

Virtual Reality Exposure for PTSD (Post-Traumatic Stress Disorder): A Systematic Review Virtual Reality PTSD Systematic Review

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The objective of the present study is a systematic review on the use of VRE (Virtual Reality Exposure) for PTSD (Post-Traumatic Stress Disorder). The following keywords were used: PTSD, Post-Traumatic Stress Disorder, Posttraumatic Stress Disorder, Virtual Reality in these databases: PsycINFO/PsycLIT, PubMed/Medline, EBSCO, ProQuest, ISI Web of Science, and SciELO/Pepsic. The studies included should have their own empirical data and the intervention should consist of exposure to virtual reality. A total of 241 publications were found, of which 28 were selected for this review: 11 case studies, eight uncontrolled case series, and nine randomized controlled trials. The treatment ranged between 3 and 22 VRE sessions (M (Mean) = 9.09, SD (standard deviation) = 1.57). Among the case studies, the results were promising; all studies were able to reduce the PTSD symptomatology. As to the uncontrolled case series, overall they showed promising results. Regarding the randomized clinical trials, there was found a wide variation concerning the VRE intervention as well as the combined and control intervention. The majority of the studies presented significant results, except two which returned modest or non-significant results. The findings of this study suggest that the use of virtual reality as a tool for exposure therapy for PTSD can be an asset.

Keywords: stress disorders, posttraumatic, VRE (Virtual Reality Exposure), therapy, review, systematic, psychotherapy

Introduction

PTSD (Post-Traumatic Stress Disorder) is defined as a symptomatic answer to a traumatic event involving recollections, avoidance, numbing, and increased arousal. It is a disturbance that causes clinically significant distress or functional impairment, with presence of symptoms for more than one month (American Psychiatric Association, 2000). The lifetime prevalence of PTSD has been estimated at 6.8% among the general population (Kessler, Chiu, Demler, & Walters, 2005). Although women are less likely to be exposed to traumatic stressors events, they show greater prevalence of the disorder, as well as more conditional risk to develop PTSD after exposure to a particular traumatic event (Breslau, 2002). PTSD has been considered the fifth most common

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mental disorder (Kessler et al., 2005), producing significant social and economic consequences (Ballenger et al., 2004). Economic costs associated with PTSD include absence from work and medical care costs. Individuals diagnosed with PTSD are also more likely to receive medical attention for psychological and general medical problems (Schnurr, Green, & Kaltman, 2007; Taylor, 2006).

Patients with PTSD are at increased risk of other disorders of the anxiety spectrum, such as panic disorder, agoraphobia, obsessive-compulsive disorder, social phobia, and specific phobias (Kessler, 1995). Additionally, PTSD shows high comorbidity with mood disorders and disorders related to substances (Kessler et al., 2005; Mills, Teesson, Ross, & Peters, 2006; Thomas et al., 2010). Once PTSD is diagnosed, these comorbidities must be examined; at least one additional psychiatric disorder was found in approximately 80% of the individuals with PTSD (Kessler et al., 2005). The role of comorbidities in treatment outcomes is still a matter of discussion in the literature. A recent meta-analysis showed, controversially, that the interaction between different psychopathologies has a positive correlation with effect size, including PTSD (Olatunji, Cisler, & Deacon, 2010).

The earlier cognitive-behavioral interventions in PTSD were based on Mowrer's Two Factor Model (Mowrer, 1960), including mechanisms of classical and operant conditioning. Subsequently, the interventions became focused on the disorder's symptoms, such as PE (the prolonged exposure) (Rothbaum, Meadows, Resick, & Foy, 2008), based on Foa and Kosik's EPT (emotional processing theory) (Foa & Kozak, 1986). This theory states that there are fear structures activated by stimuli related to the traumatic event experienced, which trigger psychological and physiological reactions. In terms of its origins, this mechanism should work like a base plan in order that one could face a treacherous situation, either with fight or flight response. However, in PTSD, most of these connections represent erroneous associations, whereby stimuli that should be neutral are conditioned to the fear response, which could be related to intrusive symptoms characteristic to the disorder. Treatments, therefore, should aim to modify these dysfunctional elements from the fear structure until it decreases the capacity of neutral stimuli to elicit anxiety responses (Cahill & Foa, 2007).

