Exploring the Potential of Virtual Reality Sensory Rooms*

Katie Potts[1], Mohammed Bahja[2] and Phillip Smith[3]

[1]University of Birmingham, Edgbaston, Birmingham, B15 2TT, United Kingdom
[2]University of Birmingham, Edgbaston, Birmingham, B15 2TT, United Kingdom
[3]University of Birmingham, Edgbaston, Birmingham, B15 2TT, United Kingdom

Abstract

There is currently an increased amount of interest in the potential uses of virtual reality outside of gaming, including in therapeutic contexts. This demo paper explores a virtual reality program designed to emulate a sensory room, helping with sensory issues common in people with autism among other disabilities. It discusses the development process, program inclusions, and the program's research applications.

Keywords

Virtual Reality, Sensory Processing, Virtual Therapy, Autism, Virtual Reality Therapy, Program Design

1. Introduction

One of the growing fields in human computer interaction and psychology is considering how virtual reality can be used to aid in therapy. While there have been a variety of therapeutic methods explored, one of the less well explored is the use of sensory rooms and how that may benefit those with a variety of mental health conditions, including autism. Therefore this paper explores how we can approach the design of a program built for this purpose and also explores its potential future uses.

2. Literature Review

The majority of virtual reality (VR) research for autism has been into the use of virtual reality to make skills based games, such as the work of Lamash et al. [1] and Ward and Esposito [2]. However far less research has been done into its use to help with symptoms of autism that affect the person, and as such the program discussed in this work is designed to fill the gap in that research. The major work in this area is the work by Mills et al. looking at the evaluation [3], the perception [4] and the effectiveness [5] of virtual reality sensory rooms for multiple

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*You can use this document as the template for preparing your publication. We recommend using the latest version of the ceurart style.
*Corresponding author.
†These authors contributed equally.
kmp672@student.bham.ac.uk (K. Potts); m.bahja@bham.ac.uk (M. Bahja); p.smith@bham.ac.uk (P. Smith)
0000-0002-0168-6273 (K. Potts)

disabilities, including autism. However, due to the lack of research that focuses on autistic people, it was decided to explore the design of a VR sensory room separate to this that could be iterated on for the purposes of aiding people with autism specifically.

The understanding of Dunn's Model used to justify the creation of this program is as described by Dunn [6]. This is a model that says there are two axes on which sensory processing can be measured; the neurological threshold and the behavioural response. The neurological threshold is measured from active to passive and describes whether the person actively engages with sensory input or passively handles it. The behavioural response is measured between a high and a low threshold, and this threshold denotes the amount of sensory input that the person is comfortable and happy with. Development of the program was focused on those classified as sensory seeking in this model, which means they have an active behavioural response and a high behavioural threshold. While it's known that sensory rooms don't only benefit people in the sensory seeking range [7], it was decided that the focus would be on developing a room for people with these needs, as this was determined to be the most ethical group to start with. This is because those with a low threshold for sensory input are more likely to have a negative reaction to the large amount of sensory input that VR can provide, not only with the program itself but with the risk that the headset could be overwhelming due to the tactile stimulus of wearing it.

3. Justification of Development

The concept behind the program was based on the fact that having abnormal sensory thresholds is a common symptom of autism [8], and that by using sensory rooms it could reduce anxiety in the user to enable everyday activities like socialising. The belief is that by ensuring that the sensory needs of the user can be met, they can feel more comfortable and reduce their state anxiety, thus putting them in a position where they feel comfortable going out to events that they would otherwise be too anxious to attend. In this context, state anxiety is as defined by Endler and Kocovski [9], where they discuss that state anxiety is a combination of the trait anxiety of the user (the average amount of anxiety a user feels) and the environment.

Given the above, the main design considerations when creating the room are to make it so that it provides sufficient sensory stimulation for someone who has sensory-seeking behaviours while requiring minimal space and minimal amounts of equipment beyond the virtual reality headset so as not to burden the user.

4. The Program

This program was built using the Unity game development engine for use on Quest and Quest 2 devices. It uses the QuickVR library to handle user interaction with objects and realistic movement of the model, which builds on the OpenXR library. The main choice behind the use of controllers is because the QuickVR library currently does not have documentation on the use of hand tracking, and there were incompatibilities with the most common hand tracking software.

