Virtual Reality Exposure Therapy for the Treatment of Posttraumatic Stress Disorder: A Methodological Review Using CONSORT Guidelines

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Context: Virtual reality exposure therapy (VRET) is an extension of traditional exposure therapy and has been used to treat a variety of anxiety disorders. VRET utilizes a computer-generated virtual environment to present fear-relevant stimuli. Recent studies have evaluated the use of VRET for treatment of PTSD; however, a systematic evaluation of the methodological quality of these studies has yet to be conducted. **Objectives:** This review aims to (a) identify treatment outcome studies examining the use of VRET for the treatment of PTSD and (b) appraise the methodological quality of each study using the 2010 Consolidating Standards of Reporting Trials (CONSORT) Statement and its 2008 extension for nonpharmacologic interventions. **Methods:** Two independent assessors conducted a database search (PsycINFO, Medline, CINAHL, Google Scholar) of studies published between January 1990 and June 2013 that reported outcome data comparing VRET with another type of treatment or a control condition. Next, a CONSORT quality appraisal of each study was completed. **Results:** The search yielded nine unique studies. The CONSORT appraisal revealed that the methodological quality of studies examining VRET as a treatment for PTSD was variable. **Conclusion:** Although preliminary findings suggest some positive results for VRET as a form of exposure treatment for PTSD, additional research using well-specified randomization procedures, assessor blinding, and monitoring of treatment adherence is warranted. Movement toward greater standardization of treatment manuals, virtual environments, and equipment would further facilitate interpretation and consolidation of this literature.
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Virtual reality exposure therapy (VRET) is a form of exposure therapy that has become more widely used in recent years as a treatment for a variety of anxiety disorders (Krijn, Emmelkamp, Òlafsson, & Biemond, 2004; Parsons & Rizzo, 2008). Unlike traditional forms of exposure therapy, which utilize imaginal, in vivo, or interoceptive stimuli, VRET presents fear-relevant visual, auditory, tactile, and/or proprioceptive stimuli via a computer-generated virtual environment produced through motion-sensitive instruments worn by the patient. Several studies have shown VRET to be an effective treatment for fears of flying (e.g., Krijn et al., 2007) and heights (e.g., Emmelkamp et al., 2002), and there is a growing body of evidence supporting the efficacy of VRET in the treatment of public speaking anxiety (Wallach, Safir, & Bar-Zvi, 2009) and panic disorder (Peñate, Pitti, Bethencourt, de la Fuente, & Garcia, 2008).

In keeping with extensive treatment outcome research documenting the efficacy and effectiveness of exposure-based interventions for trauma-related disorders (cf. Foa, Keane, Friedman, &

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Cohen, 2009; Ponniah & Hollon, 2009), VRET has been proposed as an option for the treatment of posttraumatic stress disorder (PTSD). VRET could be particularly applicable in treating PTSD for a number of reasons. Through prolonged or repeated contact to threat-related cues, exposure-based interventions help elicit trauma-related responses (e.g., distressing memories, physiological reactions, behavioral responses) in a safe context and condition new, more adaptive associations to these cues (Cammarota, Bevilaqua, Vianna, Medina, & Izquierdo, 2007; Foa & McNally, 1996). Over time, this may allow PTSD patients to more properly distinguish safe- versus threat-related stimuli, decrease situational and experiential avoidance, and minimize hyperarousal and other symptoms that are characteristic of the disorder. The virtual environment may also offer several advantages when compared to traditional methods of exposure therapy. Discrete and contextual stimuli presented during a VRET session may have greater verisimilitude to actual trauma-related scenarios experienced by the patient, thereby fostering more rapid and significant symptom reduction.

Other advantages of VRET that are not specific to treating PTSD are that engagement in a virtual environment may limit distractions and overt avoidance behaviors, and has been shown to lead to greater situational immersion and in-session attention compared to imaginal exposure (Hamm & Weike, 2005). VRET also gives therapists more direct control over the exposure, allowing them to tailor the type and intensity of stimuli.

In the past decade, numerous studies have been conducted to investigate the processes and outcomes of VRET. Although researchers have begun to synthesize existing literature (Gonçalves, Pedrozo, Coutinho, Figueira, & Ventura, 2012; Nelson, 2012), no prior review has evaluated the methodological quality of the VRET literature based on the Consolidating Standards of Reporting Trials (CONSORT) statement, which is an internationally recognized method of assessing the reporting quality of studies. Moreover, the current review identified studies not included in previous reviews.

