirmation bracelet/notification band which provides positive reinforcement based on the user	Smart glasses which guides the individual on how to be more immersed with the different senses around the user
application	anxiety application that notifies loved ones and people nearby that you require help (Anxiety first line support)	Trait/activity tracker application which reminds you of how much you've progressed, gives you daily reminders of recent achievements	Meditation and grounding exercise application which also tracks your daily progress and how you have been grounding yourself lately
physical devices	Connection light which provides comfort and warmth via input from other individuals and also loved ones	Smart mirror which provides inspirations and personalised affirmation and reminders for the individual	Grounding device which could stimulate and also sense the different things in the room. Helps ground together with the individual
Mixed therapy	Chatbot which could help people find the reason for their anxiety attack and try to mitigate it with the user	anonymous support application (indirect group therapy)	Multisensory audio visual experience with real time feedback to fully immerse the individual within the different senses (Virtual reality or simple screen)

Table 3: Ideation Matrix of Iteration 2

3.3 Iteration 3

Based on the 12 concepts which were made during the previous ideation process, a more in depth contextual description of each idea could be made. The third ideation focuses on creating a more detailed understanding of each concept by utilising a scenario and how the concept will be utilised within the scenario. The scenario/prompt which was made for the in depth contextual description of each idea is as follows:

> *You are at home alone and you suddenly feel symptoms of anxiety creeping in due to a trigger. Currently you have no clue to what or why you suddenly feel anxious but you want to find a way to help yourself become less anxious.*

3.3.1 Connection Bracelet

Concept

The connection bracelet is a combination between the two components of wearable technology and also human connection. The connection bracelet is aimed to stimulate the warmth of another individual through the use of different sensory actuators. It aims to help bring about the sense of human connection when an individual is going through symptoms of anxiety alone.

The device is a simple bracelet which holds a single button and also two different three actuators, a speaker, haptic buzzer, and also a warmer. These actuators will try to replicate the sense of human connection by providing real time input which is done through the aid of an application which another loved one can use in order to provide a sense of human connection to the individual who is struggling. The bracelet focuses on combining simple interaction between users and different actuators in a minimalistic way in hopes to increase a sense of human touch since it cannot be given from a distance.

Bracelet was chosen as it is minimalistic and unobtrusive and could also be used when at home. It is easy to use and easy to clean, often bracelets could also be a sign of connection towards another individual such as love bracelets and friendship bracelets. Thus bracelets could also already be considered a social symbol for creating human connections.

When the user is feeling anxious and in need of help or someone to help calm them down, the individual could simply press the button on their bracelet for 5 seconds until it begins to buzz. The bracelet will register that the user is currently facing an anxious situation and relays the message via bluetooth to a phone which sends a text through an application to loved ones. A loved one could then send them a virtual hug or a text message to the individual through the application, this will be displayed to the user through the bracelet which will play the voice notes sent by loved ones or even by receiving the virtual hug through a sense of feeling warmth using the warm actuator.

Analysis
Based on the concept it is seen that the bracelet cannot sense if a person is anxious but can instantaneously be activated once a person is anxious by pressing a button. It helps the individual try to contact loved ones in a simple way instead of texting or calling them one by one, the system allows for all loved ones to be notified instantaneously that the user needs help. Thus it could be seen as a good solution which could be used when an individual is currently having an anxiety attack alone at home.

In relation to the 4 criterias of compassionate technology, it is evident that this solution does not take into account the overall wellbeing of the user as it focuses simply on the mental aspect. However the solution does offer a sense of human connection for the user. More so, even though the bracelet is not able to track and sense the current state of the user it is able to give personalised feedback based on the response of the user's loved ones. Thus it could be seen that this solution meets two out of four criterias for compassionate technology.

3.3.2 Affirmation Bracelet
concept
The affirmation bracelet is a combination of wearable technology and also positive reinforcement. It is a bracelet with a small screen which could display simple text messages for the user. The smart bracelet would be accompanied with an application which would serve as an *affirmation* application where the individual could write down positive self talk and reminders

for themselves. The purpose of the device is to assist the individual during stressful situations and anxiety attacks.

In an event of an anxiety attack the individual could click on a button on the bracelet which will indicate that the user is going through an anxious period and needs positive reinforcement. The device could also track data of the individual such as heart rate and temperature, sudden changes might be a sign of tension which could be used to detect anxious moments of the individual.

Similar to the previous idea, the bracelet was a chosen wearable device as it is simple and unobtrusive, the simple concept also allows for mass customization of the product. More so, it could be developed in a way which does not only serve its purpose but also be stylish and could be worn anywhere and also be waterproof.

It utilises a simple bracelet with an led screen, simple interaction which focuses on mental stimulation or reminders for the individual which gets updated periodically It contains a heart rate sensor, temperature, and gyro/accelerometer to measure changes in the individual's body in an attempt to try and track whether there are sudden changes which might indicate It can track and try to give them positive reinforcement in the form of visual feedback using the led screen.

The solution is first used in parallel with an application which the user could also keep track of positive statements they would like to remind themselves of. During the day the bracelet will periodically update and display different inspirational quotes, reminders, and also positive affirmations for the user.

The device will also keep track of the users bio signals, during an anxiety attack, it is hoped that the solution could identify this through sudden changes in the users bio signals which in then will notify the bracelet to specifically display the positive reinforcement which the users themselves would like to be reminded of during the attack. It is hoped that it helps the individual become aware that they are dealing with an anxiety attack

Analysis
In relation to the given scenario, during an attack it does allow the individual to be more aware of the situation and also remind themselves to calm down, easy as it will always be used since it is a bracelet. The only downside is that if it is being charged or not in use then dont know if the person is experiencing symptoms. Overall it is a concept which has a great potential in aiding individuals who are facing anxiety attacks alone at home.

In relation to the criterias of compassionate technology, the solution only focuses on the mental aspect of the individual, thus it does not adhere to the overall wellbeing of the individual. More so, it does not provide a sense of human connection. However the solution is able to track and sense the different bio-signals from the individual and make sense of these data and return it in

a form of personalised feedback for the individual. Based on this, it could be seen that this solution is able to meet two of the four criterias of compassionate technology.

3.3.3 Smart Glasses for mindfulness

Concept

The smart glasses for mindfulness is a combination between wearable and mindfulness. It is a smart glass which promotes AR while also utilizing a camera to be able to track all the objects which the user can also see. The purpose of these glasses is to help individuals ground themselves through the sense of sight. Sight is an important sense which is often used in helping individual ground themselves. The glass will be able to identify different objects on the camera and ask whether the individual could see the same objects they see by paying attention to their surroundings. It could simply be activated through means of clicking a capacitive sensor button which will be available on the smart glasses.

The solution is simply a smart glasses which contains a camera, a capacitive sensor for functions while also utilizing AR technology. The camera will be used to detect objects around and in the view of the individual through object recognition. Glasses will then display questions such as ‘do you see this object’ using AR technology. The capacitive sensor will then be used as the on/off button but also to answer the questions asked by the smart glasses on whether or not they can see the same object as they do. AR is a niche field and so far, based on research conducted for this project, there are no solutions which utilizes AR in aiding symptoms of anxiety.

In order to utilise the solution, the individual must simply put on the glasses and turn it on, the glasses will then try to identify a few objects around the room and try to ask the individual whether or not they also see the same device if the answer is yes, then the glasses will display the next object to monitor, when the answer is no then the AR screen will highlight the object to make the individual aware that the object is in fact in the room. This process will continue until the individual feels that they are calm enough and wants to turn off the glasses. It is hoped that through slowly identifying with the different objects around the room the individual can learn to become more mindful of their surroundings and not be stuck in their own head, thus hoping that this will lead to a decrease in anxiety for the individual.

Analysis

In relation to the scenario, it is a good concept for individuals who are alones. It seems that the solution is simple to use and only requires the individuals and the glasses. In terms of realisation it could seem that the price would be a concern and would not be affordable for some individuals. More so, initial usage will be difficult as the individual must get used to how the glasses work before they can fluently use this technology to aid their anxiety.

In relation to the criterias of compassionate technology, it could be seen that this solution does not adhere to the overall wellbeing of the individual as it only focuses on the mental wellbeing while utilising the physical sense of sight. More so, it also does not provide a sense of human connection.Although the technology cannot sense whether or not the user is anxious, it is able

to *see* what the user sees thus it could be argued that the solution does infact sense through the use of sight which could then be used to provide the personalised feedback. Thus it meets two out of the four criterias of compassionate technology.

3.3.4 Anxiety first line support application

Concept

The anxiety first line support application is a synthesis between an application and human connection. It is simply a panic button for individuals who are facing symptoms of anxiety in the form of an application.The individuals could simply press a button and a notification would be sent to their close contacts requesting for them to call or text the individual in order to help with the individual's anxiety symptoms. The solution will come in the form of an application on the form. This will make the solution convenient as people are always with their phones and having this as an application would mean that it could be brought anywhere and be easily accessible for the users.

The initial use will require the user to connect their loved ones to the application via phone number or any other social platform. Then during events of anxiety attacks the individual can simply open the app and click the simple panic button on the application which will automatically send a notification text to all the users previously added contacts to notify them that the user is in need of help and support from them. This raises the feeling of human connection as it will really allow the user to feel supported by the people closest to them.

Analysis

Based on the scenario, it could be argued that the application is a good solution which could be used for individuals who are suffering from an anxiety attack alone. The idea focuses on human connection when the individual feels anxious and alone. It is simple and the individual is most likely to use their phones in hopes to distract themselves. However the individual must make the conscious effort to ask for help by turning on the application and pressing the panic button. Without the initial initiative the whole concept of this application will become obsolete.

In relation to the criterias of compassionate technology, the solution only focuses on the mental and emotional wellbeing of the individual, thus it cannot be said that it considers the entirety of the individual’s wellbeing. The solution does solely focus on human connection thus it meets the criteria of human connection. The solution is not able to track or record the individual’s condition, it cannot sense how the individual is feeling until they press the panic button on the application. It is however possible to provide personalised feedback but that solely depends on input from their loved ones. Based on this brief analysis it could be seen that this solution meets two of the four criterias of compassionate technology.

3.3.5 Activity tracker Application

Concept

The activity tracker application is a synthesis between positive reinforcement and an application. It is A application which allows the user to track all their activities which includes their diet, water consumption, sports, activities such as reading, talking with friends, and also how they

emotionally feel throughout the day. Through this data which is collected, the application could gauge using an algorithm on how the individual is feeling throughout the day and week and suggest different activities the individual could try to further improve their physical, mental and emotional wellbeing by performing different tasks. This application aims to reduce the symptoms of anxiety by creating a stable and productive activity tracking routine which also helps the individual reflect on themselves.

The solution will take the form of an application, making it easily accessible and could be used at any time throughout the day. This is also convenient as it would allow the user to be able to use it anywhere. It will utilize different algorithms to be able to make sense of the different data and inputs filled by the users. The user can simply utilise the application by simply logging in the activities and routines the individual have completed throughout the day, while also tracking data such as how long each activity was done, how they felt about each activity and also paying attention to how they feel generally throughout the day.

Analysis
In relation to the scenario, it seems that this application has no relationship to the provided prompt. More so, it will not be able to assist the individual when they are going through an anxiety attack. It is a good application for tracking routines, emotional physical and mental wellbeing but not very beneficial when dealing with an anxiety attack. Thus it could be argued that this would be a great idea to understand the individuals overall wellbeing but not preferable for individuals who are experiencing anxiety.

However in relation to compassionate technology it could be seen that this solution is able to meet three out of four criterias of compassionate technology. It is able to take into account the entirety of the individual's wellbeing. More so it is able to track (sense) the individual’s well being while also providing personalised feedback through the use of personalised activities suggestions for the individual. The only criteria that this solution does not meet is the criteria of providing a sense of human connection for the user.

3.3.6 Meditation and grounding application

Concept
The solution is a combination between an application and the theme of mindfulness. It is an application which could be used to help the individual learn to meditate and better ground themselves. It will utilize different methods and also simple tasks that the individual could do to help ground themselves. It is a simple application where new grounding and meditation exercises will be made available by the application. It will also feature popular methods used by popular figures and also health experts while also containing articles for anxiety individuals to use to better understand themselves. The application will also contain a reflection section for them to further understand their triggers. More so, the app will feature a calming anxiety mode for anxiety attack.

The application could be used for the individual to start and guide them through grounding and also meditating on a daily basis or during times of anxiety. The application could also be used in

calming anxiety mode in which it will focus on a guided grounding exercise of the individual's choice to help the individual calm down during times of anxiety. This mode could simply be turned on by pressing a button within the application which is easily accessible

Analysis
The concept could be beneficial in relation to the given scenario. However it seems like a simple application which does not offer much needed personalised help during anxiety attacks. It could be beneficial for individuals to try and get into the different methods to help ease their anxiety but will not be good for anxious attacks.

More so, it seems that this application only meets the well being criteria of compassionate technology. By providing different meditation and grounding techniques, it is possible for this application to adhere to the mental, physical, and emotional wellbeing of the individual. However it does not meet any of the other criterias. Thus it cannot be considered a compassionate technology.

3.3.7 Connection Light

Concept
The connection light is a synthesis between a physical device and the theme of human connection. The goal of this concept is to provide a sense of presence through the use of visual stimuli in the form of lights. The connection light is a simple night lamp which needs to be used in conjunction with another connection light. This connection light will utilize a turning mechanism and button in which the individual could use to set his mood. This mood will be reflected in the form of the color of the light. Whatever mood the individual feels, the light on the other lamp will also reflect this color to indicate how their loved one is feeling.

The concept consists of a simple lamp utilising a potentiometer as a knob, individually addressable leds and also an wifi module which allows the lamp to be connected towards the secondary lamp. During anxious moments, the individual could simply set their mood on the lamp and this will be directly displayed on their lamp and also their loved ones lamp to indicate that they are in need of help. Their loved one could then set their mood and send them positive emotions through re-setting the mood of the lamp in which it will glow by combining the colors of the two lamps together.

Analysis
In relation to the given scenario, the solution seems promising in helping an individual during an anxious period. However one obvious downside is that it requires two individuals to function. Thus in the event that the user is utilising the lamp, and their loved one is not at home, this would make the solution obsolete. This needs to be taken into consideration if this idea does push through onto the next stages of this project.

In relation to the criterias of compassionate technology. The solution does not adhere to the overall wellbeing of the individual. However it does put an emphasis on human connection. More so, the lamp is also able to track how the individual is feeling and use that input to create a

personalised feedback for them and also their loved ones. Thus based on this, it seems that this solution is able to meet three of the four criterias of compassionate technology.

3.3.8 Smart mirror for anxiety and positive reinforcement

Concept

The smart mirror is a combination between a physical device and the theme of positive reinforcement. It is a smart mirror which displays mindfulness reminders and also quotes of positive affirmations and reminders. It will consist of a touch screen so individuals can also interact and swipe to another affirmation and can connect to the internet to keep itself updated.
The mirror will also have simple reminders for the individuals such as to eat and sleep,it will be able to keep track of the different goals set by the individual. The goal of this solution is to provide positive reinforcement and increase self compassion. A mirror is a perfect tool for this as you are reminding yourself in the form of inspiration and affirmation while looking at yourself in a mirror.

The concept consists of a led touch screen while also utilising a wifi module to enable it to connect to the internet. More so, a mirror was chosen as it is a standard utility in one's room. Utilising the mirror as a source of positive reinforcement serves as a double purpose, making this concept of a smart mirror have multifunctional characteristics. The individual can simply look at the mirror while seeing daily inspirational and mindfulness quotes and reminders in which is hoped to help the individual gain a positive self image and further improve self esteem and self compassion which will help reduce the possibility of having anxiety.

Analysis

In relation to the given scenario, the smart mirror is a good concept to increase self compassion which is good in showing compassion to one's self however it will not be applicable within the scope of this project and will not help assist the individual during anxious moments. It will only serve as positive reinforcement and will not be beneficial to an individual during an anxiety attack.

More so, it would seem that this solution only meets one of the criterias of compassionate technology. Through the reminders and also positive reinforcement, it is possible for this solution to consider the overall wellbeing of the individual. However besides this criteria, it does not meet any of the other criterias thus it could not be considered a compassionate technology.

3.3.9 Grounding Device which focuses on the different senses

Concept

The grounding device is a synthesis between a physical device and the theme of mindfulness. It is a device which aims to help the individual ground themselves through three senses of sight, hearing and touch. Its shape is inspired by the tongue drum. It is a circular device, in center will be a screen which will be used to display the different images which the user can see, around the circumference of the devices will be the capacitive buttons which the user can press and under each button would be a buzzer which will be used to help create a sense of touch.

Essentially the device will ask the user to ground themselves by being mindful of their senses. Through the screen the device will ask the individuals different questions such as which button creates the hardest buzz, or what do you see on the screen. These sensory questions are aimed to help the individual become more aware of their senses by focusing on the device.

Analysis

In relation to the given scenario, this solution is a good concept as it allows the user to ground themselves during an anxious situation, more so, it is beneficial to the individual especially given the fact that they are alone. Although the concept is still being developed, if this solution does proceed in the future, it is a good suggestion to further create a better concrete understanding of what and how this solution will work and look like.

In relation to the criterias of compassionate technology, it seems that the solution utilises the individuals physical senses to further aid in their mental and emotional struggles in the anxiety attack thus it could be suggested that this solution does infact adhere to the overall wellbeing of the individual. It does also provide personalised feedback towards the individual through the use of different questions to stimulate the senses. However this device does not provide a sense of human connection nor does it sense the different feelings or track the emotions of the individual. Thus it could be said that this solution meets two of the four criterias of compassionate technology.

3.3.10 Chatbot for anxiety

Concept

The chatbot for anxiety is a solution which combines mix therapy and human connection. The solution will utilise an AI chat bot which is personalised to the individual it is trying to help. It will come in the form of an application since people these days are inseparable from their phones, making it convenient for them.The chatbot will aim to help the user understand why they are currently feeling anxious and try to help them mitigate the symptoms.

As mentioned previously the chatbot will come in the form of an application which utilises AI technology to generate appropriate responses for the users while also continuously learning which aims to better understand the situation and characteristics of the person. The technology of AI is used in this case as it could provide that needed personalised feedback for the individual rather than . More so, the utilisation of AI allows the application to continuously learn about the individual which could then be argued that with a better understanding of the user, the chatbot could provide better responses and aid for the user.

In the initial part of utilising the application the user will be asked some personal questions regarding how they usually deal with anxious situations and what usually triggers them and how they often try to mitigate this. The AI will then use this in order to be able to provide a better personalised response for the individual.

In the event of an anxiety attack the individual could simply activate the application in which they could talk to the chatbot regarding how they feel and what is bothering them. The chat bot will

then try to help the individual break down the issue while also slowly trying to understand the individual better. The chatbot will continuously learn, making it familiar to the individual's problems as they keep utilising the application.

Analysis
In relation to the given scenario, this anxiety chatbot application can provide the much needed human connection for the user. This gives the user the sense that they are not alone. More so, as phones are always by users these days, it could be assumed that this solution is never far away from reach as it will come in the form of an application on the phone. The user does however need to have the initiative to use the application as it does not sense that the individual is going through an anxiety attack. Thus, users need to be the one to activate the application to notify the chatbot that they are in need of assistance.

Based on the 4 criterias of compassionate technology. It could be seen that the application mainly focuses on the emotional and mental wellbeing of the individual. However it could be argued that through continuous learning, the AI could even understand the physical triggers of the individual thus it could also try to aid the individual's physical wellbeing. More so, one of the main strengths of this solution is its ability to try and recreate human connection through utilising AI technology.

Although the AI chatbot cannot initially recognize if the user starts to feel anxious unless they utilise the application, it could be argued that since the AI can keep track and further understand the user as they keep interacting with the solution, the AI does sense and try to make sense of the user while also striving to provide the best possible aid through personalised feedback through the information the AI has gained through interaction. Thus it could also be stated that this solution fills all four criterias of compassionate technology.

3.3.11 Anonymous support application for anxiety
Concept
The anonymous support application is a synthesis between mixed therapy and the theme of positive reinforcement. It is essentially a chat room to aid people who are feeling anxious in the form of a platform. People can enter chat rooms or call rooms when they need help. The individual will not need an account as they will remain anonymous. It focuses on ensuring that the user will not be alone during anxious situations. A simple connect button on the screen which connects them to anyone in the world who is also on the application. The solution will serve as a platform to connect rather than a solution itself; the intervention will solely rely on human connection in order to help mitigate symptoms.

The platform will follow a simple plug and play method in which the user would only need to download the application and it is ready to use. When an individual is feeling anxious, they can simply get on the platform and click to connect with a random individual world wide who can provide anything from comfort, companionship, or someone to open their problems to. The possibilities are endless in terms of what the users and individuals could ask for assistance with or even talk about.

Analysis
In regards to the given scenario, the application can simply be used at any time and any place while also providing the individual with human connection if the user does not want to be alone. It is also beneficial for when loved ones cannot be contacted at the moment. However it is also important to point out that the concept falls primarily on human connection and mixed therapy instead of positive affirmation.

In terms of compassionate technology, it could be seen that the solution does not consider the overall wellbeing of the individual. However there is a great emphasis on human connection. Although this platform will not be able to sense or track whether the user is anxious, it is possible to provide personal feedback with the help of input from random anonymous users who are there to assist the user in need. However it could be said that this could be subjective as this is a platform to connect. It only serves as a mediary rather than a solution itself. The main focus is still the human connection between the user and another, rather than the user and the technology at hand. Overall this solution meets two out of the four criteria of compassionate technology.

3.3.12 Multisensory audio visual experience (VR)

Concept
The multisensory audio visual experience is a synthesis between mixed therapy and the theme of mindfulness. It is simply a VR set up which allows the individual to fully be immersed in a different world or setting and try to calm down. It focuses on being close to nature thus the VR will display natural scenarios such as beaches, oceans, forests, mountains, et cetera. It is based on the concept that a good grounding method is to reconnect with nature **(source?).** It focuses on two senses which are sight and hearing in hopes that this will help ground the individual better.

