Senior Honors Thesis

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Virtual Reality and Addiction Recovery, Investigating Mindfulness Based Interventions

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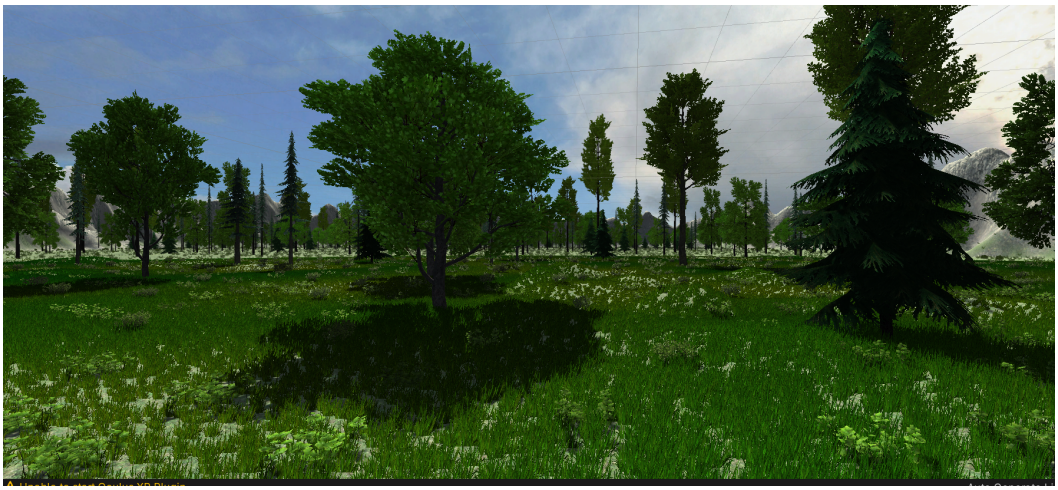

Fig. 1. Forest Used for Mindfulness Experience

Youth substance abuse is a rising issue in rural environments. Due to a lack of resources, youth substance abuse is also more difficult to address in rural areas. Techniques rooted in mindfulness have helped people recover from drug addiction in the past, and these techniques could help rural youths if a reliable delivery strategy was created. As virtual reality becomes more widely affordable and available, the Oculus Quest could deliver the experiences that rural youths need. The immersive nature of virtual reality is promising for delivering an in person, tailored experience to struggling youths from the comfort of their own homes. The software designed and presented is an application of the mindfulness therapy that can be delivered to rural youths.

CCS Concepts: • **Human-centered computing** → **Interface design prototyping**; *Participatory design*; *Activity centered design*; Accessibility technologies.

Additional Key Words and Phrases: mindfulness, personalized normative feedback, virtual reality, addiction, recovery

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1 INTRODUCTION

Youth substance abuse is a dangerous and rising issue in rural communities. In the United States, 39% of youths under 17 years old suffer from substance abuse [6], and in rural communities, the numbers are starting to rise [11]. Youth substance abuse has multiple dangerous effects, including stunted brain development and long-term health and heart issues [5]. In rural areas, access to mental health resources to help youths are limited compared to urban areas. Also, smaller friend groups, financial hardship, social pressures, and stress from working conditions can drive youths in rural areas toward addiction. Adolescent developmental stressors also put youths in a position where they are more likely to abuse substances [12].

Two strategies, mindfulness-based (MB) and personalized normative feedback (PNF), have shown great potential for incorporation into an effective intervention for rural youths. Mindfulness is a heightened awareness of one's experience in each moment [15]. Since mindfulness involves an increased state of awareness, MB strategies can target general awareness of action and associated risk, effectively modifying cognitive processes and developing better stress regulation in youths affected by substance abuse [4, 7, 9]. PNF is an intervention strategy that corrects misconceptions about what is normal behavior in order to illustrate that substance abuse is not a true norm [20]. PNF can be used to alter behaviors away from dangerous activities perceived to be norms. Together, MB and PNF can increase awareness of substance abuse triggers and better ways to manage stress while simultaneously correcting addictive behaviors. While a combined MB and PNF strategy has great potential to help youths, a combined strategy that is specific for youth substance abuse has not yet been tested. Creating a combined MB and PNF strategy is one goal of this research.

