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Recent advances in virtual reality therapy for anxiety and related disorders: Introduction to the special issue

We are very excited to be co-editing this special issue of the *Journal of Anxiety Disorders* devoted to research using virtual reality (VR) to treat anxiety. We published the first report using VR to treat a psychological or psychiatric disorder in 1995 (Rothbaum et al., 1995). Conventional wisdom claims it takes about 20 years for a discovery published in the scientific literature to gain more widespread use, and that puts us about where we are! VR is an interactive computer environment that allows the user to experience a sense of presence within that environment. The user typically wears a head-mounted-display that includes two little television screens in front of each eye, headphones, and a position tracker so that the view changes in real time with head motion. Many environments use a hand held device ("joystick") to maneuver the virtual environment; for example, to push a virtual button in a virtual elevator, or to drive a virtual Humvee.

The early studies established the efficacy of VR exposure therapy (VRE) for a number of anxiety and related disorders (Powers & Emmelkamp, 2008) starting with the fear of heights (Rothbaum et al., 1995) and the fear of flying (Rothbaum, Hodges, Smith, Lee, & Price, 2000) and then posttraumatic stress disorder (PTSD; Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001). With the reports included in this special issue, the maturity of VR for use with anxiety is evident. We open the special issue with three meta-analyses of different aspects of VR: deterioration rates, retention rates, and efficacy. It is noteworthy that the field has matured sufficiently to warrant *three* meta-analyses and on different aspects! We move next to enhancements in the treatment of specific phobias using enhanced 3D, 360°-video, and one session treatment. The remainder of the special issue is devoted to PTSD and includes the application of VRE for a new population of PTSD sufferers, the examination of trauma management therapy with and without VRE, a comparison of engagement in VRE to prolonged imaginal exposure (PE), and ends with reports of adding novel pharmaceutical agents to treatment with VRE, d-Cycloserine (DCS) and dexamethasone.

First, Fernández-Álvarez et al. (2018) conducted an individual patient data level meta-analysis of deterioration rates in VR trials. Overall, they found that deterioration rates were 4% for VR and 2.8% in active control conditions, which were both significantly lower relative to waitlist conditions (15%). Second, Benbow and Anderson (2018) conducted a meta analysis of attrition rates in VR versus in vivo exposure for anxiety. Overall, they found that dropout rates were not significantly different between VR and in vivo exposure. The attrition rate for VR was 16% and between session homework reduced overall dropout. Third, Carl et al. (2018) conducted a meta analysis of 30 randomized controlled trials with 1057 participants. They found a large effect size for VRE versus waitlist ($g = 0.90$) and a medium to large effect size for VRE versus psychological placebo conditions ($g = 0.78$). A comparison of VRE and in vivo conditions did not show significantly different effect sizes ($g = -0.07$).

Fourth, the randomized controlled trial (RCT) by Minns et al. (2018) is an interesting application using stereoscopic 3-D film, and the creation of the 3-D video is excellent! The authors included a BAT (behavioral avoidance test) with a live spider. Consistent with prediction, the stereoscopic 3D film VR condition was significantly more effective than the waitlist condition in reducing fear of spiders. This provides initial support for stereoscopic 3D film VR in treating phobias. Fifth, the Lindner et al. (2018) RCT compares therapist and internet one-session therapy for public speaking anxiety in a very nice design with a very good treatment that answers several questions within the same efficient study. They test off-the-shelf VR hardware that could potentially translate into routine clinical practice easily, examining long-term effects at six months. They show for the first time that low-cost, off-the-shelf consumer VR hardware is effective for public speaking anxiety, both in the traditional, previously impractical one-session format, and in a novel self-led, at-home format.

Sixth, while the thought of using VRE with survivors of military sexual trauma (MST) may have most people cringing, Loucks et al. (2018) demonstrate in a feasibility trial how it can be a useful tool in exposure therapy. Notably, they do not expose the patient to a virtual perpetrator, just to their own memory, matching the setting in the VR. Consistent with prediction, they showed significant decreases in PTSD symptoms, psychophysiological indices, and nonverbal markers. Seventh, Beidel et al. (2017)) conducted a RCT of VRE with Trauma Management Therapy (TMT) relative to VRE alone. Overall, VRE was effective for PTSD, depression, and anger. VRE + TMT showed a distinct advantage at reducing social isolation. Neither treatment group was effective for sleep symptoms. Eighth, Reger et al. (2018) compared the subjective distress of 108 active duty soldiers during exposure who were randomized to PE (prolonged imaginal exposure) or VRE. For both groups, between session habituation was associated with greater decreases in the CAPS-W scores. However, between session habituation was not significantly different between VRE and PE conditions. In addition, subjective distress and overall treatment response were not significantly different between VRE and PE. This represents one of the few controlled comparisons of PE and VRE. Ninth, Peskin et al. (2018) explored the temporal relationship between PTSD and depressive symptoms in an RCT comparing D-Cycloserine- (DCS) to placebo-augmented VRE therapy for chronic World Trade Center-related PTSD following the September 11, 2001 terrorist attacks. Overall, DCS significantly augmented the effect of VRE for PTSD relative to placebo. In addition, reductions in PTSD symptoms led to subsequent reductions in

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depressive symptoms to a greater extent than the converse. For example, reductions in PTSD symptoms in the DCS-enhanced VRE treatment mediated 50% of changes in depressive symptoms. The results suggest VRE primarily reduces PTSD symptoms and that this reduction in PTSD symptoms leads to subsequent reductions in depressive symptoms. Finally, the study by Maples-Keller et al. (2018) offers a caution when translational findings do not translate to the clinic. The study was well conceived and built on animal and human studies, but found using dexamethasone prior to VRE in PTSD combat veterans was associated with significantly higher dropout from treatment.

In conclusion, the meta-analyses in this special issue show: a) VRE significantly outperforms waitlists (large effect size) and psychological placebo conditions (medium to large effect sizes), b) dropout rates for VRE are not significantly different relative to in vivo treatment, and c) deterioration rates for VRE are significantly lower than waitlist conditions. The six RCTs showed that a) stereoscopic 3D film VR can be effective for treating specific phobias, b) consumer VR is effective for public speaking anxiety in both clinic and self-led home formats, c) VRE can be safe and effective for treating military sexual trauma, d) VRE alone is effective for PTSD, depression and anger while VRE with Trauma Management Therapy also reduces social isolation, e) VRE shows roughly equivalent between-session habituation and overall response to PE, and d) DCS augments VRE exposure resulting in reduced PTSD symptoms that subsequently lead to reductions in depression. Finally, a feasibility trial showed that, contrary to previous translational findings, dexamethasone prior to VRE was not more effective than placebo augmentation and resulted in significantly higher dropout rates.

This special issue provides an updated picture of the current status of VR research. This is merely the beginning of an explosion in potential provided by ever increasingly sophisticated technology brought to bear for improved mental health. We hope it will generate more innovation and discussion in the field.

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