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Can virtual reality exposure therapy gains be generalized to real-life? A meta-analysis of studies applying behavioral assessments

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ABSTRACT

In virtual reality exposure therapy (VRET), patients are exposed to virtual environments that resemble feared real-life situations. The aim of the current study was to assess the extent to which VRET gains can be observed in real-life situations. We conducted a meta-analysis of clinical trials applying VRET to specific phobias and measuring treatment outcome by means of behavioral laboratory tests or recordings of behavioral activities in real-life. Data sources were searches of databases (Medline, PsycInfo, and Cochrane). We included in total 14 clinical trials on specific phobias. Results revealed that patients undergoing VRET did significantly better on behavioral assessments following treatment than before treatment, with an aggregated uncontrolled effect size of $g = 1.23$. Furthermore, patients undergoing VRET performed better on behavioral assessments at post-treatment than patients on wait-list ($g = 1.41$). Additionally, results of behavioral assessment at post-treatment and at follow-up revealed no significant differences between VRET and exposure in vivo ($g = -0.09$ and 0.53, respectively). Finally, behavioral measurement effect sizes were similar to those calculated from self-report measures. The findings demonstrate that VRET can produce significant behavior change in real-life situations and support its application in treating specific phobias.

1. Introduction

In the last two decades, virtual reality exposure therapy (VRET) has been increasingly applied in treating individuals with anxiety disorders, in particular specific phobias. The therapeutic goals in VRET are based on treatment strategies used in behavior therapy while making use of virtual worlds that resemble feared real-life situations. Accordingly, virtual worlds are used to enable systematic exposure to feared stimuli within a contextually relevant situation. The advantage of using VRET rather than exposure in vivo (i.e., carried out in real-life situations) or imaginal exposure (i.e., carried out through imagination) lies in the possibility of controlling the quality, intensity, duration and frequency of exposure (Emmelkamp, 2005). VRET integrates real-time computer graphics, body tracking devices, visual displays and other sensory inputs to immerse individuals in computer-generated virtual environments. As a result, the perception of an interactive, three-dimensional world is constructed. The control of exposure elements might be more manageable than in exposure in vivo or imaginal exposure as the stimuli eliciting anxiety can be more easily modified and manipulated by therapists.

Three published meta-analyses have reviewed the literature on the efficacy of VRET for anxiety disorders. First, in a meta-analysis on the efficacy of VRET as compared to control conditions, Powers and Emmelkamp (2008) included 13 studies (nine on specific phobias, two on social phobia, one on panic disorder, and one on post-traumatic stress disorder). The authors reported an overall controlled effect size (ES) of 1.11 for the efficacy of VRET as assessed with self-report measures. Furthermore, the authors concluded that in vivo interventions were not significantly more effective than VRET. Lastly, the authors reported on two studies on specific

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phobias that had assessed treatment efficacy on behavioral measures (Garcia-Palacios, Hoffman, Carlin, Furness, & Botella, 2002; Krijn et al., 2004) and those showed a mean effect size of 1.27 as compared to wait-list. Next, Parsons and Rizzo (2008) conducted a meta-analysis with clinical and non-clinical samples coming from 12 trials on specific phobias, four on social phobia, three on agoraphobia, and two on post-traumatic stress disorder (i.e., a total of 21 trials). The authors conducted uncontrolled effect-sizes only and reported an overall pre-vs. post-treatment ES of 0.95. Parsons and Rizzo did not specifically report on the nature of the assessment instruments used in the included studies. Finally, a recent meta-analysis by Opris et al. (2012) included 23 studies that compared virtual reality interventions for anxiety disorders with an evidence-based intervention. Here too, the majority of the included trials were on specific phobias (n = 12) and the remaining trials were on social phobia (n = 5), panic disorder with or without agoraphobia (n = 5), and post-traumatic stress disorder (n = 1). The authors reported an overall ES of 1.12 for eight studies comparing VRET with wait-list conditions as measured with self-reports. Additionally, they reported no overall difference between VRET and cognitive behavior interventions at post-treatment ($k = 15$) and at 3–6 months follow-up ($k = 7$) on self-report measures. Opris et al. (2012) also reviewed the results of studies comparing VRET with cognitive behavior interventions on behavioral assessments. They included eight studies at post-treatment and four studies at follow-up and reported an overall effect size of −0.03 and 0.24 respectively, indicating that there is no evidence for a difference between VRET and cognitive behavior interventions on behavioral assessments. However, it must be noted that the generalization of the findings of this meta-analysis regarding the extent to which VRET gains can be observed in real-life situations is rather limited. First, the authors included both studies with clinical as well as non-clinical samples. Furthermore, they focused on what they labeled "virtual reality exposure enhanced evidence-based interventions" and consequently they included clinical trials that had applied VRET within a larger package of behavioral interventions. For example, in one of the included studies, VRET sessions had consisted of less than half of total amount of the offered sessions (Penate, Pitti, Manuel Bethencourt, de la Fuente, & Gracia, 2008) and one can argue that any measured change in this study might be a result of other parts of treatment than VRET. Additionally, in line with the focus of the meta-analysis by Opris et al. on how effective virtual reality enhanced interventions are compared to evidence-based interventions, the authors excluded VRET trials that had not compared VRET to evidence-based interventions, yet still had included observable behavioral outcomes, such as the study by Garcia-Palacios et al. (2002) that was included in the meta-analysis by Powers and Emmelkamp (2008).