CBT (cognitive-behavioral therapy), in its classical form, is a well established treatment for PTSD. Also, the use of exposure alone or as part of a CBT protocol has been shown to be highly effective (Bisson, Ehlers, Matthews, Pilling, Richards, & Turner, 2007; Bradley, Greene, Russ, Dutra, & Westen, 2005; Mendes, Mello, Ventura, de Medeiros Passarela, & de Jesus Mari, 2008). There are several ways to proceed with the exposure technique, but there are common aspects, such as the development of an anxiety hierarchy of trauma related situations and the confrontation of frightening/anxiogenic stimuli. The following exposure modalities can be used: flooding, in which the patient has to confront the most anxiogenic elements of the hierarchy (Taylor, 2006); imaginal (or "in vitro"), wherein the subject has to confront his or her memories of the traumatic event—the patient providing a narrative in the first person and the present tense; and "in vivo", where the subject has to face a real situation involving the traumatic event (Rothbaum et al., 2008). Recently, virtual reality technology has been applied to exposure treatment ("in virtuo" exposure).

The VRE cognitive-behavioral therapy for PTSD is based on the principles of PE (Riggs, Cahill, Foa, Follette, & Ruzek, 2006). In its classical format, the PE is performed over 9 to 12 sessions of 90 minutes each. The treatment is divided into four parts: (1) psychoeducation about the disorder, the experienced trauma, and the reactions these events may trigger; (2) respiratory training, as a relaxing technique; (3) "in vivo" exposure in situations related by the patient to the trauma that he/she has, since then, avoided; and (4) imaginal exposure, whereby the patient recalls continually, in session, the memories related to the trauma, and which,

by the end of the session are discussed, as well as the feelings and thoughts that occur with them. VR (virtual reality) can be used as a way of increasing the patient's emotional engagement in the exposure tasks (Reger & Gahm, 2008).

Additional advantages are highlighted in the literature for the use of VR as a tool for the treatment of anxiety disorders (Wiederhold & Wiederhold, 2004): (1) easier viewing for patients who have difficulty visualizing the traumatic event; (2) the opportunity of the therapists to visualize what the patient sees; (3) the possibility of the virtual exposure to be more realistic than the exposure based on mental imagery; and (4) the VR seems to increase the engagement of the patients in the treatment more than the imagery exposure. Despite its novelty, the use of VR as a tool for exposure therapy has returned promising results in terms of anxiety disorders; a meta-analysis showed a considerable effect size (Cohen's $d = 1.11$) for specific phobia, social phobia, PTSD, and panic disorder (Powers & Emmelkamp, 2008). Nonetheless, apart from its potential use, little is known about VR exposure in PTSD. Powers and Emmelkamp's (Powers & Emmelkamp, 2008) review included only one paper in which the intervention focused on PTSD. As far as we know, none of the systematic reviews or meta-analysis of VR exposure as a treatment for PTSD can be found in the Cochrane Library.

The present study aims to perform a systematic research of publications containing empirical data that uses virtual reality exposure as an intervention for PTSD. Such a resource is a novelty in the area and a review that summarizes the already obtained data is an imperative. While this review was under construction, another review was published on the subject (Gonçalves, Pedrozo, Coutinho, Figueira, & Ventura, 2012), which had stricter exclusion criteria, and further comments will be made in the discussion section. We hypothesize that virtual reality exposure will be effective since: (1) It has the potential to increase a patient's engagement and a therapist's control of the treatment; and (2) Other exposure techniques are already well established treatments (Rothbaum et al., 2008).

Methods

In order to search the electronic databases, the following keywords were used: PTSD, Post-Traumatic Stress Disorder, Posttraumatic Stress Disorder, Virtual Reality. The databases used for the search were: PsycINFO/PsycLIT, PubMed/Medline, EBSCO, ProQuest, ISI Web of Science and SciELO/Pepsic. Each database has its own search engine with diverse resources. However, we used the same rationale for all: Each search should concern at least one term related to PTSD and the keyword virtual reality.

The studies included should fulfill the following criteria: (1) have their own empirical data; (2) published between 1999 and 2011; (3) written in English, Spanish, or Portuguese languages; (4) sample of adults with diagnostic criteria for PTSD, according to DSM-V or DSM-IV-TR, determined by the researchers; and (5) the intervention should consist of exposure to virtual reality.

Results

The searches were conducted by the author MR, who is responsible for the searches and the publications retrieval. Several book reviews, book chapters, and congress proceedings were found, as well as theoretical and empirical articles—in total, 241 publications. Afterwards, the retrieved full-text publications were assessed by two independent judges and, after their consensus meeting, a total of 28 publications were selected for this review (see Figure 1).