The solution consists of a VR set and could be connected to a pair of headphones or speakers. VR allows the individual to feel as if they are somewhere else or anywhere they want to be rather than the place they are at right now, giving a sense of escape for the individual. VR has been used for mixed therapy for anxiety thus implementing it in another context might also prove efficient and successful. VR is still a niche field and could be further explored in hopes to aid mental health in this case anxiety.

On first use, the individual must first set which scenario they would like to be displayed in the VR set. During moments of anxiety, especially when the individual is alone, the individual could simply put on the VR headset and disappear into a digital representation of nature in hopes to ground themselves.

Analysis
In relation to the given scenario, it could be argued that the solution is a good concept which could work for individuals who are alone and dealing with an anxiety attack. However it could also be argued that VR sets are generally expensive and costly and not a good solution for a

great number of people who cannot afford it. More so, it might not be good for people who do not have much space in their homes.

In relation to the criterias of compassionate technology, it could be argued that the solution does not meet any of the criterias of compassionate technology. The only personalised feedback that could be given to the individual is when the user decides which scene they would like to use the VR in thus, it could be argued that this solution cannot be considered a compassionate technology.

3.4 Selection Criteria

In order to determine a final concept, a selection criteria was developed to assist in the decision making process. The criteria to determine the final concept comes in three elimination processes. These elimination criterias are as follows:

Criteria 1	Compassionate Technology - Concept needs to meet at least two compassionate technology criterias
Criteria 2	Relation to the given scenario
Criteria 3	Personal Choice of researcher

Table 4: Elimination Criterias

3.4.1 Criteria 1

A table was constructed to provide an overview of which criterias of compassionate technology each concept meets. The concept needs to be able to meet two criteria in order to be considered a compassionate technology. If this condition is not met, then the concept will be eliminated. The table is as follows:

Concepts	CT Criteria 1	CT Criteria 2	CT Criteria 3	CT Criteria 4
Connection Bracelet		**x**		**x**
Affirmation Bracelet			**x**	**x**
Smart Glasses for mindfulness			**x**	**x**
Anxiety First line Support Application		**x**		**x**
Activity Tracker Application	**x**		**x**	**x**
Meditation and Grounding Application	**x**			

Connection Light		**x**	**x**	**x**
Smart mirror for anxiety and positive reinforcement	**x**			
Grounding device which focuses on the different senses	**x**			**x**
Chatbot for anxiety	**x**	**x**	**x**	**x**
Anonymous support application		**x**		**x**
Multisensory audio visual experience (VR)				**x**

Table 5: Criteria 1 - Compassionate Technology

3.4.2 Criteria 2

After the first elimination criteria it was seen that 3 concepts could not be considered as compassionate technology as they fail to meet at least two criterias of compassionate technology. Thus the remaining ideas are as follows:

1	Connection Bracelet	6	Connection Light
2	Affirmation Bracelet	7	Grounding Device
3	Smart Glasses	8	Chatbot
4	First line support application	9	Anonymous Application
5	Activity Application		

Table 6: Remaining Ideas after Elimination Criteria 1

Based on the 9 ideas, a line diagram was made which identifies which ideas would be most favorable in relation to the previous scenario/prompt. Then the top four ideas would be chosen as the final four which will move on to the next stage.

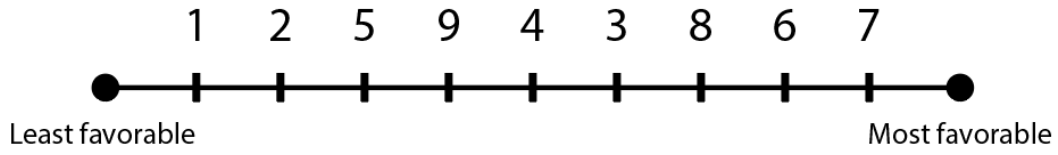

Figure 3: Line Graph of Ideas in relation to given Prompt

3.4.3 Criteria 3

A total of 4 concepts were remaining after the end of the second elimination criterias. These include the grounding device, the connection light, the chatbot application and also the smart glasses. Based on the remaining ideas, it was decided based on the researcher's interest that a synthesis between two ideas was the best way to move forward. Thus it was decided that the final concept will be a synthesis of the connection light and also the grounding device.

3.5 Final Concept

Based on the third iteration of the ideation process, the final concept is a synthesis of two ideas which passed the criterias determined within the third iteration process. These two ideas were the connection lamp and the grounding device. A synthesis was made to develop the final concept of a connection light which also serves as a grounding device.

The connection light is a smart mood lamp that aims to aid mitigate the symptoms of anxiety through the use of grounding breathing exercises while also trying to provide a sense of human connection. It resembles a minimalistic lamp which utilizes coloring changing leds which is used to reflect the anxiety level of the loved one and notify their loved ones regarding it. These leds will also be utilized to create the breathing effect resembling a breathing exercise by continuously dimming and brightening the leds of the lamp in a periodic cycle. The lamp will come in pairs, one for the user and one for their loved ones. These two lamps will be interconnected using wifi, this could be used anywhere around the world, regardless of distance.

To use the connection light, the user simply needs to turn on the lamp and then they could choose a certain predetermined color to resemble a certain mood (ie, green for light anxiety, blue for moderate anxiety, red for severe anxiety). After the user indicates their level on their own lamp, the user's lamp will then begin to glow based on the level they have indicated. This information is automatically transmitted to their loved one's lamp via the internet thus automatically turning on their lamp and glowing in the same color as the users. Their loved one could then send them a notification that they have in fact received and also recognizes the fact that they are feeling a certain level of anxiety by simply interacting with the lamp. These users could both then use the lamp together to perform breathing exercises to help mitigate the feeling of anxiety.

The user could also utilise the connection light to help ground themselves when going through an anxiety attack through a breathing exercise. This could simply be activated when the user holds the lamp with their hands. The lamp will be able to sense this and activate its breathing exercise protocol in which the lamp will turn on and slowly dim and brighten to replicate a breathing pattern in which the user could follow. The user could follow this breathing exercise up to the point where they feel calm.

4 Specification

4.1 Introduction

The final concept is a connection lamp which serves as a device which allows users to communicate their level of anxiety to their loved one while also allowing them to perform breathing exercises either on their own or with a loved one. The specifications for the concept could be developed to further understand the details of the concept and how it will be made. This chapter will outline the different components of the Connection Lamp and discuss what is needed to develop a first functional prototype.

4.2 Persona

To better understand how the Connection Lamp will function, two personas were created. These personas alongside different use case scenarios will help identify the different requirements which will be needed to develop the lamp.

4.2.1 Persona 1- Ian Pieters

Ian Pieters is a 24 year old male currently doing his bachelors in the Netherlands. Since he was 20, Ian was diagnosed with generalised anxiety disorder which has really affected his ability to function and be productive. He is quite an outgoing person with many friends. He loves to play sports, read books and also spend time with his friends. People know him as a very hardworking individual who never fails to meet people's expectations. He has a sister who is currently living in Germany and could only see her once every few weeks. Despite being very outgoing, Ian is known to be very hesitant when it comes to asking for help. He feels as if he does not want to bother or create a fuzz for anyone by expressing his emotions and asking for help.

This creates a problem for Ian as he often has anxiety attacks from different triggers such as the stress of work and university but also when he overthinks the different things within his life. More so, even though he has gone through therapy, Ian still sometimes finds it difficult to calm himself down when he is going through an anxiety attack, his mind continues to overthink and he becomes tunnel vision with his invasive and overthinking thoughts. Sometimes it could feel as if he is disconnected from reality and just stuck within his own head. His anxiety attacks and his hesitancy to ask for help has really taken a toll on his well being and he needs to find a way to relieve his struggles. Ian needs a way to be able to express his emotions discreetly to his loved ones to ask for help. More so, he also needs to find a way to be able to help himself calm down when he is feeling anxious, getting him out of his head and focusing again on what is right in front of him.

4.2.2 Persona 2 Chloe Pieters

Chloe Pieters is 27 years old. She is the sister of Ian Pieters. Ian and Chloe have been very close since they were little. Chloe is a very protective older sister and recognizes that her brother has been suffering from Generalised Anxiety Disorder for years. Chloe now lives in Germany while Ian is in the Netherlands. She sometimes worries about how she could be there

for Ian knowing that they are far away from each other and she is unsure if she could help Ian from a distance.

4.2.2 Use case
4.2.2.1 Scenario 1 - Persona 1
Purpose: Conduct a breathing exercise alone when feeling anxious

As of late, Ian has been busy conducting intensive research for his upcoming project. Today, he managed to make good progress on the project. However he suddenly begins to feel as if his work is not up to standards and starts comparing his work with his peers. This puts a certain pressure on him to actually spend more time on the task at hand even though he feels it is already sufficient. This continuous comparison between him and his peers is tedious and makes him anxious as Ian's mind is constantly thinking about all the things that still need to be accomplished while also worrying about the quality of his work.

Ian needs to find a way in which he can calm himself down from this anxiety attack. He then remembers that the connection lamp has a built-in mode which could help him during an anxiety attack. He would like to use the lamp to help in calming himself down through a breathing exercise.

4.2.2.2 Scenario 2 - Persona 1
Purpose: To send a message to Ian's loved one that he is feeling anxious and ask them for help

Ian has had a long and tiring day. More so, nothing today has gone right for him. He was late to university, his group projects had some issues and he had to cancel an appointment due to a lack of time. Upon arriving home Ian received terrible news that he has been rejected for the job he has been applying to. He suddenly finds himself feeling upset and down however he feels as if he does not have any time to process these emotions yet as he still needs to finish his upcoming deadlines. Ian begins to feel a certain amount of anxiety creeping in and it is beginning to start affecting his ability to even relax.

Ian recognizes that this anxiety will only progress and get worse over time, he knows that if he doesn't deal with it now, Ian will find himself in a terrible state in just a matter of time. Ian would like to notify his sister that he is currently feeling a certain amount of anxiety by using the connection lamp. Ian would like to tell his sister that he is feeling (light, moderate, severe) anxiety and would like to ask her to help him. Ian sends his anxiety level to his sister using the lamp.

Scenario 2a
After waiting for a while, Ian receives a response from his sister through the lamp. Now, she decides to help him pace himself through a breathing exercise by utilising the lamp.

Scenario 2b
Apparently, it seems that his sister is not available at the moment, thus she is not able to help. However it is still possible for the lamp to provide him with breathing exercise until he are able to calm himself down.

4.2.2.3 Scenario 3 - Persona 2
Purpose: To provide compassion towards a loved one, who is currently feeling symptoms of anxiety
Chloe has come home from a long day of work, she feels tired and decides to eat dinner. After eating dinner, Chloe prepares herself for bed and decides to read a book before she goes to sleep. Then in the corner of her eye, Chloe sees the lamp turning on, indicating that her brother, Ian is currently feeling some anxiety. She decides that she wants to be there for him and decides to give him a phone call while also helping him regulate his breathing pace using the lamp.

4.3 Compassion
The concept aims to provide compassion by another individual to another. The lamp thus serves as a mitigator of compassion, allowing two users to exchange and provide compassionate interactions between themselves. More so, this allows the lamp to provide a sense of human connection which as discussed in previous chapters is something that is lacking within a great number of solutions aimed for mental health. This essence of human connection does not only increase a sense of presence between the two users but rather also increases feeling of comfort for the individual who is struggling. Thus the concept will prioritize human connection in hopes to provide compassion through the use of technology.

The concept aims to create a tool which could be used by an individual to mitigate their symptoms of anxiety in a compassionate manner either alone or with the assistance of their loved one. This concept focuses on mediating compassion through utilizing technology. It could be said that the connection lamp tries to mediate and increase compassion by stimulating an emotional response from the user through discrete changes within the light of the lamp.

4.4 Anxiety
4.4.1 Grounding Exercises
In Chapter 2, it was seen that most of the solutions which were found utilises mindfulness based approaches utilising modalities such as breathing exercises and being aware of their own thoughts and feelings. Thus this approach will be used for the Connection Lamp. The Connection Lamp aims to provide the user with breathing exercise to help them focus their attention onto the light. More so it is expected that by interacting with the lamp itself, the users would become aware of their own thoughts and emotions. One study suggests slow breathing as 4 to 10 breaths per minute. More so, it was suggested that controlled breathing with 4 to 10 breaths per minute has been proven to have a great number of physiological benefits for the individual (Russo et al., 305). Thus the lamp would also incorporate breathing patterns with identical breathing paces.

4.4.2 Design choices which influences anxiety

There are three design choices which have been identified which could influence the anxiety of the user. It is important that these three factors are carefully considered as to not cause unnecessary harm for the user. The three factors identified are paces of breathing, color of the light, and shape of the lamp.

As mentioned in the previous section it was identified that a breathing pace between 4 to 10 breaths per minute has been proven to have different physiological benefits for the users. As the lamp would be able to include different breathing patterns. The lamp would allow the user's loved one to choose a breathing which ranges between the paces provided previously. This pace would then be used to assist the struggling user through a breathing exercise.

It is important that the color choice which is used on the lamp does not invoke negative emotions for the user. A paper by James T. Guthrie suggests yellow as an emotional color,

> *"The yellow wavelength is relatively long and essentially stimulating. In this case the stimulus is emotional, therefore yellow is the strongest colour, psychologically. The right yellow will lift our spirits and our self-esteem; it is the color of confidence and optimism. Too much of it, or the wrong tone in relation to the other tones in a colour scheme, can cause self-esteem to plummet, giving rise to fear and anxiety. Our 'yellow streak' can surface" (Guthrie, 1)*

This suggests that yellow could either resemble high spirits, positive self esteem, but also resembles fear and anxiety. This duality of meaning could suggest that the color yellow could be beneficial to stimulate positive emotions but also used to resemble feelings of anxiety. Therefore, as the lamp would like to portray and let the users reflect on the severity of their anxiety level, a gradient from white to yellow will be utilised within the lamp in which white resembles light anxiety and yellow would resemble severe anxiety. The user could then reflect on the intensity of their anxiety level by utilising the color of the light as a reflection of their anxiety.

Lastly, it needs to be ensured that psychological effects of the design shapes are taken into account as to reduce the chances of discomfort for the user. Larson et al. suggests that circular shapes are more linked towards pleasantness in comparison to shapes with shape edges. (Larson et al., 411). In the context of this project, it would suggest that a more rounded design could create a more pleasant and comfortable feeling for the user. Thus a more rounded and circular design will be prioritised and considered for the overall physical shape of the lamp.

4.5 Interactions

The Connection Lamp has two main functionalities. First the lamp will allow the users to conduct a breathing exercise on their own while they hold the lamp. This aims to help the users alleviate their anxiety through the breathing exercise. The second functionality allows the user to become aware of their own emotions and thoughts by determining their own anxiety level and notifying

their loved one. In return their loved one can help them by conducting a synchronized breathing exercise until the user feels that their anxiety has been relieved.

4.6 Design

4.6.1 Sketch

A sketch of the connection light could be seen below:

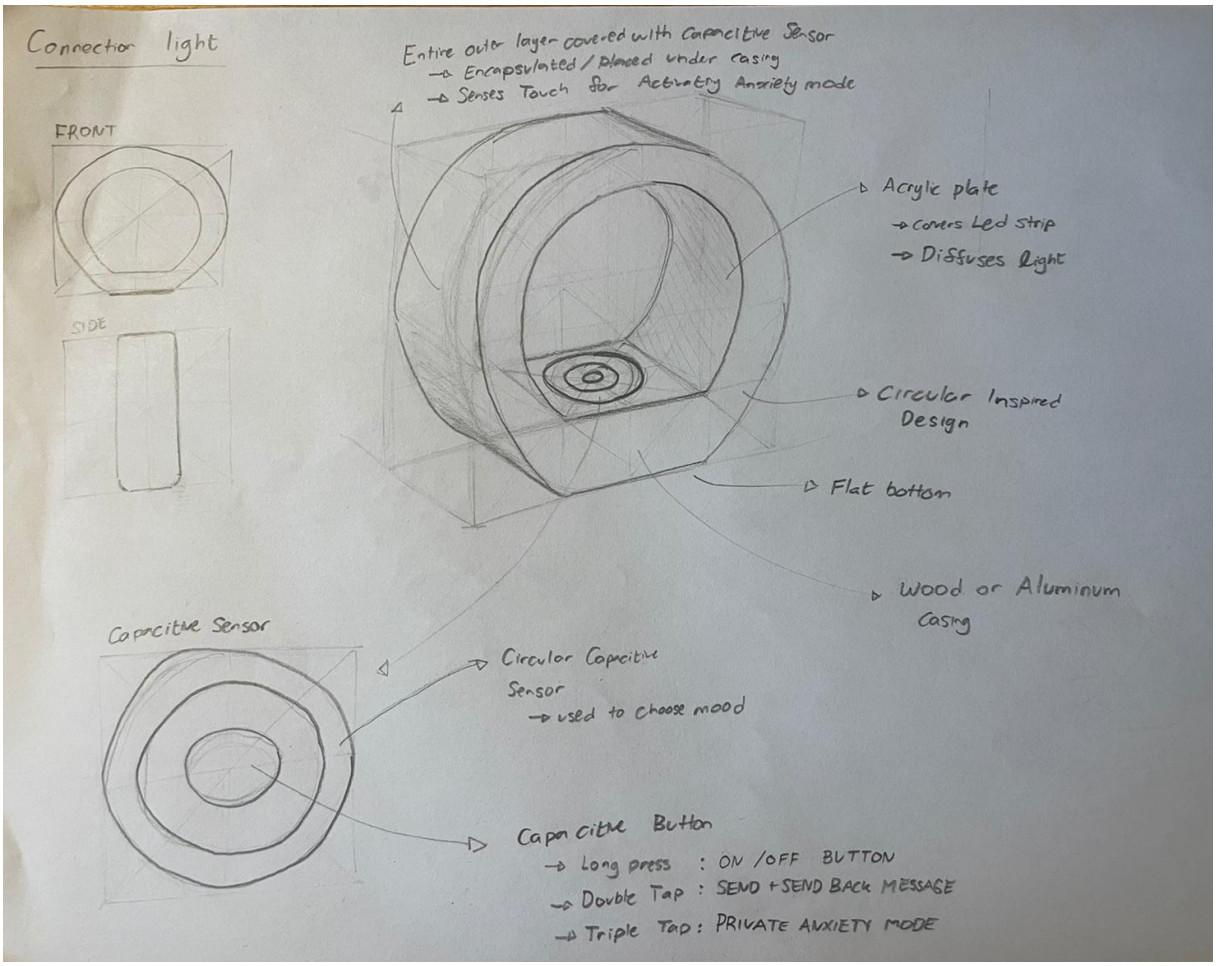

Figure 4: First Sketch of Connection Lamp

4.6.2 Material choice

In terms of the materials, it is expected that the lamp is made out of wood to provide for a more natural feel towards it. More so, translucent glass will be utilised in order to house the lights and also provide a cover between the light and the user themselves. The use of translucent glass helps diffuse the light in order to not make it too bright and also creates a more aesthetically pleasing experience.

4.7 Hardware

In regards to the specification of the hardware, this section will focus solely on the hardware components which will be used in regards to the creation of the prototype rather than in the ideal case of the concept.

The arduino microcontroller will be utilised for the development of the connection lamp. Since the development of this concept is still in its early stages, the use of an arduino is ideal for the initial prototype of the lamp. It allows for the rapid prototyping and development of the prototype. In the case of this project, an arduino nano would be ideal as it would take up less space and the aesthetics of the lamp could be preserved. The use of proto-wires and prototyping board is also expected to be used within the prototype. More so, the use of individually addressable LEDs will be a crucial component to the success of the prototype. Thus, the use of the individually addressable LED strip WS2811 or WS2812 would both work as they are both compatible with the arduino.

In the event that two lamps are made, the bluetooth module HC-05 or HC-06 could be utilised to enable lamp to lamp communication for the two users. This could be used ideally in order to test the interaction between the two lamps and also the user experience between the user and the loved one within a close distance.

Buttons would be an essential part of the prototype as it would allow for interactions between the user and the lamp. It could be used for multiple functions such as the on/off switch, sending and receiving of messages, while also allowing the user to pick a specific mood to send out. These buttons are simple to use and could easily be integrated utilising the arduino. Thus the push button microswitch will be utilised for development of this prototype.

Capacitive sensors would also be utilised in the prototype in order to be able to detect physical touch. Capacitive sensors could easily be developed by utilizing a number of wires, capacitors, and a piece of metal foil. These sensors would play a crucial role as they would be responsible for detecting whether or not the user is holding the lamp and would like to activate different modes of the lamp.

4.8 Software

In regards to the specification of the software, this section will focus solely on the software which will be used in regards to the creation of the prototype rather than in the ideal case of the concept. Since for the prototype, the arduino will be utilised, the majority or all the programming will be done within the arduino compiling language. Additional libraries to incorporate the other hardware such as the LEDs could simply be found on online forums and in the Arduino Library itself.

In the case that the bluetooth and the wifi module are no longer suitable options for connection between the lamps, serial communication could be utilised to enable the interconnectivity of the two lamps. Each lamp could be connected to a separate laptop and serial communication could be enabled to connect the two lamps together through utilising processing.

4.9 Requirements

Based on the different personas, scenarios, and design requirements discussed within this section, it was possible to draw up a number of functional and nonfunctional requirements which the prototype will require. More so, utilising the MosCoW prioritization method, it is possible to determine which requirements would need to be prioritised in order to create a minimal viable first prototype which could be used to evaluate the overall concept.

