Active Virtual Reality Sensory Room

Karina Quinn and Mary Loveless, Ph.D.

Advanced Research: Engineering, Baylor School Chattanooga, TN

INTRODUCTION

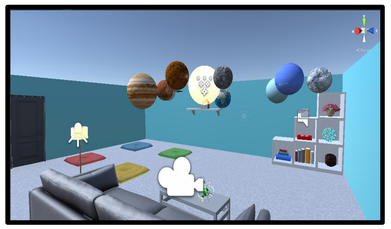
Individuals with autism spectrum disorder (ASD) are more sensitive to their environments [1-2]. Everyday situations may induce high-stress reactions. Depending on the severity, a Sensory Processing Disorder or sensory overload episode can occur at any time.

As shown in **Fig. 1**, or Calm Rooms, sensory rooms exist to aid in these situations. Calm Rooms resemble playrooms and usually consist of objects of various stimulating colors, textures, and sizes. The rooms often feature calming ambient noise or music along with multiple sources of colorful lighting.

Fig.1, Real Sensory room example

Physical calm rooms are not available everywhere and can be costly to install. VR (virtual reality) rooms can simulate a sensory room's experience while providing accessibility and low space and financial cost.

Previous work has shown that the design and use of a passive VR calm room, as shown in **Fig 2.-** an experience with no feedback, just immersion in a calming setting - have been an effective tool for mitigating a sensory episode [7-8]. In a pilot study of 4 participants, there was a 63% reduction in the amount of time it took for students to resume participation after an episode [9].



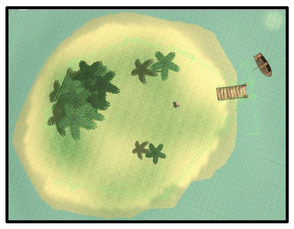


Fig.2. Examples of a typical passive calm room as well as passive calming beach environment.

The current drawback of a VR sensory room is the inability to emulate all five senses. Some individuals on the ASD spectrum struggle with making connections with virtual worlds in terms of sensation but do find comfort in virtual surroundings' predictable-ness. **Thus, haptic feedback would further ground the individual to their digital surroundings.** Haptic senses act as a source of comfort, navigation, and stabilization. Research on the use of haptics in toys and wearable technology and its effect on the user is currently ongoing. The study thus far reports positive results [5-6]

This work aims to create an active virtual reality calm room that implements adjustable audio and haptic controls to immerse the user further into a more immersive feeling sensory room.

DESIGN AND METHODS

The digital sensory room should closely mimic a sensory room's sensations but should not do so in a way that can unnerve to the user as VR may be a disorienting sensation. Though a digital room gives more opportunities to create what isn't feasible in real life, any exaggerations should be carefully navigated to maintain the room's grounded feeling. The room's goal is to have four established zones, each guiding the user through different sensations suitable for other occasions.

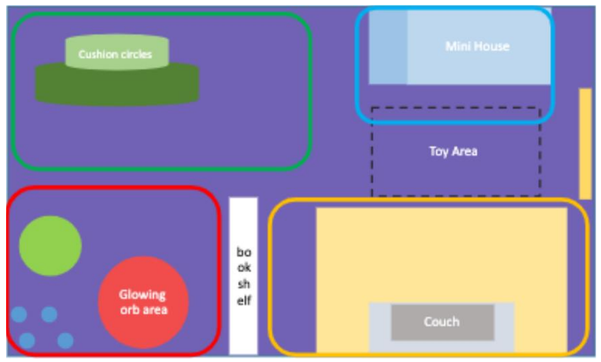


Fig. 2 Final Room layout w/ four outlined "zones"

Each distinct area needs to play a different musical tune and haptic response. The objects surrounding the user differ in purpose slightly pairing with the audio and haptics. For example, the area of the room with the glowing orbs are more stimulating as calm rooms are meant to expose the user to senses in a safe and calm environment while the visuals the audio and haptics need to be more "upbeat".

Movement is simple, using specific teleportation anchor points in each zone Once at the positions, the user is restrained from walking or moving around but is free to look around. Limiting movement also minimizes cybersickness.

RESULTS

The first prototype of the structure, texture, and lighting of the room was created in Blender, as shown in Fig. 3. Several software issues barred the option of importing this room into Unity to impart VR functionality. The structure of the room, shown in Fig 4, was imported into Unity as a prefabrication. The new room design (Fig. 5) then underwent some final modifications (Fig. 6) to improve visual appeal in color scheme, additional toys to enhance the room's comfort and relatability, and adjustments were made to the room's size for practicality.