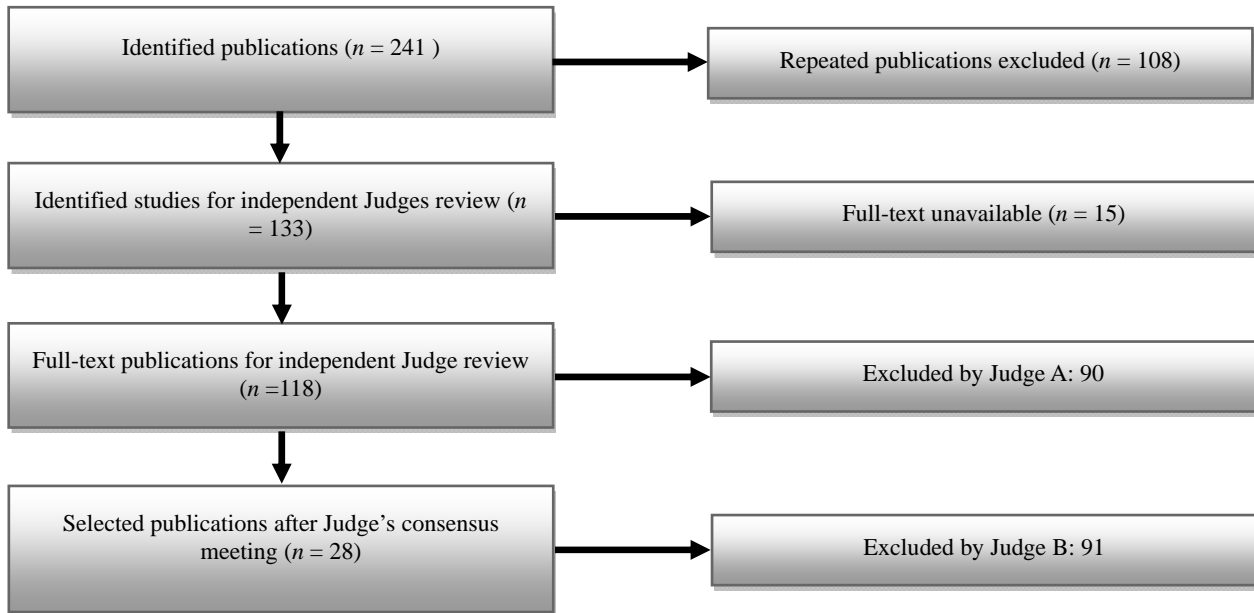


Figure 1. Studies selection.

In the 28 studies included in this review, individuals with PTSD diagnostic underwent exposure therapy with the use of VR. The majority were case studies ($n = 11$); uncontrolled case series ($n = 8$) and randomized controlled trials ($n = 9$) were also included. When observed according to the main stressful event, four different situations could be identified: the attacks of September 11 on the World Trade Center, the Iraq War, the Vietnam War, motor vehicle accident, robbery at the workplace, and street and domestic violence. The total sample was composed of 204 patients.

The treatment showed a wide range in the number of sessions with VR exposure, ranging between 3 and 22 sessions ($M = 9.09$, $SD = 1.57$), and in the techniques used alongside VR exposure, such as: relaxation training, psychoeducation, meditation, imagistic exposure, attentional refocusing, and cognitive restructuring. Most studies provided weekly or twice a week sessions of 90 minutes each. The PTSD diagnosis and measurement of its symptomatology were assessed by the CAPS (clinician-administered PTSD scale) (Blake et al., 1995), SCID (structured clinical interview for the DSM-IV) (First, Spitzer, Gibbon, & Williams, 2002), MINI neuropsychiatric interview (Sheehan et al., 1998), PDS (post-traumatic diagnostic scale) (Foa, Cashman, Jaycox, & Perry, 1997), THQ (trauma history questionnaire) (Green, 1996), PCL (PTSD checklist) (Weathers, Litz, Herman, Huska, & Keane, 1993), PSS-SR (PTSD symptoms scale self-report) (Foa, Riggs, Dancu, & Rothbaum, 1993), PCL-M (PTSD checklist military version) (Weathers, Huska, & Keane, 1991), and IES-R (impact of event scale) (Weiss & Marmar, 2004).

Another source of variability came from how each study reported results. The findings will be reported here in groups according to study design: (1) case study; (2) uncontrolled case series; and (3) randomized controlled trials. Among the case studies, the results were promising; all studies were able to reduce the PTSD symptomatology: (1) subjects no longer fulfilled criteria for PTSD diagnostic (Freedman et al., 2010; Reger & Gahm, 2008; Wood, Webb-Murphy et al., 2009); (2) a statistically significant reduction ($p < 0.05$) in PTSD symptomatology according to CAPS (Gerardi, Rothbaum, Ressler, Heekin, & Rizzo, 2008); (3) clinically significant reduction, yet non-statistical significance was presented, in PTSD symptoms (Difede &

Hoffman, 2002; Miyahira, Folen, Hoffman, Garcia-Palacios, & Schaper, 2010; Rothbaum et al., 1999; Rothbaum, Rief, Litz, Han, & Hodges, 2003; Saraiva et al., 2007; Tworus, Szymanska, & Ilnicki, 2010; Wood et al., 2006).