4.9.1 Functional Requirements

- FR1: The lamp can communicate with the respective paired lamp
- FR2:The lamp can switch between the different colors (LEDs)
- FR3: The paired lamp can send back a message that they have received the users anxiety level
- FR4: Loved ones can send back a message of how they feel back to the user
- FR5: Can dim and brighten in a periodic manner
- FR6: Can switch between the different modes/states
- FR7: Can sense the presence of the user based on touch
- FR8: Contains a protocol/mode which is used to try and reduce the symptoms of anxiety
- FR9:Able to communicate to the other lamp via the internet
- FR10: Able to communicate to the other lamp via bluetooth

4.9.2 Non Functional Requirements

- NFR1: Tries to mitigate the symptoms of anxiety
- NFR2: User can set the color theme by themselves
- NFR3: Utilises the use of light as a communication tool between the user and the loved one
- NFR4: Design choices must be based research/inspired by anxiety relieving shapes or designs
- NFR5: Must be able to notify partner about how the user feels
- NFR6: The lamp is easy to learn (users have an easy time figuring it out during first time use)
- NFR7: Must be integrated with an application that serves as a digital lamp
- NFR8: Loved one must have a lamp of their own

4.9.3 MosCow Prioritization of requirements

Requirements	Must Have	Should Have	Could Have	Won't Have
FR1: The lamp communicates with the respective paired lamp		**X**		

FR2: The lamp can switch between the different colors (LEDs)	**X**			
FR3: Loved ones is able to send back a message that they have received the users anxiety level		**X**		
FR4: Loved ones must be able to send back a message of how they feel back to the user			**X**	
FR5: The lamp is able to dim and brighten in a periodic manner		**X**		
FR6: The lamp is able to switch between the different modes/states		**X**		
FR7: The lamp is able to sense the presence of the user based on touch		**X**		
FR8: The lamp contains a protocol/mode which is used to combat anxiety	**X**			
FR9: The lamp is able to communicate via the internet				**X**
FR10: The lamp is able to communicate via			**X**	

bluetooth				
NFR1: The lamp tries to mitigate the symptoms of anxiety	**X**			
NFR2: User are be able to set the colors theme by themselves				**X**
NFR3: The lamp utilise the use of light as a communication tool between the user and the loved one	**X**			
NFR4: Design choices are based on research/inspired by anxiety relieving shapes or designs			**X**	
NFR5: The lamp is able to notify partner about how the user feels	**X**			
NFR6: The lamp is easy to learn (users have an easy time figuring it out during first time use)		**X**		
NFR7: The lamp is integrated with an application that serves as a digital lamp			**X**	
NFR8: Loved one has a lamp of their own			**X**	

Table 6: Table of MOSCOW Requirements

4.10 Conclusion

The different requirements, software, hardware, and design specifications can now be used in order to turn the concept into a first functional prototype. More so, anxiety related design choices were considered to ensure that the concept would reduce any chance of potentially causing unnecessary harm for the users. This prototype can then be used in order to conduct evaluation testing. This evaluation testing will provide an insight to how technology could be used to provide compassionate care for individuals who struggle with generalised anxiety disorder.

5 Realisation

Based on the different requirements and specifications made in the previous chapter, the first prototype for the concept was developed. The process of developing the prototype will be further discussed within this chapter. This realisation chapter will be divided into three main parts which are Design, Hardware and Software to further elaborate on the steps and process taken to create the first prototype of the concept. This will then be followed by a section which will discuss the first prototype which was developed.

5.1 Design

5.1.1 Design Iterations

The design of the physical prototype was the first priority in the realisation phase. Before the development of the hardware and software of the prototype it must be ensured that the design of the lamp is finalised in terms of its size and shape. To further have a physical feel of the initial design, a non functional design prototype must first be developed. This was achieved through means of foam modelling. Utilising foam modelling, the first design prototype was developed based on the initial design drawn in the previous chapter. From this initial design, two more models were developed as an iteration of the first design prototype to see whether the design could be improved from the initial design. These three models were then compared to each other to further determine the best design for the Connection Lamp. These three models are as follows:

Figure 5: First foam model

Figure 6: Second foam model

Figure 7: Third foam model

5.1.2 First Model

The first design was based on the sketch that was made in the previous chapter. The shape of the lamp is supposed to resemble a circle with a flat bottom. The design features bezel edges to create a more clean finish and reduce sharp edges. The interior of the ring is meant to hold the LEDs while the exterior side will house the capacitive sensor of the lamp.

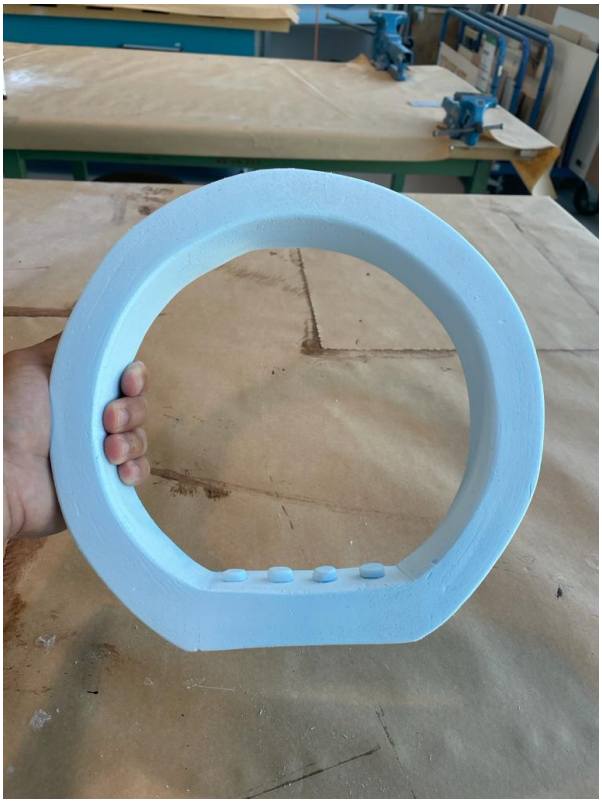

Figure 8 & 9: First Foam Model Design

5.1.3 Second Model

The second iteration which was made was closely related to the first. However this design focuses on a more circular finish on the ring. The entire ring itself was meant to resemble the led light while the section presented with pink is supposed to resemble the position in which the user could hold the lamp while also serving as the capacitive touch sensor. This design also allows the lamp to be taken out from its stand. The circular design of the ring creates a more futuristic finish compared to the clean finish of the bezel edges on the first model.

Figure 10: Handheld Second Model

Figure 11: Model one and two comparison

5.1.4 Third Model

Based on the two models which were made, a decision was made in terms of the size of the models. As it is expected that the users could hold the lamp, a design choice was made which suggests that holding the lamp would be easier if it was smaller and could be held with just one hand. Thus it was decided that the third model would emphasize on a smaller sized design. A different approach was then taken. This resulted in the sphere-like design of the third model. The center of the sphere will be where the lights will be placed while the top and bottom layers are where buttons and capacitive sensors will be placed. With the smaller volume, the user should be able to hold the lamp on one hand with ease.

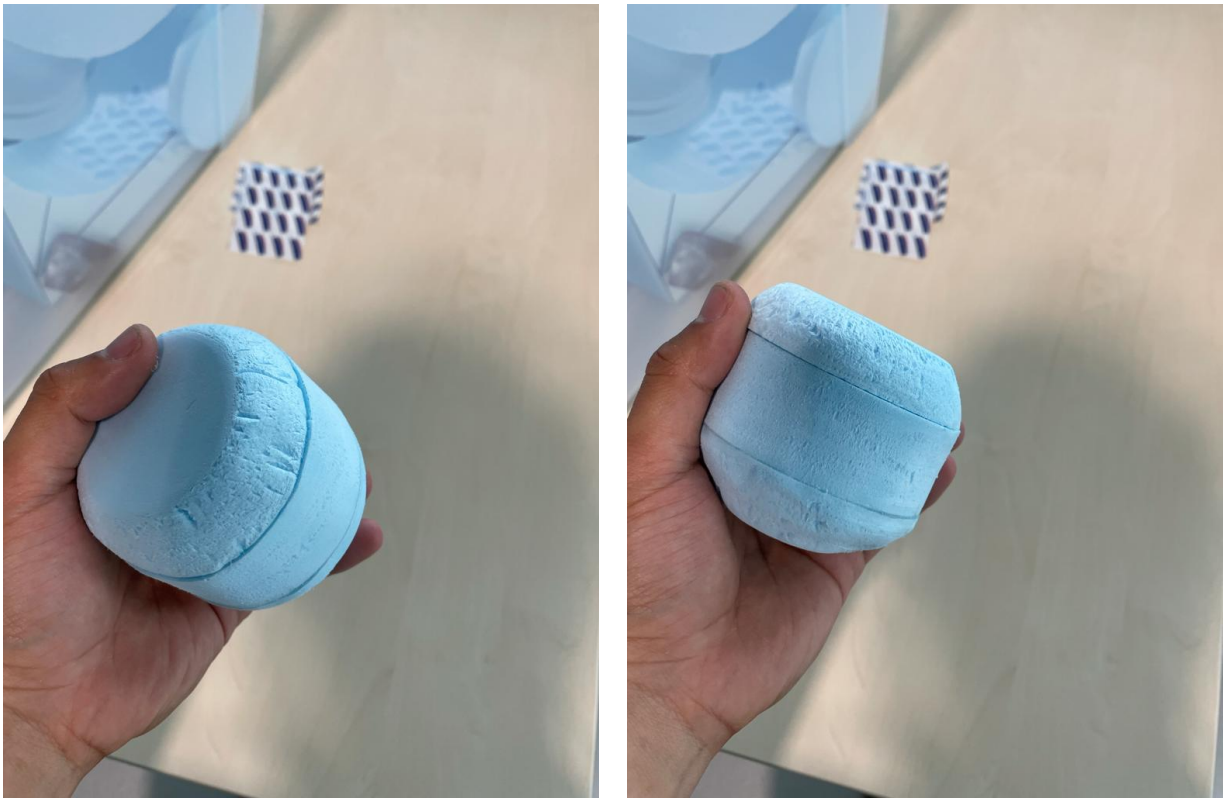

Figure 12 & 13: Third foam model

5.1.5 Final Design

Based on the three models, the third model seemed to be the most intuitive design while also The final design of the lamp was made in reference to the third iteration of the foam model. The small design will allow the user to hold the lamp in one hand comfortably while also making it large enough for the user to notice. Based on this, a final sketch of the design was made.

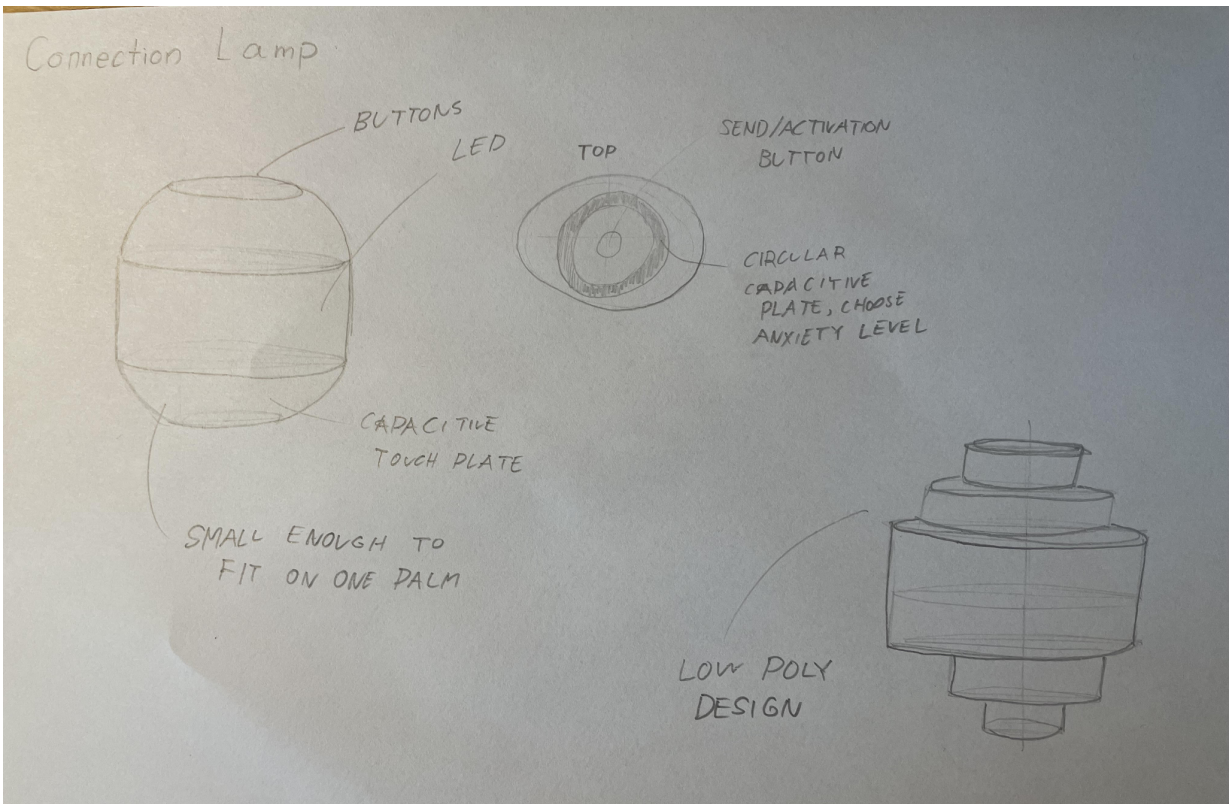

Figure 14: Final Design Sketch

5.1.6 Design Process

The physical lamp was made out of wooden and acrylic plates. Based on the final design, these plates were lasercut to create circular rings which were then stacked on top of one another to resemble a low-poly sphere. The rings were made in such a way that there was at least half a millimeter of overlap between the bigger and smaller rings to allow them to be glued and stack on top of each other. More so, by utilising these rings, it allowed to create a hollow space in the center of the design which was used to hold all the components needed including the arduino, LEDs, and the other protoboard.

Figure 15: Wooden Rings

Figure 16: Glued acrylic rings

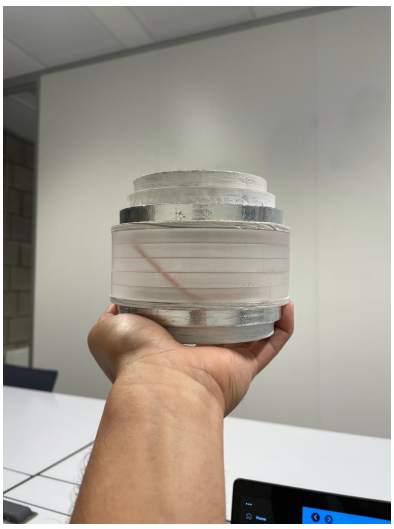

Figure 17: Glued rings

As the acrylic plates were transparent, all the rings were sanded down after being lasercut to create a more translucent finish which helps diffuse the light. Next, aluminum foil was wrapped around two of the wooden plates in order to create the capacitive sensors. The rest of the wooden rings were painted white to reduce the contrast between the different rings as the acrylic rings were essentially white while the capacitive ring was silver. This was also done to retain its aesthetic value. Once all the different rings were individually finished, each ring was then glued to each other respectively with the exception of the top and bottom layer which serves as the lid and also to allow easy access to the hardware enclosed within the lamp.

5.2 Hardware

The list of the different hardware components which were used for the prototype is as follows:

1. Arduino nano
2. 5 push buttons
3. WS21811 LED strip
4. Capacitive Sensor
    a. Capacitor
    b. Resistor
    c. Sensing Plate (Aluminum Foil)
5. Protoboard
6. wires

The connection of all these different components could be seen in the hardware diagram below.

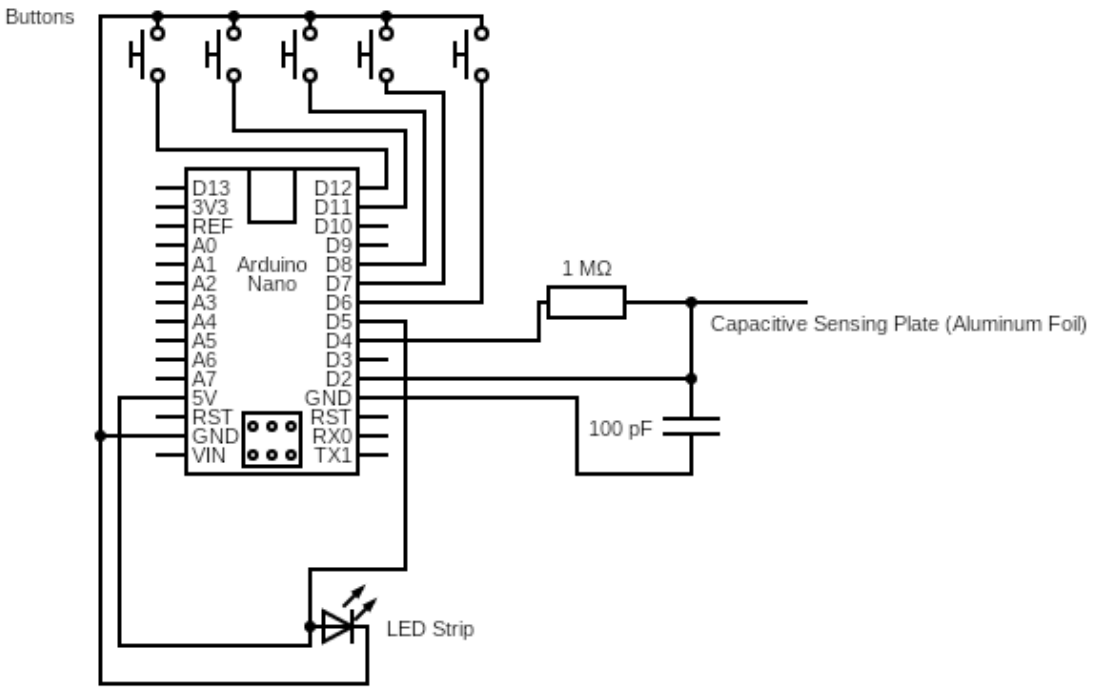

Figure 18: Schematic Diagram

Pin Number	Functionality
5V	Power to LED Strip
GND	Ground for capacitive sensor, buttons and LED strip
D2	Capacitive Sensor Receive Pin
D4	Capacitive Sensor Send Pin
D5	LED Strip Input Pin
D6	Light Anxiety/Low Pace Button Pin
D7	Moderate Anxiety/Moderate Pace ButtonPin
D8	Severe Anxiety/Fast Pace Button Pin
D11	Activation Button Pin
D12	Update/Send Button Pin

Table 7: Pin Number and Functionalities

The WS21811 LED strip was used for the lights of the lamp. In total, the strip contains 52 individually addressable LEDs which were placed into a spiral configuration by utilising a smaller circular ring which could be placed inside the lamp.

The capacitive sensor was built simply by utilising a protoboard which holds a 1M Ohm resistor and a 100nF capacitor which was connected to the sensing plate. This sensing plate is where the user touches the lamp and would allow the lamp to recognize touch. This sensing plate is the aluminum foil which was discussed in the previous section.

A total of five buttons were utilised for the first prototype of the lamp (See figure 23). The two main buttons on the center were designated to the activation/deactivation of the lamp and the sending button of the lamp respectively. The other three buttons were designed to allow the users to pick their anxiety level or the pace of the breathing.

5.3 Software

The software component of the prototype was made once all of the design and hardware components of the prototype were complete. This was done to ensure that the physical prototype is complete and ready, thus all that needed to be adjusted is the software. All of the coding that was developed for the prototype was made in the Arduino IDE. All of the code was also tested separately prior to the integration of the entire software to ensure that all individual parts (buttons, LEDs, and Capacitive sensors) were working properly.

5.3.1 Libraries

In total, three additional libraries were utilised for the prototype which include CapacitiveSensor, FastLED, and ezButton. These were found on the Arduino IDE Libraries. The capacitive sensor library was used in order to be able to create a simple capacitive sensor utilizing any material with the use of an additional resistor, capacitor and a sensing plate (in this case, the aluminum foil). Next, the FastLED library was used in order to control and manage the LED strip. It is responsible for all the LED's animations, colors, and display properties. Lastly, the ezButton library was used in order to create simple switches with proper de-bounce timings without interfering with the arduino's loop.

5.3.2 Data flow diagram

The data flow diagram used to understand the flow and phases of the software could be found below.

