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Self-Attachment Therapy Through VR

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Abstract

Self-Attachment therapy is a new form of psychotherapy which attempts to study the behaviour of a securely attached child with its primary care-givers, as determined by Attachment Theory, and present these as protocols which patients can self-administer. The patients suffer from anxiety disorders, have difficulty forming a trusting bond or suffer from depression. The self-administering of the protocols helps to construct new optimal neural pathways in their brains. This self-administering process involves a degree of imagination, where the patient pictures their child self as a separate entity and falls in love with it. They would also need to simulate hugging and consoling the child. This process can be a problem as it could take months to get to the stage where the patient feels as if they can believe that their child self is a separate entity.

This project aims to simulate the whole process so that the patient is guided systematically through self-attachment therapy. They will be informed of the process and benefits of each stage while they complete them. They will also be presented with a 3D model of their child self which they can interact with, removing the need for imagining the child.

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1 Introduction

Depression and anxiety disorders are the most common mental disorders in Britain with 7.8% of people meeting the criteria for the diagnosis as shown in the cited report [19]. Recently, a new form of psychotherapy has been suggested [13]: self-attachment therapy. It aims to help adults reduce their destructive thinking habits and form healthy relationships with others. The exercises it suggests have been proven to be effective but the time taken for these techniques to be fully learnt and integrated into daily routine is usually 2-3 months with the help of a therapist [13]. A main aspect of the exercises is to imagine your child self as a real person existing at the same time so that an emotional bond can be formed between you and your child self. Concentrating on old photographs of yourself as a child and spending a lot of time imagining the past is currently what is required to fully achieve this.

The proposed solution is to do a lot of the work for the user. Build a virtual environment where the person would be able to literally see their child self . The child would look like them and they would be able to interact with it. This was previously done in their mind but if they didn't have to concentrate on imagining the child, they could carry out the rest of the exercises.

1.1 Objectives

The user would use an Oculus virtual headset to enter a virtual world which would contain their child self as a 3D model. They would then be guided, step by step, through the many exercises outlined by self-attachment therapy in an interactive way. They would be able to control when and for how long they would do each exercise. They could also complete them in the comfort of their own home.

The user should also be able to change the appearance of the child with a simple gesture. The gesture should be a motion of the hand, intuitive and easy to perform. The child will need to be a boy or a girl to match the gender of the user. The user would also need to be able to hug the child and dance with the child so that an emotional bond can form.

1.2 Challenges

Unity is new to me and will be a challenge to begin developing in. The scripting will be done in C# which is a language I have not encountered before this. I will need to consider the time it will take to learn about them enough to complete the project. Throughout the project, I will work hard to learn the intricacies of Unity and C# so that I can carry out the objectives efficiently by doing as many tutorials that I can.

The user interface will need to be simple to follow for anyone, even people who are not experts with technology. They will need to be able to understand how the touch controllers work and also how to use them to navigate the menu to get to the correct place. This will need to be tested thoroughly, with people of different backgrounds, to ensure that the UI is sufficiently easy to follow.

The child is a VR object and will need to substitute for the user's child self. The user would need to fully accept that the child is a real, tangible person with

whom they could form an emotional bond with. I will need to make sure that the model behaves like a child would and that the user could interact with the child in a believable way. How could the user hug a virtual child in a realistic fashion when there is nothing to hold on to?

The gesture recognition needs to be precise. The user should not be able to perform the gesture by accident. I will need to see what information I can extract about the touch controllers and whether it is enough to allow for gestures.

1.3 Contributions

- A virtual reality simulation of all the stages of self-attachment therapy in virtual reality with a clear and concise UI so that users can go through this without any help.(4)
- Interactions with a 3D child model (cuddle, dance, etc) which feel organic and believable.(4.3)
- Gestures which can trigger a change in the appearance of the child. (4.3.2)

2 Background

I start with attachment theory to explain that the root of anxiety or mood disorders usually lie in the childhood of the adult undergoing therapy. This is important to understand as it is the basis for self-attachment theory which is an extension of attachment theory and suggests a new method of therapy. This treatment can then be enhanced with the virtual reality app we are developing during this project. The last part of the background looks at how VR is being used currently for therapeutic purposes and how it works. These examples are important to consider as they may offer insights into our own attempts at helping with therapy.

2.1 Attachment Theory

Attachment theory was developed by Bowlby to explain why separation of a child from their primary care giver could cause anxiety later on in life. Attachment is an emotional bond, usually between a child and a parent, which results in the comforting of the child. For instance, a child seeks attachment when under stress but seeks a playmate, another form of an emotional bond, when jovial. This behaviour is usually present in children rather than adults, but it can be observed later in life, especially when the adult is under a lot of stress. The bonds formed when children are very young can have lasting effects and tend to influence the behaviour of the child throughout their life. History has shown that children who stay with the caregiver and receive comfort through their attachment are more likely to survive. Behaviourists, such as Bowlby, who was one of the people behind attachment theory, suggested that this was due to the child being nurtured by the caregiver rather than the previously believed notion that it was the reception of food which developed attachment in children.

Bowlby's work with two of the inhabitants of a home for maladjusted boys, where he worked, led him to suggest that the mother-child disruption had a major impact on their behaviour. The boys were separated from their mother at an early age and showed a great amount of distress and led to their later psychopathology. It was at this time that he developed attachment theory and the behaviours associated with attachment are listed as follows:

- Smiling at the caregiver
- Vocalizing with the caregiver
- Crying
- Approaching or following the caregiver

These behaviours serve to either bring the caregiver to the child or vice versa. Crying results in the caregiver approaching the child to stop them from crying.

There are four stages of attachment as found by researchers Rudolph Schaffer and Peggy Emerson. These are as follows: [35]

1. Pre-Attachment Stage: The child does not attach to a single caregiver. The crying and other attachment behaviours naturally draw the primary caregiver, usually the mother, to the child. This behaviour was noticed in the first three months of the child's life.

2. Indiscriminate Attachment: The child starts to distinguish between caregivers and responds more positively to the primary caregiver. This behaviour was noticed between six weeks and seven months of the child's life.
3. Discriminate Attachment: The child starts responding to one single caregiver strongly. Separation from this caregiver or being in the presence of strangers will cause anxiety. This behaviour was noticed between seven and eleven months of the child's life.
4. Multiple Attachments: The child starts to respond to multiple caregivers such as siblings and grandparents. This behaviour was noticed after nine months in the child's life. [35]

These stages are present in children with healthy relationships but, when a primary caregiver is not present, the behaviour is not apparent in the child. The child might not have enough trust to form an attachment if they start with multiple caregivers, such as children in orphanages, as they do not go through the stages required for attachment. Care given intermittently could also be a problem as consistency is also required for the child to form trust. If the primary caregiver is sometimes cold towards the child but sometimes very warm, the child will not be able to form an attachment. They will always be guessing what the next response to their attempts to interact with the caregiver will be. The differences in care-giving lead to researchers finding that the children will form different types of attachments with their primary caregiver. [35]

