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Research on the Therapeutic Effects of Virtual Reality (VR) Technology on Psychological Disorders

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Abstract: The emergence of technologies like Virtual Reality (VR) is revolutionizing psychological therapies. This paper provides a comprehensive review of research on the use of VR in therapy for psychological disorders. The review examines literature studying the applications of Virtual Reality Therapy (VRT) in disorders such as Post-traumatic Stress Disorder (PTSD), Social Anxiety Disorder (SAD), and Public Speaking Anxiety (PSA). It explores the therapeutic effects of VRT from three perspectives: enhanced realism in exposure therapy, improved accessibility and convenience, and control over the intensity of stimuli. Key findings indicate that VRT effectively alleviates symptoms such as anxiety and physiological stress in patients. The paper also addresses challenges and ethical considerations associated with VRT, including access to VR equipment and data privacy. It concludes by suggesting potential directions for future research, such as expanding VRT applications to more mental disorders and integrating high technologies like artificial intelligence to further explore VRT's potential.

Keywords: Virtual Reality technology, psychology disorders, therapy

1. Introduction

A psychological disorder is a pattern of negative behavioral or psychological symptoms that induces adverse impacts on individuals' emotions, thinking, interpersonal relationships, or even physiological conditions [1]. According to the World Health Organization [2], one-eighth of the world's population lives with a psychological disorder. However, there are several effective prevention and therapeutic treatment options exist. With the advancement of technology, therapists have combined techniques like Virtual Reality (VR) with therapeutic treatments. VR encompasses hardware (e.g., sensory input devices and Head-Mounted displays) and software (e.g., 3D modeling software) that can mimic real-world situations in which users can explore [3]. Practitioners have developed Virtual Reality Therapy (VRT), which is mainly used to treat individuals with anxiety-related disorders like phobias and Post-traumatic Stress Disorder (PTSD) [4].

According to a number of studies, VR simulates real-life circumstances related to patients' mental illnesses, which are difficult or impossible to duplicate in the office, contributing to successful therapeutic treatments. Additionally, VR therapy sessions may be administered with little human connection, offering treatment chances to patients who are unable to attend physical therapy sessions due to reasons such as social anxiety disorder. More importantly, self-guided VR-based treatments, in particular, provide patients complete control over the simulated surroundings, including the type

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of interactions and stimulus intensity, which may drive patients to increase their exposure to perceived threats. The current article aims to discuss the therapeutic effects of VR as a treatment tool for psychological disorders from three perspectives: enhanced realism in exposure therapy, improved accessibility and convenience, and control over the intensity of stimuli.

1.1. Page Setup Brief Overview of VR technology

Virtual Reality (VR) technology can simulate real-world environments that allow individuals to interact with [3]. By utilizing specialized hardware like sensory devices and Head-Mounted displays (HMDs), users are immersed in computer-generated environments that respond to their movements [3]. HMDs typically encompass small screens in front of the eyes and incorporate audio devices (e.g., headphones) to present virtual content to the users, which can effectively block individuals from the real world [5]. In addition, users can explore the immersive environment with the assistance of sensory input devices like controllers [5].

VR was initially popular within the gaming industry and has rapidly expanded into industries like technical training, education, and healthcare. For instance, VR provides surgeons with realistic training simulations of medical surgeries, which can enhance their skills and reduce medical malpractice [6]. VR has also offered innovative solutions in the area of rehabilitation. Patients who suffer from stroke can take specialized cognitive training program that helps them relearn motor skills [3]. These examples demonstrate VR's innovative and effective applications in different fields.

1.2. Brief Overview of Psychology Disorders and Therapeutic Application of VR

Individuals who suffer from psychological disorders might experience significant disturbances in emotion regulation, cognitive abilities, or behaviors [7]. The consequences of psychological disorders can be extended to patients' life quality, interpersonal interactions, physical well-being, etc. In the treatments of common psychological disorders like Major Depressive Disorder (MDD), Anxiety Disorder, and phobias, behavioral therapy techniques have demonstrated significant effectiveness [4]. Behavioral therapy techniques refer to a category of therapeutic approaches that aim to modify patients' maladaptive behaviors to healthier ones [7]. Exposure therapy is one of the typical behavioral therapy techniques that is usually used to treat individuals who suffer from phobia (e.g., social phobia) and Post-traumatic Stress Disorder (PTSD) [4]. During the treatments, patients would experience graded exposure to their anxiety-evoking stimuli, which is known as systematic desensitization [4]. However, according to some research reviews, patients experience difficulties while imagining their prescribed anxiety-producing scene [4]. Some of the individuals expressed significant aversion to experiencing real simulations [4].

