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Review Article

Virtual Reality as Therapy for Anxiety, Depression, and Neurologic Disorders

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Abstract:

Virtual reality (VR), defined in the Oxford Dictionary as, "images and sounds created by a computer that seem almost real to the user," has become an increasingly prominent tool in the treatment of mental health disorders such as anxiety and depression, as well as certain neurologic conditions. By allowing user interaction, it permits fully immersive therapy for the patient. This literature review explores the efficacy of VR-assisted therapy in alleviating the symptoms of these conditions. By simulating real-world scenarios in a physically safe, virtual space, virtual reality allows patients to confront stimuli – both feared and therapeutic. The review also comments on the mechanisms underlying the efficacy of VR therapy, as well as its ability to augment traditional methods. As technology continues to progress, the potential applications of VR are likely to expand, offering increasingly realistic experiences for patients. This review attempts to show the capacity for VR as an addition to the psychiatric and neurologic treatment toolkit, with applications likely extending far beyond the clinical diagnoses of anxiety, depression, and acquired brain injury.

Keywords: virtual reality; brain injury; breast cancer

Introduction

In the medical field, Virtual Reality has been utilized for various purposes, including surgical training, pain management, and psychological therapy. This is because of its ability to simulate real-life situations in a controlled setting. VR has been used to create simulated environments for the treatment of cognitive, emotional, and even motor problems.

Specifically as it relates to psychological therapy, Virtual Reality has gathered an increased amount of attention and implementation in recent years. By immersing patients in virtual scenarios that replicate real-world stressors, therapists can facilitate treatment in a safe and controlled environment. Depending on the type of therapy being administered, therapists are often able to be in the room with their patients, monitoring for adverse effects and guiding patients every step of the way [1]. This approach allows for the gradual confrontation of feared situations or the exploration of mindfulness strategies, thereby reducing anxiety and depressive symptoms.

This literature review aims to explore the application of VR in therapy for anxiety, depression, and acquired brain injury by focusing on studies conducted in the United States between 2020 and 2025. By examining recent research, the review seeks to assess the efficacy, mechanisms, and challenges associated with VR-assisted therapeutic interventions in the treatment of prevalent mental health and neurologic conditions.

Methods:

This paper is a literature review examining the recent advancements in Virtual Reality therap. Electronic databases such as PubMed and Google Scholar were used to identify relevant articles and studies. Keywords included: "virtual reality," "anxiety," "depression," "mental health," "acquired brain injury," and "neurologic changes." In order to focus on the most modern technology, the focus was centered around studies from 2020 to 2025. Additionally, systemic reviews and studies utilizing randomized controlled trials (RCTs) were given preference. Case studies were also included. Articles and studies were not screened based on country of origin.

Efficacy of VR Therapy:

The benefits of virtual reality in improving mood and anxiety levels have been well-documented in recent literature. Several modern studies have examined both the self-reported mood levels of participants and more objectively, using scales and questionnaires. Both methods of data attainment have been able to demonstrate statistically significant differences between pre- and post-treatment assessments.

In the context of anxiety disorders, virtual reality has shown great potential as a tool for exposure therapy. In a small-scale clinical study, three women diagnosed with Generalized Anxiety Disorder (GAD) based on DSM-5 criteria underwent 15 sessions of Virtual Reality exposure therapy (officially termed Virtual Reality-Based Worry Exposure Therapy, or VR-WET). The intervention utilized 360 degree immersive videos tailored to the patients' specific fears and experiences. These included the distressing events of losing a loved one, being hospitalized,

and observing a traumatic event. Anxiety severity and worry were measured using two worry and anxiety scales (PSWQ and OASIS) before treatment, throughout treatment, and at a six-week follow-up. Results showed significant reductions in both worry and anxiety, with statistically significant ($p < 0.05$) improvement percentages ranging from 52.77% to 79.22%, taking both the PSWQ and OASIS scales into account [8]. Based on mean averages, the highest anxiety reduction percentages were observed at six-month follow-up. These findings suggest that VR-enhanced exposure therapy may be a promising tool for reducing anxiety severity in patients with GAD. Moreover, the benefits may provide long-term solutions rather than short-lived improvements.

The value of VR in managing anxiety may also extend beyond formal DSM-5 diagnoses. In one international study, 50 university-aged students with no prior psychiatric history were analyzed with pre- and post-VR questionnaires, including the State Trait Anxiety Inventory (STAI). They were provided a 7-minute virtual reality guided-meditation experience, which featured 360 degree views of a beachfront. Prior to treatment, study participants had a mean STAI score of 19.48. After treatment, STAI scores averaged 12.06, which demonstrated a statistically significant ($p < 0.001$) reduction in anxiety [2]. This study demonstrates the potential ability of VR to help reduce stress levels among patients with no prior diagnosis of mood disorder.