The program uses joysticks for movement – the right joystick for camera and model location and the left joystick for camera rotation. This choice was preferred over teleportation due to the need for precise user positioning. In addition to joystick inputs, the program enables real-life movement for a more immersive experience. This option was not the exclusive method to accommodate smaller play spaces, as one of the considerations when making this program was that it would have a target audience of people that wouldn't have the space for a sensory room, and as such it makes little sense for the program to require just as much space as a sensory room does.

After the user presses the button to begin using the program, they are put in the sensory room where they can move around freely and can spend as much time as they wish interacting with any item in the room. There are a number of elements within the room that the user can interact with freely. The bubble tubes provide a relaxing visual stimulus. The video floor, featuring swimming fish, and video wall, showing 'lava' bubbles moving up and down in turn offering passive visual engagement. The bubble floor encourages active movement and meets vestibular needs, as the user has to travel around the mat to 'pop' the bubbles when they move to a different random position on the mat.

The wall lights reward interaction, with one set changing colour when interacted with and the light-up pattern wall lights having three modes: scatter, row, and column. These modes change in which order the lights change colour when interacted with, either fanning out in a circular fashion from the one interacted with, or starting with the row or column respectively of the block interacted with and fanning out. The mode can be changed by interacting with a block to the side, encouraging the exploration of the environment.

The cushion corner offers a space to take a break where the cushions can be moved to suit the user. This not only is good for a change in visual stimulus, but is good for helping deal with the concerns surrounding overstimulation, as it means there is a space in the program that is designed with minimum visual stimulus, so the user can retreat to a space without as much visual stimulation even in the case where they don't want to or don't feel capable of removing the headset.

A variety of balls and cubes provide visual and tactile stimuli as they can be picked up and moved at will. The majority of these are just patterned balls, however the cubes have changing colours for a larger amount of visual stimulus and one contains moving balls within the ball in order to have a varied stimulus when interacting with it. Ropes hanging from the ceiling and bubbles offer proprioceptive input. The music adds auditory stimulus and can be stopped via the stereo for user preference in case the user only wants visual and not auditory stimulus.

The choice of items to include in the sensory room was chosen via analysis of what is commonly seen in sensory rooms, by looking at the most well known providers of sensory room equipment and analysing which of the items available from their stores would be best for a virtual environment, after considering ease of implementation and how similarly they could operate in a virtual environment compared to real world use.

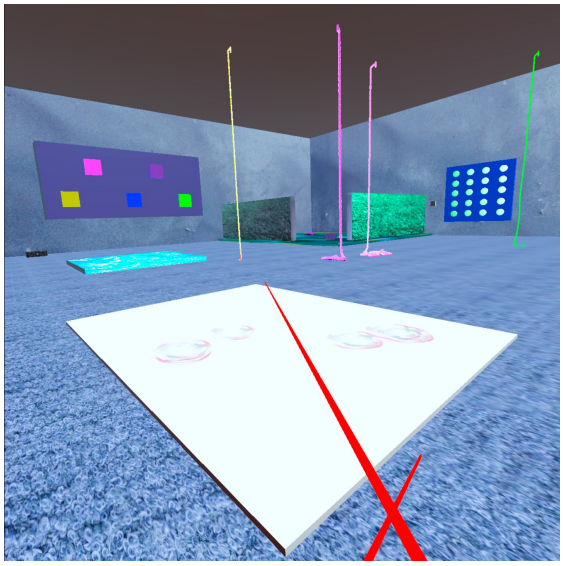

Figure 1: A picture of the majority of the room, showcasing the corner containing cushions, a couple of the interactive walls, the interactive floor mat and the ropes

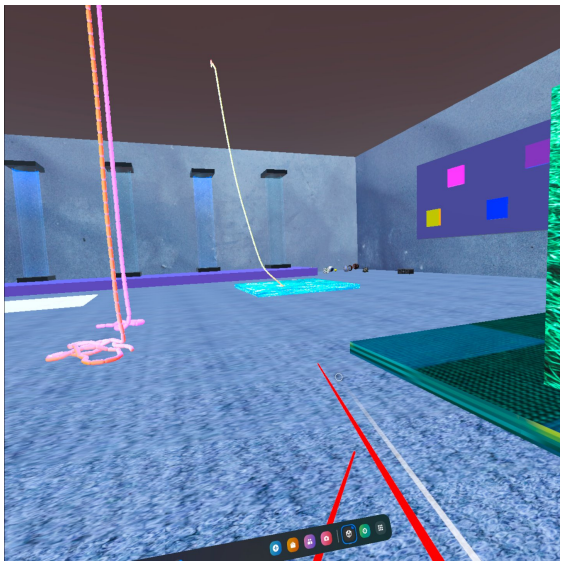

Figure 2: A picture of the room from another angle, showing the ropes, one of the interactive walls, a visual floor mat and multiple bubble tubes