Objectives

The aim of the current study is to provide a systematic review of the methodological quality of the literature on VRET for the treatment of PTSD. This review will (a) identify and review treatment outcome studies using VRET for the treatment of PTSD and (b) appraise the methodological quality of each study using the CONSORT Statement. This review is not intended to demonstrate whether one treatment is superior to another. Rather, the aim is to identify and review the quality of existing VRET studies to inform clinicians and researchers regarding the current evidence base and guide future research directions.

Method

This review utilized the 2010 CONSORT Statement (Schulz, Altman, & Moher, 2010) and its 2008 extension for nonpharmacologic interventions (Boutron, Moher, Altman, Schulz, & Ravaud, 2008) to evaluate the methodological quality of treatment outcome studies examining VRET for the treatment of PTSD. The first CONSORT Statement was published in 1996 with the aims of encouraging transparency in reporting through critical appraisal and interpretation of results (Begg et al., 1996). It has been revised several times and the current 2010 version is widely regarded as the international gold standard for reporting on clinical trials. In 2008, a nonpharmacological extension for the CONSORT Statement was published to provide specific guidance for the reporting of nonpharmacological research in fields such as behavior therapy and psychotherapy. It includes guidelines for describing interventions and how they were standardized, as well as describing qualifications of care providers and how adherence to the treatment protocol was assessed. Although the CONSORT was not intended to be used as a quality assessment instrument, many authors, peer reviewers, and editors use the CONSORT statement as a tool to identify potentially biased results and to assess the internal and external validity of trials (King, Delfabbro, Griffiths, & Gradisar, 2011; Moher et al., 1998).

Study Eligibility Criteria

While systematic reviews often examine only randomized controlled trials (RCTs), this was not possible in the current review given the relatively early stage of VRET research. Accordingly, the scope of this review was expanded to include all relevant published studies that reported treatment outcome data comparing VRET with any kind of comparison group. No other exclusion criteria were used.

Search Strategy

A database search of studies published between January 1990 and June 2013 was conducted by two independent researchers (first and second authors) using the PsycINFO, Medline, CINAHL, and Google Scholar databases. To focus the search, the reviewers used the PICO approach, which formulates clinical questions in terms of the Population/Problem, Intervention, Comparison, and Outcome. Using this strategy to search for specific search strings has been found to increase the precision of searches of empirically supported treatment outcome literature (Schardt, Adams, Owens, Keitz, & Fontelo, 2007; Villanueva, Burrows, Fennessey, Rajendran, & Anderson, 2001). The following search strings were used for Population/Problem: "posttraumatic stress disorder," "combat experience," "emotional trauma," "stress reactions," and "trauma." Search strings for Intervention were "Virtual Reality," "computer simulation," "computer applications," and "human machine systems." Comparison and Outcome search strings were "treatment," "therapy," "intervention," "outcome," "comparison," and "control group." To ensure that our search was comprehensive, we also tracked the references cited in each of the identified articles and examined the journals in which the identified articles were published.

Quality Appraisal

Two independent assessors used the 2010 CONSORT statement in conjunction with the 2008 nonpharmacologic extension to appraise the methodological quality of the identified studies. See Schultz et al. (2010) and Boutron et al. (2008) for the full CONSORT reporting guidelines. A three-point scoring system was devised for each criterion (adapted from King et al., 2011). A score of "0" was assigned if the criteria were not present or not met, "1" was assigned if the criteria were partially met, and "2" was assigned if the items were fully present or fully met. For example, Item 13b on the CONSORT checklist requires authors to report losses and exclusions after randomization, together with reasons (Schulz et al., 2010). If the authors did not report this information, this item received a score of "0." If the number of participants who were lost or excluded was reported, but the reasons for this were not reported, this item received a score of "1." A score of "2" was assigned if authors reported both losses and exclusions together with reasons.

Likewise, following King et al. (2011), a score of "0" was assigned in instances where the CONSORT item was not present due to limitations of study design. The first and second authors conducted an item-by-item-level quality appraisal of each study in relation to a CONSORT checklist. Initial inter-rater agreement was 97.7%, and the reviewers met to resolve the few scoring discrepancies using the CONSORT website and guidance documents.

Results

Overall Search Findings

The search strategy yielded 118 articles. Eleven published articles directly compared any virtual reality-based intervention for PTSD with another form of treatment. In two cases, preliminary data were published (Difede, Cukor, Patt, Giosan, & Hoffman, 2006; Roy et al., 2008) before additional participants were enrolled and findings were elaborated upon in subsequent publications (Difede et al., 2007; Roy et al., 2010). For the purposes of scoring, in both cases we used the more recent publications, which were also the most comprehensive. Therefore, nine studies reporting on unique samples using VRET for the treatment of PTSD met the inclusion criteria.