Virtual Reality has also exhibited benefits in the treatment of depression. In one study from South Korea, 57 participants between the ages of 19 to 50 years old with PHQ-9 scores of 7 or above (indicating mild to moderate depression) were recruited. The test group received x6 weekly 25 minute Virtual Reality treatment sessions, which focused on topics such as stress management, mindfulness, and the practice of emotional regulation. Specifically, the program used integrated concepts from Cognitive Behavioral Therapy (CBT), Mentalization-Based Treatment (MBT), and Dialectical Behavioral Therapy (DBT). The control group, named TAU (for "Treatment as Usual"), received standard pharmacologic treatment, determined by healthcare providers. After treatment, the groups were assessed for efficacy based on depression symptom reduction and suicidality, based on standardized questionnaires. The study was notable for a statistically significant decrease in depression scores (K-QIDS-C) in both the VR-therapy and the control group, but no significant difference in reduction between the two groups [9]. These findings suggest that VR therapy may have a similar efficacy to pharmacologic therapy alone in the treatment of depressive disorders. Also notable in this study, suicidality scores significantly decreased in the virtual reality treatment group, but not in participants assigned to the control group.

Again, the benefits of Virtual Reality have been shown to extend beyond a formal clinical diagnosis in the context of mental health conditions. In one recent study from Poland, 60 women between the ages of 60 to 85 years old participated in a randomized controlled trial, in which virtual reality therapy was tested against more traditional strategies (group relaxation and psychoeducation) for the management of anxiety and depression. The virtual reality software featured multiple components, including relaxing music and Japanese garden simulation, along with immersive cognitive stimulation in the form of mandala coloring. Participants completed eight sessions of 20 minutes each (twice weekly for 4 weeks), in either the virtual reality or control groups. Results showed that virtual reality therapy was more effective than traditional strategies in the reduction of both anxiety and depressive symptoms. Specifically as it relates to depressive symptoms, the VR treatment group saw a mean reduction in Geritatric Depression Scale (GDS) scores of 44.05%, while the control group saw a mean reduction of 13.81%; these data were statistically significant based on p-value and ANCOVA results [4]. As noted, none of the participants had formal diagnoses of depression, but all tested for "mild depressive symptoms" prior to treatment based on GDS scores. These findings suggest that virtual reality may offer meaningful benefits for individuals experiencing depressive symptoms, even in the absence of a clinical diagnosis. Furthermore, by fostering mindfulness and encouraging positive behavioral patterns, VR interventions have the potential to prevent the progression of mild depressive symptoms into more severe and debilitating conditions.

Mechanism of VR Therapy – Neurobiological Changes:

Based on the clinical trials and meta-analyses reviewed, there is significant evidence that calming scenes and exposure therapy in the setting of virtual reality can improve outcomes in patients with anxiety and depressive disorders. The neurobiological mechanism behind why virtual reality is effective is due in part to the emotional engagement of the experience. For example, in the context of exposure therapy, virtual reality is a means of taking participants directly into their fears in a physically safe environment. Studies have pointed out that VR is able to produce a "consistent experience," that would be impossible with imaginal exposure alone [8]. In this way, virtual reality has the ability to engage the senses and provide a closer-to-life experience.

There is growing evidence that VR works by creating neuroplastic changes in different regions of the brain. In one study from Italy, researchers studied VR-based cognitive rehabilitation in patients with history of moderate to severe stroke. They studied 30 patients with right ischemic CVA ≥6 months prior. The control group received conventional cognitive training, which included guided "paper-and-pen based" attention and memory tasks. The experimental cohort received similar attention and memory cognitive training, but via an interactive Virtual Reality interface. During the study period, electroencephalogram (EEG) data were collected in order to analyze and quantify brain wave activity changes. The results demonstrated increased alpha-wave and beta-wave activity in the frontal and occipital regions of the experimental group, with no statistically significant EEG changes in the control group [5]. This suggests that the treatment provided via virtual reality encouraged the reorganization of neural circuitry involved in attention, focus, and cognitive processing. Using Virtual Reality, the experimental group saw positive brain changes that were not achieved through traditional rehabilitation methods.

