The Use of Virtual Reality to Treat Anxiety-Related Disorders

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Virtual Reality (VR) is defined as the computer-generated simulation of a three-dimensional image or environment that the user interacts with in seemingly real and physical ways - using special electronic equipment - such as a helmet with a screen inside or gloves fitted with sensors (Oxford Dictionary). When using VR, people's senses - including vision, hearing, touch, and even smell - are stimulated. The head-mounted display system with binocular screens, stereo sound, and movement-tracking follows the user's head movements and alters the virtual environment based on these movements. A scent machine that uses compressed air diffuses scented substances, making the experience even more life-like (Strickland).

For an individual to obtain the proper experience of VR, there must be an element of interaction involved. Interactivity depends on three main factors: speed, range, and mapping. Speed depends on how quickly the computer identifies the user's actions and reflects them for the user to perceive. Range refers to the number of possible outcomes resulting from any particular user action. Mapping is how well the system provides natural results in response to a user's actions (Strickland). In virtual reality, the user has the freedom to navigate themselves through the environment as they please. However, these environments tend to include some other forms of interaction to provide a more exciting experience for the user.

Other than its recreational uses, one of the most significant uses for virtual reality technology is in the treatment of anxiety- related disorders. Current treatments for such disorders include cognitive behavioral therapy (which is a type of exposure treatment) and visualization and systematic desensitization. These treatment methods, however, take longer amounts of time in order to have some effect, and they are mainly used to treat phobias and not depressive disorders (McLeod).

Research in evaluating the use of Virtual Reality to treat anxiety disorders began in the 90s. In the later years, virtual reality exposure (VRE) applications were broadened and applied to the treatment of cognitive, emotional and even physical disorders. In a meta-analysis of 13 studies, VRE treatment was compared with in vivo treatments for social anxiety disorders and agoraphobia.

The results were such that the magnitude of effect with VRE was greater in the control groups ($d=1.1$, $P<0.5$) and lower with the use of in vivo methods ($d=3.5$, $P<0.5$). With VR, the therapist can apply exposure and mediate the stimuli to increase or decrease intensity depending on the patient that is being treated. For example, in treating patients who are afraid of heights or flying on airplanes, the therapist could use VR treatment to be able to manipulate aspects- such as turbulence, take-off and landing, as well as repeated exposure- all during the course of one consultation visit (Rothbaum). VR also facilitates the evoking of memories that may be difficult for the patient to relive by forming associations between those mental images and sensory cues (Rothbaum). Lastly, it is noteworthy that in a world where technology has taken over most aspects of life, VRE would be more attractive for the current generation. According to PMX Agency, the current generation, or the "Gen Z," consumers are going to become the single largest group of consumers in the technology market. According to studies conducted by the International Data Corporation, 8.1 million virtual reality headsets were shipped to consumers around the world in 2016, and this estimate is projected to rise to 60 million by 2021 (Harrison).

Virtual reality therapy has been most effective in its use for exposure therapies as in the case of Post-Traumatic Stress Disorder (PTSD) and Phobias. Post-Traumatic Stress Disorder is a mental health condition that is triggered by either experiencing or witnessing a terrifying event. Such events could include a war, a terror attack or even a traumatic accident. The symptoms of PTSD do not usually occur until a month after the traumatic event.

However, in some cases the symptoms can even surface years after the event. These symptoms typically include intrusive memories of the stressful event accompanied by upsetting dreams or nightmares, negative changes in mood, and changes in physical and emotional reactions, like being startled easily and always being on guard for danger (Mayo Foundation

for Medical Education and Research)

The major brain regions that are affected by traumatic stress include the amygdala, hippocampus and the prefrontal cortex. Findings from animal studies have concluded that PTSD leads to a decrease in hippocampal and anterior cingulate cortex volumes due to the change in the brain's "circuits," accompanied with an increase in the amygdala's response.