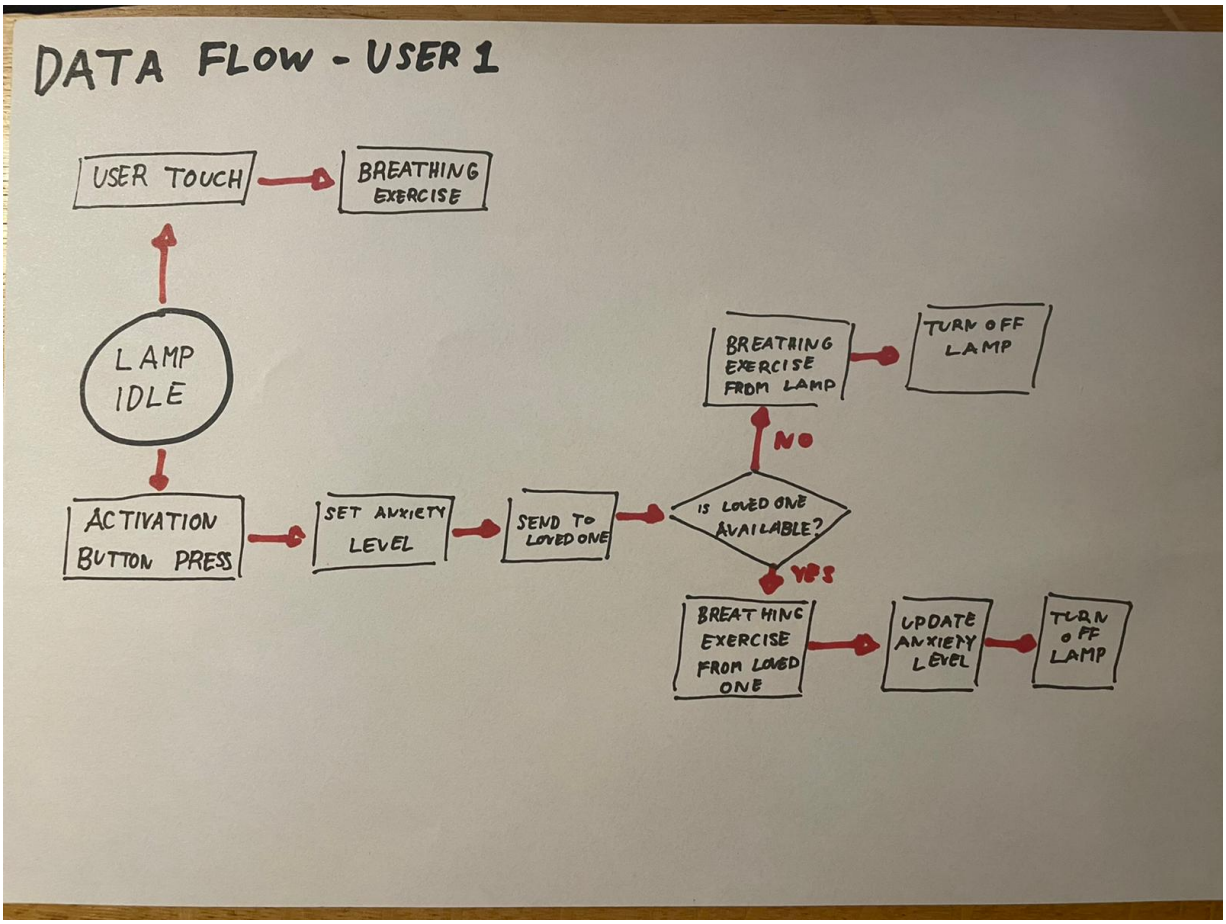

Figure 19: Data Flow of User 1

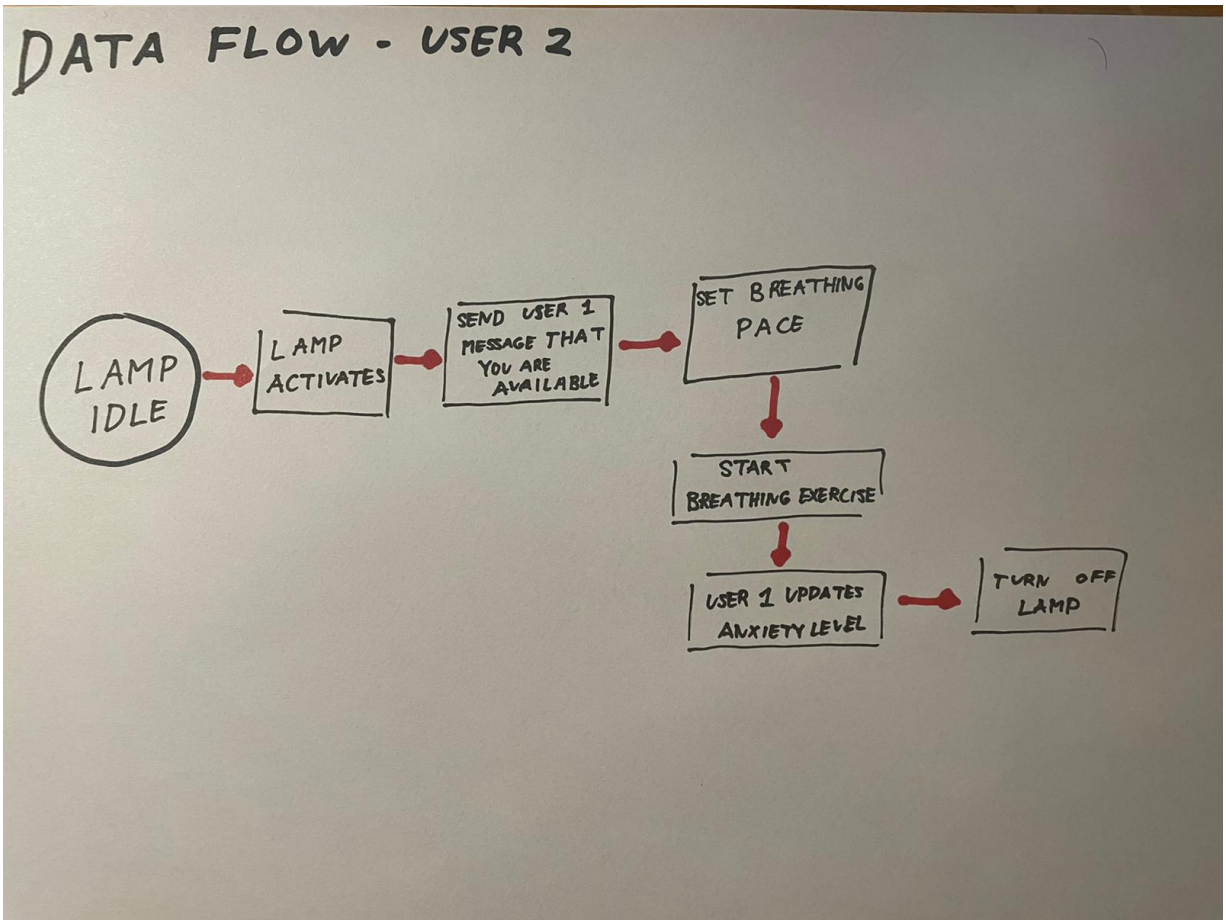

Figure 20: Data Flow of User 2

5.3.2 Software Code

The code used for the development of the prototype was uploaded to Github. This would allow future research to build upon the code which was already developed. The link to the software code could be found here: https://github.com/Raybayuaji/Connection-Lamp-Prototype-1

5.4 The Connection Lamp

The end of the realisation phase resulted in the first functional prototype of the Connection Lamp. The Connection Lamp is a smart lamp which aims to assist individuals who are dealing with symptoms of generalised anxiety disorder. The lamp has two main functionalities with the first being a breathing exercise which the users could conduct on their own while the second function allows the user to reflect on their anxiety level and ask for help from their loved one. As mentioned in the previous chapter, the lamp is supposed to come in pairs, however in this realisation, only one lamp was made, thus the lamp will serve as both the lamp for the primary user and their loved one which could easily be translated by adjusting the code on the lamp. The lamp aims to not only provide but also become a mediator of compassion for the user themselves, and also between the user and the loved one.

Figure 21: Connection Lamp

Figure 22: Lamp Buttons

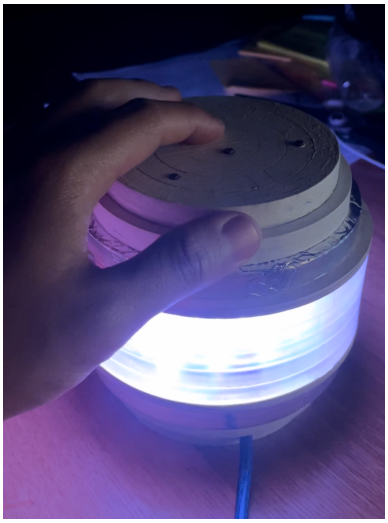

Figure 23: Lamp Lights

5.4.1 LED Animations, touch and Usability

A video was made to help visualise the different led animations and interactions. The link to the video could be found here: https://youtu.be/IT1bgu3PwQ8

5.4.2 How to use

A detailed explanation of how the lamp functions and how a user could use the lamp was developed. (See Appendix B1)

The correct manner in which to hold the lamp is as shown below.

Figure 24: Holding the Lamp (1)

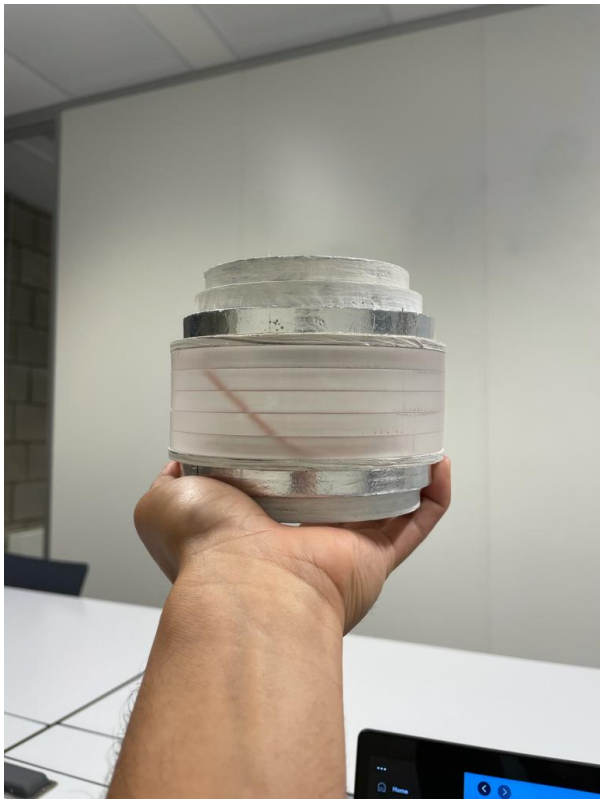

Figure 25: Holding the Lamp (2)

5.4.3 MOSCOW Requirements

A reflection on the MOSCOW requirements was conducted to evaluate whether the prototype was able to meet the different initial requirements placed during the specification phase of the project. To achieve this, the requirements were either given a (+) to indicate that the requirement has been met, (-) if the requirement was not met, a (+-) to indicate that the requirement was met to a certain degree, or N/A if the requirement cannot be answered during this phase of the project. A table to represent the different requirements are seen below.

Requirements	Requirement	Requirement Met?	Additional Comments
FR1: The lamp communicates with the respective paired lamp	Should have	-	The lamp does not meet this requirement as only one lamp was made. The response of the “second lamp” was automated
FR2: The lamp can switch between the	Must Have	+	The lamp utilised different saturations to indicate the anxiety

different colors (LEDs)			level of the user
FR3: Loved ones is able to send back a message that they have received the users anxiety level	Should have	+	An animation was made and dedicated to the purpose of indicating to the user that the loved one has received the user's message (or anxiety level)
FR4: Loved ones must be able to send back a message of how they feel back to the user	Could have	-	This was not achieved as only one lamp was made
FR5: The lamp is able to dim and brighten in a periodic manner	Should have	+	The lamp utilises this animation for the breathing exercise pattern
FR6: The lamp is able to switch between the different modes/states	Should have	+	The lamp is able to switch between the two functionalities based on touch or pressing the different buttons; state functions work perfectly
FR7: The lamp is able to sense the presence of the user based on touch	Should have	+	The lamp was able to sense the presence of the user utilising capacitive sensors in the form of aluminum foil rings
FR8: The lamp contains a protocol/mode which is used to combat anxiety	Must have	+	Contains a breathing exercise functionality
FR9: The lamp is able to communicate via the internet	Wont have	-	Since only one lamp was made, there was no need for the prototype to communicate via internet
FR10: The lamp is able to communicate via bluetooth	Could have	-	Since only one lamp was made, there was no need for the prototype to communicate via bluetooth

NFR1: The lamp tries to mitigate the symptoms of anxiety	Must have	+	Focuses on mindfulness based approach to try alleviate the user's anxiety through the use of breathing exercise and a reflection of the user's anxiety level
NFR2: User are be able to set the colors theme by themselves	Wont have	-	The prototype lamp does not allow the user to set the color theme or animations by themselves
NFR3: The lamp utilise the use of light as a communication tool between the user and the loved one	Must have	+	The prototype utilises light as a means to communicate anxiety
NFR4: Design choices are based on research/inspired by anxiety relieving shapes or designs	Could have	+-	Designs which could have a role in anxiety were previously discussed in the specification and taken into consideration during the development of the prototype
NFR5: The lamp is able to notify partner about how the user feels	Must have	+	The lamp has a protocol which allows the user to send their anxiety level to their loved one; to let them know how they feel
NFR6: The lamp is easy to learn (users have an easy time figuring it out during first time use)	Should have	N/A	Will be determined during the evaluation
NFR7: The lamp is integrated with an application that serves as a digital lamp	Could have	-	No application was made for the realisation of the first prototype
NFR8: Loved one has a lamp of their own	Could Have	+-	Only one lamp prototype was made. This lamp served as both the prototype for user one and user two

Table 8: Reflection of MOSCOW Requirements

6 Evaluation

The project focuses on developing a compassionate technology to alleviate the symptoms of generalised anxiety disorder. To tackle this problem, the connection lamp was developed. The lamp aims to help the user during an anxiety attack, more so, helps them recognize and communicate their anxiety level to their loved one. The lamp allows an individual to communicate that they are experiencing anxiety to their loved ones and could provide synchronized breathing exercises to help deal with their anxiety. The goal of this evaluation is to understand to what extent the connection lamp could support compassionate interaction in dealing with generalised anxiety disorder.

6.1 Participants

The initial target group of this project are patients with generalised anxiety disorder, due to the scope and limitation of this research, it was decided that proxy users would be utilised to evaluate the prototype. Participants who will partake in the testing are both male and female adults with an age range of 18-25. All participants are students who are currently pursuing their academic studies at the University of Twente. Each participant will be asked whether they have any underlying anxiety disorder before they take part within this study. Individuals who do have an anxiety disorder will be excluded from the study to reduce the risk of accidental discoveries and also prevent unnecessary emotional distress for the individuals. As the data collected will primarily be qualitative data, it is expected that the number of participants will not exceed 10 participants due to the scope and time constraints of this research.

6.2 Materials

A list of materials which is required for the evaluation study is as follows:

- Functional Prototype
- Printed prototype description (see Appendix B.1)
- Laptop (as powersource of prototype and recorder for interviews)
- Information Brochure and Consent form (See Appendix C.1)
- Printed Scenario and Persona list (See 4.2 of Specification)
- Task List, information cards, Procedure list (See Appendix C.2)
- Semi Structured Interview questions (See Appendix C.3)
- Corona Safety Checklist (See Appendic C.4)
- Cleaning Materials (cleaning wipes and hand sanitizer due to the current COVID-19 Pandemic)

6.3 Methodology

Usability testing will be conducted to evaluate the prototype as it is an initial prototype of the concept and has limited functionalities. The test will be divided into two phases, the first being the scenario task based usability testing where data will be collected solely through overt observations by the researcher. This phase aims primarily to understand how the user interacts with the prototype and whether or not all the tasks could be completed by the participants. The second phase of data collection will come after the usability testing in the form of a semi

structured interview. This phase aims to understand and gather data on how the user perceives and experiences their compassionate interactions with the lamp.

The majority of data which will be collected will be qualitative data.The data collected will describe how the participants interact with the prototype, more specifically if the participants could successfully interact and complete the given tasks. The participants will be asked to follow a total of three scenarios in which they will portray two different personas (or users). The completion of tasks is done through observations and also asking the participants to conduct the think aloud method. In addition, a semi structured interview will be conducted to collect participant input regarding how they experienced the lamp. These include their opinions and also their recommendations regarding the prototype.

Qualitative data regarding the prototype will still be collected primarily based on the opinions of the participants regarding the prototype. The qualitative data collected from each participant will first be analysed using a number of predetermined themes (evaluation question and sub questions), a thematic analysis of the data will then be conducted utilising the software Atlas.ti. Through compilation of the testing data and interviews based on themes, an in depth analysis could then be developed regarding each important component of the concept which is being evaluated. Additional themes which might arise and be discovered during the individual interviews will also be taken into account and discussed during the evaluation. It is also important to mention that due to the number of participants, the results of the research cannot be generalised due to multiple reasons which include the demographics and number of participants.

6.4 Results

A total of 6 participants took part in the evaluation study of the lamp. Overall there were no issues or difficulties in regards to the process of the user testing. Most of the data collected were audio recordings which were then transcribed for further analysis. More so, overt observation notes (see appendix C3) were taken during the usability testing regarding different inputs which were mentioned during the first phase of the usability test. On average, each usability test and interview took approximately 50 minutes to complete.

All data was initially coded and analysed using the software Atlas.ti. A Priori coding was used for the initial coding of the qualitative data. The A Priori codes were all based on the interview questions. However emergent coding was also used as additional themes started to arise as the analysis of the data continued. In total there were 33 codes which were divided into 5 different themes thus thematic analysis could be conducted. These themes include: Connection Lamp, Generalised Anxiety disorder, Providing Compassion, Receiving Compassion, and Compassionate Technology. A list of the codes and themes which were used to analyze the data is found below:

Theme	**Codes**		
Connection Lamp	Clarity on different	Clarity on use of light	Input - Additional help

	light stages and Interaction		through means of the lamp
	Interaction with Connection Lamp	Opinion - Differently formatted light and animation	Opinion - First time use
	Opinion - holding the lamp	Opinion - Improvements	Opinion - use of light as a communication tool
	Opinion - utilising lamp for self and recommends for others	Possibility to cause harm	Unclear functionalities and interaction
	Use case varies per person	Usability gets better after continuous use	
Compassionate Technology	Opinion - Compassion is something human	Opinion - Compassion needs individual or lamp is enough	Opinion - Importance in knowing who provides help
	Opinion - Importance of knowing who initiates breathing exercise	Opinion - Lamp as a mediator of Compassionate Technology	Opinion - Lamp as Compassionate Technology
	Criterias of compassionate technology		
Generalised Anxiety Disorder	Users ability to determine the different breathing paces	Benefits for GAD patients	Integration to users routines
	Opinion - Having multiple breathing paces		
Providing Compassion	Ability for user to determine anxiety of loved one	Input - Additional help through means outside the lamp	Opinion - Importance of being able to determine anxiety level of loved one
	Opinion - Providing compassion depends on the degree of suffering	Providing Compassion	

Receiving Compassion	Opinion - Needs of the users who is receiving compassion	Receiving compassion from someone you care about	Opinion - Being able to understand users' own anxiety

Table 9: Codes and Themes used for evaluation analysis

6.5 Discussion

To further divide the discussion of the evaluation of the study, the themes were used to format the discussion. Thus the discussion is divided into five parts. These are the Connection Lamp, generalised anxiety disorder, providing compassion, receiving compassion, and compassionate technology. Each subsection would discuss the evaluation of the study based on the different themes identified and contains a mini conclusion within the end of each subsection. The discussion will then conclude with an overarching conclusion of the mini conclusions made within the different subsections of the discussion.

6.5.1 Connection Lamp

This section will focus on discussing the user interaction with the connection lamp. It will be divided into three subsections which include, clarity of the use of light interaction, modalities, and features as a communication tool, lamp usability, and unintentional harm and recommendations. This will then be followed by a short summary and conclusion of the section.

6.5.1.1 Clarity of the use of light interactions as a communication tool

Based on the usability test, all participants were able to determine their own anxiety levels using the lamp. All participants were able to easily navigate through the different anxiety levels (light, mild, and severe) by utilising the three buttons which were individually associated with the levels of anxiety. However the use of color was not completely clear to some of the participants. The lamp has three different color saturations (white, light yellow, and yellow) to indicate the different levels of anxiety (light, mild, and severe). Out of the 6 participants who took part within the study, one of them experienced the color white as a light shade of blue, while another participant mentioned that it *"also imitates a bit of light yellow" (Participant 3)*. With these exceptions, all the participants were still able to distinguish each color to their respective anxiety level.

All the participants were able to correlate the correct designated color to the correct anxiety level. However the way the user perceives the color itself differs. More so, it suggests that the way the participants experience (or sees) the colors is an important factor within the interaction between first and second user. One participant mentions that the way the two users could perceive the color (and relates it to the degree of anxiety) could differ.

> *"[it is] a learning experience because your or my level, white level, is not [user one's] white level, or my red level is not user one's red level" (Participant 2)*

This suggests that the way user one perceives light anxiety (as white), might not be the same way as how user two perceives light anxiety. What might be experienced as light anxiety for one, could be experienced as medium or severe for the other user. Thus it was deduced that it

is important that both users have a mutual understanding of what each color actually represents in terms of what the user who is dealing with anxiety is feeling or experiencing. Moreover, it is important that the users themselves have a clear understanding of the visual cues provided by the lamp itself to begin with. However it was seen that not all visual cues were clear.

A trend was found in which half the participants actually did not notice the trailing light (which indicates that the lamp is waiting for a response from their loved one) when doing scenario 2. They also missed the random light pattern (which indicates that their loved one has responded). Also, a total of 3 of the participants failed to update their anxiety level while conducting the breathing exercise with their loved one. This failure to recognize these different visual cues can be attributed to a number of factors.

Firstly, it was seen that the users misunderstood what component of the light needed to be focused on. For instance one user focused on the color of the light and completely missed the animation. Another factor which caused this misinterpretation of the different light cues could be due to the users' unfamiliarity using the lamp. This could indicate that the animations and colors used are not significant enough for the participants to take notice. Some of the animations were not distinct enough from each other and the use of colors could be increased.

Based on the evaluation study, the participants felt that the use of light as a communication tool to be useful and advantageous. One participant suggests that although utilising light might not be as invasive and apparent as utilising sounds, having visual feedback allows to further understand the anxiety in a non verbal manner. One participant quotes,

> *".... [having it] visually represented in front of you, I think, kind of grabs your attention for that moment and helps in the whole calming process." (Participant 4)*

This could suggest that external visual representation of the users anxiety could help their calming process. Another participant supports this argument by adding that it allows users to communicate their anxiety level when they do not wish to speak verbally. More so, the use of a spectrum creates an easier classification to help the users identify their anxiety, this suggests that breaking down anxiety into measurable categories can contribute to alleviating the feelings of anxiety

Based on this, it could be concluded that the lamp does infact allow the users to successfully communicate. The participants felt that the use of lamp and light as a medium of communication allows for a minimalistic form of communication which is not too invasive. More so, the lamp was able to provide meaningful queues for the users, however this aspect of the lamp still needs to be further improved as some of the animations and colors are not bold enough for the users to recognize.