While a combined MB and PNF strategy would be helpful to curb youth substance abuse, rural youth accessibility is another issue that must be addressed. To increase accessibility to youths who do not have the time or ability to commute to an urban area for help, an online format is the most sensible form of delivery to reach many rural youths. A big issue with using an online format is that it does not effectively simulate in-person interventions in the same way. To address this issue, using a virtual reality (VR) head-mounted display (HMD) may be an innovative way to better model in-person care in an online format. VR is unique because it provides immersive, lifelike experiences that transport the user to a dual virtual in-person experience. As VR HMDs like the Oculus Quest 2 become more accessible and affordable, VR becomes a more obvious solution to the issue of in-person care, as it can be taken anywhere. A VR solution using MB and PNF strategies to target youth substance abuse has not yet been created. Another goal of this research is to create a VR solution.

The lacking resources and limited availability of helpful tools for youths in rural areas have been insufficient to address the issue of substance abuse. Because of this, a new tool is needed to better help the population of rural youths who are suffering from drug addiction. The goal of this research is to develop a well-informed prototype for a tool to help these youths, combining MB and PNF strategies in an immersive VR setting. The new system will be called Feed My Mind (FMM). This prototype will then be tested in future work.

This work will contribute to the field in many key ways. First, it will contribute a combined application of MB and PNF strategies specifically for youth addiction. Also, it will test the capability of VR as an innovative substitute when in-person care is not available, effectively expanding the range of people that can get mental help. Last, this work offers a novel system, FMM, with the potential to help rural youths recover from substance abuse and avoid a lifetime of associated health issues.

2 RELATED WORK

Drug abuse and relapse often starts with a craving for the temporary positive feeling achieved after abusing the substance. Research regarding cravings tends to focus on the neurology behind those cravings with the goal of understanding how cravings exist and manifest within the brain. Kober researched the neural systems associated with craving. Kober observed neural activities in smokers in order to identify which parts of the brain activate when a person desires an instant reward substance. This research found that areas in the brain used for regulating craving are the same areas that regulate emotion [13]. These results indicate that the ability to regulate emotions, especially when under stress, are linked to addiction, cravings, and relapses. Considering the cognition behind cravings, another researcher Tiffany analyzed existing models for urges and use behaviors, proposing a new model for behaviors. The new model asserts that there are cognitive processes that are activated either to follow or block urges [22]. These cognitive processes are what interventions try to target.

While cognitive processes behind craving are important to consider during treatment, additional research has shown the importance of social norms for perpetuating addictive behaviors. Essentially, being around triggers that cause cravings and perceiving use responses as norms can lead people to fuel addiction to fit in. Neighbors investigated this and incorporated Deviance Regulation Theory (DRT) to create a better PNF application for drinkers. DRT is the theory that people act in a way that is positive with respect to how others act. This research investigated the way to stage interventions with respect to the norms that cause addictive behaviors, and they found that it was important for recovery to build treatments with norms in mind [17]. In rural areas, where heavy alcohol use is a norm, using PNF strategies to target that norm and enforce that it is negative offers more potential for intervention success. Saxton's research supports this use case. Saxton conducted a literature review investigating research on PNF interventions for different addictions. The research encompassed 34 studies and included alcohol, cannabis, and gambling. The research verified that PNF treatments are effective for alcohol, but additional research would be needed for other drugs and gambling [21]. For targeting heavy alcohol usage, PNF is an effective strategy.

In addition, mindfulness is important in the treatment of substance abuse. Hozel conducted a literature review to analyze the ways that mindfulness meditation effects the brain and which parts of the brain are affected. They found that mindfulness meditation affects regulation of emotion and attention, self-perspective, and awareness of the body [10]. Mindfulness is also associated with neurological changes and can be used to treat different stages of psychological disorders. Since mindfulness affects emotion regulation, it targets the part of the brain that also manages craving responses. Positive effects on emotion regulation have the potential to aid in recovery from addiction due to way mindfulness can rewire the brain. Garland et al conducted two studies to investigate this potential. First, the team administered either a traditional intervention or a new mindfulness-based intervention to alcohol dependent adults and had participants report attentional bias and cue-reactivity. They found that MBSR is a good treatment alternative to mitigate alcohol addiction relapse due to stress [8]. Also, they conducted a literature review to create a framework of cognitive processes that mindfulness-based interactions (MBI's) target. Their model is based off evidence of MBI's helping better emotional regulation and unlinking triggers from addictive responses [7]. Garland's research shows that MB interventions, through their capacity to improve emotion regulation, help people learn better responses to stress and triggers than resorting to drug abuse. These results highlight the importance of incorporating MB alongside PNF.