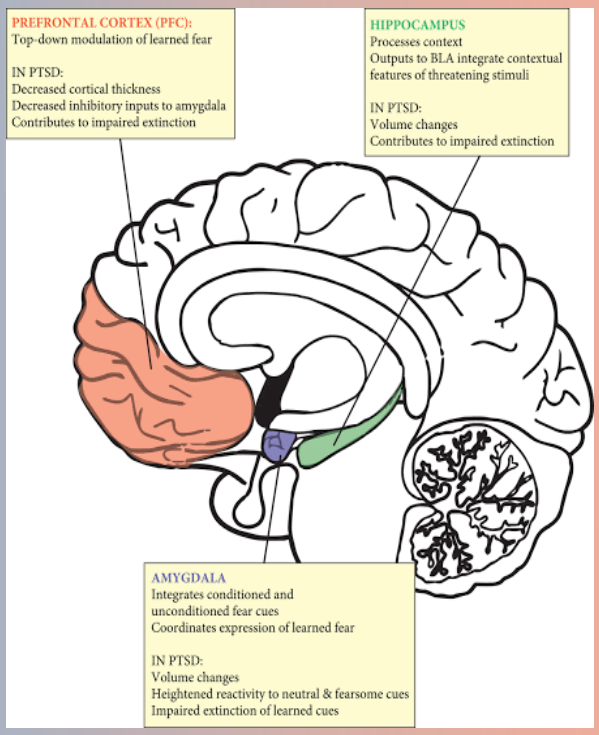

Fig 1. Diagram depicting the regions of the brain affected by PTSD

There is also a spike in norepinephrine and cortisol response to stressors. The hippocampal volume in Vietnam Veterans was studied using Magnetic Resonance Imaging, and it was found that they had 8% smaller right hippocampal volume relative to controls matched for a healthy brain (Brenmer).

To test the reliability of VR therapy, the department of psychiatry at the Emory School of Medicine in Atlanta, Georgia conducted a test on a participant- a 50-year-old Caucasian who served as a helicopter pilot in the Vietnam war. "He met the DSM-IV criteria for current PTSD, and current major depressive disorder, and past alcohol abuse" (Rothbaum 265).

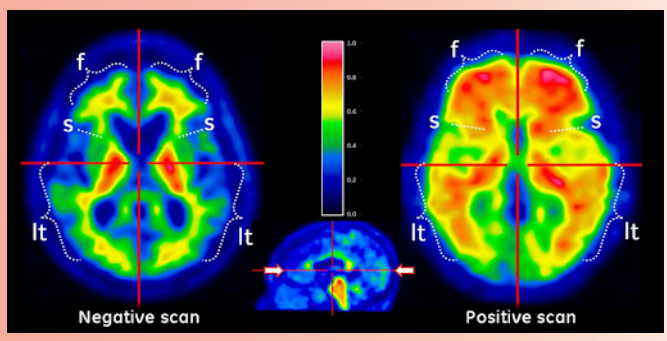

Fig 2. Comparison of a healthy brain (L) with a brain affected by PTSD (R) to depict the difference in brain volume of certain brain structures

During the VR exposure treatment, the patient was equipped with a head mounted display containing two mini-television screens and earphones over each ear. The set up was connected to a computer whose graphics and audio were consistent with the orientation of the patient's head and were computed in real time as the patient explored the surrounding environment. The therapist could communicate with the patient via a microphone attached to the headset. The treatment was delivered in 14, 90-minute sessions and the sessions increased in intensity as the weeks progressed. The participant could feel vibrations similar to those felt while seated in a helicopter through the VR set up. He was also shown virtual environments, such as those of a jungle clearing and was exposed to audio effects comprising noises that one would typically hear on the battlefield. In the later sessions, the participant's most traumatic memories were triggered and prompted by the therapist. To do this, the therapist would ask the patient to recount those traumatic memories repeatedly in past tense until his anxiety decreased due to a process known as habituation.