These studies, including descriptions of the VRET environments and equipment, are described in Table 1.

The remaining search results included review articles (n = 40), treatment development studies (n = 21), case studies (n = 18), small within-subjects treatment studies (n = 7), basic research using VR technology (n = 5), editorials and position papers (n = 5), descriptions of prospective studies (n = 4), and studies of VR as a training tool (n = 3). In addition, three articles did not pertain to PTSD, and one was a reprint of a previously identified case study.

CONSORT Evaluation and Methodological Characteristics

The CONSORT appraisal revealed that the methodological quality of extant research on the use of VRET for treating PTSD was variable. While it is beyond the scope of this review to present a written item-by-item explanation and analysis for all 25 CONSORT items, Table 2 summarizes the main findings of our CONSORT analysis. Refer to Schulz et al. (2010) and Boutron et al. (2008) for more information on CONSORT reporting guidelines. The following section focuses primarily on consistent deviations from the CONSORT guidelines.

Abstract and objectives. The nonpharmacologic extension of the CONSORT checklist states that the abstract should include a description trial design, methods, results, conclusions, and details of the experimental treatment and comparator, as well as information on care providers, centers, and blinding status. However, none of the nine studies fully met these criteria. The abstract for one study (Botella et al., 2010) included none of the requisite information, and the other eight included only partial information. The CONSORT checklist also states that authors should provide specific objectives or hypotheses, however, only two studies (Botella et al., 2010; Roy et al., 2010) implicitly stated their studies' objectives or hypotheses.

Trial design, eligibility criteria, and settings. The CONSORT checklist maintains that authors should describe the trial design, including a clear description of the different conditions, how many participants were allocated to each condition, and a statement explicitly stating that the study intended to compare outcomes between conditions. Six studies fully reported this criterion, whereas three studies partially reported this item. Although they identified their study as a case series, McLay and colleagues (2010) did not clearly indicate that they were comparing case outcomes. Likewise, Botella et al. (2010) and Roy et al. (2010) did not specify how many participants were in each condition.

The checklist also requires authors to report eligibility criteria. Eight studies fully reported this item, whereas Miyahira et al. (2012) only partially met this criterion because they were not fully explicit in describing their inclusion/exclusion criteria. CONSORT states that information on study settings is crucial for judging a study's applicability and external validity. Seven studies fully reported this item. One study did not provide any information about the settings and locations where data were collected (Roy et al., 2010), and Miyahira and colleagues (2012) partially reported this item because although they reported the organization that approved the study protocol, they did not clearly state if this is where the study was conducted. The majority of studies were conducted in the United States with the exception of Baños et al. (2011) and Botella et al. (2010), who conducted their studies in Spain, and Gamito et al. (2010), who conducted their study in Portugal. The treatment settings comprised civilian outpatient hospitals (Difede et al., 2006, 2007), military camps (McLay et al., 2010), VA hospitals (Ready et al., 2010), naval medical centers (McLay et al., 2011), and university research centers (Baños et al., 2011; Botella et al., 2010).

Interventions and standardization. The nonpharmacologic extension of the CONSORT checklist states that authors should provide precise details of both the experimental and the comparison interventions. For the purposes of this review, if authors did not fully report information on the interventions but stated where such details could be accessed, then they fully met the criteria. Whereas eight of nine studies fully reported this criterion, Gamito et al. (2010) partially described the VRET condition, but did not provide precise details on the comparison groups.