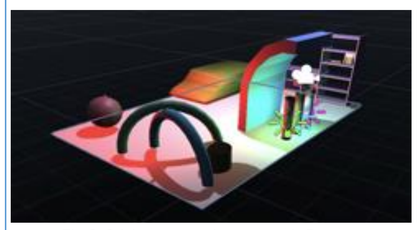


Fig. 3, Original room design rendered in Blender

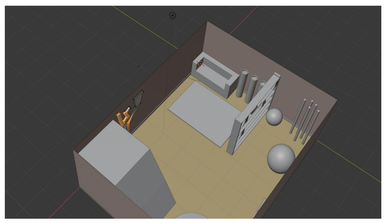


Fig. 4, New room design modeled in Blender, no textures

RESULTS (continued)

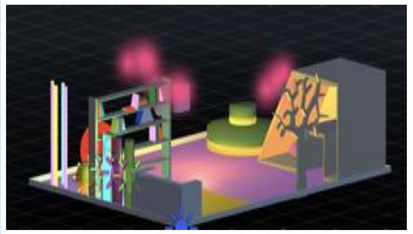


Fig. 5 ,New room design textured and lit in Unity,

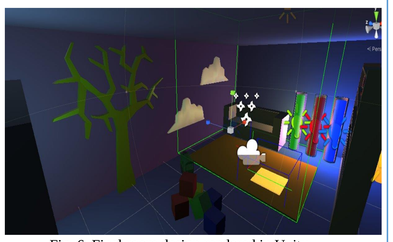


Fig. 6, Final room design rendered in Unity

FUTURE DIRECTIONS

While navigation and a select few audio samples have been implemented into the scene, haptic output that complements the visual/audio stimuli still needs to be implemented. Additionally, signature haptic patterns need to be determined for each zone

Finally, the room is designed to perform on a Windows machine and an Oculus Rift headset; future work requires adapting this experience to work on mobile devices.

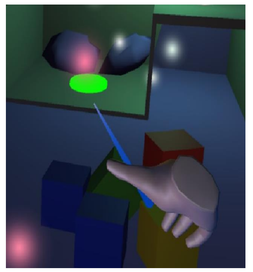


Fig. 7. Example of in-game teleportation UI and anchor point

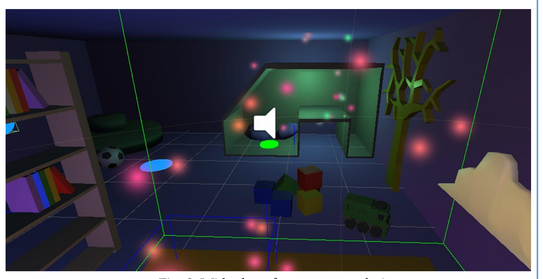


Fig. 8. Wide shot of current room design

REFERENCES

1. MARCO, ELYSA J. et al. "Sensory Processing In Autism: A Review Of Neurophysiologic Findings". *Pediatric Research*, vol 69, no. 5 Part 2, 2011, pp. 48R-54R. *Springer Science And Business Media LLC*, doi:10.1203/pdr.0b013e3182130c54. Accessed 18 Dec 2020.
2. "Sensory Processing Issues And Anxiety: What You Need To Know". *Understood.Org*, 2020, https://www.understood.org/en/learning-thinking-differences/child-learning-disabilities/sensory-processing-issues/sensory-overload-anxiety. Accessed 18 Dec 2020.
3. Puts, Nicolaas A. J. et al. "Impaired Tactile Processing In Children With Autism Spectrum Disorder". *Journal Of Neurophysiology*, vol 111, no. 9, 2014, pp. 1803-1811. *American Physiological Society*, doi:10.1152/jn.00890.2013. Accessed 2 Mar 2021.
4. *Scholarworks.Csun.Edu*, 2021, http://scholarworks.csun.edu/bitstream/handle/10211.3/202982/JTPD-2018-ID00-p1-18.pdf?sequence=1. Accessed 2 Mar 2021.
5. Changeon, Gwénaël et al. "Tactile Emotions: A Vibrotactile Tactile Gamepad For Transmitting Emotional Messages To Children With Autism". *Haptics: Perception, Devices, Mobility, And Communication*, 2012, pp. 79-90. *Springer Berlin Heidelberg*, doi:10.1007/978-3-642-31401-8_8. Accessed 18 Dec 2020.
6. Taj-Eldin, Mohammed et al. "A Review Of Wearable Solutions For Physiological And Emotional Monitoring For Use By People With Autism Spectrum Disorder And Their Caregivers". *Sensors*, vol 18, no. 12, 2018, p. 4271. *MDPI AG*, doi:10.3390/s18124271. Accessed 18 Dec 2020.
7. Liu H. and M. Loveless. *A Virtual Reality Approach to Pediatric Conflict De-escalation and Anger Management*. PEARC '19 Proceedings. July 2019.
8. Hayley Harwood. *Virtual Reality Calm Room*, AOTA National Conference (presentation). 2018.
9. Poole CW, M Loveless, et. al. The Use of Virtual Reality Calm Room Interventions on Student Behaviors International VR Healthcare Association Symposium (presentation), 2021.

ACKNOWLEDGEMENTS

I would like to thanks Baylor Research for funding this project. I would also like to thank Dr. Mary Loveless for her advice, aid, and revisions during this project. Jade Liu for her work and research on passive VR sensory rooms.