As regards the uncontrolled case series, overall they showed promising results (see Table 1). The sample ranged from 2 to 24 participants ($M = 12.3$; $SD = 7.7$), the number of treatment sessions ranged from 7 to 20, and the number of sessions with virtual reality ranged from 3 to 18 ($M = 10.7$; $SD = 5.6$). It is worth noting that only two studies did not report the use of combined techniques (Ready, Pollack, Rothbaum, & Alarcon, 2006; Reger et al., 2011), while others employed several others (relaxation methods being the most mentioned). In two studies of combat related PTSD, the participants no longer met criteria at the end of treatment (Roy et al., 2008; Wood et al., 2009), while the rest presented significant symptoms reductions according to the respective instruments.

In relation to the randomized clinical trials (see Table 2), it was found a wide variation concerning the VRE intervention as well as combined and control intervention. The samples ranged from 5 to 21 participants ($M = 13.3$; $SD = 5.7$). The number of sessions of the VRE treatment ranged from 5 to 14 sessions, and the sessions with VRE accounted for 5 to 8 sessions ($M = 7.5$; $SD = 1.6$). Combined interventions were less used when compared with the uncontrolled case series (see Table 1), yet imagistic exposure, anxiety control training, and unspecific CBT techniques were reported. As for the control group, waitlist was the most employed, followed by treatment as usual. The majority of the studies presented significant results, except Roy et al. (2008), who found modest results, and Gamito et al. (2009), who found no significant differences. For further scrutiny of Gamito et al. (2010), Botella et al. (2010), McLay, McBrien, M. D. Wiederhold, and B. K. Wiederhold (2010), and Ready, Gerardi, Backscheider, Mascaro, and Rothbaum (2010), see Gonçalves et al. (2012).

Table 1

Uncontrolled Case Series

Study	PTSD assessment	Sample	RV sessions	Total sessions	Combined interventions	Main findings
Wood et al. (2009) ⁴⁴	CAPS, PCL-M	12	18	20	Meditation, attentional refocusing	No PTSD
Wiederhold et al. (2010) ⁴⁵	PCL-M	2	18	20	Meditation, progressive relaxation training, attentional refocusing, paced abdominal breathing	No PTSD
Walshe et al. (2003) ⁵⁶	FDI, CAPS	7	12	12	Diaphragmatic respiration training, cognitive restructuring	Significant symptom reduction SUDS ($p = 0.008$); FDI ($p = 0.008$); CAPS ($p = 0.008$); HR ($p = 0.008$)
Reger et al. (2011) ⁴²	PCL-M,	24	3	7.4	-	Significant symptom reduction ($M = 47.08$; $SD = 12.70$; $p < 0.001$)
Rizzo et al. (2010) ⁵⁷	PCL-M, PHQ-9	20	7	10	Imagistic exposure	Significant symptom reduction ($t = 5.99$, $df = 19$, $p < 0.001$)
Ready et al. (2006) ⁴³	CAPS, IES SUDS	14	9	10	-	Significant symptom reduction ($p < 0.0001$)
Beck et al. (2007) ⁵⁸	CAPS, PSS-SR, CSQ, SSQ,	8	8	10	Relaxation training	Significant symptom reduction CAPS total ($p < 0.05$)
Rothbaum et al. (2001) ⁵⁹	CAPS, IES	6	4-15	8-16	Imagistic exposure, brief breathing relaxation method	Significant symptom reduction post-treatment ($p = 0.0727$) and at six month follow-up ($p = 0.0021$)