The therapist simultaneously viewed the virtual environments with which the patient was interacting and would comment appropriately while maintaining the exposure until the participant's anxiety habituated. Results from pre-treatment to post-treatment are positive (Rothbaum).

After the treatment, the values indicating arousal and depression, among others, appeared significantly lower, indicating a decrease in clinical severity.

The scales used to measure the results included: The Clinician Administered PTSD Scale (CAPS), The Impact of Events Scale (IES), and the Beck Depression Inventory (BDI). The patient's CAPS total score was 64 (severe) before treatment, which dropped to 42 (Moderate) after treatment, indicating a decrease in clinical severity. The patient's pre-treatment IES score was 33 (1 standard deviation (SD) above the average of all Veterans suffering from PTSD in his group) which decreased to 18, indicating a 2 SD move following therapy. His 6-month follow up indicated a total IES score of 0 which denoted a complete absence of intrusive symptoms related to the traumatic incident. Lastly, his BDI score dropped from a 37 to a 30 which was still in the severe depression range. However, his 6-month follow up score of 21 fell into the moderate depression range (Rothbaum).

Another effective use of Virtual Reality therapy is in the treatment of phobias. A phobia is an extreme and irrational fear or aversion to something, which may or may not have a grounding in reality. These phobias interfere with the day-to-day functioning of an individual and are often paired with anxiety. Symptoms include panic attacks, elevated heart rate, trembling and feeling out of control or powerless (Open Path Psychotherapy Collective). One of the most common phobias is the fear of flying. About 10-40% of the population has a fear of flying, and the anxiety produced by flying is so intense that it can impede an individual's daily functioning and can even influence the kind of job they settle for (Price).

People who have the disorder usually ingest some form of alcohol or sedative in order to deal with the fear.

Exposure therapy is the most common method used in the treatment of phobias. It involves exposing a patient to the stimulus that he/she fears, so that they can habituate to it. Habituation is the diminishing of a psychological or emotional response to a frequently repeated stimulus (Oxford Dictionary).

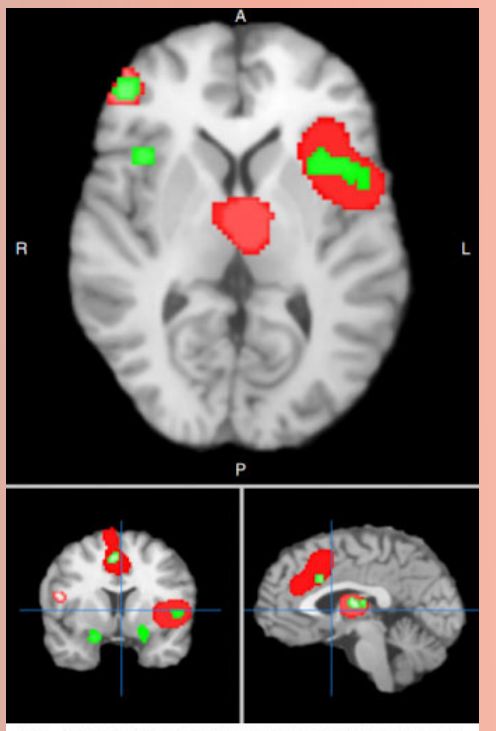

Fig 3. (green) regions activated in response to a phobic stimuli

Repeated exposure to the stimulus in a controlled manner for prolonged periods of time can help the patient cope with the phobia. Virtual Reality is itself a type of exposure therapy and this makes it an effective tool in combating phobias. In this type of therapy, patients learn how to identify the thoughts that are causing this anxiety and then learn how to overcome and replace these thoughts with more helpful ones (Winerman).

A study was conducted by Price et al. to treat the fear of flying in a 42-year-old female who met the criteria for a situational type phobia according to the DSM-IV criteria. During the first half of the treatment, the female sat for seven sessions of anxiety management techniques which included: breathing relaxation, biotherapy, thought-stopping, cognitive restructuring and preparation for stressors*.