Several studies have also demonstrated the capacity of VR therapy to improve outcomes in patients with traumatic brain injury. In a systemic review of 13 studies on the topic, it was found that virtual reality activates cortical firing in cognitive and motor brain regions, promoting "reactive synaptogenesis," or neural remodeling [3]. Specifically, this leads to the improvement of gross and fine motor tasks in patients with brain injury, improving hand dexterity, coordination, and gait. Overall, the analysis highlights Virtual Reality Therapy as a valuable complement to more traditional rehabilitation methods, with further research needed to completely understand the mechanisms and place in therapy.

The findings of these studies suggest neuroplasticity as a major underlying mechanism in the efficacy of Virtual Reality as therapy in neurologic conditions. Depending on the type of therapy administered (such as CBT, which calls upon cognitive processes), it is likely that changes in brain wave activity and synaptogenesis also contribute to the success of VR therapy in anxiety and depressive disorders.

Discussion:

Virtual Reality remains an exciting area of research, with new technological advancements occurring on a consistent basis. It is poised to become a powerful complement to established psychotherapeutic approaches. In the treatment of conditions such as anxiety and depression, therapies often focus on enhancing self-compassion, which is critical in helping patients navigate self-judgment in order to cultivate a kinder, more supportive internal dialogue. Virtual reality provides a unique opportunity for patients to practice self-compassion in innovative, immersive ways that traditional therapies cannot offer. By placing individuals in virtual environments where they can interact with "avatars" or explore scenarios from different perspectives, VR allows them to engage with their own emotions and reactions in a novel and meaningful

way [10]. In this sense, VR does not replace existing therapies but rather complements them, providing an additional layer of engagement and emotional connection that reinforces the goals of traditional strategies.

Through novel attention and memory programs, Virtual Reality may also become a key component in the rehabilitation of those with both acute and chronic stroke. The current evidence of VR's ability to reorganize synapse connections in the setting of ischemic brain injury is worthy of continued research and implementation. Moreover, positive cognitive response to VR therapy has been characterized in other neurologic conditions, including traumatic brain injury [3].

The implications of these findings and considerations are multifaceted for healthcare professionals. Firstly, the use of virtual reality as a means of complementing anxiety and depression management is worthy of discussion in the clinic, especially when more traditional methods of management are either contraindicated or have failed. Virtual reality is also a potential adjunct to pharmacological therapy as it relates to the treatment of mood and anxiety disorders. In individuals with no psychiatric conditions, the potential of VR to aid in mindfulness and meditation exercises by providing an immersive experience may also be a topic worthy of discussion for providers. Virtual Reality will likely also have a place in the treatment and rehabilitation of patients with neurologic conditions such as cerebrovascular accidents and traumatic brain injuries, especially as software becomes more nuanced and available.

Important considerations for the advocacy of virtual reality in the clinical setting include cost and availability. Additionally, there can be fear surrounding the experience of virtual reality itself. However, if utilized correctly, the potential for side effects in the use of VR therapy is likely low overall, especially with trained providers in the room guiding patients through the experience. The risk of adverse effects will be much higher in patients receiving exposure therapy compared to those using virtual reality for mindfulness exercises. Because of the realistic experience, VR has the power to invoke distress, which is a side effect that must be discussed with potential candidates for therapy.

Another potential side effect of Virtual Reality therapy has been termed "simulator sickness," which is when the user experiences symptoms such as nausea and dizziness from the use of VR. Studies have shown that simulator sickness usually decreases overtime as users become accustomed to the experience. Additionally, VR companies and software developers advise consistent breaks to prevent symptoms.

Further Reading & Study Limitations:

In the setting of psychiatric disorders, the applications for VR likely extend far beyond generalized anxiety and major depressive disorder. Growing areas of research and exploration include the use of VR for periprocedural care in pediatric patients and in adult patients receiving treatments such as chemotherapy. Virtual reality has also shown to be efficacious in the treatment of anxiety disorder subtypes such as phobias and social anxiety, the discussion of which is beyond the scope of this paper.

Evidence of neuronal and EEG changes with the use of VR has exciting implications in the treatment of stroke and brain injury. These positive, neuroplastic improvements may also have applications in cognitive impairment and movement disorders, such as Alzheimer's Disease and Parkinson's Disease.

In addressing the limitations of this review, it is important to recognize the subjective nature of anxiety and depressive symptoms, even with the use of standardized questionnaires. The articles explored in this study also exhibit variability in sample sizes and population characteristics, raising the possibility that cultural differences influenced the interpretation and reporting of mood symptoms. Another limitation of this project is that Virtual Reality software programs are unique; therefore, it is difficult to objectively quantify the "realistic" nature of the software used in the studies. However, by screening for papers published within the past five years, this review aims to ensure that the most modern technologies were utilized.

Conflicts of Interest

The authors declare no conflicts of interest.

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