Table 2

Randomized Clinical Trials

Study	PTSD assessment	Sample	VR sessions	Total sessions	Combined interventions	Control intervention	Main findings
Roy et al. (2008) ⁴⁵	PCL-M, CAPS, SCID	13	8	12	CBT	PE	Modest symptom reduction
Ready et al. (2010) ⁵⁰	CAPS, SCID	11	-	10	Imagistic exposure	Present centered therapy	Post-treatment and follow-up significant effect sizes (Cohen's $d = 0.28$ and 0.56)
McLay et al. (2010) ⁴⁹	PCL-M, PHQ-9	10	-	6.5	Anxiety control training	Exposure therapy (Foa's protocol)	Significant difference between pre- and post-treatment ($p < 0.001$), no group differences
McLay et al. (2011) ⁵¹	CAPS	20	8.8	10	-	Treatment as usual	Significant difference between groups, over the course of treatment (35.4 vs. 9.4, $p < 0.05$)
Gamito et al. (2009) ⁴⁶	CAPS, IES-R, SCL-90R	5	5	5	-	Waiting list or traditional psychotherapy	No significant differences
Gamito et al. (2010) ⁴⁷	CAPS, IES-R, SCL-90R	10	11	12	-	Waiting list or imagistical exposure	Significant effect CAPS screening ($p > 0.05$), CAPS reduction VRET (8%); EI (1%) and WL (6%)
Difede et al. (2006) ⁶¹	CAPS, SCID	20	-	14	-	Waitinglist	Significant effect size 1.53 and symptoms reduction CAPS ($t = 3.32$, $p = 0.01$)
Botella et al. (2010) ⁴⁸	CAPS, DTS, PTCI	10	5	9	CBT	CBT	Significant reduction on CAPS ($Z = 2.032$; $p < 0.04$) and PTCI ($Z = 2.032$; $p < 0.04$)
Difede et al. (2007) ⁶²	CAPS, PCL, GSI, THQ	21	7.3	14	-	Waitinglist	Significant effect between-groups 1.54

Discussion

The present review compiled several VRET for PTSD studies, most of which reported the intervention as effective and more effective when compared with waitlist and treatment as usual. This suggests that given the correct conditions, the use of virtual reality can be an asset in the treatment of PTSD, which may be due to the possible increase in the emotional engagement and the therapist control over the exposition process.

The use of virtual reality in exposure techniques has been studied in a wide range of anxiety disorders, including specific phobia, social phobia, panic disorder, and PTSD with encouraging results. Even though Powers and Emmelkamp (2008) were able to gather a number of independent studies with VRET, only one of these was with PTSD patients. Although we were not able to perform a meta-analysis of the present data, the present findings point in the same direction.

As previously stated, Gonçalves et al. (2012) performed a similar review, although they differ in the following aspects: (1) There are a few month between the two searches, ours were made in September, 2011, while theirs in May, 2011; (2) The databases were the same, although we also searched EBSCO end SciELO/Pepsic; and (3) Our review had a broader scope (all empirical data), while Gonçalves et al. narrowed theirs to 10 studies, excluding case studies and subclinical PTSD. Given the interventions novelty, we consider the broaden search and more liberal criteria as an advantage.

The present review presents an array of studies with a wide variation concerning design, sample, and the intervention itself as well as the control intervention, when used. Arguably, the sample variation can be positive, providing data that the intervention works in different populations, including samples that already failed to improve having gone through the treatment as usual (McLay et al., 2011). The findings of this study suggest

that the use of virtual reality as a tool for exposure therapy for PTSD can be an asset, although there is an evident need for studies with better methodology, bigger samples, and randomized control trial designs that concern control groups with other interventions like imaginal exposure and “in vivo” exposure.

The use of virtual reality in the treatment for PTSD is based on the premises of PE (Rothbaum et al., 2008), which aims to reduce the anxiety paired with trauma related situations as well as restructure the trauma memory. The mechanisms underlying the PTSD development and remission are still a subject of spirited debate in the scientific community and several models have been proposed. With regard to how the memory behaves, Brewin, Dalgleish, and Joseph (1996) proposed two separate memory systems, VAM (verbally accessible memory), which is overall cohesive with autobiographical memory and can be intentionally retrieved, and the SAM (situationally accessible memory), which is not deliberately retrieved, usually comes in flashbacks triggered by trauma related situations, and consists generally of sensorial and image memories. It is hypothesized that the exposure treatments seek to create new SAM memories with lower emotional valence that overcome the traumatic ones, and aim to put these memories into a rational and autobiographical context.

The present findings point toward a novel way to treat PTSD through exposure. With the exponential advances in computer simulations, the future possibilities are impossible to foresee, although it may directly interfere with the presence factor. Presence can be defined as the perception of being in the virtual environment. It has been shown to play an important role in treatments involving virtual reality (Alsina-Jurnet, Gutiérrez-Maldonado, & Rangel-Gómez, 2011; Price & Anderson, 2007; Price, Mehta, Tone, & Anderson, 2011). This can be an important aspect to be taken in account concerning patients with difficulties to engage emotionally in exposure treatments as well as when the traumatic situation is pragmatically impossible to recreate for an “in vivo” exposure.

Despite the methodological variability found in the selected publications, the intervention showed itself as a promising option for PTSD treatment. Overall, the studies in this review presented positive results toward the aimed intervention. More research in the field is needed in order refine the understanding the mechanisms underlying the intervention and to create a standardized protocol.

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