With the assistance of VR, therapists introduced Virtual Reality Therapy (VRT) as a novel therapeutic approach to the field. Individuals who encounter difficulties in imagining their anxiety-evoked stimulus and/or are too phobic to experience real situations can interact with immersive ones generated by computers through wearing sensory devices and HMDs [4]. More importantly, VR has the capability of creating scenes that are difficult or impossible to reconstruct in vivo therapeutic environments (e.g., army scenes), which can potentially enhance the treatment effectiveness for patients with PTSD [4]. In addition, different from traditional exposure therapy, VRT can be performed within the privacy of a single room, which avoids public embarrassment and violation of patient confidentiality [4]. VRT has paved an innovative pathway for the potential evolution of therapeutic approaches for psychological disorders.

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2. Therapeutic Effects of VR as a Treatment Tool

2.1. Enhanced Realism in Exposure Therapy

According to the Emotional Processing Theory [8], psychological disorders like PTSD and phobia disorders contain pathological fear structures that are triggered when stimuli represented in the structure are encountered. Individuals with the disorders take escape and avoidance of such stimuli as rewards since they believe the stimuli are associated with danger, even though the stimuli itself is harmless [9]. The theory aligns with Mowrer's two-factor theory, which argues that both Pavlovian and instrumental conditioning are involved in acquiring fear and avoidance behaviors [9]. As a consequence, some theorists proposed that conditioning processes are crucial in evoking and maintaining phobia disorders and PTSD. These theorists proposed that in order to change the pathological components of the fear structures such that the stimuli no longer induce fear, effective treatment requires emotional processing of the fear structure. Imaginal Prolonged Exposure (PE) allows patients to revisit the traumatic or feared events repeatedly in a safe setting to mentally interact with the fear structure, which effectively reduces individuals' fear associated with these situations and obtain a healthier lifestyle [9].

However, patients experience difficulties in visualizing their anxiety-evoked stimulus and/or are too afraid to experience real situations. VR can mimic real-life environments associated with patients' psychological disorders that are difficult or impossible to recreate in the offices, leading to effective treatments. Previous studies from the 1990s first demonstrated that VR could effectively treat acrophobia [10], claustrophobic [11], and fear of flying [12, 13]. VR could recreate stimuli such as views from high-rises, elevator scenes, and airplane scenes, which are nearly impossible to stimulate in therapists' offices. Through exploring those immersive environments by VRT, patients can spend as much time in each circumstance as necessary for their anxiety and fear to subside. Results of these studies indicate that VRT groups' anxiety, avoidance, and distress showed a significant decline from pre-treatment to post-treatment, while the control wait list group showed little improvement. For participants who received VRT, the average anxiety ratings showed a consistent downward trend throughout the sessions, suggesting habituations for the treated individuals. In addition to phobia disorders, recent studies also show that VRT can be implemented to treat patients with PTSD. Loucks et al. [14] and Rizzo et al. [15] found that the BRAVEMIND Virtual Iraq/Afghanistan system, which is a specialized virtual system for the delivery of VRT for PTSD, is effective in reducing United States Service Members' PTSD and depression symptoms.

In conclusion, VRT has proven to be successful as a safe and effective treatment for patients with phobia disorders and PTSD. Individuals interact with computer-generated fear-evoked stimuli to desensitize themselves and eventually overcome their anxiety and fears.

2.2. Improved Accessibility and Convenience

VR therapy sessions can be delivered with little interpersonal interaction, which provides patients who are unwilling to (e.g., social anxiety disorder) to attend physical therapy sessions with treatment opportunities.