5. Potential Benefits And Future Work

The research that will be conducted within this framework aims to explore the hypothesis that virtual reality can create more accessible, and as such beneficial, sensory rooms, by reducing the limitations to access sensory rooms by using a device that is cheaper than commercial sensory rooms and requires less dedicated space for use than a sensory room takes up. By

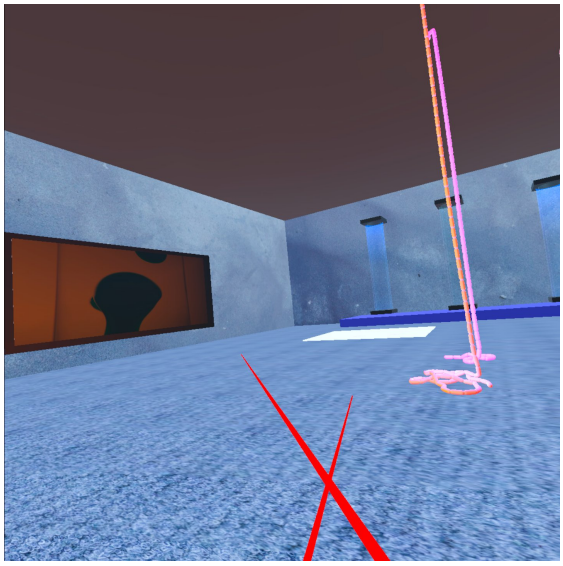

Figure 3: Another picture of the room that shows off more of the ropes, the visual wall, the interactive floor and some of the bubble tubes

linking human-computer interaction with psychology in this way, the goal is to expand the understanding of how sensory therapy can be applied to virtual reality. To start with, this prototype will be developed further by interviewing autistic people and people who self-identify as having autism, and using the information from discussing virtual reality with them to apply to the next iteration of the program. There is also work to be done to test whether hand tracking would work well with this sort of program.

Once the prototype is finalised, the plan is to then proceed to in-person experiments using the program to examine its effectiveness in reducing anxiety in autistic adults with sensory-seeking inclinations. There are two levels of pre and post testing planned. The first stage will be to test the short-term effectiveness of the program with regards to its ability to cause a reduction in state anxiety. This will test its use as a tool for when the user has a heightened state of anxiety and desires a way to lower it. The second stage will be to test its usage in the long term, as a tool to reduce state anxiety. The theory behind this is that if the user is frequently in a space that meets their sensory needs, that will cause them to be less anxious on a longer-term scale as they have another digital location that they feel safe in, thus increasing their general feelings of safety.

If it is proven to be effective when used by autistic people, the goal is to enable its use outside of academic settings by autistic people. The benefits to this are that it could be used in places that don't have the money or space to commit to a sensory room. [tomorrow add discussion of the cost of sensory rooms] The hope is that by enabling people with autism to access tools to reduce anxiety, this can lead to them feeling empowered to go out and do activities they would otherwise avoid, increasing their ability to engage with social events. In addition, it is hoped that by doing this, it enables people who previously didn't have access to therapy for their autism due to lack of diagnosis, or lack of services in their area to have tools they can use.

As 41.9% people didn't get support after a diagnosis of autism and 28.9% of those with autism who had a comorbidity of anxiety (as 28.1% had moderate anxiety and 28.9% had severe anxiety) didn't get any help for those symptoms [10], and it takes on average two years to get an autism diagnosis even after the person is aware they are likely to have the condition, it is valuable to consider other methods to help autistic people that don't rely on currently overburdened services.

6. Conclusion

In conclusion, this work has explored the potential for the use of virtual reality to create an emulation of a sensory room and has explained the design process and final design of a single prototype of this form of program. In doing so, it has gone over the background understanding of the use of virtual reality for autism, and why it is believed that sensory therapy is well suited to being adapted to virtual reality, discussed the sensory room objects that were chosen to be implemented and why, and then discussed the potential future work and and applications of this program.

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