- Secure Attachment: The child is upset when the caregiver leaves but is secure in the idea that they will return to them. The child is also confident that they will receive comfort if they ask for it and do so when it is required. They feel like they can depend on the adults.
- Ambivalent Attachment: The child feels like they cannot depend on their caregiver and is very upset when they leave. When they return, the child shows anger towards the parent.
- Avoidant Attachment: The child does not differentiate between a caregiver and a stranger and will avoid them altogether if they can. This can happen when carers are neglectful or abusive. The child avoids seeking help when they need it as they have not received it from their primary caregiver.
- Disorganized Attachment: The child acts disorganized, sometimes accepting comfort and sometimes not. This happens when the caregiver is both the source of fear and comfort to the child and is inconsistent in how they behave. [35]

Bowlby, the behaviourist behind attachment theory, suggested that anxiety disorders arise from the anxiety that the primary caregiver, or the attachment giver, is unavailable. The last three forms of attachment could lead to this as all of the caregivers in those scenarios are either distant, absent or overbearing. There are many scenarios where children could experience these attachment issues. These include, but are not limited to a household where:

- A parent is overprotective of the child and will not let them go for fear that they will come to harm.
- A parent relies on the child to survive.
 - The child feels responsible for the parent and perceives themselves as the caregiver.
- A parent is abusive towards the child.
 - The child feels that they may be rejected, unwanted or abandoned by their primary caregiver.

The term "anxiety disorder" is very broad, however, and should not be generalised. There are a variety of causes of such a disorder, a traumatic event, which may not have anything to do with the caregiver. Each individual case should be considered when diagnosing the cause but a majority of the results indicated that a troubled household played a big part in the disorder. [17]

2.2 Attachment Therapy

To treat problems with attachment play therapy is usually suggested, even for adults. This can be harder to do as we often lose the ability to express ourselves through play as we grow up; we become more guarded and less able to express ourselves. The adult would play a variety of different games with their therapist. This would allow them, once they had gotten comfortable doing so, to express themselves either vocally or through the play.

Another common treatment is to allow the adult to relive their early loss, through their own imagination, to experience it for a second time. This would allow them to grieve for the neglect that they received as children and express the emotion that they may not have been able to at that time. Through this, the adult would gain closure as they learn to let go of the damage done to them in the past. They would also learn to form new bonds while doing so as their childhood attachments would no longer dictate whether they trust other people. [12]

2.3 Self-Attachment Theory

Self-attachment is a new psychotherapeutic technique to promote the adult undergoing therapy's ability to form meaningful bonds with other people. It builds upon attachment theory which, previously discussed, proposes that the root of adult mood and anxiety disorders stems from poor attachment during childhood. It is also self-administrative which lends itself very well to the virtual reality platform; the main goal of this project.

The distinguishing concept of self attachment theory is that the self of the adult undergoing therapy is conceptualised as two separate entities. These entities are the inner child and the adult self. The inner child represents the emotions that the adult feels when they are under duress or when threatened. These are emotions such as fear, anger and sadness. The adult self represents the more balanced emotions that the adult feels when they are calm and feel safe; emotions such as joy. The adult embodies the adult self and acts as a good primary care giver, as opposed to the care they may have received as children. This affection is internalised as the adult is giving care to themselves. This aims to stimulate the production of hormones which are usually produced when a child receives comfort so that the adult is able to function more like they had a good primary caregiver when they were children.

There are four stages to this therapeutic process:

1. Introduction
2. Conceptualization
3. Bonding
4. Reparenting

The introduction stage aims to educate the adult undergoing therapy what attachment theory entails and the underlying scientific principles which drive it. They are also made aware of what exactly they need to do as part of the process and that it will require dedication.

The conceptualization stage requires the adult to begin separating the two identities. They will need to visualise the inner child concretely as distinct from the adult self for the therapy to work. Once this has been complete, the adult self can begin interacting with the child self. The adult self would show the child self compassion and care when in distress and the adult should begin empathising with the child. One exercise used to help with the connection is for the adult to watch good parents, in their life, interact with children. They are then asked to memorise those actions and recall them when interacting with their own inner child. This is, as with any of the exercises, repeated many times to cement their understanding and also to make this a routine.

Another technique is thus. The adult is told to choose two photographs from his childhood, one representing happy memories and one representing sad or distressing memories. They are then told to visualize the child in the photos as a real child that they can hold and touch. The photographs are to enhance the memories of their childhood.

In addition to this, the adult is told to focus the negative emotions onto the inner child which they are visualising. This is to separate the inner child and adult self more and also to allow the adult to console the child. They are then told to console the child loudly to enhance the feeling of consolation.

The bonding stage is an extension to the second stage as it requires the adult to adopt the child and love the child as their own. The two stages are very similar in this regard. The adult must make a vow to consistently support the child as not doing so would lead to disorganised attachment, as mentioned in the previous subsection. This vow would be spoken loudly and without doubt or hesitation as it needs to be able to convince the child that the adult is telling the truth. The adult also uses techniques such as self massaging and simulation of an embrace to strengthen the bond between them and the child and make it more real. They can also participate in song and dance with the inner child which promotes a positive bond with the child. Louis Armstrong's "What a wonderful world" is a good example of this.

The reparenting stage is to allow the adult self to function as a good parent who interacts with a child who has become more and more secure in their attachment. One example of a method used to achieve this is as follows. All of these exercises are performed with the eyes closed to as to enhance the experience. The adult self pictures a traumatic event in their childhood, with as much detail as possible, in which the inner child self is placed. The adult then imagines a more positive outcome due to the intervention of their adult self who removes the negative emotions attached to the event by cuddling/embracing the child and vocally calming them.

Another method is to ask the adult to remember a traumatic event in the past and project the feelings onto the child. The adult will then comfort the child and reassure it. They will get angry with the abusers of the child, if any exist, and defend it loudly while also comforting the child [15].

A similar method is, instead of a past traumatic event, the adult will focus on negative emotions in relation to current family members, friends, etc. These are now the emotions which are projected onto the child and it is due to these emotions the adult will console the child. They would also simulate a cuddle with the child by massaging their own face [15].

The song chosen by the adult is very important in their therapy. As part of the exercises that the fourth stage consists of, the adult will have to sing the song in a joyful way while picturing their inner child. This will ensure that the song is associated with the child so it is important to be happy when doing this. The adult is also told to stand in front of a mirror and imagine the reflection is of the inner child. People with anxiety tend to have rigidity in their body, so these exercises will help loosen them up. Imagining the inner child do this will eventually make the adult feel like the child can finally experience happy emotions. [15].

