Can You Feel It?
Effectiveness of Anxiety Cues for the Design of Virtual Reality Exposure Therapy

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ABSTRACT

Virtual reality exposure therapy (VRET) has been widely acknowledged as an effective alternative for in vivo exposure therapy (iVET). So far, previous research focused on long- and short-term effectiveness and comparisons to iVET, whereas the impact of design choices is understudied. Hence, the present study focuses on the effectiveness of several types of anxiety cues for the manipulation of anxiety. More specifically, five interoceptive cues (i.e., "fake" bodily sensations for tunnel vision, light flickering, heartbeat audio, blurred vision, and dizziness) and a physical cue (i.e., heat stimulation) are implemented in the VRET design of a within-subjects experiment with people who have claustrophobic and panic tendencies (N = 24). Results show that adding interoceptive cues significantly increased reported levels of anxiety, independent of the type of interoceptive cue. However, introducing a physical cue in VRET can also be effective but has no real added value when combined. Studies focusing on the design of anxiety cues can be valuable in understanding the effectiveness of VRET.

KEYWORDS

Anxiety Cues, Effectiveness, Perceptual Cue Stimulation, Physical Heat Stimulation, Virtual Reality Exposure Therapy

INTRODUCTION

Virtual reality exposure therapy (VRET), which uses computer-generated images to immerse patients in a phobic situation, has been widely accepted as an effective alternative to one of the most efficient techniques to treat anxiety disorders in clinical psychology: in vivo exposure therapy or real-life exposure therapy (iVET) (Anderson et al., 2013; Botella et al., 2016; Bouchard et al., 2017, Carl et

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al., 2019; Freitas et al., 2021; García-Palacios et al., 2007; Raghav et al., 2016). iVET, by its nature, results in a direct confrontation with patients' fear stimuli in real-life, which can have greater financial and practical implications (e.g., having to take a plane in case of fear of flying or gathering a lot of people for social phobia related to for example public speaking). VRET is a more cost-effective alternative and has the opportunity for creating more controlled and complex interactions with different scenarios and in a safer environment (Boeldt et al., 2019; Bouchard et al., 2017). Moreover, some phobic patients even prefer VRET and clinicians have also reported positive attitudes towards adoption of VRET (Boeldt et al., 2019; García-Palacios et al., 2007, Ma et al., 2021; Rimer et al., 2021, Yoones et al., 2017). VRET can thus lower the threshold by simulating the real world and serve as an intermediate step in a psychologist's workspace before implementing iVET.

Crucially, a key element that must be present in all exposure exercises in order to have an effective psychotherapy, is the repeated confrontation with patients' fear-eliciting stimuli. Although there are many published studies assessing the effectiveness of VRET on both long- and short-term (see meta-analysis papers from Fodor et al., 2018; Opris et al., 2012, Carl et al., 2019), there are only a few about the impact of design elements in the virtual environment on anxiety psychotherapy. These design choices (such as different kinds of anxiety stimuli, or different levels of a virtual scenario) are, however, of utmost relevance for developing effective, evidence based VRET environments, preferably in collaboration with software developers, therapists, and patients.

User experience tests should be an essential part when developing a new VRET tool or when transferring a specific effective VRET treatment to another anxiety domain, providing specific design guidelines (Mozgai et al., 2020). For example, Igras-Cybulska et al. (2020) gathered feedback on different existing VR applications for fear of public speaking and found out that the 'responsiveness of the crowd' is an important design factor. Another interesting example is the inclusion of multisensory cues (visual + auditory + tactile + olfactory), as this has a great impact on the feeling of presence and immersion, which consequently has an impact on the effectiveness of fear elicitation, as reported by end-users (Peperkorn & Mühlberger, 2013; Marquardt et al., 2018; Song et al., 2021). Also, when designing VRET, the possibility of combining the treatment with other complementary elements of effective methods such as serious games (with different levels and challenges) could be considered, enabling the interaction with anxiety cues and the feeling of presence (Levy et al., 2016; Rizhan et al., 2021), as tested by Yoones et al. (2017) through the comparison of an active vs passive virtual scenario in eliciting social anxiety. However, when focusing on the impact of implementing different types of perceptual cues and configurations in VRET, this is usually not assessed. The present study will focus on design elements such as different kinds of anxiety cues and their exposure duration, which likely impact the fear elicitation in VRET, with people that have claustrophobic and panic tendencies.

VRET Design and Perceptual Fear Elicitation

Virtual reality exposure therapy relies on the assumption that fear is elicited, which happens through two pathways: a perceptual pathway and a conceptual pathway. In the perceptual pathway, fear is elicited by rather sensory-related fear-evoking cues (i.e., visual, auditory, touch, smell sensations), while in the conceptual pathway, fear is elicited by fear-related semantic information (Shiban et al., 2016). VRET mainly relies on perceptual cues to elicit fear, as it immerses the patient in a computer-generated environment or a 360-degree filmed video recording. However, it also offers the opportunity to use the conceptual pathway, by informing the patient about a feared object or situation outside the VR environment, even though less effective (Diemer et al., 2015). Current VRET environments offer the opportunity for psychotherapists to mainly manipulate the perceptual cues, creating the possibility to choose different scenarios or configurations, or even configure the environment itself before or during an exercise (Martijn et al., 2002). Typical configuration options are related to situational elements (e.g., underground, elevator, MRI, corridor, cave, basement, tunnel, maze) (Christofi and Michael-Grigoriou, 2016; Malbos et al., 2008; Rahani, Vard & Najafi, 2018), spatial elements (e.g., the size or openness of a room) (Bruce & Regenbrecht, 2009; Christofi & Michael-Grigoriou,

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