Table 1
Treatment Comparison Studies Using VRET for PTSD

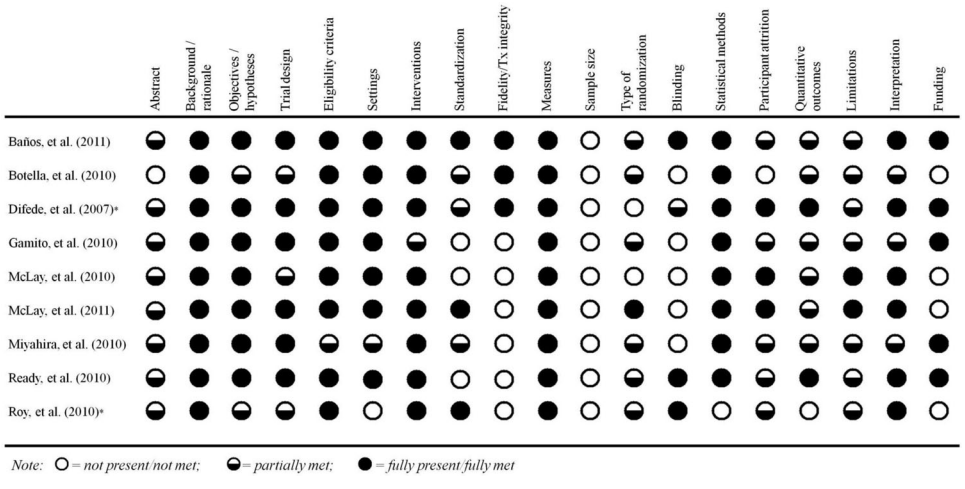
Study	Participants	VRET environment	VRET equipment	Comparison	Total N	# VRET sessions	Follow-up	Statistical sig. (between groups)
Baños et al. (2011)	Civilians who experienced abuse, criminal assault, or car accidents	Customized symbols and personalized imagery	Projectors and screen, wireless pad, speakers	Cognitive behavioral therapy	10	9	No	No
Botella et al. (2010)	Civilians who experienced domestic violence, car accidents, robbery, or assault	Customized symbols and personalized imagery	Computers, projectors and screen, wireless pad, speakers	Imaginal exposure	10	9–12	No	No
Difede et al. (2007)	Civilians and disaster workers exposed to 9/11/01 terrorist attacks	Scenery of lower Manhattan including jets flying over the World Trade Center and dust clouds	Helmet and tracking system	Treatment as usual	21	6–13 ($M = 7.5$)	Yes (6 mos.)	Yes
Gamito et al. (2010)	Portuguese colonial war Veterans	Scenery of footpath with blast sounds and images of bullets, mortar, black smoke, and spraying particles	Head-mounted display and computer graphics unit	Imaginal exposure; waitlist control	10	Not reported	No	No
McLay et al. (2010)	Active-duty military in Iraq	Scenery and sounds of basecamps, battlefields, marketplace, and military convoy under attack	Head-mounted display and joystick controller	Imaginal exposure	10	3–10 ($M = 6.5$)	No	No
McLay et al. (2011)	Active-duty military in Iraq and Afghanistan	Scenery and sounds of basecamps, battlefields, marketplace, house-to-house search, and military convoy under attack	Head-mounted display and joystick controller	Treatment as usual	20	4–20 ($M = 8.8$)	No	No
Miyahira et al. (2012)	Active-duty military in Iraq and Afghanistan	3D computer-generated environment (details not reported)	Helmet and head tracker	Minimal attention	32	10	No	No

Table 1
Continued

Study	Participants	VRET environment	VRET equipment	Comparison	Total N	# VRET sessions	Follow-up	Statistical sig. (between groups)
Ready et al. (2010)	Vietnam Veterans	Scenery of Vietnam war including helicopters, rocket explosions, and landmines	Head-mounted display and joystick controller	Present centered therapy	11	10	Yes (6 mos.)	No
Roy et al. (2010)	Iraq and Afghanistan combat Veterans	Scenery of marketplace, HMMV ride; smells of spices and trash burning	Head-mounted display with tracking, earphones, olfactory sensations, motion platform, and physiologic monitoring equipment	Prolonged exposure	15	12	No	Not reported

Note. VRET = Virtual Reality Exposure Therapy; PTSD = posttraumatic stress disorder; M = mean.

Table 2
Evaluation of Treatment Comparison Studies Using Selected Items From the CONSORT Checklist



CONSORT = Consolidating Standards of Reporting Trials. Articles marked (*) contain data also presented in previous publications.

The VRET environments and equipment differed widely among studies. Computer generated environments included the World Trade Center (Difede et al., 2007), Vietnam (Gamito et al., 2010; Ready et al., 2010), Iraq and Afghanistan (McLay 2010), and the nonspecific EMMA's World (Baños et al., 2011; Botella et al., 2010). Some modalities used only laptops and headphones, whereas others included motion-activated helmets, rifle-shaped controllers, goggles, motion platforms that vibrate during an onscreen explosion, and machines that generate odors. The VRET interventions were administered by a variety of professionals across studies including psychologists, psychiatrists, doctoral students, registered nurses, and licensed counselors. The number of completed VRET sessions ranged from 3 to 20.

