The Efficacy of Augmented Reality in Exposure Therapy

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MSHF 618 Human Factors in Virtual and Simulated Environments

Abstract

This paper explores the application of augmented reality (AR) in clinical psychology, with a particular focus on its integration into exposure therapy for the treatment of anxiety disorders and specific phobias. Unlike virtual reality (VR), AR overlays digital elements onto the real world, creating an immersive but grounded therapeutic experience. The combination of virtual stimuli with the patient's real environment offers a unique opportunity to increase ecological validity and patient engagement. This paper examines the evolution of AR and virtual simulation in exposure therapy, highlighting the efficacy of AR-based approaches, distinct advantages over traditional and VR-based therapies, and the primary challenges associated with implementation. Studies demonstrate that AR exposure therapy (ARET) is effective for treating phobias involving animals, with potential for broader applications. However, technical limitations, data security concerns, and accessibility barriers remain key challenges. This paper aims to contribute to the understanding of AR's therapeutic potential and future implications for mental health treatment, suggesting that continued research and technological advancements are essential for AR to become a widely accessible tool in clinical practice.

The Efficacy of Augmented Reality in Exposure Therapy

Augmented reality (AR) is an interactive experience that incorporates digital information with the real world environment. Unlike Virtual Reality (VR), which creates a fully digital environment that removes users from the real world, AR creates an interactive experience that enhances the real world, rather than replaces it. AR overlays digital content onto the real world, allowing users to control their presence in the environment while interacting with images, animations, or text. AR blends real and virtual elements to enhance the user's perception of the real world, integrating multiple sensations that are perceived as natural elements of the environment. This integration of real and digital makes AR particularly useful for applications where contextual information can be used to improve and inform our understanding of realistic scenarios.

In recent years, the application and popularity of AR has expanded in numerous industries, including entertainment, aviation, healthcare, education, and retail. Heads-Up Displays (HUDS) were originally developed for military aviation, projecting critical flight information directly on the pilot's windshield, allowing pilots to maintain visual awareness while accessing vital information. Classrooms have started to use AR as an educational tool to visualize complex scientific concepts, such as molecules or the solar system, which can be challenging for students to understand through traditional methods. AR is also been used by retailers such as IKEA, Wayfair, and Amazon to complement the retail customer experience through product visualizations and virtual try-ons. The use of AR in healthcare has been particularly exciting, emerging as a tool to aid in education and training, in addition to its application in diagnostics and treatment. The ability of AR to offer surgical students practical training in the absence of a real cadaver can enhance aptitude and proficiency. In addition, studies have shown that AR can be an effective novel technology for treating substance dependence, anxiety disorders, and phobias (Hasan et al., 2023).

This paper will explore the application of AR in clinical psychology, focusing on the integration of AR in exposure therapy to treat mental health disorders and phobias. It examines the evolution of extended reality in the practice of exposure therapy, the efficacy of these treatment plans, AR's distinct advantages that make it well-suited for exposure therapy, and the challenges of integrating AR that must be addressed for effective implementation. Incorporating AR into exposure therapy holds significant promise, with numerous studies offering insights on the affordance of AR to treat mental health. Through a comprehensive literature review, this paper seeks to contribute to the understanding of AR's potential in clinical therapy, and its implications for future interactions between the digital and physical realms.

Exposure therapy is widely regarded as a highly effective treatment for disorders such as anxiety, specific phobias, OCD, and PTSD. However, the effectiveness of exposure therapy has been limited by its accessibility to feared objects/situations in a clinical setting, minimal diversity of exposure options, lack of control over patient behavior, and the limitations of clinical settings to offer real life experiences (Javanbakht et al., 2021). In vivo exposure therapy, also referred to as flooding, is a form of real life behavior therapy that involves directly facing the feared object or situation, using desensitization and the principles of respondent conditioning to treat the phobia. Real life exposure therapy has the advantage of high fidelity, allowing patients to experience their fears in a realistic but safe environment. In vivo exposure is practical in treating phobias that are easily accessible, such as a patient with a fear of heights would be asked to walk across a bridge, or a patient with social anxiety that would be instructed to speak in front of an audience. In situations when in vivo exposure is not feasible, extended reality can safely provide exposure to stimuli, creating environments which may not be suitable in the real world.

