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Review

Virtual reality exposure therapy for the treatment of anxiety disorders: An evaluation of research quality

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ABSTRACT

Randomized controlled trials (RCTs) support the effectiveness of virtual reality exposure therapy (VRET) for anxiety disorders; however, the overall quality of the VRET RCT literature base has yet to be evaluated. This study reviewed 27 VRET RCTs and the degree of adherence to 8 RCT research design criteria derived from existing standards. Adherence to the study quality criteria was generally low as the articles met an average 2.85 criteria (SD = 1.56). None of the studies met more than six quality criteria. Study quality did not predict effect size; however, a reduction in effect size magnitude was observed for studies with larger sample sizes when comparing VRET to non-active control groups. VRET may be an effective method of treatment but caution should be exercised in interpreting the existing body of literature supporting VRET relative to existing standards of care. The need for well-designed VRET research is discussed.

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Contents

1. Introduction

With a lifetime prevalence rate for anxiety disorders at 28.8% (Kessler et al., 2005), research demonstrating efficacious therapeutic interventions for such disorders has the potential to benefit a large population. Cognitive behavioral therapy (CBT) is considered one of the most effective treatments for anxiety disorders (Arch & Craske, 2009; Norton & Price, 2007). Exposure therapy (ET) is an effective CBT component for the treatment of many anxiety disorders including posttraumatic stress disorder (PTSD; (Institute of Medicine of the National Academies, 2007; Rothbaum & Schwartz, 2002), panic disorder (Marks et al., 1993), generalized anxiety disorder (Stanley et al., 2009), obsessive compulsive disorder (Foa et al., 2005), and specific phobias (Davidson et al., 2004). The ET is accomplished through in vivo and imaginal exposure, which involves the confrontation of feared but objectively safe stimuli, situations, or memories. The use of multi-sensory virtual reality (VR) has been proposed as a cost-effective and logistically convenient clinical tool for ET, relative to traditional in vivo exposure procedures (Rothbaum et al., 2006). It has also been proposed as an exposure technique for those who

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may fail to effectively activate fear networks (Difede & Hoffman, 2002), which is deemed necessary to achieve a therapeutic effect (Jaycox, Foa, & Morral, 1998).

The VR incorporates computer graphics, visual displays and sensory inputs to create an immersive virtual environment that facilitates the psychological sense of participating in the computer world. Given that VR permits the creation of customized virtual environments, this modality lends itself well to ET. Prior research has studied the use of VR to treat a range of anxiety disorders to include fear of flying, social phobia, panic disorder, and PTSD (Choi et al., 2005; Difede et al., 2007; Klinger et al., 2005; Maltby, Kirsch, Mayers, & Allen, 2002; Reger et al., 2011).

Three meta-analyses conducted on VRET for anxiety disorders have concluded that VRET is superior to waitlist control and no difference relative to active treatments (Opriş et al., 2012; Parsons & Rizzo, 2008; Powers & Emmelkamp, 2008). Similarly, Meyerbröker and Emmelkamp (2010) concluded in a narrative review that VRET is a promising treatment for anxiety disorders; however, the authors noted that the literature base for this treatment would benefit from studies with stronger methodologies. Additional concerns have been raised about the quality of the current VRET literature due to the use of small sample sizes, and a lack of breadth and uniformity in the reporting of data (Parsons & Rizzo, 2008). While concerns about the quality of VRET studies have been raised, the quality of this literature has yet to be assessed in a systematic way.

A previous study reviewed the literature on psychotherapy for depression (Cuijpers, van Straten, Bohlmeijer, Hollon, & Andersson, 2010) and found that the studies rated as being of high quality reported smaller treatment effect sizes compared to low quality studies. The authors concluded that while the effects of psychotherapy for depression remain significant, meta-analyses have over-estimated the effects of this intervention. Cuijpers et al. posited that this over-estimation is largely due to the "inadequately rigorous methods" found in the literature.

