Virtual Reality Exposure Therapy for Anxiety and Specific Phobias

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Thomas D. Parsons
University of North Texas, USA

INTRODUCTION

There is a growing body of research indicating the multiple ways that affective dysregulation (e.g., anxiety disorders, specific phobias, panic disorder, and post-traumatic stress disorder (PTSD)) may lead to significant impairments in normal life functioning. Anxiety and fear are concentrated emotional experiences that serve critical functions in organizing necessary survival responses (Fendt & Fanselow, 1999). In properly functioning affective systems, the responses are adaptive. LeDoux (2012a) posits survival circuits that enable humans to adapt to feared stimuli by organizing brain functions. The fear induced arousal and activation of survival circuits allows for adaptive responses to take priority and other responses are inhibited. Further, attentional processing focuses on pertinent environmental stimuli and learning occurs (Scherer, 2000; LeDoux, 2012b). Hence, adaptive survival circuits are optimized to detect threatening stimuli and relay the information as environmental challenges and opportunities. The adaptive survival circuits use this information to adjust behavioral and psychophysiological responses for appropriate adaptation and resolution. Excessive fear responses, however, can be restrictive and may be a sign of dysregulated anxiety. When exposure to stress occurs early in development and is repeated in persons with a particular genetic disposition, a decreased threshold for developing anxiety may result (Heim & Nemeroff, 1999). Further, over-excitation and deprivation can influence the affective system and may induce changes in the emotional circuitry of the brain that can contribute to stress-related psychopathology (Davidson, Jackson, & Kalin, 2000).

A good deal of research has shown that exposure therapy is effective for reducing negative affective symptoms (Rothbaum & Schwartz, 2002). In vivo exposure therapy has been found to have greater efficacy when compared to imaginal exposure, especially in the treatment of specific phobias (Emmelkamp, 2003). Exposure to emotional situations and prolonged rehearsal result in the regular activation of cerebral metabolism in brain areas associated with inhibition of maladaptive associative processes (Schwartz, 1998). Identical neural circuits have been found to be involved in affective regulation across affective disorders (De Raedt, 2006; Mineka, Watson, & Clark, 1998). Systematic and controlled therapeutic exposure to phobic stimuli may enhance emotional regulation through adjustments of inhibitory processes on the amygdala by the medial prefrontal cortex during exposure and structural changes in the hippocampus after successful therapy (Hariri, Bookheimer, & Mazziotta, 2000).

A novel tool for conducting exposure therapy is virtual reality exposure therapy (VRET), in which users are immersed within a computer-generated simulation or virtual environment (VE) that updates in a natural way to the user's psychophysiological arousal, head and/or body motion (Parsons and Courtney, 2011, Parsons and Reinebold, 2012). Virtual environment applications that focus on treatment of affective (see Powers & Emmelkamp, 2008; Parsons et al., 2008a; Opris et al., 2012) and cognitive disorders (see Rose et al., 2005; Parsons 2009a) as well as assessment of component cognitive processes are now being developed and tested: attention (Parsons, et al., 2007, 2011) spatial abilities (Beck et al., 2010; Goodrich-Hunsaker and Hopkins, 2010; Parsons, et al., 2013), memory (Moffat, 2009; Parsons & Rizzo, 2008b; Parsons et al., 2013; Knight & Titov, 2009), spatial memory (Parsons et al., 2013); and executive functions (Armstrong et al., 2013; Henry et al., 2012; Parsons et al., 2012, 2013, 2014). The increased ecological validity of virtual scenarios may aid differential diagnosis and treatment planning. Within a virtual world, it is possible to systematically present cognitive tasks targeting neuropsychological performance beyond what are currently available using traditional methods (Parsons, 2011, 2012).

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When users are immersed in a VE, they can be systematically exposed to specific affect inducing stimuli within a contextually relevant setting (Parsons et al., 2009a). VRET comports well with the emotion-processing model, which holds that the fear network must be activated through confrontation with threatening stimuli and that new, incompatible information must be added into the emotional network (Foa and Kozak, 1986; Wilhelm et al., 2005). Although cyberpsychology researchers contend that VRET has been shown to be efficacious, a potential problem in interpreting and reconciling findings about the nature and extent of affective changes ensuing from VRET is that the vast majority of VRET studies have reported on small sample sizes and made use of inadequate null hypothesis significance testing. Until large-scale studies on the affective effects of VRET are published, statistical meta-analyses represent an interim remedy. Regrettably, the majority of VRET trials to date have made use of a range of different outcome measures (see Parsons and Rizzo, 2008a; Powers & Emmelkamp, 2008; Opris et al., 2012). This article proffers potential resolutions to clinical heterogeneity of the outcome measures and inadequate reporting of results for VRET trials.

BACKGROUND

Empirical data from research assessing the efficacy of VRET on affective outcomes have been increasingly emerging over the last 10 years as VR systems have become less costly, more available and generally more usable. While much of the initial VRET research has been comprised of case studies, open clinical trials, and uncontrolled designs, a number of qualitative reviews (Botella et al., 2004; Glantz & Rizzo, 2003; Hodges et al., 2001; Krign et al., 2004a; Pull, 2005) and more recently quantitative reviews (Parsons and Rizzo, 2008a; Powers & Emmelkamp, 2008; Opris et al., 2012) of VRET have concluded that VRET has good potential as a treatment approach for anxiety and several specific phobias.

A potential problem in interpreting and reconciling findings about the nature and extent of affective changes ensuing from VRET is that a number of factors other than virtual reality exposure per se may be associated with such changes, including, for example, presence, immersion, anxiety and/or phobia duration, diagnostic groups, demographics (e.g. age, gender, and ethnicity). Furthermore, the vast majority of VRET studies have reported on small sample sizes and made use of inadequate null hypothesis significance testing. Until large-scale studies on the affective effects of VRET are published, statistical meta-analyses represent an interim remedy. Such analyses provide estimates of a population effect size across independent studies. They increase statistical power to detect true nonzero population effects by lowering the standard error, and consequently narrowing the confidence intervals associated with the population effect size estimate (Cohn & Becker, 2003; Sackett et a., 1997).

In a recent meta-analysis comparing in vivo exposure, VRET and control conditions, Powers and Emmelkamp (2008) aimed to collect well-controlled studies that had either random or matched assignment of VRET for anxiety disorders. Although the literature search produced 95 studies that had evaluated anxiety and/or phobia before and after VRET, only 13 articles met the eligibility criteria for inclusion in the meta-analysis. While it is the case that a meta-analysis can be done with so few studies (i.e., 13 articles for Powers and Emmelkamp), the potential for inadequate ability to detect moderator variables may preclude one from so doing. Moderator variables are variables that impact the direction and/or strength of the relationship between an independent/predictor variable and a dependent/criterion variable (Baron and Kenny, 1986). Such variables are hypothesized to moderate or alter the magnitude of a relationship (e.g., gender; cybersickness; or immersability of the subject(s)). According to Hunter and Schmidt (1990; 1997), there are a number of problems with using a small number of studies to conduct a meta-analysis: 1) when sample size is viewed as the number of studies, the power to detect a given moderating variable relationship in the meta-analysis may be low; 2) with small numbers of studies, the moderators may be confounded with each other. For the Powers and Emmelkamp meta-analysis, this may be an even greater issue because they attempted to assess multiple hypotheses across groups (e.g. VRET, in vivo exposure, and control conditions) in a small number of studies (N=13) without adequate information related to potential moderators. Hence, the fact that the studies included in the meta-analysis did not provide adequate statistics severely limits the conclusions that can be drawn from the meta-analysis related to the differences between VRET and in vivo