Virtual Reality Exposure Therapy (VRET) emerged in the 1990s to treat specific phobias, leveraging virtual reality (VR) technology to create immersive and controlled virtual environments, whereby patients can confront and manage their fears. VRET's level of immersion is dependent on the fidelity of the artificial stimuli, the amount of sensory modalities

activated, and the level of interactions, therein the system's ability to create an immersive experience that can isolate the user from stimuli outside of the virtual environment (Baus & Bouchard, 2014). VRET has shown to be effective in treating phobias such as the fear of flying (aviophobia), fear of heights (acrophobia), social phobia, and animal phobias. VRET allows for a high degree of customization, enabling therapists to adapt the intensity and nature of exposures to accommodate individual needs and progress. The immersive experience that VRET offers, combined with greater scalability and consistency, has often led to higher patient engagement and acceptance than traditional therapies. However, high-quality VR systems can be expensive, and VR headsets can cause some patients to experience motion sickness. Furthermore, the fully virtual experience lacks realism, contributing to the difficulty for a patient to suspend disbelief. This lack of realism can impede the effectiveness of the therapy treatment.

Augmented reality exposure therapy (ARET) emerged as an alternative to VRET, providing higher ecological validity as the feared stimuli is embedded in the user's real environment. The user's ability to physically interact with the virtual stimuli, as opposed to a virtual representation of their body in VRET, creates an experience with higher fidelity, ultimately improving the efficacy of the interventions (Suso-Ribera et al., 2109). The patient is able to maintain their sense of presence in the real world, increasing its authenticity, and eliciting higher realistic judgements of the feared stimuli. The progression from VR to AR usage in exposure therapy can be viewed through the lens of cost and accessibility. VRET systems usually include expensive headsets that require extensive programming, while ARET systems can be made available on the patient's smartphone or tablet, allowing patients access to controlled exposure treatment outside of clinical settings, including from the comfort of their own homes (Baus & Bouchard, 2014) .

An analysis of studies published between 2016 and 2020 showed ARET's promising success in treatment for specific phobias of small animals, in addition to a preference for ARET over VRET in treatment of PTSD (Albakri et al., 2022). AR offers a unique advantage in phobia

treatment by blending realistic digital representations of feared animals into the user's real-world environment, allowing for gradual and tailored exposure without the need for real animals. A study implementing a mobile ARET application, designed to treat arachnophobia, demonstrated that gradual exposure via AR could help individuals desensitize from their fear (Zimmer et al., 2021). The application incorporated a multi-level system, initially showing users non-threatening images of spiders, then progressively increasing the realism, size, and perceived proximity of the virtual spiders, with the final stages involving realistic spiders moving within the user's real-world environment. The application was used to treat adolescents in Peru suffering from arachnophobia, with patients reporting a reduction in their perception of spiders as threats, along with a greater ability to manage stress associated with arachnophobia.

ARET has also been used to treat phobias of insects, snakes, and cats. Patients can be exposed to virtual insects such as beetles or cockroaches, with insects moving across real surfaces, allowing the patient to slowly build comfort with the insects, and enabling patient control on the level of interaction. The insect's proximity and behavior can be adjusted to increase comfort levels gradually. Furthermore, the application of AR has been shown to be effective when using a projection-based ARET (P-ARET) to treat a fear of cockroaches (Palau-Batet et al., 2023). The P-ARET encourages a more natural interaction with the environment, enabling patients to directly confront the cockroaches without intrusive hardware. The results indicated that the P-ARET system is a viable treatment for small animal phobias, comparable with outcomes achieved by similar studies using traditional treatments.

