Virtual Reality Technology to Treat Mental Illness

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Abstract: Virtual reality is a new technology of immersive interaction. A 3D model created by a modeler, animators, etc. are used to interact with users and bring a sense of realism to users. Therefore, it has contributed to blanching achievements in different fields. It has shown great application potential in the field of medical health. For example, VR treats mental illness (depression, anxiety, PTSD, etc.). Because of the limitations of traditional mental illness treatment, such as the treatment environment is difficult to simulate real-world scenarios, and patient engagements is insufficient. Virtual technology of traditional psychotherapy by building a highly simulated virtual environment to provide patients with a safe, controllable and personalized treatment experience. Therefore, virtual reality technology has a significant role in the treatment of mental illness. This paper aims to review the application status, research achievements, theoretical basis, research gaps and innovations of VR technology in the treatment of mental illness.

1 INTRODUCTION

Virtual reality technology, as a new immersive interactive technology, has shown great application potential in the medical and health field in recent years, especially in the treatment of mental illness. This research was proposed in the 1960s, and today, it has moved from the laboratory to the clinical and applied. Traditional psychological disorders, such as cognitive behavioral therapy (CBT), psychoanalytic therapy, and humanistic therapy. Traditional treatments for mental illness rely on the patient's imagination and recollection. The effect of traditional mental illness treatment is often limited by subjective factors, such as the treatment environment is difficult to simulate the real scene, and the patient's participation is insufficient (Koronka, 2025). Virtual reality creates a simulated 3D environment, enabling patients to confront fears in a secure, controlled setting, alleviate stress, and transform cognition (Emmelkamp et al., 2021). This way breaks through the limitations of traditional treatment, so it opens up new possibilities for psychological treatment. From post-traumatic stress disorder to anxiety disorders, phobias to depression, virtual reality technology is changing the approach to psychotherapy. This technology not only improves the treatment effect, but also promotes the development of psychological treatment to the direction of precision and individuation.

In the treatment of mental illness, the widely used technology is VR technology. Because of the effectiveness of VR technology, it covers a variety of mental illnesses. Such as anxiety disorders, post-traumatic stress disorder (PTSD), phobias, depression, and many other mental illnesses. In the study, patients released their stress through realistic scenes of VR technology, no longer overthinking and depression and other emotions, so it is very effective in treating mental health problems.

However, despite the significant advantages of VR technology in the treatment of mental illness, its application still faces many challenges. First, the high cost of the technology limits its popularity in the clinic, and not all patients have the opportunity to choose VR to treat mental health problems; Secondly, the realism and interactivity of virtual reality environment still need to be further improved to enhance the patient's sense of immersion and treatment effect. Creating a realistic virtual environment requires the help of animators, modelers and illustrators. During this period, numerous

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technical problems and limitations arose. Therefore, the reality and interactivity of virtual reality environment are still the key points of whether mental illness can be treated by VR technology; Finally, the long-term effects and safety of VR therapy still need to be further validated through large-scale clinical studies (Saeed, et al. 2024).

This paper discusses the application status of VR technology in the treatment of mental illness, advantages and challenges, and looks forward to its future development direction. Through the review and analysis of the existing research, this paper will provide theoretical basis and practical guidance for promoting the in-depth application of VR technology in the field of psychotherapy.

2 MANUSCRIPT PREPARATION

Virtual Reality (VR) technology, as a new immersive interactive technology, has been widely concerned in the field of mental illness treatment in recent years. By building a highly simulated virtual environment, it provides patients with a safe, controllable and personalized treatment experience, making up for the shortcomings of traditional psychotherapy. The purpose of this paper is to review the application status, research achievements, theoretical basis, research gaps and innovations of VR technology in the treatment of mental illness.