A method used to get over negative emotions is to stare at a picture of a gestalt vase. The black center (the vase) represents the negative emotions of the adult. As they progress through the therapy, they are asked to begin to focus on the faces looking at each other. These represent the faces of themselves and their inner child. The changing of the interpretation of the image represents the changing of perspective of the adult. These processes are repeated by the adult until it becomes

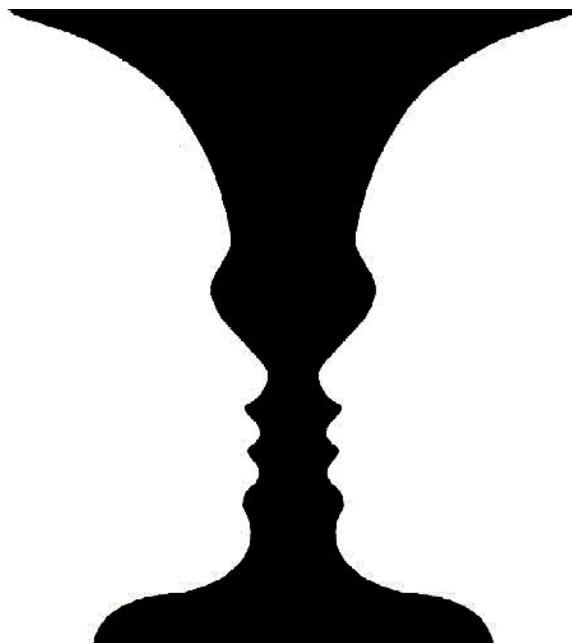


Figure 1: A Gestalt Vase. [15]

second nature for them to engage with their inner child and feel like their attachment needs are met. They are also able to perform these exercises with their eyes open this time.

Interacting with a therapist is a requirement for adults who have no experience of psychotherapy as they need to learn how to apply these techniques on themselves. Once they are taught, however, adults who are able to better visualise the inner child are able to perform these activities by themselves and self-administer the therapy needed. They also need to be able to perform these tasks regularly for them to take affect but if they are able to manage this, they do not require supervision. [13]

2.4 Existing use of VR in Therapy

VR

Virtual Reality is the term used to describe a three-dimensional, computer generated environment which is then explored by the user. The user is immersed in this world and can interact with virtual objects inside the world. A 3D model of a child can be created for the user to interact with instead of using their imagination to do so.



Figure 2: A user using the Oculus Rift. [11]

The Oculus Rift is a virtual reality headset that we will use in the project to create the world in which the therapy will take place. There are alternatives to the Oculus Rift which include the HTC Vive and Google Cardboard. It is one of the most powerful headsets which makes it ideal for us to work with. It also comes with touch controllers which map the movements of the user's hands into the virtual world.



Figure 3: The HTC Vive, an alternative to the Oculus rift. [16]



Figure 4: A Google Cardboard, a cheaper alternative to the Oulus rift. [32]

Therapies using VR

Cognitive behaviour therapy [10] is treatment which is administered by therapists to relieve people who are focused on very specific problems. For example, people who are afraid of flying and think about scenarios in which the plane crashes. This could lead to them avoiding air travel altogether. This form of therapy is similar to Exposure Therapy in that the person is slowly exposed to their fear until they can get used to them without reacting negatively. This can be achieved through VR as sometimes, as in the fear of flying example, being exposed is unfeasible due, partly, to the cost and to the waste of time. There is no gradual exposure in that case; the person either flies or doesn't. They cannot decide to stop flying because they are too scared. The use of VR allows for a finer control on the time spent exposing the patient. The height being flown or the number of people who are in the cabin with the patient, which are common causes of anxiety, could also be controlled.

VR techniques were used in Oxford to comfort people who suffered from anxiety [3]. The coping mechanisms they used included reducing eye contact, reducing the length of social interactions or avoiding them entirely. These mechanisms, however, only make matters worse as they reinforce the fears that the people maintain. Then they become routine to the point that they are perceived as helpful behaviours which would cause harm if not adhered to. The help offered by Professor Daniel Freeman's team is to help the afflicted relearn positive behaviours through the use of VR. The difficulty of the tasks would increase slowly until the situation would resemble real life situations.



Figure 5: Riding London's Victoria line. [31]

The image shows what the participants would see through the VR headset. They would be able to roam the train freely and see for themselves that the situation was harmless. They would be able to walk close to the people on the train and participate in long eye contact. They would stand closer than usual, almost standing toe to toe, with the simulated people. The participants who lowered their defenses and behaved thusly reported reductions in their paranoia. VR allows for the patient to have total control over the situation and be less afraid to do things they normally wouldn't do. They also react as they would in the real world due to their immersion in the simulation. Seeing that the reactions, though simulated, wouldn't be as harsh as they would normally expect them to be helped calm the participants. They reported less paranoia while out and about, going to the shops for instance. These reports were taken on the day of the VR testing, however, so the results cannot be used to predict the long-term affects.

PTSD is another condition being treated by VR. [8]. Soldiers returning from war might suffer from PTSD when they walk outside in a crowded street. It might trigger memories of past trauma and make it unbearable to participate in social situations, sometimes leading the person to be seized by fear. The University of Southern California is developing VR therapies to be used by soldiers suffering from PTSD so that they can be rehabilitated.

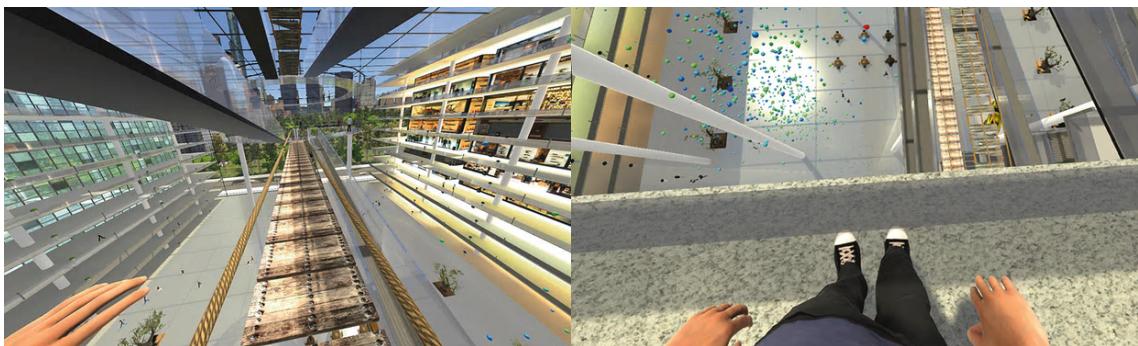


Figure 6: One of the simulations used by University of Southern California. [8]

The therapeutic technique used here is, again, exposure therapy. The soldier is slowly exposed to more and more stressful situations through VR to be able to overcome their fear.

Another ailment being treated is acrophobia, the fear of heights [1]. The user, in this case an army pilot, is told to put on the headset and walk out onto a walkway to save a cat on the branch of an indoor tree. The user is ten storeys high in the building and is able to see all the way down as shown in the images.

Initially, it is very challenging for them to walk across the walkway but through intense concentration they manage to do it. The reason is that they know they are in a room in Oxford and not actually that high. Since the environment is very controlled and not dangerous, they are able to get over their fear. The key point in these exposure therapies using VR is that the participant is given control over the situation, which they would not have in real life. If they feel that nothing unexpected will affect them, it reduces anxiety and will allow for more growth in the participant.



(a) High walkway.

(b) Long drop down.