The nonpharmacologic extension states that authors should provide details regarding how interventions were standardized. Three studies fully reported this item, and three studies either did not provide any information on standardization or stated that procedures were not standardized (Gamito et al., 2010; McLay et al., 2010; Ready et al., 2010). The remaining three studies (Botella et al., 2010; Difede et al., 2007; Miyahira et al., 2012) that partially met this criterion made reference to the existence of a treatment protocol or manual without fully describing it or providing details regarding where a description could be accessed. Given the variation in practitioner qualifications, VRET training, equipment, and virtual environments, there is no evidence that the VRET treatments were standardized across studies.

Fidelity/treatment integrity. The nonpharmacologic extension of the CONSORT states that authors should report on treatment fidelity to measure how closely therapy providers adhered to treatment protocols. Of the nine reviewed studies, three fully reported protocol adherence practices. There was no evidence that the remaining six studies monitored treatment fidelity (Gamito et al., 2010; McLay et al., 2010; McLay et al., 2011; Miyahira et al., 2012; Ready et al., 2010; Roy et al., 2010).

Sample size. The CONSORT checklist states that authors should provide information on how the sample size was determined prior to the intervention. None of the studies in this review explained how sample size was determined prior to the start of the study or reported conducting a power calculation to ensure a sample size large enough to detect statistical differences. Sample

sizes ranged from 10 to 32, with many studies including very small cell sizes by treatment condition.

Randomization and blinding. The CONSORT checklist states that authors should report type of randomization used (if any) as well as details of any restrictions, such as blocking and block size. One study fully reported this item. Two studies (Difede et al., 2007; McLay et al., 2010) did not use randomization procedures and employed a quasi-experimental or care series design, respectively. Six studies partially reported this item because although they employed randomization, they did not report type or details of how the randomization sequence was generated (Baños et al., 2011; Botella et al., 2010; Gamito et al., 2010; Miyahira et al., 2010; Ready et al., 2010; Roy et al., 2010).

CONSORT indicates that authors should report if assessors were blind to treatment conditions. Three studies fully reported information for this item. Five studies provided no evidence of assessor blinding, though this was sometimes due to limitations of study design (Botella et al., 2010; Gamito et al., 2010; McLay et al., 2010; McLay et al., 2011; Miyahira et al., 2012). Difede et al. (2007) made reference to an independent assessor, but did not explicitly state whether this assessor was blind to treatment condition. Roy et al. (2010) reported using a blind assessor in their description of baseline data, but were not clear whether this assessor was blind at other points of data collection.

Statistical methods and quantitative outcomes. CONSORT requirements include a description of statistical methods used to compare groups for primary and secondary outcomes. One study (Roy et al., 2010) did not utilize statistical methods to compare groups, and thus did not fulfill this criterion due to the limitation of the reported study. The remaining studies fully reported statistical methods. CONSORT requirements also include results for each group for each primary and secondary outcome, as well as the estimated effect size and its precision. Two studies fully reported this criterion. One study did not report results for each group (Roy et al., 2010) and six studies reported group results, but did not specify effect size (Baños et al., 2011; Botella et al., 2010; Gamito et al., 2010; McLay et al., 2010; McLay et al., 2011; Miyahira et al., 2012).

Participant attrition. CONSORT indicates that authors should report losses and exclusions after randomization for each group, including reasons. Three studies fully reported this item. One study (Botella et al., 2010) did not explicitly report attrition information. Five studies (Baños et al., 2011; Gamito et al., 2010; Miyahira et al., 2012; Ready et al., 2010; Roy et al., 2010) reported attrition rates, but did not include specific reasons for each participant's withdrawal.

Adverse events. The CONSORT guidelines state that authors should report all important harms or unintended effects in each group reported. For example, there are some concerns that virtual environments may cause discomfort (a.k.a. "cybersickness") or even exacerbate PTSD symptoms (see McLay et al., 2011). However, of the nine studies evaluated, only two (McLay et al., 2010, 2011) reported whether any adverse events had or had not occurred.

Limitations. CONSORT indicates that authors should report trial limitations, assessing sources of potential bias and imprecision. Specifically, the nonpharmacological extension requires authors to discuss three areas of limitation: blinding, unequal expertise of treatment providers, and choice of comparator. Two studies fully reported this item while seven studies included discussion of some, but not all, of these requisite items (Baños et al., 2011; Botella et al., 2010; Difede et al., 2007; Gamito et al., 2010; Miyahira et al., 2012; Ready et al., 2010; Roy et al., 2010).