Mindfulness can be improved using nature applications. Primarily, shinrin-yoku, or forest bathing, has been shown to reduce stress and restore mental resources [19]. Forest bathing, or immersing oneself in nature, is a mindfulness experience where one is hyperaware of nature and feels connected

with it, leading to the restorative benefit. Choe et al observed people completing a Mindfulness-Based Stress Reduction (MBSR) application one hour a week for six weeks, assigning people to either a natural outdoor, man-made outdoor, or indoor environment to observe environmental effects. They found that the MBSR application was more beneficial when done in nature rather than indoors [19]. These findings can be extended to MBSR drug addiction interventions to create maximally beneficial MBSR applications through the incorporation of nature. Furthermore, MBSR nature applications have shown promise for youth interaction as well. In a literature review by Madsen, mindfulness in nature applications was found to be an important avenue for youth nourishment [14]. Nature is restorative, and a heightened awareness of one's present state while in nature helps nourish the mind, especially the minds of young audiences. When creating a MBSR intervention for youth substance abuse, nature is an important consideration for drawing the most benefit from the experience.

3 METHODS

The goal of this thesis is to develop a prototype of a virtual environment that could be administered to rural youths suffering from drug addiction. The first step to completing this virtual environment was selecting a target device. The Oculus Quest 2 is becoming increasingly more accessible and affordable. Due to affordability and portability factors, it is the HMD people are most likely to have success using for addiction recovery purposes. After selecting the headset, I configured the Unity editor to support the headset. I tried a few different ways of integrating Oculus, including the Oculus integration asset package [18] and the XR Management Plugin; however, I had legacy issues with these methods. I eventually was able to use the new Unity XR Plugin with Oculus compatibility.

After initial Oculus setup, I began development of the virtual nature environment. I purchased a few asset packages that had calming nature features, keeping in consideration the importance of green nature and plant variety for the relaxing effect. The main package used was the European Vegetation Pack One by ALP8310 [2]. It has nice quality trees and bushes with landscape features like grass and flowers that I could paint on the landscape. I also purchased the 2in1 Birch, Spruce Pack by ALP8310 [1], and the Spruce Trees Pack by ALP8310 [3].

Using the Unity terrain sculpting and smoothing tools, I began by sculpting mountains around the open environment. These mountains were designed both as a pleasant geological feature as well as a billboard to prevent users from seeing outside of the forest environment. After the mountains were sculpted, I began painting the landscape. Using ground and rock materials from the European Vegetation Pack, I painted four landscape layers. First, I painted a rock layer that covered the landscape. Second, I added detail to the mountains by painting a gravel layer over the rock layer in places. Third, I painted a layer of dryer grass and leaves to add more detail toward the base of the mountains. Last, I painted a grass layer at the bottom of the mountains and across the flat areas to give the ground texture and depth.

Once the landscape was painted, I added the plant life. I added five tree varieties and three bush varieties, dispersing them randomly throughout the terrain. After painting the trees and bushes onto the landscape, I used the Unity terrain detail brush to paint on grass and two different types of flowers. I had to play with the brush size and target strength to get the distribution of the plants to look good. After some experimentation, I was able to get an even coating of each detail on the terrain, completing the environment.

After the environment was finished, I began the process of putting a virtual reality player in the environment. Taking inspiration from an intro vr game tutorial series [23], I created a VR Rig, which is an empty game object with another empty game object called the Camera Offset as a child. Then, the main camera was made a child of the camera offset along with the VR hands, which are

represented as quest controllers out of the Oculus Integration asset package [18]. The main camera displays the view from the Quest headset, and the camera offset is how far off the ground the main camera is.

I implemented this same VR Rig system in the main environment, which I created after the forest environment. The main environment is designed to be a place where people can encounter potential triggers under the guidance of a counsellor and better learn how to react to those triggers. For my main environment, I used an asset with simple home items to create a room that resembles an apartment [16]. In this room, I created interactable objects that users can grab, which can be replaced by specific triggers. Upon grabbing the object, the user is taken to a menu displaying the list of treatment experiences. In the case of this prototype, the treatment option is in the forest environment, but these environments can be expanded in the future. The user selects the environment, then is transported into the MB therapy intervention. This functionality completed the design of the prototype.

4 RESULTS

These results depict the prototypes of the initial, trigger encounter environment and the forest environment where the mindfulness intervention would take place.