6.5.1.2 Lamp Usability

Five of the participants mentioned that the initial use of the lamp was quite difficult. This could be attributed to a number of factors. Firstly, there was a great amount of instructions and functionalities in which the users had to initially understand regarding the lamp. More so, participants were not familiar with utilising the lamp thus the initial minutes of the usability test was mostly attributed to the participants still trying to understand the overall functionalities of the lamp, even during the test. However as the test continued, the participants became more fluent with the functionalities of the lamp, further knowing what to expect and what to do.

These participants further suggest that the use of the lamp becomes more clear and intuitive as the study progresses. The participants strongly suggested that the interaction of the lamp became clear after multiple uses, furthermore one participant suggests that, *"people who are going to use this have to use this…. [for] literally a week without actually having anxiety attacks. Just to understand the difference [interactions, functionalities, breathing paces]." (Participant 2)*

Thus it suggests that the lamp could prove beneficial towards the intended users. However, an amount of time has to be dedicated by the users to familiarize themselves and fully understand how the lamp works. This might not be suitable for users who would like to *plug and play* or would instantly like to utilise the lamp. Although the project is still far from testing with actual users and also realising the concept into a real product, it could be suggested that a more visual guide (walkthrough, video tutorial) could be provided to further accelerate the familiarization process of the users to the lamp. Physical handling of the lamp could also be a factor in the overall functionality of the lamp.

During the tests, most participants were not able to correctly hold the lamp the way it was designed to be held. During the test, the participants were asked to hold the metal plates of the lamp to activate the breathing exercise. Four of the participants held the lamp incorrectly by either only touching the lamp with their fingertips or holding the lamp from the top, placing their fingertips on the metal plate. Only two participants were able to successfully hold the lamp the way it was originally designed for. This might suggest that the symmetrical design and ergonomics of the lamp itself creates a different interpretation of how users are supposed to hold the lamp.

More so, participants had conflicting opinions regarding holding the lamp during the event of an anxiety attack. Two participants stated that holding the lamp during an anxiety attack might cause the interaction to be more difficult and would rather have it placed in front of them as they follow the breathing exercise,

> *"If I'm trying to focus on my breathing, I might want to like place it in front of me, and not always be holding it. So if I'm very anxious, I might be like sweating my hands… so I might want to put it in front of me [instead]." (Participant 4)*

However four of the participants argue that being able to physically touch and hold the lamp allows for a more intimate and personal experience. One participant quotes,

“I think it's something that this does, for me, it is something that I would, I would probably do, because it would help me like, focus more on the thing in front of me and solve the problem. So if I was just like, leave the lamp far away and still stay here. And just like breathing without I think I would still be thinking about that problem , but holding, it will at least try to get my mind off the problem of thinking about it, it also helps you stay focused as well. I think holding it is better in my opinion.” (Participant 6)

This might suggest that the design of the lamp could still be improved. More so, it could be argued that holding the lamp might be beneficial for individuals who are dealing with anxiety as it helps shift their focus onto the lamp while also creating a more intimate and personal experience.However, due to the conflicting opinions in regards to holding the lamp, it could also be a suggestion that the lamp should still have touch as an activation factor however it should not be a factor for the lamp to stay activated. It should still be able to continue the breathing exercise when it is placed down and not touched.

6.5.1.3 Unintentional Harm and Improvements

Even Though all the participants felt that being able to communicate with a loved one could prove to be a beneficial aspect of the lamp, three of the participants also felt that this interaction alone could cause unnecessary emotional distress to the users. The participants felt that waiting for the loved one to respond might induce and unintentionally make the users’ anxiety worse. More so, this situation could be worse if the loved one doesn't respond. A participant quotes,

“If you’re anxious and for example, the person on the other side doesn't respond, then that might influence your thoughts” (Participant 5)

Another participant adds on to this idea. They mention that,

“If you're feeling anxious, and then you press the button, and then you know, the other person is not responding. I think there’s a chance that it aggravates your situation, like oh my god where is this other person when I need them the most, you know, and yeah, that’s one of the potholes...” (Participant 1)

Although the ability to communicate with a loved one could prove to be a beneficial aspect of the lamp, it also has the greatest potential to cause unintentional emotional distress towards the users, especially during the situation where the users are undergoing an anxiety attack and are emotionally vulnerable to external triggers. This is a factor that needs to be carefully looked into if the project enters the user testing phase with actual users.

Overall there are a number of improvements which could be made for the lamp itself. Most of the participants felt the buttons on the lamp could be labeled to avoid confusion. This could be done by utilising texts or colors. This improvement might not only help users understand what each button functions as, but it could also limit confusion. It might even cause distress, especially when a user is going through an anxiety attack and is trying to figure out the buttons.

Moreover, the animations could further be iterated and further tested as participants felt that some of the animations of the LEDs were not clear or were missed. Different animations such as an emoji could be considered as suggested by one of the participants. The same could be said for the colors of the lamp. As mentioned in a previous section, a participant experienced the white color of the lamp to be blue. During the realisation, there was a slight power issue with the light, this might be due to the amount of LEDs used and not enough current flowing for the LEDs thus this resulted in the alteration of the saturation of the LED colors especially during the breathing pattern. This issue however was not investigated and was neglected due to the time constraints and as it was not seen as a major factor which could influence the functionality. It is crucial for both the colors and animations to be correct and understandable as they are the main components of the lamp and the communication medium.

The test showed that there were conflicting opinions as to whether the lights were formatted in a different manner. Three of the participants were in favor of the lamp to utilise a gradient or shade theme to signify the anxiety level. Two participants prefer utilising RGB to signify anxiety level as they related each color to a specific anxiety level. The last participant was against the RGB pattern.

One participant suggested that the lamp itself could be made out of softer materials. This could give the lamp a smoother and warmer feel while also increasing the likelihood of users to hold the lamp. In parallel to using light, haptic feedback might also be an improvement to add an additional means of communication. However adding haptic might cause confusion or induce anxiety for an individual who is going through an anxiety attack, especially when they feel that the light itself is already plenty to understand and to focus on.

The lamp was intended to help the users during an anxiety through a breathing exercise and provide a sense of human connection when their loved one is available to help them. This interaction allows the two users to conduct a synchronized breathing exercise and allows their loved one to help by suggesting the main user's breathing pace. In addition the participants felt that a different form of interaction could be implemented to allow loved ones to provide help through the lamp. These come in the form of a comfort or mood light, activity light, and also an LED game element. The comfort or mood light is supposed to resemble a color in which the loved one knows the user loves and could manually set that color and send it to the user who is struggling in hopes by seeing their favorite *mood* color, it could create a sense of calmness further helping the user during an anxiety attack.

Another suggestion was the activity light in which the loved one could periodically send different colors of light. And based on the agreement between the first user and their loved one, each color represents a specific activity the user needs to complete such as going for a walk or calling someone they love. This modality is aimed to shift the focus of the users' anxiety towards a more productive action or activity. This concept however would require both the initial user and the loved one to mutually agree which color would resemble what specific activity.

The last suggestion is the LED game element in which both the user and the loved one could continuously play an LED game displayed on the lamp by simply pressing the different buttons. Similar to the previous suggestion, this concept aims to shift the focus of the user's anxiety, rather than "being stuck in [their] head".

Based on the different recommendations provided by the users and also based on observations during the test a number of definite improvements should be made. First, it should be addressed that buttons are labeled to avoid possible confusion for the users. Second, the power issue of the lamp must be fixed in order to properly display the correct colors. Then, it should be addressed that the colors and animations are revised, made more appealing, and also distinguishable for the users. It is also a recommendation that more interactions utilising the lamp are further explored as have been discussed within this section.

6.5.2 Generalised Anxiety Disorder

The lamp focuses on a mindfulness based approach to try and alleviate anxiety. The lamp uses a breathing exercise as a method to help relieve the anxiety of the user. In addition, the lamp also persuades the users to understand their own anxiety level and seek help from their loved ones. All the participants found that being able to identify their own anxiety level and categorizing them into light, mild, and severe anxiety based on the three given colors is a beneficial interaction which could help the users understand their own anxiety level better. Based on different inputs from the participants, by understanding one's own anxiety the user could achieve recognition and reflection of their anxiety which could further help them communicate their anxiety.

Firstly, by being able to determine their anxiety level, it allows the users to recognize that they are in fact feeling anxious. This first step of recognition allows the users to become mindful and reflect on themselves, to further help them understand what is causing their anxiety and how severe it feels to them. More so, it further helps them figure out how they should go about their anxiety and tackle it. Lastly, it further helps the users communicate their anxiety to their loved one in a non verbal form of communication which is beneficial especially for the people who struggle to communicate their emotions using words.

In the test, the participants were asked to distinguish between three different breathing paces while portraying user 2 in scenario 3. It was seen that 5 out of 6 participants were not able to distinguish between the different breathing paces which were displayed through the lamp. Only one participant was able to correctly distinguish between the three paces while others could only discern between two of which being the slowest and fastest pace. More so, these 5 participants also felt that there was not that big of a difference between the different paces of the light.

This failure to determine the breathing pace (in the perspective of user 2) could be ruled out by a number of factors. First, some of the participants thought that by responding to the lamp, they have already initiated the breathing exercise for them and user 1, thus they did not bother trying to further test the different breathing pace. Second, some participants did not allow the lamp to

actually go through one breathing cycle and instead scrolled through the different breathing pace (buttons) quickly, this also further hindered their ability to identify the different breathing paces. Thirdly, one participant thought that the different breathing pace would be determined by a change of color instead of the speed in which the light oscillates between dimming and brightening. This further suggests that the participant focused on a different form of lighting cue provided by the lamp.

Overall, there are mixed opinions from the participants regarding having multiple breathing paces. While some participants found that the ability to set the breathing pace to be a component of the interaction which could prove beneficial for the individual who is suffering, some found it unnecessary and could even cause misunderstanding between the primary user and the loved one.

Some participants suggest that having different breathing paces could be beneficial as depending on the severity of the users anxiety, they could suggest the user to breathe slower or faster. Not only does this have the potential to help the user who is struggling, but participants mentioned this could provide sense of connection,

> *“[As if receiving] confirmation that the other person is kind of listening or somewhere around, maybe not always there to talk [to the user and] help [the user] out, but is still kind of present.” (Participant 4)*

However it could be argued that this functionality might not be beneficial and could actually cause unintentional emotional distress. Two participants found it unnecessary to have multiple paces and would prefer just having one universal breathing process which matches them. Another participant also suggested that there is a risk that the breathing pace which they *intend* to use to help their loved one might be too fast or too slow which might cause unintentional emotional distress,

> *“I don't think I can give advice on that (breathing pace) because I'm not like a doctor or something. And I haven't done enough research to know how the breathing pace that’ll be able to be used to calm a person down.” (Participant 6)*

Although the specification of the Connection Lamp has already considered the breathing paces based on scientific literature, this suggests that user 2 (the loved one), despite their best intention to help, might not be able to provide their loved one with the correct breathing pace if they do not properly understand how it could help and understand what is best for the individual who is struggling. Based on this insight it could be suggested that the option to choose a breathing pace could be replaced with another interactive component (See recommendations in end of section 6.5.1) and only have one option which could fit the user best. Another suggestion could be that instead of allowing the loved one (user 2) to be the one to determine the pace of the breathing, the individual who is struggling (user 1) should also have a say in what the appropriate breathing pace should be. These changes could make the lamp more beneficial.

All the participants found that the connection lamp could be beneficial for individuals who are dealing with generalised anxiety disorder. The participants suggest that by incorporating another individual (a loved one or user two) into the picture through the lamp, this could be a beneficial aspect to further help individuals who are dealing with generalised anxiety disorder. One participant mentions,

> *"I think this can definitely help someone who's suffering from anxiety attacks. For example, it's good to not be inside your own head and have something to focus on basically. And knowing that there would be a person on the other side… that you can reach out for help. It's definitely something that can help " (Participant 5)*

Although external help is a factor which could play a role in aiding an individual's anxiety, some participants even mentioned that just the breathing exercises might actually be enough to aid individuals with generalised anxiety disorder,

> *"When you're feeling really anxious and having an anxiety attack, then you've got to immediately touch the lamp and just follow the breathing process. And honestly, for me, I think that will help a lot just by holding the lamp and following the breathing process." (Participant 3)*

The participant suggests that even without the aid of another individual, the lamp has the potential to provide compassion to an individual who is struggling. More so, another participant mentions that the lamp could easily be integrated into any individual's self-care routine even without the help of another individual,

> *"...I think this could definitely be incorporated into whatever routine that you have to calm yourself down. I mean, some people definitely have different routines, but this lamp can definitely be part of it. You know, just press the button and then follow whatever breathing exercise that it gives you. Even without the lone ones, I think it works right now. So yeah, I think it can definitely be part of your routine." (Participant 1)*

Thus with or without being able to communicate to a loved one, it suggests that the individual could potentially still benefit from the breathing exercise. The functionality to be able to connect with a loved one further enhances this aid given by the connection lamp. Furthermore all participants mentioned that they are in favor of having the project be continued into a suitable technology as they themselves would recommend this to their close friends and family. One participant suggests that the connection lamp itself could be used by a wider target audience and not only specified to only individuals who are suffering from generalised anxiety disorder but rather different mental illnesses in general.

6.5.3 Providing Compassion

Based on the usability test, it was seen that compassion could be divided into two individual sections, providing compassion and receiving compassion. Providing compassion focuses on how the loved one (User 2) could properly provide the proper amount of help and compassion

for the individual (User 1) who is struggling. In this scenario, the user would try to provide compassion from a distance for their loved one who is struggling by utilising the lamp as a mediator for help and compassion. One participant quotes,

> *"When you know that they're facing something, and the fact that they are asking for help means that you have the opportunity to actually do more, especially when you're available. If you're not, that is a different story" (Participant 1)*

This section will focus on the significance of user 2's (the loved ones) involvement in aiding the primary users anxiety through means of the lamp.
One task which was done to understand how compassion could be provided was determining whether or not the participant (as user 2) can determine the anxiety of their loved one (user 1). The participants were asked to portray the loved one of an individual who is experiencing anxiety. The testing shows that only four of the participants were able to correctly identify the anxiety level of their loved one. One of the two participants who failed to correctly identify the level mentioned that they lost focus during the study. The other mentioned that they were preoccupied, thinking that they were on the next phase of the test (identifying the breathing pace), thus they paid little attention to trying to identify the anxiety level through the lamp. The other four participants were able to easily identify the anxiety level of their loved one.

This could further suggest that there is still a degree of unclarity in regards to the way the lamp tries to portray the anxiety level of the primary user to their loved one. User two might not be able to properly recognize the anxiety level of user one, which could hinder the effectiveness of the lamp.

All the participants felt that the ability to see the anxiety level of their loved one to be a very beneficial aspect of the concept. The participants felt that being able to see the anxiety level of their loved ones, allows for a non-verbal minimalistic communication and also gives them a sense of how severe their loved one's anxiety is thus creating a plan of action which is appropriate to the severity of the anxiety.

The lamp allows for a non-verbal communication which comes in the form of light. This could be beneficial for those individuals who struggle with verbalizing their emotions but would still like to seek help. As one of the participants mentions,

> *"Just based on my experience, maybe sometimes people aren't very good with expressing their level of anxiety in words. They can't really indicate it. [And by using the lamp], you kind of have an idea of how bad the other person perceives his or her anxiety to be." (Participant 1)*

A second participant supports this claim by suggesting that the light provides a low-barrier form of communication, it provides a minimalistic and non-invasive form of communication while still communicating a sense of danger to the loved one, indicating that something is *wrong*. More so, another participant adds,

> *"I can imagine a case where maybe the person might not want to, or he's not able to text or call. And the quickest way….to send a message would be the lamp." (Participant 6)*

This interaction could prove to be an immensely important component of the lamp, especially for those individuals who would like to ask for help without needing to verbalise their emotions. More so, participants also suggest that by understanding their loved one's anxiety level, it allows them to have a better understanding of what they could do to further assist their loved one. A participant suggests that the severity of their loved one's anxiety would ultimately determine whether they would help them with only using the lamp or whether they have to go the extra length such as give them a phone call, or come over to actually help them as they do not want to over burden their loved one with too much help or too little help. This suggests that by understanding an individual's anxiety level, their loved ones could provide the correct amount of help and that providing the right amount of compassion is proportionate to the suffering of the person who is struggling.

The participants felt that the degree in which they would like to provide compassion and help to their loved one greatly depends on the degree in which their loved one is suffering. They want to ensure that they can be able to properly provide the help their loved ones need. The majority of the participants felt that based on the anxiety level of their loved one, they would know whether interaction and helping with the lamp is enough or if they would need to give an additional text, or phone call depending on the situation and intensity of their loved one's anxiety. It should be ensured that the individual who is providing compassion is providing enough and not too much help for the individual who is struggling,

> *"It really depends on the amount of anxiety that the other person has. Because I think, sometimes it will just be uncomfortable for them to always have someone come, or have some to to talk him through something that you don't want to disclose [yet]" (Participant 3)*

All participants suggested that if they could provide additional help outside the lamp, they could either give their loved ones a text or a phone call. However this depends on the situation and also the needs of their loved one. One participant mentioned that regardless of the breathing exercise, they would still like to verbally communicate with their loved one at the end of the day. Other participants support this by mentioning how they would still give their loved one a call when they have a chance or even meet them face to face if it is possible. This further emphasizes the desire for both parties (the individual who is struggling and also their loved one) to communicate verbally after utilising the lamp, further showing the importance of verbal communication in regards to providing compassion to an individual.

Upon analysis, a number of conclusions could be drawn in regards to providing compassion. Firstly, providing compassion is proportionate to the degree in which the individual is suffering. Thus the more an individual is suffering, the more compassion and help should be provided in terms of how they would provide help. Secondly, by understanding the severity or the situation

more clearly, the provider of compassion could determine the possible set of actions to take in order to assist the struggling individual. This works in parallel with the first conclusion.

This further shows that being able to understand the anxiety level of a loved one through the lamp is a key component in order to create successful compassionate interaction between the users through the lamp. Currently if the loved one does not respond, the lamp would automatically start a breathing process for the user, despite the level of anxiety. Thus it could be suggested the lamp should be able to take the user's anxiety level into account when it attempts to provide the user with compassion through the breathing exercise. It could be concluded that based on this analysis, It is not merely about providing compassion, rather it is important that compassion is provided in the correct manner and in the right amount based on the situation at hand.

6.5.4 Receiving Compassion

One interesting component which was uncovered during the study was the needs of the person who is receiving compassion. In the initial phases of this project, the project focuses on the concept of providing compassion. However it was not considered how the user who is receiving, perceives compassion. Thus this section will focus on the perspective of the user who is seeking help from the lamp, and another individual (user 2) by utilising the lamp.

It could be argued that despite the compassion given, if the user who is receiving compassion does not feel helped, then a compassionate interaction is not achieved. The same argument could be implemented on the lamp. If the user does not feel any form of compassion from the lamp (or their loved one through the lamp), then it fails to create a compassionate interaction.The interviews show that there could be different needs of an individual who is seeking help. One participant mentions that there will be moments and situations in which they will use the lamp without seeking help from a loved one, they would just want to be left alone. Another individual adds on that being self sustained is important however knowing that another individual is there to help could be beneficial.

A majority of the respondents shows that as a user who is seeking help, having another individual assist them might already ease their negative emotions. Three of these participants mention the importance of "not feeling alone". Having the feeling of going through the negative emotions with another individual already helps them shift into a more positive mindset; knowing that they do not have to go through it alone,

> *"Whereas from a person, you're not even necessarily looking for a response from them. For a particular response from that person. You're just looking for any response depending on their situation. You're just looking to be not alone" (Participant 4)*

Most of the participants mentioned that receiving compassion could differ based on the emotional response or connection they have to the entity(in this case, individual) who is providing them with compassion. One participant suggests that human connection alone does suffice to aid an individual who is struggling. Rather, it is important to know who (or what) the

compassion is coming from as it allows the user to create an emotional bond with the provider of compassion. This highlights the importance of knowing who is providing them with compassion. Another participant supports this argument by suggesting that they would feel more comfortable knowing that the person who is providing them with compassion is in fact someone who they can rely on. The participants suggest that by having a deep bond between the user and their compassion provider, it creates a more intimate and personal connection and experience which in the context of this study could potentially increase the likelihood of aiding an individual suffering from symptoms of generalised anxiety disorder.

Thus within the scope of this study, it could be argued that the human and emotional connection towards the entity who provides compassion to the individual who is suffering is a crucial component in creating successful and positive compassionate interactions. More so, this also raises the question on whether or not emotional bond directly influences the effectiveness of providing compassion towards an individual who is struggling. Further research will be needed to understand the influence of emotional bond on creating successful compassionate interaction between two entities.

6.6.5 Compassionate Technology

All the participants felt that the lamp is able to mediate compassionate interaction between the two users. One participant suggests that the lamp acts as a low barrier form of communication which easily allows two individuals to provide help to each other in a quick manner. However there are conflicting opinions in regards to whether the lamp is enough to provide compassion or another individual is needed. Half of the participants felt that the technology itself could be enough to provide an individual who is struggling with compassion. However two of the three participants felt that this would depend significantly on the level of anxiety felt by the user and what the user needs. They argue that the lamp could be enough to provide compassion in the situation where the user's anxiety level is low or when the user would want to be left alone to deal with their anxiety. In the case that the user feels that they need another person, that is when the lamp is considered not enough to provide compassion and another individual is needed.

The other three participants felt that the lamp alone would not suffice to provide compassion, rather they argue that human connection is what allows for the compassionate interaction between the user and the lamp. Without the component of being able to connect with another human being, compassion cannot be provided, thus stressing the importance of human connection. More so, two of the participants suggest that the success of the lamp in providing compassion would further be enhanced by the emotional connection the user has to their loved ones or entity (in this case, the lamp) who is providing them with compassion.

The participants found that it was indeed important to know who initiated the breathing exercise for them. As the option to contact a loved one or do a breathing exercise alone is available on the lamp, the participants felt that by knowing someone is willing to help, it provides a sense of presence for the individual who is struggling which makes them feel as if they are not alone when dealing with the anxiety attack.