3 STUDY THE MAIN MENTAL ILLNESS

3.1 Anxiety

Anxiety. Research has shown that anxiety is often thought of as an adaptive response to a potential threat and occurs when individuals exhibit extreme behavioral tendencies. On the one hand, excessive caution causes individuals to disengage from the environment and prevents people from correcting inaccurate perceptions. Excessive carelessness, on the other hand, enables individuals to be in constant contact with their surroundings, enabling them to quickly identify and correct mistakes. As a result, high sensitivity to perceived threats becomes common, while insensitivity to actual risks becomes rare. The researchers believe that this imbalance may lead to pathological anxiety in humans (Frazer & Carl T，2016).

3.2 PTSD

Post-traumatic stress disorder (PTSD) is an important psychiatric illness occurring following trauma. This condition is characterized by symptoms in the form of intrusional recollections, repeated dreams related to trauma, and flashbacks; avoidance of trauma-related stimuli; negative views regarding oneself, the world, and future; increased arousal; and alterations in sleep patterns. Treatment is established by clinical evaluation of these traits. Psychotherapy is employed in most patients in preference to pharmacological treatments for certain symptoms in certain patients (Barnhill & New York-Presbyterian Hospital, 2023).

The World Health Organization has carried out investigations regarding post-traumatic stress disorder (PTSD). In its conclusion, the World Health Organization defines the characteristics of PTSD. As opposed to widespread myths, post-traumatic stress disorder is not just caused by suffering distress or experiencing other psychological problems in response to a traumatic experience since scientific proof suggests otherwise. Symptoms of post-traumatic stress disorder include reviving the traumatic experience, avoidance of individuals or contexts related to the experience, increased arousal with notable distress, and interference in regular routines and family, social, academic, or work-related pursuits. Post-traumatic stress disorder victims commonly experience intrusive recollections about distressing experiences, making them experience things as though the experience is recurring. Other factors including family background problems related to psychiatric diseases, an earlier age, and fewer school years achieved in school work significantly increase vulnerability to developing post-traumatic stress disorder in response to a potentially traumatic experience. Such recollections are commonly preceded by intense fear or fearfulness. Sensory cues including visible images, audible sounds (for example, sounds produced by gun-shooting), smells (for example, smell by an aggressor) or touch can trigger such recollections. The recollection can take the form of intruding thought, nightmare or in extreme forms, flashbacks. When in a flashback episode, an individual responds and reacts just like he is transported to the period in life during which this traumatized situation happened, repeatedly experiencing in vivo the dangerous situation. Post-traumatic stress victims can also experience depression, fear, substance dependency diseases, in addition to suicidal thoughts and conduct. Physical stress and harmful drinking have been known to be factors causing various diseases including

cardiovascular diseases. Post-traumatic stress disorder can be treated by psychological interventions, including trauma-focused cognitive behavioral therapy and eye movement desensitization and reprocessing therapy. Many treatment methods incorporate exposure methods, where the victim narrates, explains, or imagines the trauma in order to trigger recollections in distress in an organized and safe manner. Actual or virtual presentation to provokes that can induce trauma-related recollections can be an essential part of psychological treatments in post-traumatic stress disorder (WHO，2024).