Figure 7: Treating acrophobia. [10]

Another study in Barcelona [5] uses VR to allow the participants of the study to give advice to themselves. The theory behind this is that we tend to generally give ourselves very harsh and critical advice when we need it. This technique gives the participant the feeling that they are someone else (Sigmund Freud) and that they are giving advice to a patient and not themselves. They would be scanned and a VR model of them would be generated which would then be placed opposite Freud's desk. They would have to embody Freud which means that they would perceive their own body as Freud's body; they would see from his perspective and be looking at themselves. The movements are captured by motion capture and then translated into the virtual world by mapping the movements onto Freud's body.

- Phase One: The participant would enter the room and sit opposite Freud, the therapist in this situation, and talk to him about a problem they are dealing with.
- Phase Two: The participant would then embody Freud and listen to the problems that they had previously talked about, as if it was someone else who had done so. Freud, would then respond to the complaints as if talking to someone new.
- Phase Three: The participant would switch back into their own body and listen to the advice they had given, but through Freud. Their voice would be altered, making it lower pitched and slower to act like Freud's voice.

These phases would then be repeated for as many times as the participant wished.



Figure 8: Talking to Freud. The mirror next to Freud is used when the patient inhabits his body. Moving around and seeing a reflection of yourself (as Freud) makes it easier to imagine that you are someone else. [5]

This study highlights what is needed for the participant to believe that they are someone else. The mirror is a key component in this as it is seeing their movements reflected which helps the embodiment.

A study from UCL and ICREA-University of Barcelona [9] shows how virtual reality therapy could help people with depression to be more compassionate towards themselves. Being self-critical makes matters worse when it comes to depression.



Figure 9: Comforting a crying child. [9]

Participants in this study would see a life sized version of themselves in the mirror which would move as they did. This adds to the sense of embodiment with the VR model representation. They would then see a virtual child who would be crying. The participant was told to console the child by talking and showing compassion. They then embodied the child and received compassion and consolation from themselves. This was repeated numerous times so that they could imagine, without the use of VR, to be more positive in their behaviour towards themselves.

All of these VR solutions require the repetition of the simulation to create a long-lasting impact. The user would need to be told the importance of repetition while using the VR simulation. The most common method to encourage embodiment is to see the model move in the mirror and that the movements match the user's movement. Looking into a mirror and seeing that the reflection is something else would be useful in Stage 4 of the therapy. Instead of a full body scan of the user, the reflection will be of the child model. It is also interesting to notice that the detail in the world is not paramount for the user to believe that they are somewhere else. The fact that everything they see is of the same quality is enough to convince them that, for example, a long drop is real.

3 Design

3.1 Platform

I am using Unity, a game engine which is cross-platform, to create the world in which the child will exist. It is a simple tool to use, is well supported and can be built to support almost 27 different platforms. There are many users who are active constantly and will provide support for any problem that may arise due to lack of knowledge about the game engine. It also means that learning how to work with Unity and C# will be made more manageable as there are multiple tutorials which can help with it.

It supports development in VR with just a button click and multiple supporting APIs are available so that there is no need build everything from scratch. The project can also be run from a window in the editor to see what it would look like on the Oculus without having to put the headset on. This allows for the observation of the behaviour of the objects while the project is running.

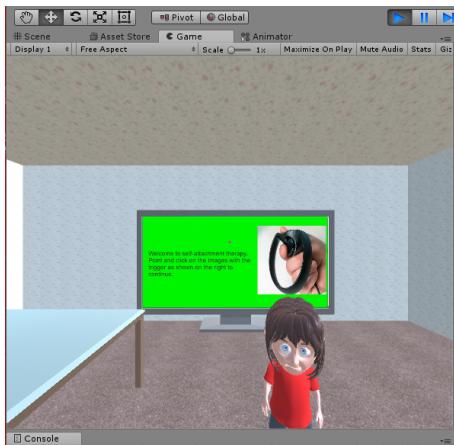


Figure 10: Game View allows the project to be run and viewed as if the headset is being used. [27]

It supports the Oculus Rift well, providing a number of APIs to help use the Oculus to its full potential. The touch controllers, which come with the Oculus, are also supported though they are new to market. In the virtual world, the hands will appear as blue and see-through but will be mapped to the movement of the hands which hold the touch controllers.



Figure 11: A Hand in VR. [34]

As can be seen in the image above, the touch controllers are sensitive to the location of the fingers. If the buttons are being touched, the virtual hands will reflect this. This allows for more complex hand shapes to be made and recognised.

3.2 3D Model of the Child

The child avatar inside the room is a model made in Blendr from Summer Jones' project "Immersive Self-Attachment Therapy through Personalised Avatar Generation". I will import the model and use it to represent the inner child.

The model comes with animations already and they will have to be used to create a satisfying way to interact with the child. The child will be able to look happy, sad, really sad and be able to dance. It will also have an idle animation which will look like it is standing still and breathing. There are two hairstyles to the child, one with long hair and one with short hair. These hairstyles are a substitute for the different genders of the child. This is so that the child can be more relatable to the user as the child will represent them. The gender will be chosen based on the user's preference.



(a) Boy Model



(b) Girl Model

Figure 12: The difference between the boy and the girl. [25] [24]

Though the child does not look photorealistic, when in full VR with the headset on, the child will seem more real as everything around the child will look similar. Since the user will be able to interact with and change the emotion of the child, it will help them think of the child as a real entity.

3.3 Layout

The objective of the world is to allow easy navigation of the different stages of self-attachment therapy. There would be a series of rooms connected together with corridors. Each room will represent a different stage of the therapy and would look visually different. This is to add to the immersion of the virtual world. The user

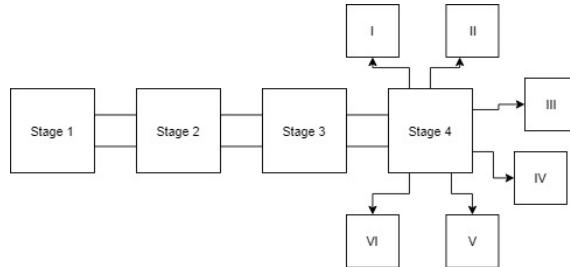


Figure 13: The initial design. [28]

would start in the room labeled "Stage 1" and follow the only path once they had finished with the exercises given in the room. This means that they would complete the stages strictly in order every time they attend a session. Once they reach "Stage 4", they would be able to choose the developmental exercises that they would like to work on. At this point, it would be up to the user to decide which exercise to complete because these are meant to strengthen their relationship with the child and can be completed in any order. The movement through these passages would be controlled by the user, who will use the touch controllers to do so. Moving the joystick on the left touch controller would move the user through the rooms. The child would follow them to each stage and react as the exercise required. This is so that the user will feel an attachment to the child who they will perceive as showing an interest in being in the company of the user.

Guiding the user in this fashion would ensure that they understand the therapy completely and be strong with the beginning stages first and foremost. These stages are the ones which build the foundation on which they can then build on to form a strong bond with the child. The physical traversal of the rooms would make the users feel as if they were occupying a real space.

3.4 User Interface

To navigate the stages, the user would use the joystick on the touch controller to move. The speed of the movement would generally be set to a gentle walking pace so as not to cause nausea and if they wished, they would be able to increase or decrease the speed depending on their preference.