The primary goal of this study is to systemically evaluate the quality of the VRET literature, quantify the extent to which quality research design characteristics were present, and to examine whether or not study quality relates to treatment effect size. Toward this end, the eight criteria laid out by Cuijpers et al. (2010) were applied to randomized-controlled trials (RCTs) conducted to evaluate VRET for the treatment of anxiety disorders. An additional goal of this study was to assess for a change in VRET RCT study quality and treatment effect size over time. It is possible that as VRET has become a more established treatment over the last two decades, the quality and effect size values associated with the VRET RCTs have increased and decreased, respectively. Finally, an analysis was conducted to assess for a relationship between sample size and effect size. It was hypothesized that there would be a negative relationship between study quality and effect size, that study quality of VRET RCTs would improve over time, and that there would be a negative relationship between sample size and effect size.

2. Method and materials

Inclusion criteria for reviewed articles were: a randomized total sample size equal to or greater than ten, at least two different comparison groups with an active or inactive control condition and at least one VR condition, report of interval or ratio data, use of an anxiety outcome measure, and written in English. Studies were excluded if a non-clinical population was employed. Databases searched included PsycINFO, PubMed, MEDLINE, Academic Complete, Cochrane, and EMBASE. Keywords used to search were: "virtual reality" and "treatment"; "specific phobia"; "generalized anxiety disorder"; "obsessive compulsive disorder"; "anxiety"; "posttraumatic stress disorder"; "claustrophobia"; "driving"; "flying"; "aviophobia"; "panic"; "acrophobia"; "agoraphobia"; "social phobia"; "spiders"; "arachnophobia"; "public speaking"; "heights"; and "insects." "Virtual reality" was individually paired with each of the above terms to encompass as many articles as possible. Articles were also identified for inclusion by way of review of VR article reference sections.

2.1. Procedure

Twenty-seven articles met inclusion criteria and were coded independently by two psychologists. The two coders were blind to each other's ratings. Articles were coded for the presence of Cuijpers et al. (2010) eight quality criteria, which were based on Chambless and Hollon's (1998) review of empirically supported psychotherapies and the Cochrane Collaboration's (Higgins & Green, 2011) criteria on study methodology. The eight quality criteria required: 1) that participants met diagnostic criteria for an anxiety disorder according to a personal diagnostic interview; 2) use of a treatment manual; 3) providers received treatment specific training; 4) treatment fidelity was evaluated throughout the study; 5) intent-to-treat analyses were used; 6) the comparison of treatment and control included $\geq$50 participants; 7) a third party independent to assessment and treatment conducted randomization, and; 8) assessors were blind to condition. Each criterion was evaluated for each article and assigned either 1 point (if the study fit the criterion) or 0 points (if the study did not fit the criterion). Quality criterion adherence was not assumed or inferred. Items were only coded as 1 if the information was explicitly stated in the article. After the coders rated each article, they met with two additional investigators to resolve any rating discrepancies and reach consensus.

2.2. Analyses

To determine which variable from each study would be used to calculate an effect size, articles were first organized into groups by diagnosis treated. Primary outcome measures within diagnostic criteria were then identified and these values were used when available in articles. If an article did not use the modal measure for its diagnostic category, behaviorally anchored outcome measures of avoidance were used, after which the first measure reported in Section 3 germane to the diagnosis became the variable of focus. If data were only available for one outcome measure, that variable was used. Finally, measures were only included in the effect size calculation and the related analyses when sufficient data were reported to calculate an effect size. Four of the 27 articles met inclusion/exclusion criteria but did not report sufficient information to calculate an effect size. Accordingly, these studies were included in the review of quality criteria but excluded from the effect size analyses.

Given the small sample sizes of the included studies, Hedge's g effect sizes were estimated to correct for small-sample bias (Deeks, Altman, & Bradburn, 2001). The primary goal of the analysis was to examine the magnitude, not the direction, of effect sizes as a function of study quality. To that end, the absolute value of the effect size estimates was used as the outcome in the analysis. Weights for each study were calculated using the inverse variance. We used meta-regression to compare the difference in the average effect size magnitude between groups based on quality score and total sample size. We used a joint effects exposure definition to separate the effects of study quality and total sample size. This allowed us to examine the association between study quality and average effect size within strata of total sample size, and vice versa. To account for nonindependence of studies that reported comparisons with both an active and a non-active comparison

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