3.3 Depression

Depression represents a widespread psychiatric condition in human society. Characteristically, its symptoms present in the form of continuous low spirits or decreased enjoyment or pleasure in various undertakings. During an episode of depression, patients experience feelings of sadness, irritability, or empty feelings. At the same time, various symptoms present in combinations. Further symptoms can be in the form of difficulty in concentration, over-guilt or feelings of worthlessness, feelings of hopelessness about the future, suicidal or death-related thought patterns, changes in sleep patterns, changes in eating patterns or body weight, and presence of extreme fatigue or decreased energy. One should note that depression can present in various patterns. Patients can have three types of episodes: single episode depression, which refers to the patient's first and only episode; recurrent depression, where patients have had at least two previous episodes; and bipolar disease, where manic symptoms alternate with depressive symptoms. During manic phases, patients can present with increased agitation or irritability, increased activity or increased energy. Other features can be increased talkativeness, increased flow of thought processes, increased confidence in himself, decreased amount of needed sleep, distractibility, and acting in an impulsive manner or in an uninhibited manner. The etiology of depression is multidimensional in etiology, including both social factors, psychological factors, and genetic factors. Patients can have an increased risk of developing depression in response to an unfortunate experience in life, e.g., job loss, grief, or various distressing occurrences. Additionally, extended bouts of down spirits or intense stress can lead to additional psychiatric conditions in patients. Management of depression is inextricably related to physical condition because various factors causing development, remittance, or effecting depression have in-depth interconnection to patients' physiological status. Patients frequently have below-average rates of physical exercise in addition to patterns of binge drinking, both factors that have been correlated with an assortment of diseases including cardiovascular disease, cancer, diabetes, and pulmonary diseases. Physical inactivity interacting with these factors can lead to the resultant development of depression. On the other hand, it is imperative to realize that patients suffering from these diseases can suffer from depression because of the difficulty in coping with both physical illness and emotional well-being. Current programs by the World Health Organization (WHO) towards prevention have been proven to reduce symptoms in patients suffering from depression. As an illustration, the WHO Mental Health Gap Action Plan (mhGAP) emphasizes identifying depression and attempted suicide/self-harm as essential factors in screening for depression in priority areas in mental illness. This system provides patients with easier accessibility to treatment through non-psychiatric providers who get support in treating individuals suffering from neurological diseases, substance dependency, and psychiatric illness by the WHO. Additionally, the World Health Organization has developed an abridged guide to providing psychological therapy to patients suffering from depression by trained lay counselors (WHO，2023).

4 RESEARCH ACHIEVEMENT

4.1 Anxiety treatment

Anxiety intervention. Evidence suggests that virtual reality (VR) technology has a significant impact upon the treatment of anxiety disorders. One example is virtual reality exposure therapy (VRET) used to treat certain phobias, including acrophobia (height fear) and aviophobia (fear of flying) and social anxiety. This entails the imitation of settings like a virtual altitude scene or virtual queue situation. Furthermore, building an intense social get-together atmosphere is part of the process. Evidence suggests that VRET can reduce symptoms in patients significantly. The therapy outcomes achieved by this method equal or in certain cases exceed those gained by conventional exposure therapy (Powers & Emmelkamp, 2008).

4.2 PTSD treatment

Post-traumatic stress disorder (PTSD). VR technology has also made important advances in the

treatment of PTSD. By recreating traumatic scenes, VRET helps patients gradually face and overcome psychological trauma in a safe environment. Six virtual reality treatments were associated with reduced PTSD judgments and symptoms in Iraq and Afghanistan veterans, although there was no control condition for virtual reality exposure. Studies have shown that VRET can significantly reduce symptoms in PTSD patients and improve their quality of life (Rothbaum et al., 2014).

4.3 Depression treatment

Depression. The use of VR technology in depression treatment is also increasing. For example, VR cognitive behavioral therapy (VR-CBT) helps patients improve mood and cognitive function by simulating positive situations and activities. Preliminary studies have shown that VR-CBT can effectively reduce depressive symptoms and improve patients' feelings of self-efficacy (Falconer et al., 2016).

5 THEORY OF THERAPEUTIC METHODS

5.1 Exposure therapy

The theory of exposure therapy. Exposure therapy is the main theoretical basis of VR technology in the treatment of mental illness. Through repeated exposure to fear or trauma-related virtual environments, patients are able to gradually adapt and overcome their psychological disorders (Rothbaum & Hodges, 1999).

A separate study was carried out examining virtual reality (VR) exposure therapy. This study demonstrates the efficacy of technologically aided single virtual reality exposure therapy (VRET) in treating arachnophobia, using accessible consumer-grade equipment and novel automated programs, compared to established conventional practice, in vivo single therapy (OST), in a parallel group randomized non-inferior design. The results revealed through linear hybrid modeling evidenced decreased avoidance behavior and reported fear in both cohorts upon completion of the treatment, with VRET trending toward approaching the notable therapeutic benefits of OST over time. No notable drift was evidenced during the follow-ups conducted during months 3 and 12, although notable deterioration was not evidenced until month 12. Tests to detect negative effects evidenced no notable differences between both experimental treatments. This work confirmed automatic VRET to reduce symptoms related to arachnophobia in the short term while determining that in the longer term, this was equal to in vivo exposure therapy. Additionally, the efficacy trial in VRET is designed to determine both true effectiveness and non-specific therapy factors developing during therapy that are influenced by dosing technician intervention (Lindner, et al. 2019).