Individuals with Social Anxiety Disorder (SAD) often worry about being judged or receiving negative evaluations from others, which leads them to behave embarrassingly in social interactions and eventually avoid interpersonal relations [1]. SAD is one of the most common mental disorders in the world population, but only one-third of individuals are willing to seek treatment, which is mainly because of patients' apprehension of interpersonal interactions in traditional therapies [16]. VRT has been utilized as a new form of therapeutic approach to treat SAD. During each VRT session, participants are required to engage in immersive stimuli (e.g., virtual social interaction) that can evoke

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their levels of social anxiety [17]. Several studies have demonstrated that different types of virtual feedback and settings can significantly impact psychological responses such as anxiety and heart rate in both healthy participants and those with SAD [18]. For instance, Hartanto et al. [19] found that positive feedback in a virtual job interview scenario could reduce anxiety and physiological stress, while negative or ambiguous feedback could exacerbate anxiety levels, especially in patients with SAD. These findings support the potential of VRT for managing social anxiety, with further studies developing home-based virtual systems to allow remote, therapist-led/self-led treatment that enhances accessibility and patient adherence.

The study by Klinger et al. [20] investigated the effectiveness of VRT for patients with SAD and compared the result with individuals who received group Cognitive Behavior Therapy (CBT). The researchers divided the SAD participants into two groups, matched by factors like gender, and age. Both groups went through 12 sessions of VRT or group CBT, and the result illustrated that VRT, which used various social environments, was as effective as traditional group CBT in treating individuals with SAD. In 2016, Hartanto et al. [21] proposed a home-based VRT system for patients with social anxiety. The technique covers several novel features, such as dialogue approaches, a multi-modal automatic anxiety feed-back loop to control anxiety levels, and motivating tactics used by the virtual agent. The method successfully created the anxiety required for exposure treatment in a five-patient pilot research. The findings showed a progressive decline in heart rates and self-reported anxiety levels throughout the course of treatment, which is consistent with exposure therapy's predicted effects.

VRT offers an accessible treatment option for patients with SAD, especially for those hesitant to undergo traditional owing to their dread of interpersonal interactions. Based on a number of studies, this therapeutic method has been proven in trials to effectively reduce social anxiety symptoms, with results equivalent to standard CBT. The introduction of home-based VRT systems improves accessibility and patient adherence by providing additional options for remote, therapist-directed/self-directed therapy. Overall, VRT has a great potential as a therapeutic tool for dealing with social anxiety, providing a more accessible and perhaps more effective alternative to traditional treatments.

2.3. Control over the Intensity of Stimuli

VR-based therapies, specifically self-guided VR-based therapies provide patients with full control of the simulated environments, from the intensity of stimuli to the nature of interactions, which could encourage patients to increase their exposure to perceived threat.

Several studies have demonstrated the effectiveness of exposure therapy in treating phobia disorders [22]. Some researchers suggested that understanding the function of client control during exposure therapy is essential because it affects the way patients receive treatment and the type of therapeutic interactions that occur during the treatment process [22]. Since the individuals are required to participate in an uncomfortable and scary experience that they often avoid when given the option, the role of client control is especially crucial during the exposure treatment [22]. Many theorists have proposed that high levels of client control over the therapeutic process led to greater effectiveness in exposure [23]. Psychosomatic medicine studies also demonstrate that control over unpleasant events typically results in a reduction in distress [22]. In 2017, Healey et al. [22] recruited 96 students who were afraid of spiders, allowing them to regulate the distance they drew from a virtual spider using a joystick. Joystick control varied in degree, emulating varying degrees of control over exposure. Each high-control participant was paired with a low-control opponent for an equal amount of exposure time. The findings illustrated that after around 17 days, people with more control approached the spider more closely and reported avoiding spiders less after the exposure. The effectiveness of high client control in exposure therapy can be extended to the VRT for managing phobia disorders, with future research developing self-led therapeutic treatments.

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A recent study by Premkumar et al. [24] investigated the use of self-directed VRT to address university students with Public Speaking Anxiety (PSA), which is a common type of social anxiety. Through manipulating control over their exposure to virtual audiences, participants in treatment are able to properly manage their heart rate and anxiety. Results indicate that self-led VRT not only lessens psychological and physiological symptoms, but also retains these improvements for up to one month. The study also suggested that with high control over the virtual stimulus, patients are more inclined to participate and adhere to the therapy. This increased engagement led to greater exposure to virtual social challenges and resulted in significant improvements in social anxiety. Another study compared the self-led, home-based VRT against a control group [25]. Each participant was provided with a VR headset and accessed the therapy via an online platform, which guided them through the VRT without direct therapist intervention. The self-led sessions focused on exposing participants to an immersive environment where they practiced public speaking. During each session, participants could complete the structured activities and exercises at their own pace. Compared with the control group, participants who received self-led VRT reported significantly lower PSA scores, with the effect persisting for up to twelve months.