More so, it was seen that having the knowledge of whether it is another individual (a loved one) or technology which is helping the user plays an important role for the user. One of the participants suggests that by knowing who initiates the breathing exercise or is helping, it could put the user into a specific state of mind which could be used to tackle their anxiety either alone, with the lamp, or with the help of a loved one. Thus this knowledge allows the user to emotionally and mentally arm themselves with the correct mindset to deal with the anxiety, whether they need to deal with it alone or they could have someone to assist them. Understanding and having the knowledge of who and what is there to help the user creates a different connection. It was also suggested that having knowing who is helping, could determine the emotional resonance or connection the user has towards them which creates a more personal experience.

Based on this, a number of factors could be considered which could be argued as deciding factors in the success of providing compassion through technology.

1. Intensity of suffering
2. Emotional connection
3. Human connection

Human connection pertains to the presence of another person (which aims to help the user) when the individual (user 1) is struggling. Emotional connection refers to the emotional bond the individual (user 1) has to the person(user 2) or entity(in this case the connection lamp) in which they seek help and compassion from. It raises the question of whether technology in of itself could even be considered compassionate without the need of another human being. More so, this suggests that regardless of how technology tries to provide compassion, it also depends on the connection the individual has to the entity which is providing compassion. It also raises the question whether compassion is purely a human trait and that technology could only mimic it. Two of the participants suggest that compassion is something that could only come from humans and not technology, thus they argue that the technology itself could be programmed or designed to mimic humans in order to provide compassion, but it can never fully replace the compassion which is provided by an actual human being.

> *“I don't think the lamp is enough to just provide you with compassion, I think maybe it would help in the breathing. But most times, I think human interaction is probably needed…. I think in most cases, human interaction probably supersedes every other form of providing compassion” (Participant 6)*

This could suggest that technology in of itself is not able to be compassionate on its own. It could try to mimic the compassion provided by humans, but human intervention is still needed in order to fully be able to provide compassion using technology as a medium. This philosophical aspect of compassionate technology could provide insight to what future research could possibly explore. However due to the limitation of this difficult study, the philosophical aspect will not further be discussed as the focus of the study is the technology and interaction with the prototype.

Thus based on the evaluation, it could be argued that within the scope of the study, technology could do its best to try and provide compassion; however the emotional connection and bond an individual has towards the compassionate provider plays a crucial influence in the success of the overall compassionate interaction. The connection lamp has the potential to provide this emotional connection by becoming the mediator of that emotional and human connection between the two users. It could also be argued that the lamp could help the individual (user 1) become more emotionally connected to themselves as they try to be mindful by conducting a breathing exercise and also determining their own anxiety level.

During the study, the participants were asked which criterias of compassionate technology, as proposed in the start of the study, the connection lamp meets. To summarize, compassionate technology has been defined within the scope of this study as technology which takes into account the user's comfort and experience. It does not only understand the physical, emotional, and mental aspect separately but also considers all three aspects interconnectedly in the design process. More so, compassionate technology tries to provide a sense of human connection.

Compassionate technology could be divided into 4 criterias:

1. Design of the technology takes into account the mental, physical, and emotional wellbeing of the user (overall wellbeing)
2. Strives to provides a sense of (human connection)
3. The solution must be able to sense, record, or keep track of the user's state (empathizing)
4. The solution must make sense of the current state of the user (understanding)

The results are as follows:

	Criteria 1	Criteria 2	Criteria 3	Criteria 4
Participant 1	x	x	x	x
Participant 2	x	x	x	x
Participant 3	x	x		
Participant 4		x		x
Participant 5	x	x	x	
Participant 6	x	x		x
Count	5	6	3	4

Table 10: Participant Response vs Criterias of Compassionate Technology met by lamp

As mentioned during the start of the study, a technology needs to fulfill at least two of the criterias to be considered a compassionate technology. As seen on Table 10, it is evident that the connection lamp meets more than just two of the criterias. Thus the connection lamp could

be considered a compassionate technology which mediates compassionate interactions between two users.

As discussed within this evaluation, it was elaborated to what extent the connection lamp was able to support compassionate interaction in dealing with generalised anxiety disorder. One key component of compassion which was identified was emotional connection. With that in mind, the true extent of the lamp's ability to mediate compassionate interaction could not be properly tested as this study was not an effect study. However it could be argued that the lamp has the potential to meditate compassionate interactions for individuals who are dealing with symptoms of anxiety.

6.6 Conclusion

The evaluation study further helps understand how compassionate interaction could be mediated using the Connection Lamp. Based on the evaluation, a number of conclusions can be drawn which fit the scope of this study. Firstly it could be said that the lamp has a potential to be beneficial to individuals who are dealing with generalised anxiety disorder. However, the option for the second user to set the breathing pace for the main user could cause some confusion thus it could be recommended that other forms of interactions are explored to help mitigate the symptoms of anxiety utilising the lamp.

Second, it was identified and explained how compassion could be divided into two different components, receiving and providing compassion. It was suggested within this evaluation study that providing compassion varies based on the situation and also the degree of suffering. More so, there is an emphasis that being able to understand the situation is a key aspect of providing compassion as it allows the formulation of the best course of action. It was also suggested that receiving compassion plays an important role in the success of compassionate interactions. It is crucial for compassion to be provided, but it was also discussed that in order to mediate successful compassionate interactions, compassion must also be properly received by the struggling individual.

Next, it was seen that the connection lamp was a non-invasive means of communication. However it was also seen that there were a number of improvements which could be made. The visual cues were clear however they could be made more bold and meaningful. More so, it was also discussed how different aspects of the lamp such as holding the lamp, feedback, and also familiarisation could affect the overall interaction.

Lastly, it was discussed how the lamp has the potential to mediate compassionate interactions. The lamp itself was not a provider of compassion, rather it was a mediating tool which allows users to provide compassion to one another (and themselves). It was seen that understanding and knowing where compassion or help is coming from or provided by plays a role in compassionate interactions. More so, it was seen that there are three additional components which have a crucial role in the success of compassionate interactions utilising technology. These include the intensity of the suffering, human connection, and also emotional connection.

7 Discussion

This chapter will provide an overview discussion of the entire study. By combining the results of the evaluation study and the different theories researched during the start of the study, it is possible to answer the different research questions. The conclusion of the evaluation study shed light on a number of different key points which could help strengthen the study. Thus the main research question and the sub questions could be answered.

7.1 Discussion of main research questions and sub questions

What is compassion? What is the difference between showing and giving someone compassion? How can it be given to ourselves?

As discussed in chapter two, there are multiple definitions of compassion and experts have suggested a number of different definitions for compassion. Based on these different definitions, a definition of compassion for the study was proposed. Within the scope of this study, compassion was defined as the ability of an individual to recognize, understand and empathize with the physical, mental, and emotional struggles and needs of another who is suffering, which creates a motivation to help. The results of the evaluations show a significant difference in showing and giving someone compassion. To show someone compassion, the individual who is receiving compassion must properly understand the compassion which is provided by the individual or entity who is trying to help.

Thus, showing compassion could be rephrased as receiving compassion (from oneself, another individual, or an entity to the individual who is struggling) in the perspective of the individual who is struggling. The individual who is struggling must understand and receive the compassion which is *shown* to them by another individual or entity. In essence, if a loved one were to provide compassion or show compassion, this is perceived as receiving compassion in the perspective of the struggling individual. Therefore, showing compassion is rephrased as receiving compassion in the perspective of the struggling individual and giving compassion could be rephrased as providing compassion in the perspective of the assisting individual. Both receiving and providing compassion is equally as important. Providing and receiving compassion could be related to the concept of communication between two individuals. It is important for individuals to be able to communicate, but it is equally as important for individuals to be able to understand what is trying to be communicated to them.

Based on the evaluation, it was seen that providing compassion could be dependent on three factors. Firstly, it was suggested that providing compassion greatly depends on the situation at hand. The individual who wants to provide compassion needs to be able to understand what exactly the user is dealing with and under what circumstances. Second, the severity of the suffering faced by the individual who is struggling. And lastly, the specific needs of the individual who is struggling. The combination of these three factors ultimately provide a certain course of action or response in which the individual who wants to provide compassion can take in order to

help the struggling individual. This will help determine how the individual would provide compassion and to what degree compassion should be given in the right amount, not excessively or insufficiently.

Receiving compassion is another aspect of compassion which was not properly covered during the start of the study. In this research, It was found that how the individual (who is receiving compassion) receives and perceives the compassion provided is an important component for successfully providing compassion. More so, it was seen that having another person present already put the individual who is struggling in a better headspace. More so, it could be suggested that this helps the individual who is struggling understand how they should deal with their suffering and if there is anyone there at the moment who can assist them. However human connection is not the only factor which is important, the emotional bond could be argued as another factor which is important for the individual who is receiving compassion.

It could be argued that within the scope of the research, human connection and emotional connection are considered two separate concepts. Human connection could be equated to human interaction one individual has with another person at any given moment. This could be through a phone call, text message, or physically in person. Emotional connection refers to the emotional bond an individual has towards another person or entity. An individual does not need to have human interaction at the present moment to feel an emotional bond. For instance the emotional love an individual feels for their family member; even though they have not spoken in a week, there is still a strong emotional connection between their family members. Human interaction would thus be equated to the interaction between two or more people. The findings suggest that emotional bond helps create successful compassionate interactions. This could be attributed to feelings such as comfort, respect, and trust which the individual feels towards the other person who is providing compassion.

There are a number of ways compassion could be provided to one's self. As previously discussed in chapter 2, mindfulness based approaches is one proven method in which users could provide compassion to themselves. This mindfulness based approach was tested using the concept which was developed and proved successful. As seen through the use of the Connection Lamp, this was demonstrated when the user utilised the lamp to become mindful of their own situation and gauge their own anxiety level which was followed by requesting for help from their loved one. Thus it could be suggested that within the scope of this study, one individual could provide themselves with compassion by becoming mindful of their own situation physically, mentally and emotionally and gauge how they need help.

What are some general characteristics and challenges of individuals who face anxiety disorders?

The anxiety disorder of focus within this study is generalised anxiety disorder (GAD). In the evaluation, the testing only included proxy users, thus the discussion on the characteristics and challenge of individuals who struggle with generalised anxiety disorder will only utilise the

research gathered in chapter 2. As discussed previously in the background research of chapter two, generalised anxiety disorder is considered a common mental health issue which is often characterised by excessive amounts of worrying. It was seen that the generalised anxiety disorder is uncommon for individuals below the age of 25.

Generalised anxiety disorder is often characterised by excessive worrying and individuals struggle to take control of invasive thoughts. More so, “individuals find it difficult to control the worry and to keep worrisome thoughts from interfering with attention to tasks at hand” (American Psychiatric Association., 222). This could also be seen during the evaluation study in which the participants suggested that individuals who are facing anxiety often have a difficult time staying present, rather they are stuck within their own heads. This further emphasis the difficulty for these individuals to stay mindful of their thoughts which could lead to a “reduced work productivity and increased healthcare cost” (Allgulander, 104).

What type of sensory feedback would increase the sense of compassion within the prototype? How will this be measured?

The sensory feedback which was used to increase the sense of compassion utilising the prototype was light. Lighting was used for the prototype. Participant input was collected during the evaluation study to further understand how utilising light in a technological intervention could potentially increase a sense of compassion. This was achieved within the evaluation study by asking participants to complete a set of tasks while also asking relevant questions within the interview regarding the use of light and compassion.

As suggested within the evaluation, participants found that the use of light is a beneficial means of non verbal communication as it allows for non-invasive minimalistic communication. Examples of the use of light as a form of communication can be found in everyday life. Such pedestrian lights to indicate when it is safe for an individual to cross the road, or blinking lights to indicate which direction a vehicle will turn.

In the context of compassion, the lamp utilizes light to allow users to visualise their emotions externally which in return does not only help their loved one understand how the individual (who is struggling) feels, but also helps the individual understand their emotions and situation themselves. This could help them take the necessary steps and action to provide themselves (or their loved one) with compassion and help in the right manner.This suggests that light could be beneficial especially for individuals who have a difficult time verbalising their emotions.

How can empathy and emotions be implemented into mental healthcare interventions and technology?

The findings of the study, it could be suggested that empathy and emotions can be implemented in technology through the use of human connection as a focus point of interaction. Allowing users to communicate with another individual (especially those who they have an emotional

bond with) could help alleviate the individual's struggle. Marianna Fotaki further supports this claim by saying that, “there is evidence that being cared for by compassionate clinicians increases and speeds up recovery (8)” (Fotaki, 1). This further highlights the importance of human connection in adding empathy and emotions to effective interventions.

As suggested during the start of the study, human connection is a common aspect which was seen missing in different mental health solutions (“Technology and Future of Mental Health Treatment”). Thus incorporating interactions which focus on human connection into mental healthcare interventions and technology could help add empathy and emotions to these interventions. In the context of the Connection Lamp, this was achieved through allowing the users to be able to share their anxiety level to their loved one and ask them for help.

This was also distinctly seen in two of the state of the art solutions which were found: Sanvello and XRHealth. The Sanvello anxiety and depression application achieves this by accommodating social groups and coaching which allows users to communicate with like minded individuals and also experts to ask for help (“Sanvello”). More so XRHealth incorporates a blended virtual reality and conversational therapy into one allowing users to communicate with experts from the comfort of their home (“XRHealth”). In conclusion, empathy and emotions could be implemented into mental healthcare intentions and technology by incorporating human connection.

What form of innovation would prove most compassionate for the end users? Physical, digital, a mix of both?

The distinction between physical and digital forms of innovation must first be clarified. Physical innovation are those which are tangible in the physical world and could utilise different forms of sensory feedback. Some examples of physical innovations could include virtual reality, wearable devices, and the lamp which was designed within this study. On the contrary, digital innovations are innovations which are primarily found on digital devices such as applications and websites.

It was previously discussed that physical externalization and representation of a user's condition could benefit the users as they try to become more mindful of their situation in order to provide themselves with compassion or ask assistance from a loved one. This further shows how physical devices could be utilised in order to help users communicate their own anxiety. This can be achieved through physical innovations, such as the lamp as designers could try implementing and experimenting with different sensory feedbacks available

Digital solutions could also prove beneficial as it could allow for easier communication between users such as the Sanvello application discussed in the previous question. It could be argued that the concept of the Connection Lamp is a hybrid of both digital and physical as it enables users to physically interact and externalise their anxiety while also allowing for human connection through connection to the other lamp (only one lamp was made during the project).

Thus possibly combining both physical and virtual(digital) forms of innovation could prove beneficial for the end user.

Although not thoroughly discussed within this study, it could be suggested that the form of the innovation has a smaller impact than the impact of compassion. Thus, regardless of the form of the innovation, the innovation must still be considered a compassionate technology. It is suggested that innovation must be able to mediate compassion by integrating human connection and emotional connection into the design.

How has the prototype provided compassionate care towards the user?

The Connection Lamp uses a mindfulness based approach to try and alleviate the anxiety of an individual. The lamp was not a provider of compassion, it rather served as a mediator of compassion. It acts as a tool in which users could use to provide and receive compassion from another individual or to provide compassion for themselves. It could be said that the lamp was able to mediate compassion between the initial user and their loved one and also themselves. Thus this discussion could be divided into two sections, how the lamp mediates compassion for users and themselves. And the second is how the lamp mediates compassion for users and a loved one.

Based on the evaluation study, it could be argued that the lamp has the potential to help the user provide compassion to themselves. During an anxiety attack, the lamp motivates the user to become mindful of themselves. The lamp motivates the users to become aware of their own situation and emotions in order to be able to properly handle the situation. This was achieved by allowing the user to conduct breathing exercises on the lamp. This helps grab the users attention and provides them with something to focus on rather than being distracted by worrying thoughts. More so, this was also achieved allowing the users to be able to measure their own anxiety level which was seen to be beneficial as it helped them classify how severe their anxiety is feeling. In return the users could also ask for the assistance of their loved ones to provide compassion. This way, the user could provide compassion for themselves.

On the other hand the lamp could also serve as a mediator between the user and their loved one. As stated previously, the lamp helps the user communicate their anxiety level to their loved one. This allows their loved ones to properly understand and gauge how severe the user's anxiety is which in turn could help their loved one understand the proper set of actions needed in order to provide the user with the necessary amount of compassion.

Although the lamp in itself did not provide the user with compassion. It could be suggested by the results of the evaluation study that the lamp has a significant potential to serve as a mediator of compassion for individuals who suffer from generalised anxiety disorder.

Main Research Question: How can compassionate care be provided to individuals who are experiencing symptoms of anxiety disorders using technology?

Within this research, compassionate care was provided to individuals who are experiencing symptoms of generalised anxiety disorder utilising the Connection Lamp. In this case, technology was used as a mediating tool to provide compassionate interaction. Within the scope of this study, compassionate care is considered equivalent to compassion interaction. The lamp was able to mediate compassion between the user and their loved one by allowing the user to communicate their level of anxiety and request assistance while also allowing the loved one to be able to understand and take the necessary actions to provide compassionate care for the user.

More so, the users themselves could provide compassionate care for themselves by conducting breathing exercises on their own using the lamp, which also persuades them to stay mindful of their situations and emotions. In this case the lamp does not provide compassion, rather the user utilises the lamp as a tool to guide them to provide compassionate care to themselves. This could be related to a reflection journal. A reflection journal in of itself is not compassionate however the user utilises the reflection journal as a tool to provide compassion to themselves. The lamp itself does not provide compassion. In both situations previously described, the lamp only acts as a guide or tool in which the users use to provide compassion to themselves or others. The lamp is considered a compassionate technology in the sense that it mediates compassionate interactions between the users.

Thus it could be suggested that technology itself does not necessarily have to provide compassionate care for the individual dealing with generalised anxiety disorder. Rather the technology could be a guide, tool, or communication medium in which a user or multiple users could express compassionate care for themselves or for others. In order to achieve this, there are a number of components which are essential for a technology to meet in order to properly meditate compassionate care.

As suggested within the start of the study, there are four different criterias of compassionate technology. These include overall wellbeing, human connection, understanding, and empathizing. It is important that the technological solutions which aim to help assist individuals who face generalised anxiety disorder are able to meet at least any two of the criterias in order to be considered a compassionate technology; as this was the condition proposed during the start of the study in order to be able to consider a technology as compassionate. These components help outline what a technology should be able to do in order to integrate compassion. However it does not guarantee successful compassionate interaction.

Additional components need to be considered so that compassionate interaction could be achieved successfully utilizing technology. Based on the evaluation study, it was suggested that there are three important components in which technology should take into account in order to properly provide compassionate care for the individuals. These three components are human connection, emotional connection, and intensity of suffering.

The addition of human connection plays an important role in creating successful compassionate interaction in technology. Based on the results of the evaluation study it was concluded that being able to feel that another person is there to assist could alleviate some negative emotions for the individual who is struggling. However it could be argued that human connection alone is not enough as in relation to the second point of emotional connection, it is important for the user to create an emotional bond with the compassion provider. The evaluation study shed light on the importance of knowing who is providing compassion as one participant suggests that they would prefer receiving compassion from someone they could rely on.

In the study *Delivery of Compassionate mental health care in a digital technology-driven age: protocol for a scoping review*, the researchers expounds on the importance of a trusting relationship in the success of providing compassion.

> "Given the importance of a trusting relationship between a patient and a health professional in mental health, any degradation to interaction and communication by virtue of technology (or otherwise) may negatively impact patient outcomes" (Strudwick et al., 2)

This highlights two key points, first emotional and human connection could be argued as a crucial factor in the success of compassionate interactions. It is crucial that the individual could trust the other entity or individual who is providing them with compassionate care. This further supports the finding of the literature review (See Appendix A) which states that one reason why users are hesitant to try new interventions is due to the lack of trust between the user and the technology. This further shows the importance of an emotional bond (in this case, trust) between the user and the other individual or technology in creating successful compassionate interaction.

Second, this highlights the importance of clear mutual understanding and communication that technology must be able to provide. Thus, it could be suggested that in order to properly meditate successful compassionate interactions, technology should be able to support clear communication between the different users involved. Communication should also come from an individual in which the user themselves could trust such as a professional or their loved one. Thus technology designed to mediate compassionate interaction should prioritize individuals and their close relationships as the primary user group.

During the evaluation study, it was suggested that compassion needs to be given proportionately to the situation at hand. Thus the amount of compassion given is proportionate to the amount of suffering. However a study conducted by Shane Sinclair et al. suggests that compassion should always be given to the best of the provider's ability. The research suggests that,

> Participants identified supererogatory acts whereby health care providers went "beyond the call of duty" or "going the extra mile," as exemplars of compassionate action. (Sinclair et al., 200)

This contrast in results might suggest that regardless of the amount of suffering, compassion should always be provided in excess. To put it in another way, the provider of compassion should always try to provide compassion to the best of their ability. However it could also be argued that this again would also depend on the situation at hand just like suggested within the evaluation study. For instance, there might be a situation where the user would want to be left alone when feeling anxious, thus it could be argued that providing compassionate care in this sense would be to understand their request and leave the user alone. Sinclair et al. supports this claim as they suggest that seeking to understand the individual's need is also an important component of compassion. In their study, two patients quotes,

> *"They've invested in me, emotionally, to understand me and my needs (Patient 53)"*
> *(Sinclair et al., 199)*

> *"when someone is trying to be helpful on their terms, that's just not going to cut it… to be compassionate is to listen to see what the other person needs (Patient 17)"*
> *(Sinclair et al., 199)*

This highlights an important condition in regards to providing compassionate care. As previously suggested by the evaluation study compassion should be given proportionately based on the amount of suffering. However this idea was challenged as another study suggests that compassion should be given to the best of the provider's ability. Thus this could indicate that regardless of the intensity of the suffering, compassion should be given in excess. More so, it was also identified that compassion ultimately depends on the individual's needs. Therefore it could be suggested that compassion should always be given to the best of the providers' capability depending on the needs of the individual who is suffering. However, providing excess compassion could be limited due to the constraints of a certain technological solution. A technology is limited to what it could offer the user. Thus as of now, it could only be suggested that technology does its best to mediate compassionate interaction based on the specific needs of the user.