Fig. 2. Snapshots Inside of the Initial Room

Figure 2 reflects snapshots taken in the initial, trigger encounter environment. The green shapes on the table are generic shapes designed to be replaced with specific trigger items under the guidance of a specialist recommendation. Users can use the grip button on the Oculus controller to grip the objects, and the 'A' button to interact with the objects. Once a user interacts with an object, a menu appears to take the user to the forest scene. The forest scene is where the mindfulness intervention occurs. Some additional features of the room include a sofa, bed, desk, tv, bookshelf, and table with a mirror. The room is currently meant to mimic a living space but can be altered while preserving functionality to personalize the environment.

Figure 3 depicts snapshots from the forest environment. In these snapshots, some notable features include the texture layering on the mountains to create erosion and rocky effects. Also, notice the scattering of grass, bushes, and flowers to create authentic forest ground foliage. The last notable feature is the variety and disbursement of the virtual trees, creating a forest that is visually pleasing without feeling enclosing and potentially claustrophobic.

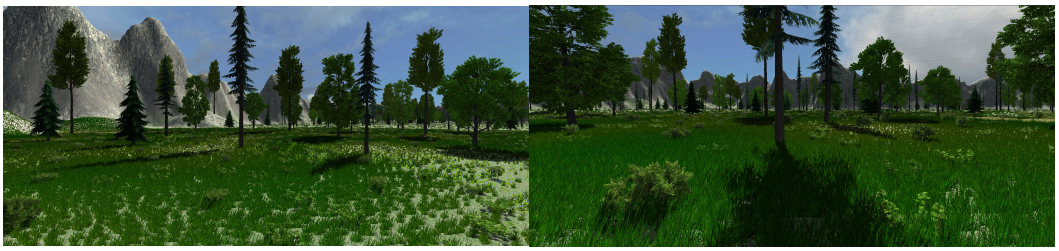

Fig. 3. Snapshots Inside of the Forest

5 DISCUSSION

The environments I have created will help with the development of a full application combining MB and PNF addiction treatment strategies into an accessible platform for rural youths struggling with drug addiction. Until this point, there has been little research done on using virtual reality to treat drug addiction, so this research will serve to expand on field knowledge. Also, this research has the potential to create an experience that is more effective than other virtual treatment options, which will expand on the knowledge about the efficacy of existing virtual substitutes with respect to in person experiences. This research combines MB and PNF strategies to treat youth addiction, which is another topic where more research is needed. Overall, this thesis is helping expand the knowledge of addiction recovery strategies and effective implementation of these strategies for widespread accessibility.

Through this project, I have learned many new skills while simultaneously improving my old skills. I started the project with some basic knowledge about Unity and basic knowledge about developing virtual nature environments. Through developing a virtual nature environment for this project, I learned about landscape sculpting, layer painting, and detail painting. Through a lot of trial and error, I was able to become proficient with these tools and make an environment that I was proud of. In my future projects, which also utilize virtual nature, I will be able to apply this new knowledge to create improved end products. Also, I have discovered a variety of new virtual tools that I am working on mastering to create more lush, realistic environments. Had I not been researching tools to use for this project, I would have not learned about the different nature development tools available to me, so the experience has been super valuable for expanding my knowledge of my resources.

Before this project, I also knew little about drug addiction, addiction treatments, or the impact that addiction was having on rural youths. Reviewing and synthesizing the literature taught me about the psychology behind MB and PNF strategies, the way that addiction affects neurology, and how mindfulness can help correct the neurological changes caused by addiction. I learned that emotion regulation and cravings are closely linked, and it is fascinating how mindfulness, or increased awareness of present moment experience, can help emotion regulation. I also learned more about norms and how they affect people and addictive tendencies, and I learned about how external stressors tend to cause relapse due to the links between stress and emotion regulation.

6 CONCLUSION

Overall, the thesis experience was a huge learning and development opportunity for me. I was drawn to this project because I was fascinated by the potential of virtual reality to aid in the addiction recovery process. As someone who comes from a family with an agricultural background, I have seen firsthand how the stress of farming and ranching can cause substance dependencies, namely alcohol and tobacco. In fact, I have seen people recover from dependencies, go through

relapse processes, or even die from addictions. The ability to deliver a personalized experience to rural youths who needed it became something I was passionate about, and it drove me to help with this project. Even though there is more research and work to be done on this topic, a solution that works would be groundbreaking.

The thesis helped me learn and refine technical skills that I will be using for my graduate school research. It also inspired a collaborative effort that helped me become more knowledgeable on psychology. My new psychology knowledge is also helpful for my other research project, where I am investigating virtual nature applications for stress relief and mental resource restoration. In conclusion, the thesis was a great learning experience and a culmination of all that I have learned in research thus far, making it a great capstone for my undergraduate research education.

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