In summary, previous meta-analyses on the efficacy of VRET for anxiety disorders have primarily focused on self-reports of inner states rather than behavioral laboratory tests or behavioral activities in real-life. In general, the increasing reliance on self-reports of inner states and thus the decreasing use of behavioral assessments and observations in psychology has been criticized (Baumeister, Vohs, & Funder, 2007; Furr, 2009). In fact, our knowledge about the efficacy of psychotherapy in general can be enhanced if both self-reports of inner states as well as behavioral tasks and observations of daily life activities are applied to better assess the impact of interventions in changing behavior. This seems particularly relevant with regard to VRET given that this approach makes use of virtual environments to treat psychological complaints rather than real life situations. Accordingly, it is relevant to examine the extent in which VRET has the potential to produce behavioral change that can be observed in daily life. For example, with regard to fear of spiders, self-reports of inner states would rather focus on thoughts, emotions and attitudes associated with fear of spiders. Yet, as the ultimate aim of treatment is to help clients with fear of spiders to better cope when confronted with spiders, we also need to assess how clients are coping with the specific situation in question on the behavioral level.

In sum, previous meta-analyses have shown that VRET is effective in treating anxiety disorders as measured by self-reports. However, as clients undergoing VRET get exposed to feared stimuli within virtual environments, it seems essential that we have a better understanding of the generalization of treatment effects in real-life situations. The aim of this study was to provide an updated and comprehensive systematic review and meta-analysis of the extent in which VRET gains can be transferred to real-life. We aimed at including studies on the efficacy of VRET as measured in behavioral laboratory tests (such as approaching a real spider or speech length in minutes) or behavioral activities in real-life (such as having flown in the past six months). We hypothesized first that VRET would lead to significant uncontrolled changes as measured in behavioral laboratory tests or behavioral activities in real-life. Second, we hypothesized that VRET would outperform inactive control conditions on these behavioral assessments. Finally, we hypothesized that there would be no significant difference between VRET and in vivo conditions on behavioral laboratory tests or behavioral activities in real-life.

2. Method

2.1. Identification and selection of studies

The criteria for including studies into the current meta-analysis were: 1) participants were diagnosed with an anxiety disorder according to DSM or ICD criteria; 2) a virtual reality-based intervention was applied to address core symptoms of the relevant psychological disorder; 3) at least 50% of treatment consisted of virtual reality-based interventions; 4) at least ten patients were treated in the virtual reality condition; and 5) efficacy of treatment was assessed with some sort of behavioral laboratory tests or behavioral activities in real-life. If a publication did not provide enough data to calculate effect-sizes, its authors were contacted by e-mail to retrieve the data. After two contact-attempts, the studies were excluded if the authors did not respond with sufficient data to perform the meta-analysis. No restrictions were made upon publication language.

We searched the following databases: PsycINFO, MEDLINE, and Cochrane. The last search was conducted on March 04, 2014 and included the following search terms: "virtual reality" alone and in combination with "treatment" or "intervention" or "therapy" or "psychotherapy" or "exposure" or "trial". The search string yielded 335 hits. When duplicate publications were removed, 165 publications remained. An examination of the abstracts led to the exclusion of 105 studies that were evaluated as irrelevant. The evaluation of the full text of the remaining 60 publications led to the exclusion of 45 publications. Of the remaining 15 publications, 14 were conducted with patients with specific phobia and with patients with social anxiety disorder (Anderson et al., 2013). Given this outcome, we decided to focus on trials on specific phobias only. Fig. 1 presents a flow diagram of the study selection process. As shown in Fig. 1, publications were excluded for a variety of reasons, including three publications that did not report enough data to be included in our meta-analysis (Anderson et al., 2006; Bouchard et al., 2011; Kahan, Tanzer, Darvin, & Borer, 2000).

2.2. Quality assessment

All studies were rated with a methodology rating form for