However it does not mean that all technology has to be considered compassion in order for it to be successful. It could be suggested that there are certain conditions in which technology needs to be designed with compassion in mind. Based on the discussion of the study and literature works, it could be suggested that within the scope of this study, compassion should be taken into account in the design process when the technology would require a strong emotional bond and human connection in order to be successful. A designer should take into account the focus of their technologies' interactions to determine whether it is necessary to incorporate compassion into the design process as it was seen that technology plays the role of a mediator of compassionate interactions. Additional research is needed on how compassion could excessively be provided through technology as there are limitations in which compassion can be provided when using technology as a medium.

The evaluation study also further shed light on the different key interactions which might cause unnecessary emotional distress for the users. The amount of feedback provided should be carefully considered as too much might induce emotional distress. More so, There is a chance where individuals might get externally triggered if their loved one does not reply given that the users are in a vulnerable state. These are additional factors which could also play a role in the success of mediating compassionate interactions which needs to be further explored within the design process of design compassionate technology.

To summarize, compassionate care could be provided to individuals who are dealing with generalised anxiety disorder through technology by allowing technology to become a mediator of compassion. To successfully mediate compassion technology must first be able to meet the different criterias of compassionate technology in order to be able to integrate components of compassion into the design. Technology should then be able to successfully mediate compassion interaction by doing it's best capability to mediate compassion based on the specific needs of the user. This communication needs to be clear and mutually understood by the users involved and the technology itself. More so, communication for the users needs to come from individuals in which they could trust such as their loved ones or professionals. Thus the technology designed should be catered to individuals and their close relationships.

7.2 Limitations

A number of limitations regarding the project were identified. Firstly, due to the number of participants which took part within this study, the findings of this research cannot be generalised for the public. More so, due to the scope of the study, the evaluation did not make use of actual generalised anxiety disorder patients. Thus proxy users were used in their place. Lastly, since the study was not an effect study, the findings of this research has the potential to be biased as the experiences were not genuine rather they are representations.

Due to the scope of this study, it was also not possible to involve actual stakeholders for the purpose of understanding the user group. Thus, the use requirements which were developed for the design process only came from background research. This could mean that the scenario and the user needs might not be completely accurate to the experiences of the stakeholders as it was not possible to cross reference the information gathered through literature research with actual patients of generalised anxiety disorder.

7.3 Recommendations

As this thesis provides a useful initial project and study into compassionate technology, future research could be suggested to further understand the role of compassion in technology. The framework of compassionate technology could also be revised as the definition and criterias proposed within this paper is relatively new and has a great room for improvement. More so, as the findings of this study could not be generalised it could be a suggestion that future research incorporate actual individuals from individuals who suffer from generalised anxiety disorder to further gain insights into the specific needs of the user group.

7.4 Ethical Considerations

Due to the current situation of the Coronavirus Pandemic, special measures need to be taken to ensure that the study could continue with safety. As all participants are students from the University of Twente, it is expected that each participant is aware of the rules and regulations enforced by the University while being on Campus grounds. This ensures that pre-existing measures are already in place against Covid-19 on the venue of the testing. More so both participants and researchers all wore masks and followed a certain safety checklist (See Appendix C.4) to prevent further spread of the virus. The study was not an effect study thus proxy users were used; the focus of the test was the user experience and the technology itself. This ensured that there are no potential risks or discomfort which could affect the participants.

There was no personally identifiable information which was collected except for the participants name and signature which was used for the informed consent. More so, all participants participated on their own accord and had the right to withdraw after 48 hours of the usability test. Furthermore all the data which was collected was deleted within 6 months after the publication of this research.

The research further helped understand how different design choices might cause harm to the users based on evaluation study. It was seen that different interactions and design choices could have the potential to cause the users unintentional emotional harm. The research further helped shed light on these different factors which future researchers consider in order to design better compassionate technology for mental health while decreasing the chance for unintentional harm.

8 Conclusion

The aim of this study was to design compassionate technology for mental health. More specifically the study tries to answer how compassionate care could be provided for individuals who are struggling with generalised anxiety disorder through the use of technology. Thus a definition of compassion was proposed which helped formulate a brief framework of compassionate technology. The Connection Lamp was then developed as a means to mediate compassion for the user group. More so, evaluation study and discussion further help understand the difference between providing and receiving compassion and how compassion could be mediated through technology. It further shows how the Connection Lamp could play a role in mediating compassion for the intended user group while highlighting the different possible negative effects it might have.

Therefore, within the scope of this study it could be concluded that

1. The Connection Lamp has the potential to mediate compassionate interaction for patients of (but not limited to) generalised anxiety disorder through a mindfulness based approach by allowing the users to become aware of their own situation and emotions while also allowing them to conduct breathing exercise and seek help from loved ones. Further improvements could still be made to further develop the concept. More so, it was suggested that compassion is an important factor to consider when designing technology. However not all technology needs to be designed for compassion in order for it to properly function. Technologies which prioritise human connection as the focus of its interactions should take into account compassion into the design process. as a strong emotional bond was seen to play a crucial factor in creating compassionate interactions. Compassion should be incorporated into the design process when a strong emotional bond (in the context of this study: trust) and human connection is at the core of the technology's interaction.

2. Using technology as a mediator of compassion could help provide compassionate care for individuals struggling with generalised anxiety disorder. Technology in of itself does not need to be able to provide compassion, rather mediating compassionate interactions could be suggested as enough. The technology could serve as a guide, tool or communication device to allow people to provide themselves or others with compassion. Technology should try to mediate compassion to the best of its ability while also tailoring to the specific needs of the user. More so, the design of the technology should also be tailored for individuals and their important relationships as it was seen that trusting the provider of compassion plays a crucial role in the success of compassionate interactions. Technology will not replace the role of the other individual within a compassionate interaction, rather it would serve as an addition in creating more successful compassionate interactions.

Generalised anxiety disorder is one of the common mental health issues faced today. As the world moves forward into a more technologically advanced world, technological solutions for different mental health issues will continue to be made. The use of technology as a mediator of compassionate interaction has the potential to significantly provide a solution in mitigating the symptoms of generalised anxiety disorder by incorporating human connection and considering emotional connection within the focus of the interactions.

Appendices

Appendix A

Note: This literature review was part of a previous assignment for the subject Academic Writing in Module 11 of the Creative Technology Bachelor's Program.

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Citation Style: MLA
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Factors for a Successful Mental Disorder E-Health Solution: A Literature Review

Introduction

Mental health is often an overlooked aspect in the daily lives of every individual. An Individual's mental well being is just as important and their physical well being. With the emergence of the internet, the opportunity of electronic health (e-health) solutions to tackle mental health issues continues to rise, further providing the opportunity to tackle mental health issues through creative and novel interventions (Hollis et al, 1). With the growth of e-health solutions, mental health applications have grown in popularity. However there is still a lack of understanding regarding the effectiveness of these solutions on an individual's mental health. It is important for developers to understand the different factors in which they need to consider which are crucial in assisting an individual's mental health.

This literature review aims to investigate the different factors which makes an effective and impactful e-health solution. Thus, this paper aims to answer the question "What factors are essential for developing a successful e-health solution for mental health?". These factors could be broken down into a list of key elements which are important in developing an effective solution. There are a number of factors which could be considered crucial in the development of an e-health solution for mental health however, due to the scope of this literature review, this paper will only discuss three which have been considered as topics of interests of the researcher. These are adherence, clinical approval, and user trust.

The paper will be divided into three sections each discussing a different factor important for e-health solutions. The three factors which will be discussed within this paper includes adherence, clinical approval and user trust. Within each section, the definition of each factor will first be described. This will then be followed by an analysis of the factor which include several subtopics regarding why each factor is crucial to creating a successful solution, and also how it could be tackled within the design process. Each section will then end with a discussion and conclusion of the role and importance of each factor in the development of a successful e-health

solution for mental health. Finally, the paper will then conclude with a deduction on the key factors which could be focused on in order to create an effective mental e-health solution followed by recommendations for developers within the field.

Adherence

Adherence often has a different meaning depending on the field it is used in. Within the medical field, adherence refers to the willingness for an individual to stick towards a given treatment or medication. During a WHO adherence meeting, adherence was defined as “the extent to which the patient follows medical instructions” (WHO, 2003). Within this context, medical instructions could come in the form of medical prescription, advice from experts, or even the utilization of medical care technologies as directed by medical professionals. Thus in the case of e-health interventions for mental health, adherence refers to the extent in which patients or users would follow through using the intervention to further improve their mental health. This paper will highlight three aspects which greatly influences adherence and vice versa this includes usability rates, design components and insight into users.

Understanding the relation between adherence and usability rates further provides insight into the relevance of adherence as a success factor for mental e-health solutions. As stated by Mohr et al, many e-health solutions, “such as Web-based interventions and, in some instances, virtual reality interventions, have high dropout and low utilization rates. Research in this area has been plagued by a lack of a shared definition of what constitutes adherence (4). Nielsen et al further supports this by mentioning, “Among the articles reviewed, seven stated the need for improved instructions to users to enhance usability and promote treatment adherence" (12). These studies indicate that low adherence could be linked to high drop out rates thus further creates emphasis on the importance of the users engagement of the solution.

Increasing adherence could prove to be a difficult task, however there are numerous components which are crucial and could help with increasing a solution’s adherence rate. This paper will strictly focus on the design component and how it would influence adherence. It could be argued that, “without an explicit design plan to ensure that users can interact with the intervention, it is impossible to understand the specific factors that affect adherence or nonadherence to the treatment protocol" (Nielsen et al, 12). Thus it is crucial for developers and stakeholders to understand that design is a crucial component in the creation of a mental e-health solution. More so, it will have a great impact on the users adherence towards the solution.

There are multiple design components that could be focused on to further improve the adherence of an e-health solution. For instance, the use of human touch or support through the use of emails or phone calls could further increase adherence however this does depend on factors such as the type of mental illness and even the user group themselves (Mohr et al, 3). Neilsen et al further supports this by suggesting that the use of encouragement text messages helps in increasing adherence within blended treatment methods (13). Moreso the ease of learning, information availability, and ease of use are crucial factors which contribute to increasing adherence for a solution (Stoll et al, 9). Thus it could be seen that human support,

encouragement and usability are essential to increasing the adherence of a solution.

Improving adherence would not only indicate a good solution, rather it could also provide insight into the well being of the user themselves. As the individual returns to continuously engage with the solution, it could further provide evidence that the treatment could actually be working and they are indeed satisfied with utilizing the intervention. Donkin et al further supports this claim by stating that "...adherence may be a more general indicator of orientation to healthy behaviors. Therefore, individuals who are adherent may be more likely to follow healthy lifestyle practices and therefore have improved outcomes " (7). This further suggests the importance of adherence not only in regards to the effectiveness of the solution but also in providing insight towards the impact of the solution to an individual's overall wellbeing.

It was discussed that adherence has a critical role in the effectiveness of a e-health solution. More so, it was also discussed that there were different aspects which could ultimately influence the overall adherence of these solutions. It is essential for developers to understand how adherence is influenced by the usability rate of the solution and how it further provides insight into the wellbeing of the individual or user. More so, developers could further try to increase adherence of their solution by utilizing methods such as stimulating human connection, encouraging text messages while also utilizing blended treatment methods in parallel with their digital solutions.

Clinical Approval

Understanding the clinical approval of a solution could often become the definitive factor in a solution's success. Clinical approval could be defined as the solution's acceptance by mental health professionals. A clinically approved solution would indicate that a professional trusts and would recommend the solution as an effective intervention method for their patients. Clinical approval is an essential factor to further integrate different e-health solutions as reliable and effective methods in the mental health industry. However there are still multiple concerns and issues faced regarding the integration of e-health solutions and professional care. Clinical approval could be influenced by a number of aspects, this includes medical efficacy, the lack of evaluation methods, and usability testings.

Medical efficacy remains an issue within the field of mental e-health solutions. It is worth noting that as advancements are made within the field of e-health and m-health, more developers are coming into play. These developers thus compete to put out various digital interventions aimed for mental health. This raises the concern of whether or not these publicly available solutions have been individually tested for their efficacy (Pham et al, 3). This creates an issue for both users and clinicians alike. Hollis et al further argues that, "evaluating the safety and efficacy of m-health interventions should be subject to the same rigour as evaluations required for new drug or psychological treatments" (2). These studies further indicate that clinical efficacy proves to be a widespread issue in regards to mental health solutions.

The lack of medical efficacy for the solution is in itself caused by difficulties evaluating these different mental e-health solutions. Stoll et al argues that there is a serious shortage of

evaluation methods for these types of novel interventions (8). This is further supported by Bakker et al, suggesting that there is a lack of random controlled trial evidence needed to justify the efficacy of these solutions (15). The lack of evaluations methods further complicates the efficacy trials of these interventions, further influencing its clinical approval. Furthermore, "It is unknown what proportion of these applications actually utilizes evidence-based principles and techniques" (Price et al, 7). With the lack of available evaluation methods to test these solutions, it could be argued that determining the medical efficacy would be near impossible for these solutions.

Multiple studies have suggested that the use of usability testing is a crucial evaluation method not only to understand the effectiveness of a solution, but also to obtain clinical approval. Nielsen et al emphasizes the importance of human computer interaction (HCI) design as a key factor which could further assist these different interventions in gaining clinical approval (16). Clinicians should also consider usability ratings rather than only focusing on the effectiveness of these different mental health interventions (Stoll et al, 8). Ignoring usability ratings might cause the intervention to be considered incompatible as "Poor usability is a primary cause for failed adoption of health technologies" (Price et al, 5). Thus, usability testing could be used as an evaluation method which could ultimately help gain clinical approval while also providing concrete evaluation methods for the solution.

Clinical approval is an essential factor in the long term success of a mental e-health solution. Having approval from experts would not only indicate an effective treatment method but also suggests that experts feel safe and trust these solutions, further prescribing them to their patients. It is crucial that developers take into account the medical efficacy of their solutions as it would impact the success of the solution in the long run. Even though there is currently a lack of possible evaluation methods, developers could resort to usability testing and clinical trials to further gain insight into the efficacy of their solution which will ultimately increase the chances of success and gaining of clinical approval for the solution.

User Trust

As a solution is purposeless without the user, user trust is another important factor which needs to be considered. User trust can simply be defined as the user’s interest and also willingness to use the solution to further aid their mental health. The user’s trust towards a solution would further determine the engagement the solution has with the primary end user group. More so, the effectiveness and efficacy of the solution would also play a role in determining the user's trust for the solution and vice versa. Thus, user trust would ultimately impact the solution’s clinical approval. There are a number of considerations which need to be accounted for to achieve user trust such as user safety, user comfort, and also the different privacy risks involved in creating a digital mental e-health solution.

User safety is essential in gaining user trust regarding a mental e-health solution. The field of e-health continues to grow and multiple applications continue to be made available; however, a great number of these applications lack clinical approval due to reasons such as the lack of evaluation methods. As a consequence, these applications could potentially cause more

harm towards the users. More so, “users who are experiencing low-level symptoms of a disorder may feel labeled by an app that assumes that they have a clinical diagnosis. Self-stigma from this labeling can be harmful, lowering self-esteem and self-efficacy "(Bakker et al, 7). This might cause some concerns for the users to which intervention they would feel safe and comfortable with using.

The user’s comfortability with the solution will also greatly influence how much an individual would trust and utilize a solution. Mohr et al suggests that users or patients might find these interventions uncomfortable or even lack the understanding to use the different technologies which are being utilized within the intervention (5). These barriers could further indicate the reluctancy for individuals to even utilize these interventions. Despite these barriers, a study conducted by Wozney et al claims that the use of e-health intervention for anxiety has been a growing treatment option, especially for individuals who are reluctant to have face-to-face treatment. Furthermore their study found that 75% of their usability testing participants had negative attitudes towards e-health solutions prior to utilizing the e-health intervention (2, 7).

Despite the struggles in obtaining user trust, e-health solutions create an opportunity for an alternative treatment method. The study conducted by Wozney et al and Mohr et al does not only indicate the reluctance of users to initially use e-health interventions due to reasons such as the lack of understanding and discomfort. But it also puts forward the notion that given the opportunity, e-health interventions could provide a promising alternative in aiding mental health. Individuals who are limited due to different factors and circumstances could look towards these different solutions to help aid their mental health and not only resort to conventional and traditional methods of mental health treatments. However, e-health intervention also raises concerns regarding privacy.

In the digital age, privacy continues to become a growing concern, this essentially also impacts e-health solutions for mental health. Issues such as the breach of privacy or mishandling or personal information are only some concerns which come into the minds of users and stakeholders when it comes to digital e-health solutions. Hollis et al mentions that the use of sensitive personal information and data within the field of mental healthcare needs to be addressed as these raise ethical issues. More so, "Maintaining public trust when handling and sharing personal health data is paramount and this requires serious public engagement over issues of consent, data security and privacy" (2).

It is crucial that developers are aware of the privacy issues and concerns which revolve around their intervention. More so, developers should further ensure that each user understands all the privacy risks involved in utilizing their intervention. Price et al supports this claim, further emphasizing that, "Patients should be made aware of any explicit security and privacy risks associated with inputting potentially confidential information into a mobile device (6). Furthermore it is important for developers to take into account privacy concerns as it would ultimately play an important role in user trust. If these are not dealt with properly, these could have grave consequences on both the developer and the end user group.

It is at utmost importance that developers understand how user trust could be improved. In this paper, only different design techniques will be discussed to further increase user trust. One method which could help increase user trust is familiarity. Familiarity would facilitate feelings of trust and hopefulness towards the intervention. More so, familiarity would further ease the learnability of the intervention (Nielsen et al, 13). More so, Wozney et al identified in their study that aesthetics is another important method in creasing user trust. It does not only make the intervention user-friendly but would improve satisfaction and useability of the intervention(7). Simulating human interaction could also aid in increasing user trust. A study Morrison et al suggests that even the use of simulated person-to-person interaction through the use of automated dialogues and avatars could further help increase the sense of user trust (4).

It was discussed how without users utilizing a given solution, it would prove it obsolete, thus indicating the importance of user's trust in a solution. The user's trust in a solution is crucial as users need to be able to feel safe and comfortable using the solution. It is at utmost importance that the user's safety is the main concern when developing the solution. More so developers should consider design aspects which could increase a sense of comfort for these users such as utilizing aesthetics and familiarity. Finally developers should also seriously consider the different privacy risks involved within the development of the solution and understand how these issues would be tackled.

Conclusion

This literature review has further outlined and discussed the importance of three key factors which are crucial for the success when designing an e-health solution aimed at improving mental health. It is crucial that developers understand how the factors of adherence, clinical approval and user trust individually and interconnectly influence a mental e health intervention. Based on this literature review, it was seen that adherence is an important factor to take into account when designing e-health solutions. Adherence does not only increase user engagement and the efficacy of the intervention, but could also further indicate and give insight to the overall well being of the user themselves.

Moreso, it was discussed how the lack of available evaluation methods has greatly impacted the clinical approval of many interventions. Furthermore it was highlighted that it is crucial that the efficacy of interventions are tested and determined as it would be needed by mental health experts to further prescribe the right intervention to the right patients. User trust was also seen to be interconnected and significantly influencing adherence and also clinical approval. It is important to consider the users trust towards the intervention itself as they would be the ones primarily utilizing the intervention. More so, different aspects such as privacy concerns and methods to increase user trust were discussed to further provide guidance for developers in creating their e-health solution.

Over the years it could be predicted that the interest and availability of mental health application and interventions will continue to grow. It is critical that developers understand the correct methods and guidelines to follow when developing their interventions. Factors such as

adherence, clinical approval, and user trust are just a few of the many key factors which are needed to further create a successful mental e-health intervention. It is recommended that developers consider the different design choices and also considerations discussed within this paper to further understand the importance and effect of adherence, clinical approval, and user trust as three key factors which would influence the effectiveness and success of digital e-health solutions for mental health.

References

"Adherence." *World Health Organization* , 2003, www.who.int/chp/knowledge/publications/adherence_Section1.pdf.

Bakker, David, et al. "Mental Health Smartphone Apps: Review and Evidence-Based Recommendations for Future Developments." *JMIR Mental Health*, vol. 3, no. 1, 2016, doi:10.2196/mental.4984.

Donkin, Liesje, et al. "A Systematic Review of the Impact of Adherence on the Effectiveness of e-Therapies." *Journal of Medical Internet Research*, vol. 13, no. 3, 2011, doi:10.2196/jmir.1772.

Hollis, Chris, et al. "Technological Innovations in Mental Healthcare: Harnessing the Digital Revolution." *British Journal of Psychiatry*, vol. 206, no. 4, 2015, pp. 263–265., doi:10.1192/bjp.bp.113.142612.

Mohr, David C., et al. "Behavioral Intervention Technologies: Evidence Review and Recommendations for Future Research in Mental Health." *General Hospital Psychiatry*, vol. 35, no. 4, 2013, pp. 332–338., doi:10.1016/j.genhosppsych.2013.03.008.

Morrison, Leanne G., et al. "What Design Features Are Used in Effective e-Health Interventions? A Review Using Techniques from Critical Interpretive Synthesis." *Telemedicine and e-Health*, vol. 18, no. 2, 2012, pp. 137–144., doi:10.1089/tmj.2011.0062.

Pham, Quynh, et al. "Feasibility and Efficacy of an MHealth Game for Managing Anxiety: 'Flowy' Randomized Controlled Pilot Trial and Design Evaluation." *Games for Health Journal*, vol. 5, no. 1, 2016, pp. 50–67., doi:10.1089/g4h.2015.0033.

Price, Matthew, et al. "MHealth: A Mechanism to Deliver More Accessible, More Effective Mental Health Care." *Clinical Psychology & Psychotherapy*, vol. 21, no. 5, 2013, pp. 427–436., doi:10.1002/cpp.1855.