5.2 Cognitive behavioral therapy

Cognitive Behavioral Theory (CBT) is used to form the theoretical background in this research. This study aims to analyze the tenets of CBT to inform improved patient care through alterations in their thought process and conduct. Research has established that virtual reality (VR) has immense potential in treating psychiatric illness. Evidence is in support by proving that virtual reality is rich in potential in psychiatric condition management. However, effectiveness is dependent upon seamless cooperation between design professionals and researchers in virtual reality to design true virtual environments since patients respond in various ways; thus, developing personalized and true environments is imperative in each case. Economic and technical requirements are thus anticipated to keep rising (Freeman et al., 2017).

The utilization of virtual reality therapy in combination with Cognitive Behavioral Therapy (CBT) has been investigated through an equivalent-sized, single-blind, randomised controlled trial across nine trusts in the United Kingdom's National Health Service (NHS). Study participants included patients who were over the age of 16 and who had been diagnosed with spectrum schizophrenia or who were exhibiting emotional symptoms related to psychosis, in addition to difficulty leaving their residences because of problems related to anxiety. Study participants were randomised (1:1) to receive gameChange VR in addition to usual treatment or to continue to have only usual treatment. Randomisation used block algorithms with block sizes varying by both study site and by type of service delivered.

The gameChange VR app has been specially created to target individuals suffering from agoraphobia and related fears in usual contexts. It is meant to aid individuals in reducing fear during social interactions and in public contexts. The subjects received six sessions over a period of six weeks through the gameChange VR therapy. Clinical testing revealed that with assistance by an expert in mental health, noticeable improvement in avoidance

symptoms and distress related to anxiety was registered upon completion of these sessions. Participation in therapy through virtual reality was extremely engaging to the subjects. However, overall effectiveness in treating was constrained by the reality that most individuals in the treatment cohort had low pre-baseline avoidance scores regarding fear, leaving little prospect for noticeable change. Though patients indicated partial remission to an extent, most notable was in symptom relief regarding agoraphobia. This is among the largest trials carried out to test virtual reality treatments in treating psychiatric conditions. The gameChange VR simulation gave patients a chance to practice coping in true life contexts, including leaving their residence, attending cafés, shopping, attending doctor visits, and taking transit. Sessions have been created in collaboration with individuals who have suffered psychiatric problems to guarantee that the treatment is responsive to problems in true life.

Compared to standard treatment alone, game change VR treatment significantly reduced fear avoidance and distress in everyday life. Patients with severe difficulties experienced moderate to substantial improvements lasting up to 6 months, particularly in controlling agoraphobia. The therapy works by reducing exaggerated threat perception and defensive behaviors, which are central to the cognitive processes underlying anxiety (Freeman, et al., 2022).

Explore self-compassion in VR. Another study investigated whether immersive virtual reality enhanced self-compassion in people with depression. The researchers designed an eight-minute virtual reality scenario in which 15 patients practiced expressing compassion from one virtual body and then receiving their own compassion in another virtual body. In open trials, repeating this exercise three times over four weeks significantly reduced the severity of depression and self-criticism, while significantly increasing self-compassion. Four participants showed significant clinical improvement. These findings suggest that immersive virtual reality interventions have considerable clinical potential, although further development and controlled trials are needed to verify their effectiveness (Falconer, et al. 2016).