To convey information to the user, a floating menu will be placed above the child's head so that the user would have easy access to it. It would exist in world space, which means that it will appear as a real object to the user. If the menu was to exist in screen space, it would mean that menu would be stuck to the user's viewpoint; it would take a fixed space on the screen and would always be visible where ever they looked. This menu would either have to be made transparent, which is distracting, or will need to block the view. This is not ideal as it would remove the user from the experience and may cause them to miss certain parts of the simulation.

The floating menu would also force the user to navigate the exercises while being in the vicinity of the child. More specifically, the user would have to stand in front of the child and face it to use the menu and progress through the exercises. This will reduce distraction and make sure that the child will not be lost, however small the chances of that happening are.

The Unity VR tutorial [2] suggests that, to interact with objects, I would need to ray-cast from between the eyes. This means that they would have to look at an object, in this case the menu, and click a button on the touch controller to trigger an event. A small circle will be placed in the center of the screen which will act as a target to make clear to the user what they are looking at. The menu item would also highlight to convey to the user that they are now able to select the option. This would be very simple for the user to understand and it would take very little time to start using the menu.

3.5 Stages

3.5.1 Stage 1: Introduction

The first stage of the therapy is to introduce the user to it and make sure that they understand everything before they move on to the other stages. For this, the menu will be used to explain all of the intricacies of the therapy. The explanation will have to be split up into smaller sections that the user can scroll through as one big chunk of text will not be easy to read. The user can sit while reading the explanation as no input is required from them. The first room will be dedicated to this stage and the user will have to begin from this room every time they start the therapy so that they will be able to read again what their goals are. This will help them get the most out of the experience since they will be very knowledgeable. The child will be present while the user is reading and it is at this stage that they can choose to change the gender of the child if they wished. This change in gender will stick throughout the whole session.

3.5.2 Stage 2: Conceptualization

The main goal of the second is to make sure that the user can separate their inner child from themselves and visualise this. The menu will inform the user that they would have to imagine a happy memory then to project the feelings onto the child. To help with their visualisation the child will begin to smile and look happy. Then the user will be asked to imagine a sad moment in their past and project those feelings onto the child. The child will then begin to look really sad. It is at this point that the user is asked to loudly and vocally comfort the child while hugging it. Once they hug the child, it will cease to be sad and begin to look happy again. This concludes the second stage and the user can move on to the next room.

3.5.3 Stage 3: Bonding

The main goal of this stage is to make sure that the user forms an emotional bond with the child. The menu will reiterate the need for this exercise as the repetition of it is key to forming a bond with the child. The user is told it will form neural pathways which are beneficial to healthy growth. The menu will then ask the user to sing and dance with the child. I have chosen to commence this dance via a gesture so that it seems more organic to dance with the child as opposed to pressing a button to do so. Once the dancing and singing has been completed, the user will get a chance to loudly proclaim to adopt the child, as promising to protect it increases their bond. Once the user has done this, the child will begin smiling to indicate that the action has pleased the child. The user can then move on to the next room.

3.5.4 Stage 4: Reparenting

This stage will have a variety of exercises which will help with bonding with the child.

- Room I will lead to an exercise which will ask the user to think of a traumatic event from the past and to project those feelings onto the child. The child would become sad as the user imagines and projects the feelings. The user will then comfort the child loudly and hug it to make it happier. The lighting

in the room will be dim so that it feels more contemplative and the user is encouraged to relax and think deeply about their past.

- Room II will be identical to Room I but the user will be asked to picture negative feelings that they are feeling at the moment. The same interaction with the child will then occur. The lighting in the room will be dim so that it feels more contemplative and the user is encouraged to relax and think deeply about their past as before.
- Room III will be to help the user loosen their body and mind. They are asked to stand in front of a mirror where the reflection is their inner child. They will then be asked to perform certain movements and massages to their face and body to loosen them up. They are also asked to sing a love song that they have chosen, there and in their regular lives.
- Room IV will contain an image of a Gestalt Vase. They will be asked to look at the image intently, with the black vase representing negative emotions and the white faces representing positive emotions and the faces of themselves and their inner child. This exercise will help them realise that they are not thinking negative thoughts anymore and are, in fact, forming a deep loving bond with their child selves.
- There will be a menu item for the users to be able to take a PHQ-9 test here. The PHQ-9 test is a questionnaire which will determine the level of depression that the user is experiencing. This will allow them to see the progress that they are making as they continue the therapy [4]. The score will be counted and revealed to the user. The child will not be present in this section as this is an evaluation of the effectiveness of therapy. This will occur when the user has finished their session.

4 Implementation

Before beginning to implement any of the designs, it is first vital to understand the Unity game engine. To do this, it is necessary to complete a few tutorials to get used to the layout of the tools and what each window offers to the designer [7]. The tutorials are extensive, engaging but also challenging as the amount of information given can be overwhelming at times. It takes consistent practice to achieve fluency with the game engine.

Unity offers designers a set of tools to help them achieve their goals. To begin with, Unity opens up a default Scene with a camera and a directional light. The camera is the viewpoint of the user and the directional light illuminates everything uniformly. There are other light sources to choose from such as a point light source. These will mimic light sources in the real world, like a light bulb for example. A selection of objects are provided which can be used by designers to create more complex structures. To allow for interaction with these objects, C# scripts need to be attached to them which contain instructions, allowing them to react to events.

To work in VR, the camera needs to be changed to an OVR Camera Rig so that the movement of the Oculus headset can be translated into camera movement. OVR is a utilities package which is provided by Oculus and is available to download, providing an assortment of tools for VR development [14]. To integrate touch controllers, the OVRAvatar package provides a Local Avatar object which represent the hands of the user.

4.1 Building the world

Unity's GameObject menu was used to create the rooms. Cubes, which were reshaped, formed the walls and a plane formed the floor. The corridors were created in a similar fashion. Though the process seemed simple, it was time consuming to position every piece separately. Even when textures were attached to the walls to add a flowery wallpaper, there was a feeling of claustrophobia. The solution to this was to model a window so that the user could look outside. However, creating windows proved to be slightly challenging as Unity does not provide a way to cut holes into objects. This meant that the windows had to be modeled by creating oddly shaped panels which would form a hole when slotted together. These panels could not overlap because, when the project was run, a shimmering effect was created as both shapes occupy the same space. This was fixed by crafting the shapes precisely so that they fit together snugly.

The default background for a scene in Unity is a dull grey which did not help with the claustrophobic element. A Skybox, which is a large sphere that acts as the sky, was downloaded for free from the Unity Asset Store [6] to simulate a bright and sunny day. Though the user cannot step outside of the room and there is actually nothing outside, looking out of the window feels like looking out into vast open space.

Once the basic structure of the rooms was complete, a quick survey on how the world traversal felt revealed that the movement of the player (which is the camera), though slow, was disorientating. The participants did not like that when they were moving through the rooms, they were not walking. The camera motion while they



(a) Before Skybox [23]

(b) After Skybox [20]

stood still was uncomfortable. Even if it did not disorientate people, the speed at which they had to move to feel comfortable doing so was slow enough to be a hindrance. The solution to this was to remove the option entirely. There would only be one room in which all the exercises would take place and the only movement which was translated into the virtual space was the actual movement of the user. This removed the need for a large house-like structure so the final layout of the world became a single room with off-shoots for more specific exercises. In end, it only became a necessity for the exercises of Stage 4 to need the extra rooms. This is shown in the diagram below.