Stoll, Ryan D., et al. "Usability of a Smartphone Application to Support the Prevention and Early Intervention of Anxiety in Youth." *Cognitive and Behavioral Practice*, vol. 24, no. 4, 2017, pp. 393–404., doi:10.1016/j.cbpra.2016.11.002.

Søgaard Neilsen, Amalie, and Rhonda L. Wilson. "Combining e-Mental Health Intervention Development with Human Computer Interaction (HCI) Design to Enhance Technology-Facilitated Recovery for People with Depression and/or Anxiety Conditions: An Integrative Literature Review." *International Journal of Mental Health Nursing*, vol. 28, no. 1, 2018, pp. 22–39., doi:10.1111/inm.12527.

Wozney, Lori, et al. "Usability Evaluation with Mental Health Professionals and Young People to Develop an Internet-Based Cognitive-Behaviour Therapy Program for Adolescents with Anxiety Disorders." *BMC Pediatrics*, vol. 15, no. 1, 2015, doi:10.1186/s12887-015-0534-1.

Appendix B.1

Connection Lamp User Manual

Connection Lamp functionalities

The connection lamp has two main functionalities, it allows the users to conduct breathing exercises on their own, and also it allows users to communicate their anxiety level to their loved ones and conduct a synchronized breathing exercise together.

There are 5 main buttons on the lamp. Two buttons on the center, and three buttons along the edges of the top of the lamp. The three buttons along the sides are used to determine your level of anxiety (light, mild, severe) or also to set the breathing pace if you are assisting your loved one. The pacing and the colors have been pre determined by the researcher. In regards to the two buttons on the center, one button serves solely as switching the lamp from idle to active state(on/off switch) while the other is used to send a desired message to the loved one.

In addition there are also two metal plates present on the lamp, these two plates are conductive, allowing it to detect human touch.

How to use

User 1

Conduct breathing exercises:

If you hold the lamp by the metal plates, the individual breathing exercise mode will be activated, this will resemble a light which will dim and brighten in a periodic manner, to conduct the breathing exercise you could simply follow the pattern on the lamp, syncing your breathing towards it. This mode will continuously be active as long as you hold the lamp by the metal plates.

Sending anxiety level and asking for help

In order to ask for help you must first activate the lamp by pressing the activation button. The lamp will glow differently, indicating that it has been activated. You then determine your anxiety level which will be represented with a static light with a gradient from white to yellow (white resembles light anxiety, light yellow resembles mild anxiety, while yellow resembles severe anxiety).

Once you are sure that you have selected the correct anxiety level, you could then send this to your loved one by utilising the send button. You will know that your message has been sent and you are waiting for your loved ones to reply as the light mode will change. This is visualised by a trailing light which could be described as *seeming to be waiting for a response.*

If your loved one is not available and does not respond, the light will glow red indicating that they are not available, an automated breathing exercise will then begin to assist you with your anxiety. Once you feel better, you could simply turn off the light by pressing the on/off switch.

If your loved one does reply, this will be indicated with the lamp glowing with a random pattern, indicating that they have recognized your struggle and desire to help you. They will then start a breathing exercise session for you in which your lamp will begin to follow a breathing pattern (as described previously). The lamp will still show the same color as your anxiety level, you could continuously update your anxiety level to tell your loved one if you are feeling less or more anxious.

When you feel better, you could press the send button once more to indicate that you now feel calm to your loved one. You both could then stop the breathing exercise by turning off the lamp.

User two
Providing Help
Your lamp will remain in idle mode until your loved one sends you a message that they are feeling anxious. This could be visualised by the static light of white, light yellow, or yellow, respectively resembling their anxiety level.

To let your loved one know that you have seen and recognized that they are anxious, you would press the on/off button, if done correctly, the light will then begin to resemble a breathing pattern. Using the three buttons, you could then set the pace of breathing, either making it slow or fast based on what you feel is the best for your loved one.

Once you have determined a breathing pace, you could activate the synchronized breathing exercise by pressing the send button which will in turn, start the breathing exercise for you and your loved one. For a brief period of time, the light will glow green indicating that the breathing exercise has started for both you and your loved one.

The lamp's color will automatically update depending on how your loved one feels in terms of their anxiety. Once they feel calm, the light will then start to glow in a random pattern indicating that they in fact feel better. You could then turn off the lamp by simply pressing the on/off button.

Appendix C.1

Information Brochure

Dear Reader,

My name is Rayhan Aryoseno Bayuaji. I am a student in the University of Twente and am currently doing a Bachelor's thesis on Designing Compassionate Technology for Mental Health. The goal of this research is to understand how compassionate care could be provided to individuals who are currently experiencing symptoms and feelings of anxiety.

I have developed a prototype which aims to not only connect individuals with their loved ones in times of anxiety but also provides breathing exercises for the user. With this I have designed a mood lamp which comes in pairs. This mood lamp is able to display an individual's mood to another person using the form of different colors of light. More so, this mood lamp is able to provide breathing exercises for the users when they feel anxious. The initial target group of this research are patients of generalised anxiety disorder, however due to the scope and limitation of my research, my study will involve proxy users, primarily students, both females and males from the university of Twente, preferably between the ages of 18-25.

Thus your participation in this study would be greatly appreciated and further benefit my research to further understand how users will experience the prototype. You will need to be physically present at the testing venue to participate. I will be conducting usability tests on the prototype and also to further provide a proof of concept. Within this test, you will first be introduced to the physical prototype and I will explain its functionalities and how it would work. You would then be given a role playing scenario in which you need to complete certain tasks as a persona. This process will be observed by myself. After the usability test we will conduct a semi structured interview regarding your experience which will be recorded.After which we will finish with a debriefing of the research process.

There are no adverse effects which could appear from your participation as the focus of the test is the user experience and the technology itself, not the users. Thus there are no potential risks or discomfort which might arise by participation. There is no possibility for any accidental discoveries which might arise during participation in this research. More so, there is no remuneration for participation. Your participation within this study is completely voluntary and if you do decide to opt out, you may do so at any time of the research process. If you decide to withdraw after 48 hours after participation, data collected from your session will be deleted immediately.

This research will not utilise any personally identifiable information except your name and signature which would only be utilised and seen in consent form which is needed to participate in this research. More so, by participating you will acknowledge that your input will be part of the evaluation of this research. Any information collected will stay confidential. And any quotations

from the interview will be kept anonymous within the report which will eventually be published online with the possibility of being cited by other scientific publications. All data collected from the study will be destroyed within 6 months after the completion of the research. Furthermore, you have the rights to ask for additional information or request to be notified regarding the progress of the research if you wish.
Thank you for your time. Your participation would be greatly appreciated. If you have any questions regarding the research or participation, please do not hesitate to contact me or my supervisor.

Respectfully,

Rayhan Aryoseno Bayuaji

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Phone Number: 0628869158

Supervisor: Randy Klaassen
Email: r.klaassen@utwente.nl

Informed Consent

By signing this form, I declare that I will be taking part in this research and I have read and agreed to the information brochure provided by the researcher. I understand that I will have to be physically present at the testing venue which will be arranged at a later date and time and will agree to follow all the corona measures. I understand that I have the right to withdraw at any time during the period of the research process even after 48 hours after participation.

I understand that participation is upon my own free will. I acknowledge that my participation means that observed during the test and my actions will be monitored and recorded on paper. Furthermore I understand that all data that will be collected within the study will be destroyed within 6 months after the research has been completed.

I understand that my personal information will not be disclosed unless I have given permission. My participation within this research dictates that the results of the usability test could be used within the context of this scientific research and any reference, quotations, and remarks made to my test will remain anonymous when written within the report. I understand that I have the right to ask for information regarding the progress of this research if requested.

If you have any questions or remarks regarding this research please do not hesitate to contact me or my supervisor.

Researcher	Rayhan Aryoseno Bayuaji	rayhanaryosenobayuaji@student.utwente.nl
Supervisor	Randy Klaassen	r.klaassen@utwente.nl

If you have any complaints about this research, please direct them to the secretary of the Ethics Committee of the Faculty of Electrical Engineering, Mathematics and Computer Science at the University of Twente, P.O. Box 217, 7500 AE Enschede (NL),
email: ethicscommittee-cis@utwente.nl

I have read the informed consent and agree to take part in this research: yes / no

_____	_____	_____
Name of participant	Signature of Participant	Date

_____	_____	_____
Name of Researcher	Signature of Researcher	Date

Appendix C.2

Task List

Scenario 1

- ☐ Hold the lamp
- ☐ Understand the breathing pattern
- ☐ Follow the breathing pattern
- ☐ Put lamp back when it is not being used

Scenario 2

- ☐ Turn on the lamp
- ☐ Determine the anxiety level
- ☐ Understand the different anxiety levels (add here the different levels)
- ☐ Send anxiety level to user two
- ☐ Recognize that the lamp is *waiting* for a response

  Scenario 2a

  - ☐ Recognize that user two has responded
  - ☐ Recognize that user two has started the breathing exercise
  - ☐ Understand the pace and follow the breathing exercise
  - ☐ Notify user two that they are feeling better
    - ☐ Update anxiety level
  - ☐ Turn off the lamp

  Scenario 2b

  - ☐ Recognize that user two has not responded
  - ☐ Recognize that an automated breathing exercise has been initiated by the lamp
  - ☐ Follow the breathing exercise
  - ☐ Turn off the lamp

Scenario 3

- ☐ Recognize that the lamp has turned on
- ☐ Recognize that user 1 is going through an anxiety attack
- ☐ Recognize the level of user 1's anxiety attack
- ☐ Respond to user's 1 request for help
  - ☐ Acknowledges the anxiety attack
  - ☐ Respond by using the lamp
- ☐ Understand and determine the pacing of the breathing exercise
- ☐ Activate the synchronized breathing exercise for user 1
- ☐ Follow the breathing pattern
- ☐ Recognize that user 1 feels better (indicated by the lamp)
- ☐ Turn off lamp

Information Cards

These information cards are designed to help the participant understand the concepts surrounding the research briefly. These texts will each be printed on a separate sheet of paper.

Generalised Anxiety Disorder

Generalised anxiety disorder is one form of anxiety disorder which is considered a common mental health issue. Often characterized with symptoms such as stress, increased heart-rate, muscle tension, shortness of breath, individuals who suffer from GAD often find themselves overwhelmed by the excessive amount of anxiety and worrying. GAD could affect an individual's wellbeing, quality of life, and their performance in their daily lives.

There are a number of treatments which could be used to help combat GAD. Researchers often suggest interventions such as meditation and mindfulness based approaches, cognitive behavioural therapy, or even self help material. However studies have shown that only two out of five patients who suffer from GAD actually seek professional treatment for the disorder. More so, treatment of GAD could often be considered expensive. With the continous growth of technology being used within the healthcare industry, the goal of the research is to develop compassionate technology which could be used to help GAD patients deal with their symptoms of anxiety.

Compassion

Based on research, experts suggest that there is no one definition which could be used to define compassion. However a number of definitions could be provided as suggested by experts:

Being moved by another's suffering and wanting to help (Lazarus, 1991, p.289)

Compassion consists of three facets: Noticing, feeling, and responding (Kanov et al., 2006).

"Being touched by the suffering of others, opening one's awareness to others' pain and not avoiding or disconnecting from it, so that feelings of kindness towards others and the desire to alleviate their suffering emerge. It also involves offering non-judgmental understanding to those who fail or do wrong" (Neff, 2003a, p. 86–87).

Based on these definitions, within the scope of the study compassion has been defined as:
The ability of an individual to recognize, understand and empathize with the physical, mental, and emotional struggles and needs of another who is suffering, which creates a motivation to provide help.

Compassionate Technology

Based on the previous definition of compassion, compassionate technology has been defined within the scope of this study as technology which takes into account the user's comfort and experience. It does not only understand the physical, emotional, and mental aspect separately

but also considers all three aspects interconnectedly in the design process. More so, compassionate technology tries to provide a sense of human connection.
Based on this definition, compassionate technology could be divided into 4 criterias.

1. Design of the technology takes into account the mental, physical, and emotional wellbeing of the user (overall wellbeing)
2. Strives to provides a sense of (human connection)
3. The solution must be able to sense, record, or keep track of the user's state (empathizing)
4. The solution must make sense of the current state of the user (understanding)

Connection Lamp

The connection lamp is a smart lamp which aims to help individuals deal with their anxiety. The lamp allows you to communicate your level of anxiety to your loved one, which could be beneficial especially when you are dealing with an anxiety attack. This allows your loved one to know how anxious you feel and could even allow you both to conduct synchronized breathing exercises. The lamp also has a feature which allows you to conduct your own breathing exercises on your own. The lamp aims to not only provide but also become a mediator of compassion for the user themselves, and also between the user and the loved one.

Procedure List

1. The study will begin after the participant has completed the pre testing safety guidelines
    a. The participant and the researcher will sit on the same table, across from each other ensuring that a 1.5 meter distance is kept in between.
2. The participants will then be asked to read and fill out the information brochure and the informed consent form
3. After completing the form, the participant will then be introduced to the study in depth through the use of the information cards, the researcher will then also explain the process of the test and the observations which will be made on the participants. During this step, any questions by the participants will be answered
4. The participant will then be introduced to the prototype and the information sheet regarding the prototype. They will also be introduced to the persona in which they will have to portray during the test
5. Each participant will be asked to complete all the scenarios as the two personas and further conduct a semi structured interview, followed by a debriefing.
6. Once the participant feels comfortable playing the personas, the test could be conducted by starting with the first scenario.
7. For clarity purposes, the participants will be asked to speak aloud the scenario that is given, then they must verbally speak aloud as the perform the tasks that needs to be completed and as they go through the scenario
8. The researcher will make notes on these observations, if in the situation that the participants find any interaction unclear and is stuck with completing a task, they may ask for assistance and the researcher will guide them towards completing the tasks (this must also be noted down)
9. Steps 5 to 7 will be repeated for all scenarios
10. After the completion of each scenario, the semi structured interview will be conducted and completed
11. The participants will now be debriefed and will follow the post - testing safety guidelines, then the test will be completed.

Appendix C.3

Observation Points

See Task List and Tick off every task each participant has completed (without the help or guidance of the researcher)

Additional observations

- How does the user interact with the prototype?
- How does the user hold the prototype in their hands?
- What tasks were most commonly seen to be the easiest to do?
- What tasks were most commonly seen to be the most difficult?
- What task did users struggle with
- Any Impressions and comments

Note: Participants must think aloud to provide clarity towards their thoughts and experience as they go through the scenarios. The researcher may assist the participant if they get stuck in any section or tasks. Please remember to take note of the tasks which the participants request help or struggle with.

Semi Structured Interview Questions

1. How did you experience your interaction with the connection lamp
    a. Was the use of light as a means of communication clear? Why or why not
    b. Were you able to distinguish between the different modes and phases of the lamp based on the different lights that were displayed?
    c. How did you find the use of light to provide interaction and communication?
    d. If the light was formatted in a different way, do you think this could have been beneficial and create a more clear form of communication? (Show the different presets of lights)
    e. Were there any functionalities or interactions which you found unclear or confusing? Please explain and provide suggestions

2. Do you feel that by utilizing this lamp, you might be able to increase a sense of self compassion? Why or why not?
    a. In the scenario, you were asked to hold the lamp to activate the breathing exercise mode, do you think holding the lamp plays a role in its usage? Does it make the interaction more difficult, or easier?
    b. Do you feel that by being able to determine your level of anxiety, it allows the user to be able to understand their anxiety better? How is this a beneficial aspect of the concept?

3. Do you feel that by utilizing this lamp, you might be able to provide compassion to your loved one (Ian)? Why or why not?

    a. Were you able to determine the level of anxiety of your loved one? Do you feel that this would be beneficial in order to provide proper help to them?
    b. Were you able to clearly identify the different breathing paces for your loved one? Do you feel that this interaction might be helpful or rather unnecessary for the first user?
    c. Do you feel that it is possible for you to provide help through a different means besides the use of a breathing exercise through the help? If so, what would it be?
    d. What do you think could be done to help your loved one within this situation?

4. Do you find it necessary for another individual to be present in order to provide compassion? Or is having the lamp itself enough?
    a. Do you feel that who initiates the breathing exercise (or the form of help) influences the interaction? Would it matter if user 2, or the lamp, or the initial user themselves initiates? Why or why not
    b. As you experienced within the second scenario, your “sister” activated a breathing exercise for you. However since you cannot see her, you do not know whether it is actually your sister who is responding or whether it is an automated response from the lamp. Do you think it is important who starts the interaction/breathing exercise? Why or why not?
    c. Would it make a difference if you knew or didn't know whether it was your sister or the technology itself who was helping you?
    d. Given the fact that their lamp was programmed (for this evaluation testing) to respond automatically, rather than having a secondary user, do you think you would have felt differently knowing that you were interacting with only technology, not another human being?

5. Based on the previously discussed categories of compassionate technology which we have introduced in the start of the study, which criterias do you think the lamp meets?

6. Do you feel that this lamp could increase and mediate compassionate interactions? Why or why not? More so would you then consider the lamp as a compassionate technology?

7. Do you feel that this solution might be beneficial for an individual who is dealing with symptoms of GAD? How, why and why not?

8. Do you think the prototype lacks something, if so what would it be? What would you add or change to improve it?

9. Would you use this technology yourself? More so, if this project was continued, would you suggest and recommend this to someone?

10. Are there any additional final remarks, comments, or recommendations you would like to add?

APPENDIX C.4

Corona Safety Checklist

Pre - testing Safety Checklist

- ☐ The participant and researcher both acknowledge and confirm that they have not had any symptoms of COVID-19
- ☐ Both parties have acknowledge that they have not been in contact with any individual who tested positive in the past 14 days
- ☐ Both parties has disinfected their hands using a hand sanitizer
- ☐ The prototype and area of the testing (table and chair) has been sanitised
- ☐ Both parties are using masks

Post - Testing Safety Checklist

- ☐ The participant sanitises their hands after interacting with the prototype
- ☐ The prototype and other additional materials have been sanitized by the researcher
- ☐ The researcher disinfects the entire set up and resets everything for the next participant

Work Cited

Allgulander, Christer. “Generalized Anxiety Disorder: What Are We Missing?” *European Neuropsychopharmacology*, vol. 16, 2006, doi:10.1016/j.euroneuro.2006.04.002.

Barnard, Laura K., and John F. Curry. “Self-Compassion: Conceptualizations, Correlates, & Interventions.” *Review of General Psychology*, vol. 15, no. 4, 2011, pp. 289–303., doi:10.1037/a0025754.

Bolognesi, Francesca, et al. *Psychological Interventions in the Treatment of Generalized Anxiety Disorder: a Structured Review*, 2014.

“Comfort and Protection for Medical Devices.” *Vital Beat*, 12 Jan. 2021, www.vitalbeat.com/.

“Common Mental Health Problems: Information for the Public: Common Mental Health Problems: Identification and Pathways to Care: Guidance.” *NICE*, www.nice.org.uk/guidance/cg123/ifp/chapter/Common-mental-health-problems.

Diagnostic and Statistical Manual of Mental Disorders: DSM-5. American Psychiatric Association, 2017.

“Eat with Confidence.” *Liftware*, www.liftware.com/.

“Experience Calm.” *Calm*, www.calm.com/.

Fotaki, Marianna. “Why and How Is Compassion Necessary to Provide Good Quality Healthcare?” *International Journal of Health Policy and Management*, vol. 4, no. 4, 2015, pp. 199–201., doi:10.15171/ijhpm.2015.66.

Guthrie, J T. “Psychology and Perception of Colour and Shape.” *Surface Coatings International Part B: Coatings Transactions*, vol. 86, no. 1, 2003, pp. 35–42., doi:10.1007/bf02699591.

Larson, Christine L., et al. “Simple Geometric Shapes Are Implicitly Associated with Affective Value.” *Motivation and Emotion*, vol. 36, no. 3, 2011, pp. 404–413., doi:10.1007/s11031-011-9249-2.

“Meditation Made Easy.” *Muse*, 1 Apr. 2021, choosemuse.com/.

“A Place to Feel Better, Wherever You Go.” *Sanvello*, www.sanvello.com/.

Russo, Marc A., et al. “The Physiological Effects of Slow Breathing in the Healthy Human.” *Breathe*, vol. 13, no. 4, 2017, pp. 298–309., doi:10.1183/20734735.009817.

Sinclair, Shane, et al. “Compassion in Health Care: An Empirical Model.” *Journal of Pain and Symptom Management*, vol. 51, no. 2, 2016, pp. 193–203., doi:10.1016/j.jpainsymman.2015.10.009.

Strauss, Clara, et al. *What Is Compassion and How Do We Measure It? A Review of Definitions and Measures*, 2016.

Strudwick, Gillian, et al. “Delivery of Compassionate Mental Health Care in a Digital Technology-Driven Age: Protocol for a Scoping Review.” *BMJ Open*, vol. 9, no. 7, 2019, doi:10.1136/bmjopen-2018-027989.

“Technology and the Future of Mental Health Treatment.” *National Institute of Mental Health*, U.S. Department of Health and Human Services, www.nimh.nih.gov/health/topics/technology-and-the-future-of-mental-health-treatment/index.shtml#part_152631.

Tyrer, Peter, and David Baldwin. “Generalised Anxiety Disorder.” *The Lancet*, vol. 368, no. 9553, 2006, pp. 2156–2166., doi:10.1016/s0140-6736(06)69865-6.

“The Wearable Wellness Device For Stress Relief.” *Apollo Neuro*, apolloneuro.com/.

Weisberg, Risa B. “Overview of Generalized Anxiety Disorder.” *The Journal of Clinical Psychiatry*, vol. 70, no. suppl 2, 2009, pp. 04–09., doi:10.4088/jcp.s.7002.01.

“XRHealth Virtual Clinic: At-Home Virtual Reality Therapy.” *XRHealth*, 8 Apr. 2021, www.xr.health/.