VR-based therapies, particularly self-guided approaches, offer patients greater control over their treatment environments. This increased control encourages patients to confront and manage their fears, leading to significant improvements in social anxiety and phobia disorders. The effectiveness of self-led VRT has been demonstrated in various studies, including those focusing on public speaking anxiety, where participants showed lasting improvements in psychological and physiological symptoms. These findings highlight the importance of providing patients with control over their therapy and suggest that self-led VRT can be a valuable tool in the treatment of social anxiety and phobia disorders.

3. Disadvantages, Challenges, and Ethical Consideration

Despite that VRT has provided a novel therapeutic approach to treating diverse psychological disorders, the current treatment still contains disadvantages and challenges. One major concern is the expenses associated with utilizing the VR equipment, which includes the cost of purchasing and maintaining the software and hardware. Patients who are from lower socioeconomic backgrounds and clinics in low-resource settings might have little access to the technology necessary for VRT.

Another challenge is the potential side effects or cybersickness users may have after using VR. According to Bouchard et al. [26], some individuals may experience nausea, dizziness, and disorientation while wearing VR technology. These adverse reactions could impact the effectiveness of VRT and/or result in failure of treatment. In addition, depending on the patients' sensitivities to virtual environments, some individuals might find their anxiety levels are intensified under specific virtual scenarios.

Ethical considerations also arise while using VRT as a treatment. One crucial concern is data privacy regarding patients' treatment progress. While the patients are engaging in virtual environments, they may reveal information, such as personal preferences, emotional responses, and physiological reactions, about themselves. Technical companies that developed the VR equipment may collect and store these extensive amounts of sensitive data in their systems. Especially given that the VR system is used to treat psychological disorders like phobia and PTSD, the data is more sensitive and valuable. Therefore, to protect the patients' privacy and well-being, it is essential for both the companies and therapists to protect the data.

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4. Future Development of VR Application in Mental Health

The current studies of VRT primarily focus on therapies in the area of phobia disorders and PTSD, future research can expand the usage of VR therapy to a wider range of psychological disorders (e.g., eating disorders). For instance, companies can develop virtual scenarios that can stimulate patients' appetites or modify patients' negative thoughts and behaviors related to eating. Through engaging in these virtual scenarios, individuals can enjoy a safe and controlled environment to reframe their attitudes and thoughts toward food and body image. The potential expanded application of VRT to a wider range of psychological disorders such as eating disorders can lead to innovative and effective treatment options. This could contribute to more personalized and targeted interventions that address the unique challenges faced by individuals with these disorders.

In addition, researchers can combine VR-based therapy with other therapeutic techniques, such as pharmacotherapy and neurostimulation, to determine if treatment effectiveness can be enhanced. More importantly, scientists can explore the possibility of integrating VR-based therapy with artificial intelligence. For instance, researchers can implement artificial intelligence that is primarily used to analyze peoples' psychological emotions and physiological reactions in the VR software or hardware, so that the system can evaluate the dynamic change in users' reactions in real time. With the help of artificial intelligence, researchers may develop more efficient and personalized therapeutic programs.

5. Conclusion

In conclusion, VRT has paved an innovative way for psychological therapies. Numerous studies have found that VR helps patients receive effective treatments by simulating real-life situations linked to their mental diseases that are difficult or impossible to replicate in an office setting. VR therapy sessions can also be delivered with little human interaction, which provides treatment opportunities for patients unable to attend in-person therapy sessions for various reasons, including social anxiety disorder. More significantly, patients have total control over the simulated environment, including the kinds of interactions and stimulation levels, with self-guided VR-based therapies in particular. This may encourage patients to increase their exposure to perceived threats. However, concerns like expensive costs, cybersickness after using VR, and data privacy still exist. Future studies can focus on resolving the current shortcoming, as well as broadening the application of VRT to a wider range of psychological disorders. In addition, researchers can explore the potential of combining artificial intelligence with VRT to increase the effectiveness of treatments.

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