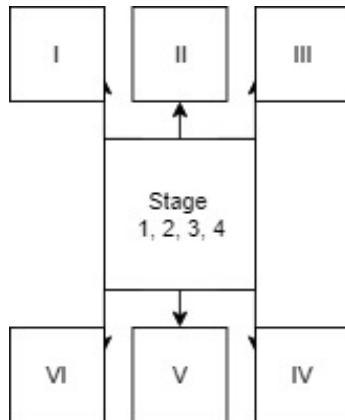


Figure 14: The final layout of the virtual world. [26]

Having a single room be the whole world was achieved by creating a multitude of scenes which all share the same room model. A scene is a snapshot of the virtual world in which objects exist. Different scenes can have different objects and can be traversed between. In this instance, all the scenes have the same room and child objects so changing scene does not feel like anything has happened. The difference would be that the tasks which can be performed and the instructions given will have changed.

To make the room more relaxing, it was modeled as a living room which contains a sofa and a TV and other assortments of objects. This helps immerse the user into the world.

Since the user cannot move using the joystick, they will have a small area in which they can walk around. This will translate into the virtual world so that they do not feel like they are completely rigid but they will not be able to move too far.

This will improve their focus as there will be nothing else to distract them. The image below shows an early iteration of the single room.

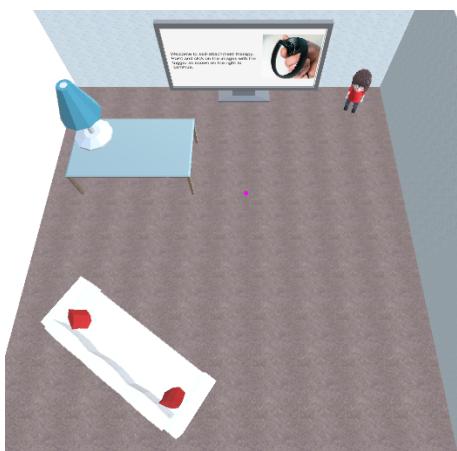


Figure 15: An early iteration of the room. [30]

4.2 Animation

The child only comes with one single animation attached to it. This animation cycles through all the actions capable for the child: idle, dancing and looking sad, shock and happy. This animation needs to be broken down into their separate components in order for them to be useful. Unity provides an animation window for this purpose. Once the child's animation window is open, the individual animations need to be isolated by selecting their starting and ending times using the slider (seen in image below). It is important to note that the starting frame and ending frame of the animation should be identical or it will look jerky. This is done by hand and requires good judgment from the designer.

Once the animations are separated, they are added into a state machine which controls how they behave in relation to each other. The entry node is used to transition into the state machine and will lead to the animation that is set as default. This is the idle animation which will play on loop as soon as a scene loads so that the child looks like it is living and breathing. The animation can then only transition happy and sad which then transition respectively into dance and shock. These restrictions were applied to aid the exercises conducted in Stage III (4.4.3) and Stage IV (4.4.4).

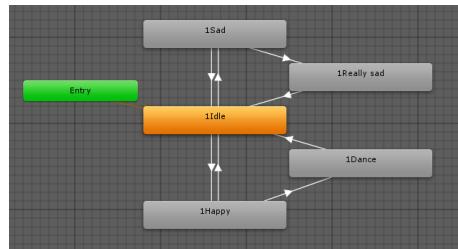


Figure 16: The State Machine. [21]

All the animations can transition back to idle as sometimes it is required for child to return to normal without dancing or expressing shock. The time it takes to fully transition from one animation to the other is controlled from the transition menu. This is also to reduce the jerkiness of the animation to make a more believable child model.

4.3 Interacting with the Child

The interactions with the child proved to be one of the most challenging aspects of this project. Touching an object that is not real is impossible to simulate and so an amount of suspension of disbelief is needed from the user to make this work.

4.3.1 Hugging

The physical interactions need to be organic but because the user cannot receive any response from touch, they will need to be informed that an interaction has occurred. The main physical interaction with the child is hugging. The user needs to hug the child to comfort them and see that their hugging has caused a change in the child's demeanor. For a hug to happen, the user must wrap their arms around the child as if they are holding them. Since there are no arms simulated, the hands will need to be placed on the child to simulate this. So that the child can detect when the hands are placed on it, there needs to be a collision detector attached to the child. A collision detector will cause an action when another object, acting as a trigger, collides with the area specified. In this case, the hands are the triggers, with their own cages. As seen in the image, the hands must interfere with the green cage depicted to trigger the hug animation. The child will extend its arms and close its eyes, which will tell the user that a hug has occurred. The happy animation will play next so that the user can see a change in the child's demeanor.

4.3.2 Swipe Gesture

The first gesture that needed to be recognised is the swipe to change the hairstyle of the child. The swipe first needs to be defined before any code is written. This is as follows.

- The speed of the motion must be higher than that of regular hand movement.
- The movement must be horizontal.
- The distance traveled must be greater than a chosen length (30cm).

The speed of the hand was chosen so as not to accidentally swipe. After a lot of trial and error experimentation, the speed of 0.3 m/s was chosen. Slow hand movements that would occur if the user was turning around did not count as a swipe.

The horizontal movement restriction was placed so as not to count hand movements that contained any vertical or forward motion such as when the hand moves from the hip to the center of the chest. This motion can occur when the user is transitioning from a relaxed position to making a selection from the menu. The hand would move up, forward and to the left.

The swipes have been split into two categories, a swipe to the left and a swipe to the right. The left swipe changes the hairstyle from short to long and the right swipe changes it from long to short. This is so that it does not seem random that the hairstyle changes whenever the user swipes. The swipe is deliberate and for only one action.

The chosen length gives the user enough distance to move the hand fast enough to match the required speed. It also makes sure that the movement is deliberate so that accidental movements are not recognised. It is also not too long so as to inconvenience the user when they are performing this action.

The inputs that I have to work with are the position and velocity of the controller. The update function will be useful for this as it is called frequently and can be used to record the changes in the controllers' behaviours. The swipe is only allowed to occur with the right hand controller as of now, future iterations of the project would include an option to choose a left handed option. As soon as the x component of the velocity reaches 0.3 m/s, the position of the controller is noted. If the y or z component of the velocity increases above 0.05 m/s it is assumed that the motion is not strictly horizontal and the function is aborted. If this is not the case, the position of the controller is noted as soon as the speed drops below 0.3 m/s. The distance between the two marked positions of the controller should be 30 cm. If the distance is positive, the swipe has been made to the right and left otherwise. At this point, the long hair of the child is toggled on or off. Since the long hair covers the short hair and blocks it from view, only the long hair has to be interacted with.

4.3.3 Dance Gesture

Implementing the dance gesture was a little more challenging. Deciding upon the universal gesture for a dance was difficult but, since the child's dance is simple, the dancing gesture should follow suit. The requirement for the dance gesture is as follows.