5.3 Biofeedback mechanism

Biofeedback mechanisms. Studies have shown that combining virtual reality (VR) technology with biofeedback systems enables patients to visualize in real time physiological responses to therapy interventions, including skin conductance and heart rate. When used in virtual reality exposure therapy (VRET), this combination provides an unprecedented degree of control; therapists can adjust exactly the degree of intensity, duration, and speed of exposure to each individual's requirements. Additionally, in the event of undue stress in a patient, therapy can be stopped in an instant. Therapy effectiveness can be increasingly improved by applying biofeedback to achieve increased specificity and effectiveness (Repetto et al., 2013).

A follow-up study emphasized problems related to integrating systems of biofeedback, especially tracking heartbeat variation in virtual reality (VR) environments to support in situ adaptation in these contexts. As an example, an automatic adjustment in scene complexity in accordance with increased patients' anxiety can induce feelings of calmness. Military professionals including army troops, flyers, and crew members work assiduously towards integrating increasingly advanced and efficient stress training programs. This systematic review discusses an overview of experimental work carried out in previous years examining virtual reality-grounded stress management training programs among military professionals. This novel and advanced technique has immense potential to act as an efficient methodology to support military officers in coping with stress (Pallavicini, et al. 2016).

6 CHALLENGES AND EXPECTATIONS

6.1 Cost and popularity

Technology cost and popularity. The research shows that although VR technology has the possibility of future development, it has not become a hot topic in the world. The biggest limiting factor for the use of VR in clinical practice is cost. The researchers did not have the research funds to develop the clinical application of VR technology and the corresponding high application software. New software comes from many laboratories around the world, and these researchers test and develop VR for clinical use, so the cost of developers is too high, and the price will naturally increase, and the high cost of development and VR technology needs to have safety and effectiveness, so they continue to not be commercialized. Because the development of VR technology is too fast, the new technology will replace the old technology, researchers need new

equipment to continue research, and even overturn the previous research data, so these problems hinder the clinical development of VR technology (Bell, et al, 2020).

6.2 Reality and interactivity of virtual environment

The authenticity and interactivity in virtual contexts have an essential role to play in ensuring greater ecological validity, an essential goal in virtual reality (VR) design. However, the degree of required immersion to induce presence is an area in which researchers continue to conduct extensive work. Influencing this immersion is the display quality in VR equipment (such as frame rates and resolutions) as well as design factors (such as representing entities in virtual contexts in life-like ways in an engaging manner) and multi-modal interactivity. One notable effect commonly referred to in VR is referred to as the "valley of terror." This refers to the point where humanoid entities in an otherwise believable virtual context with minimal faults (such as unrealistic breathing patterns) can elicit revulsion or unease in an otherwise plausible situation. Curiously, avatars with greater exaggeratedness avoid this effect better since these elicit better responses in users compared to humanoid presentations with increased reality (Mori et al., 2012).

6.3 Personalized treatment

Personalized therapy is an essential pathway to developing virtual reality (VR) technologies. Research has shown that VR has the potential to act as an efficient diagnostic tool in analyzing psychiatric diseases, including depression, in addition to providing personalized motivational factors tailored to therapy, thus facilitating immense engagement leading to beneficial therapy outcomes. Additionally, incorporation of wearable sensors significantly enables user interaction in the virtual reality domain, thus further optimizing therapy processes (Waqas et al. 2024).

7 CONCLUSIONS

This paper reviews the application status, research achievements, theoretical basis and gaps of virtual reality technology VR in the treatment of mental illness. Studies have shown that VR technology is effective in the treatment of anxiety disorders, PTSD and depression, especially in exposure therapy and cognitive behavioral therapy. Its theoretical basis includes exposure therapy, cognitive behavioral theory and biofeedback mechanisms, which provide a scientific basis for VR therapy. However, the application of VR technology still faces challenges such as high technical cost, insufficient sense of virtual environment, and long-term effect and safety to be verified.

Future research should focus on reducing the cost of technology, improving the realism and interactivity of virtual environments, and verifying long-term effects and safety through large-scale clinical studies. In addition, combining artificial intelligence and big data technology, the development of personalized treatment plans is an important direction. Despite the challenges, VR technology has great potential in the treatment of mental illness and is expected to become a mainstream treatment in the future.

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