After six weeks, the second part of the treatment was initiated in which there were six sessions of VRE administered. Each session lasted 30-45 minutes and exposed the patient to the simulation of taking off and landing along with various variables such as turbulence and adverse weather conditions. After this time period, the outcome of the therapy was evaluated with a self-report questionnaire and subjective unit of discomfort (SUDS) ratings. It was noticed that the patient experienced a decline in self-reported anxiety and could complete an actual flight with very little anxiety which indicates that the treatment was successful (Price).

Research conducted at the University of California on the neural activity of rodents provides promising results relating to Virtual Reality Therapy. Experiments are being conducted on them in VR settings, wherein their brain signals from the

*The anxiety reducing techniques employed in the first half of this study were to prepare the participant for the flight. The techniques were not a control of any sort.

hippocampus are being recorded.

Being associated with memory and spatial mapping, the neurons in the hippocampus have a GPS-like system, which helps them navigate their way through space. The purpose of this study was to find out whether VR could simulate the same type of brain mapping as in the hippocampus. Interestingly, they found out that 60% of the neurons in the hippocampus stopped firing during the experiment. This is possible because VR is immersive, and this immersion can lead to changes in the way the brain processes stimuli. It has been speculated that VR's ability to "shut down" the hippocampus could have rewired the brain and that the various pathways in the brain can be formed and reinforced through repetition (Guillette, Verizon). These findings indicate that the long-term use of VR on the brain can be an effective cure for phobias. As mentioned before, VRT is a type of exposure therapy. Exposure Therapy can change the fear circuit- which involves the amygdala and the prefrontal cortex- after treatment. During habituation, the bilateral anterior medial temporal lobe and the amygdala show a decline in regional cerebral blood flow on repeated exposure to the feared stimuli. This results in a decrease in subjective anxiety ratings and a drop in the patient's heart rate during stressful conditions (Landowska). In this manner, VR proves to be effective against phobias.

While analyzing the benefits of Virtual Reality Therapy, it is equally important to keep in mind the drawbacks associated with it. The first major drawback is that VR interfaces have not been designed to be used as medical equipment yet. This means that the major challenge associated with VR therapy is the sterilizing of the equipment for its use on multiple patients. VR equipment has not yet been modified to accommodate people with disabilities and special needs, which limits the extent of its use. This can pose problems because a large number of war veterans- who need the treatment most- will not be able to reap its benefits. Additionally, cost is another hindrance in the use of VR therapy in a number of medical facilities. Although equipment cost has reduced significantly in the previous years, schools and health centers are afraid to purchase equipment in the absence of subsidies.

The cost of the equipment also limits the availability of the treatment, leading back to the issue that it will fail to satisfy the needs of most people (Burdea).

With the invention of technology, science has opened several opportunities that are proving to be necessary for the betterment of humanity. These opportunities are providing a better chance for us to adapt, and therefore we shouldn't forgo them. When it comes to Virtual Reality Therapy, its uses now encompass the treatment of anxiety-related disorders such as PTSD and phobias. According to the meta- analysis, when compared to other exposure therapies such as systematic desensitization, VR therapy appears to have a greater magnitude of effect. VR, when used to treat veterans of the Vietnam war showed a significant reduction in the patient's symptoms of depression and anxiety. The immersive quality of VR therapy allows it to be used for the treatment of phobias too. It achieves this by rewiring the brain's circuitry – such as the fear circuit- involving the amygdala and the prefrontal cortex. It also stimulates habituation, causing reduction in the cerebral blood flow in the amygdala and the bilateral anterior medial temporal lobe. Further research and development in the use of Virtual reality equipment in treatment, if encouraged, can prove to be immensely beneficial and can improve the standard of living for people who have experienced many hardships, helping them come close to leading a normal life.

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