- One hand must have a positive vertical velocity while the other has a negative one.
- The distance between the highest point and the lowest point of the hand movement must be 60 cm.
- There should be no horizontal movement.

The hands moving opposite to each other means that there is not strict requirement that any hand should move up first which makes the dance move seem more organic. The child moves its hands side to side but the vertical movement of the hands was to make the dance more energetic. It would allow the user to loosen up a bit.

The distance the hands have to move are also for this very reason. This motion requires the user to move their arms instead of just at the elbows to make for a more energetic dance move.

This time there is no restriction on the forward movement of the hands as pivoting the arm naturally forces the hand to move slightly forward and back. Restricting this movement would have made for an uncomfortable dance. The speed which triggers this dance, once again, is 0.3 m/s but this time both hands are considered. However, one hand must have positive y velocity and the other must have negative y velocity with a small error margin of 0.05 m/s in the x direction. The full dance move concludes when both hands have stopped twice; once at the highest point and

once at the lowest. The distance is measured and is required to be above 60 cm for the child's dancing animation to trigger. The child will dance as long as the user does and will transition into the happy animation once done, to show the user that the child had responded positively.

4.4 User Interface

For the initial implementation of interaction in VR, raycasting was used. To do this, a line is drawn outwards from the eyes and if that line is blocked by any object, the object recognises that it is being looked at. Then, the user can trigger an event associated with that object by pressing a button on the touch controller [2].

This method was used for the user to interact with the menu, which has been implemented in Unity as a series of buttons which display text. A button in Unity is an object which triggers an event if interacted with. If the user looks at the text on the button, a blue circle (GazePointer) will appear to confirm that the button is ready to be pressed. If this part of the menu is an explanation, the button with the text will disappear to be replaced by the next instruction. If another event is to be triggered, it is triggered.

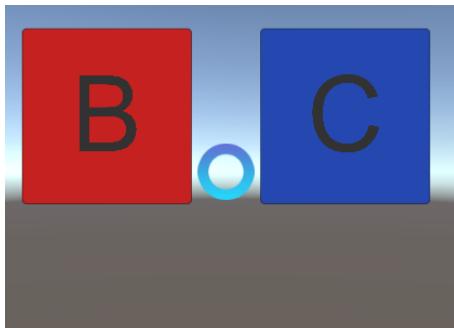


Figure 17: An example GazePointer. [18]

The clicking is detected by an EventSystem which needs to be told which button on the touch controller corresponds to a trigger. To detect the trigger, the menu needs to be a Canvas object which contains the OVR Raycaster script. This can be found in the Unity Asset Store [6]. The script will calculate the details of the raycasting and allow the menu to recognise when it is being looked at.

While testing the efficiency of this method of interaction, a problem arose. The user would be looking at the menu when they triggered an action. The menu would need to contain enough text to explain the significance of the action so the user would be more focused on the text. The child would usually not be visible while the text was being read as a result of this. Since the child cannot be seen, the user would have to move their head towards the child every time an action was triggered. This inconvenienced the users substantially and needed to be altered.

The solution was to transfer the raycasting from the center of the eyes to one of the hands. This was challenging because Unity does not provide a simple solution to this problem, the OVR Raycaster script is not designed to work on the hand as it is a personalised script. A new script was attached to the hand with a new EventSystem added to the scene to recognise the new origin of raycasting. The

ray was invisible, however and the user would not be able to see where they were pointing. The solution this was tricky to reach. To begin with, a long beam/pointing stick like object as attached to the hand. This worked as long as the user kept their hand up and point horizontally but when hanging the hand down by their side, the beam/stick would sink through the floor. The stick could not be made rigid as it was always attached to the hand. Even if the could exist as a physical object in the world, it would be inconvenient to pick it up and put it down every time the menu needed to be interacted with. The solution then was to use a GazePointer-like object

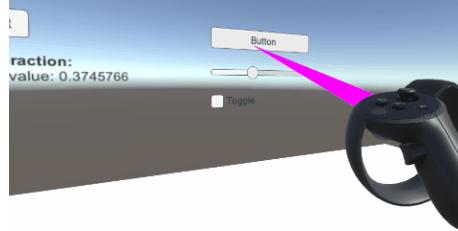


Figure 18: The beam extending from the controller. [33]

from the first design so that it would only appear when it encountered an object which could be interacted with. A sphere object was flattened to make a small disk and placed a certain distance away from the hand. This method is almost like using the beam/stick but only the end of the stick is visible.

Since the menu contained a lot of explanation text, it was not viable for it to remain floating above the child. The solution to keeping the menu floating would be to split up the text into smaller chunks and have the user scroll through but this was time consuming and annoying to do. The participant would read the text quickly and would need to click too often. Since the user would not be moving around the house at all, the menu should exist in a single fixed point in the world. Using the TV seemed a more organic way to receive information and to control the environment. It also fit with the living room theme that the world had now taken. It was then simple to resize the menu and have it fit inside the TV screen so that all the interaction would happen almost as if the user were changing channels. The navigation through the stages has now changed drastically. When timing the

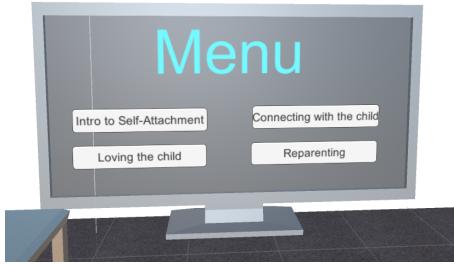


Figure 19: The TV as a central hub. [29]

traversal through the whole therapy, it took a long time to get to the later stages. Forcing the user to stick to the rigid path-like structure seemed an inconvenience at this point as, though repetition is recommended, the user would not enjoy being forced to do so. The menu was then changed to include a main page from which

the user could navigate to every other stage. If a stage contained a sub-stage, they would not be able to access it from the main menu as the integrity of the stage needed to be kept. Each exercise within a stage must be performed in the order specified but the stages can be done in any order. If the user wishes to exit the stage at any point, there is a button on the table next to the TV which can transport them back to the main menu, which is the central hub. This gives the user more control and personalises their experience.

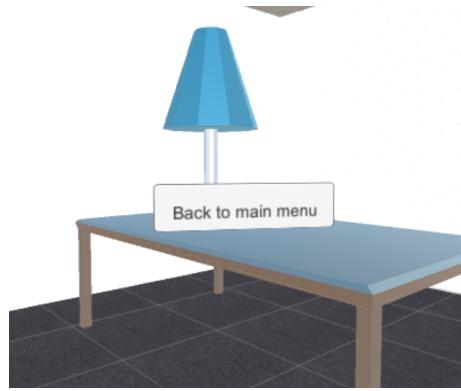


Figure 20: User can go back to the main menu at any time. [22]

4.5 Stages

During all these stages (excluding the exercises described in stage 4), the room will remain the same in appearance. The only thing that will change is what the menu describes.

4.5.1 Stage 1: Introduction

This stage requires a lot of information to be conveyed to the user so it is split up into chapters. The user clicks on the image to reveal the next panel of information. The child is present during this as it is important for the user to get used to the appearance which can take a little time.