In addition to the studies discussed above, research by Saadet et al. (2023) found ARET as an effective tool in reducing cat phobia when combined with cognitive intervention. Using Microsoft Hololens mixed reality glasses, participants engaged in ARET sessions that simulated realistic encounters with virtual cats. Each participant was exposed to a tailored hierarchy of fear, gradually exposing them to the feared stimuli. The results showed that ARET, combined with cognitive intervention, significantly reduced the severity of the cat phobia and anxiety

related to encounters with cats. Significant improvements were especially evident post-ARET, suggesting exposure to be the key component in reducing phobia. Participants reported that virtual interactions with cats felt real, triggering genuine fear responses similar to actual encounters. The structured, gradual exposure through AR allowed participants to engage with their fears progressively, reinforcing confidence and enabling real-life application of coping skills. Participants highlighted safety in a controlled environment, combined with improved treatment adherence, ultimately led to faster therapeutic outcome. However, participants noted challenges with equipment weight, limited scenario variations, and the absence of physical contact with virtual animals, restricting full desensitization to real cat interactions.

Since its inception, AR has evolved significantly, driven by advances in hardware such as smartphones and smart glasses, as well as improvements in processing power, graphics rendering, and real-time data analysis. Cameras on smartphones, tablets, or AR glasses can scan the real environment and feed this data to the AR system, displaying digital information that is overlaid onto the user's view of the real world. Some AR devices, such as Microsoft HoloLens, are mounted on the head while others are handheld. Depending on the type of AR experience, users can interact with digital content through touchscreens, gestures, or voice commands. ARET can be an affordable and accessible alternative to in-vivo exposure, especially for patients with phobias that are difficult or costly to recreate safely. ARET can provide patients with high-quality exposure therapy at a fraction of the cost.

Integrating augmented reality into exposure therapy holds considerable potential for the treatment of phobias, but there must be consideration of the challenges and technical limitations of its implementation. Many AR applications require specific hardware, such as AR-compatible smartphones, tablets, or headsets. This can limit accessibility for patients who may not have access to these devices, especially if high-quality AR headsets are needed to provide immersive experiences. Developing realistic and responsive ARET applications tailored to different phobias or anxiety triggers is a complex and resource-intensive process, with individual

therapy needs as a necessary component of developing the technology, which can require frequent software updates and adjustments. For AR to be effective in exposure therapy, the virtual elements must align accurately with the real-world environment. The presence of lag or calibration issues can quickly disrupt the experience, reducing immersion, and potentially increasing anxiety rather than helping to manage it.

Ethical considerations regarding the application of AR in clinical settings include the collection of user data, biometric information, environmental data, and potentially sensitive patient interactions. Protecting patient data is critical to maintaining patient confidentiality and trust, thereby requiring secure storage and adherence to patient confidentiality regulations. Therapists must also be trained in using AR technology, ensuring that therapists understand its capabilities and limitations, and emphasizing the ethical and effective usage of AR. Furthermore, patients using AR outside a clinical setting pose a risk of becoming overly distressed, and the absence of immediate support from a therapist can lead to negative outcomes.

In conclusion, augmented reality demonstrates significant potential as an innovative tool in clinical exposure therapy, especially for treating specific phobias and anxiety disorders. Its unique capability to blend digital elements with the real world offers a high level of ecological validity and authenticity, allowing patients to engage with their fears in a safe yet realistic environment. Studies highlight the efficacy of AR in improving patient outcomes, with advantages such as flexibility, accessibility, and user engagement. However, challenges remain, including the need for accessible AR-compatible hardware, precise calibration, and strict data security protocols to protect patient confidentiality. Overcoming these technical and ethical barriers will be crucial to integrating AR as a standard option in therapeutic settings. Continued research and technological advancements in AR can potentially transform exposure therapy, offering a scalable, customizable, and highly immersive approach to mental health treatment.

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