4.5.2 Stage 2: Conceptualization

The user must begin to think of the child as a separate entity. This will be achieved by having the user hug the child while the sad animation plays. The hug will result in the happy animation playing, which will be a response to the user.

4.5.3 Stage 3: Bonding

This stage requires the user to sing and dance with the child. The reasoning behind this will be conveyed to the user through the menu and then they will get a chance to sing and dance with the child. They are able to use the dancing gesture at this stage and the instructions for this dance will be conveyed to them.

There is also an option for the user to vow to adopt the child. The user will now be moved closer to the child and are able to face it. They will then repeat the vow to the child. Once this has finished, the happy animation will be played to convey to the user that the child is pleased with this. These choices are all provided by the menu in the TV.

4.5.4 Stage 4: Reparenting

This room will act as a hub, connecting the user to the exercises that they wish to complete. To process their past and current negative emotions, the technique is the same. The user is told to imagine these feelings and project them onto the child. The child will begin to look sad. When the user is being told to comfort and console the child, it will begin to look shocked. When the user hugs the child, the animation will transition back to the happy animation to convey to the user that their consolation has been effective.

The room with the Gestalt Vase will not require the presence of the child as it is mainly for quiet contemplation. The user will be able to view a large version of the vase which will fill their view to exaggerate the psychological effects of the vase. The menu on the table which used to return them to the main menu will now return them to the stage 4 hub. The room will also look different, to break away from the monotony if the user looks around.

The final room contains a mirror from the asset store [6]. The child is standing in front of in the same position as the camera so the user can believe that their reflection is the child. The fact that the camera is a lot lower to the ground will be

disorientating at first but it will be easy to get used to. The user will then be asked to move their body and sing out loud while doing so. This is all done through the menu, which will not exist next to the mirror so as not to distract from the exercise.

There will be an option for the user to fill out a PHQ-9 questionnaire in the stage 4 room. This is achieved by creating multiple panels which will disappear when clicked on, acting as if the user is scrolling through a menu. The user will be able to take the quiz, which is shown on the next page, and be given a score at the end of it. The score will be out of 27 and there are five intensities of depression that this questionnaire predicts: 0-4 none, 5-9 mild, 10-14 moderate, 15-19 moderately severe, 20-27 severe. [4]

| | | |
|---|--|---|
| <p>Little interest or pleasure in doing things?</p> | <p>Feeling down, depressed, or hopeless?</p> | <p>Trouble falling or staying asleep, or sleeping too much?</p> |
| <p>Not at all Several days More than half the days Nearly every day</p> | <p>Not at all Several days More than half the days Nearly every day</p> | <p>Not at all Several days More than half the days Nearly every day</p> |
| <p>Feeling tired or having little energy?</p> | <p>Poor appetite or overeating?</p> | <p>Feeling bad about yourself - or that you are a failure or have let yourself or your family down?</p> |
| <p>Not at all Several days More than half the days Nearly every day</p> | <p>Not at all Several days More than half the days Nearly every day</p> | <p>Not at all Several days More than half the days Nearly every day</p> |
| <p>Trouble concentrating on things, such as reading the newspaper or watching television?</p> | <p>Moving or speaking so slowly that other people could have noticed? Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual?</p> | <p>Thoughts that you would be better off dead, or of hurting yourself in some way?</p> |
| <p>Not at all Several days More than half the days Nearly every day</p> | <p>Not at all Several days More than half the days Nearly every day</p> | <p>Not at all Several days More than half the days Nearly every day</p> |

5 Project Evaluation

Since the project is to build a product for other people to use, it stands to reason that the evaluation of the project is subjective. During the development of the project, at multiple points, peers and colleagues were asked to review the state of the project. They were asked to consider a few aspects:

- The quality of the VR world and exercises.
- Organic interactions with the 3D child model.
- Intuitive UI.

The responses to the rest of the talking points were all more or less very similar. The quality of the world was mediocre, with users stating that though the objects inside the virtual world were of comparable quality, it was very apparent that the quality did not come close to that of the real world. It would take a while to get used to the virtual world. It does reduce the effort needed to conceptualise the world in the mind but it is not yet effortless. The exercises were all straightforward and easy to complete, however, which is a success.

The fact that no physical contact was made when hugging the child was mentioned often. This is understandable as, to hug the child, the user would have to bend down and put their hands around an object they could not touch. A solution to this could be to place an object, such as a pillow, in the same position as the child. The swiping and dancing, however, were met positively with users saying that they actions were intuitive to perform. It was surprising to hear that the dancing was easy and intuitive to do as I had not considered the motion a valid dance move.

The UI seemed to be a highlight as the users said it was easy to follow. The selection of the menu items being pointing and clicking was intuitive and the users could begin to do this from the get go.

The effectiveness of the therapy in VR compared to regular therapy is something that cannot be measured by the people who participated in the tests as none of them were suffering from anxiety or depression at the time. It was not feasible to test the simulation on actual patients so it is not possible to know if the VR helped in that sense.

5.1 Final Thoughts

To conclude, I want to say that the project has gone well. The objectives which I set out with have been met and the VR simulation works well. Working with Unity has improved my proficiency with it, in general not just in VR.

I do not think, however, that this is a replacement for self-attachment therapy which requires the patient to picture everything in their head. They would still need to use a lot of imagination to see the child as their past self but the way the simulation guides them through the process is simple, yet effective. In my opinion, I do think that patients would benefit from the use of this project but not as substantially as intended. A few suggestions for improvement have been presented on the next page.

6 Future Work

3D World

In retrospect, one of the biggest challenges of this project was making the VR world seem real. Even though the world was immersive, it was very apparent that it was, in fact, a simulation. Spending more time on the models would mean that their quality could be improved massively. Filling the rooms with items which can be interacted with would also improve the immersion. This would mean that the objects in the virtual world would behave the same way as they would in the real world.

Giving the user the opportunity to customise the world is another addition to the project. They would be able to upload pictures which they may have hung up in their homes as children or they could play the song that they have chosen through the VR simulation.

3D Child Model

A key piece of information gained from conducting tests with a variety of people was that the child seemed almost robotic. While actions were being performed, the child seemed realistic but the idle animation of the child standing still was unnerving to the participants. The child would remain in the same place without moving and constantly looking at the participant. A solution to this problem is to add more animations to the child. A running animation would make the child seem more energetic and full of life and if the child were able to interact with objects, they could be made to play with toys. More dancing animations would give the user more choice when interacting with the child as they would not always perform the same motion over and over again. To achieve an organic experience with the child, there would need to be a vast number of animations which would allow the child to react to any given situation. Since the point of this project was to make it easier for the user to imagine themselves as children, being able to see the child as alive would be a big step towards achieving this.

The other step which needs to be taken is for the user to believe that the child model is their inner child. This means that the child would have to look like what the user would have looked like when they were children. The child currently can only have two different hairstyles but, in the future, it would improve the immersion if the child could be customised more. The child would have a few different hairstyles, hair colour and a variety of clothing options. The user would be able to choose the combination which would closely resemble them and would have to work a lot less to see the model as their inner child.

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