Interpretation. The CONSORT checklist includes interpretation of study findings that are consistent with the results and that balance benefits and harms. Six studies fully reported this item, and three studies reported a balanced interpretation of their findings consistent with

their findings, but did not address benefits versus possible harm to participants (Botella et al., 2010; Gamito et al., 2010; Miyahira et al., 2012). The lack of discussion regarding possible harm caused by VRET was particularly surprising in the article by Miyahira and colleagues (2012), given the 47.6% attrition rate from their study. Although all studies were enthusiastic in their discussion of the results as supporting the efficacy of VRET, most were careful to report that VRET is an emerging treatment approach, and the factors that may influence its effectiveness are not well understood.

Funding. CONSORT indicates that authors should disclose sources of funding support. Four studies did not acknowledge funding sources (Botella et al., 2010; McLay et al., 2010; McLay et al., 2011; Roy et al., 2010), whereas the remaining five reported receiving funding from a variety of sources.

Discussion

This CONSORT review suggests variability in the methodological quality of extant research on the use of VRET for treating PTSD; however, several limitations should be noted. Foremost, systematic reviews following CONSORT guidelines are limited by reliance on published reports, which may be condensed during the publication process (Petrosino, Turpin-Petrosino, & Buehler, 2003). In addition, newly completed, unpublished research findings (i.e., gray literature) were not included in this review.

Much of the literature regarding VRET for PTSD to date involves feasibility studies, and most were not designed as strong tests of efficacy. The fact that 21 treatment development studies were identified yet the literature search yielded only nine comparison trials suggests that careful attention is being paid to the development of VRET protocols. Sample sizes were generally very small, with some treatment conditions having only two or three participants, which calls into question the power and validity of the statistical analyses that were utilized. Not surprisingly, two studies (Ready et al., 2010; Roy et al., 2010) reported that their sample sizes were insufficient for detecting between-group differences, and six found nonsignificant results between groups on total PTSD severity (Baños et al., 2011; Botella et al., 2011; Gamito 2010; McLay 2010; Miyahira et al., 2012; Ready et al., 2010). Only one study (Difede et al., 2007) found significant differences between groups on total PTSD severity, and this study compared VRET to treatment as usual (TAU). Miyahira et al. (2012) found significant results for the VRET group with regards to decreased Criterion C symptoms, but not overall PTSD severity.

In addition, not all studies employed randomization to treatment condition, utilized a treatment manual to promote standardization, or addressed provider adherence to the treatment protocol, and only two studies provided follow-up data (Difede et al., 2007; Ready et al., 2010). In addition to the items included in the CONSORT guidelines, we found that only one study (Botella et al., 2010) reported pretreatment rates of co-occurring disorders, which is important given the high rates of co-occurring disorders and the effect of co-occurrence on treatment outcomes among patients with PTSD (Meyer, Kimbrel, Tull, & Morissette, 2011). Perhaps most important, variability in treatment procedures across studies limits our ability to draw firm conclusions regarding this literature. Overall, these findings likely reflect the state of this literature, which largely comprises treatment development and preliminary outcome studies.

In the context of these limitations, preliminary data are consistent with the broader exposure therapy literature documenting a robust positive effect of exposure-based interventions for PTSD (Foa et al., 2009). However, only one of the treatment comparison studies found VRET to be superior to a TAU condition for reduction of overall PTSD symptoms (Difede, 2007). Also, while many of the remaining articles claimed the effects of VRET were comparable to other exposure-based interventions employed in their studies, their sample sizes were too small to establish statistical power. To date, there have been no published RCTs comparing VRET to an active comparison treatment that was sufficiently powered to detect between-group differences on overall PTSD symptoms. Additional empirical support is needed before VRET could be considered to meet criteria for the designation of a "probably efficacious treatment" established

by Chambless and Hollon (1998). Reflecting growing interest in the use of VRET, there were 14 trials registered on www.clinicaltrials.gov examining VRET for the treatment of PTSD at the time that this review was submitted for publication.

There are potential advantages of VRET as a mechanism of exposure treatment delivery as compared to traditional (i.e., imaginal or in vivo) exposure therapy. First, in an increasingly technology savvy population, VRET may be a preferable alternative for many people. Similarly, given that stigma has been identified as a significant barrier to receiving mental health treatment in the military (Hoge et al., 2004), it has been hoped that VRET may be useful in addressing these problems. However, in contrast to this notion, two VRET studies with military populations (McLay et al., 2011; Ready et al., 2010) reported difficulty recruiting for VRET treatment studies. While the factors cited as recruitment barriers (i.e., military lifestyle, avoidant tendencies characteristic of PTSD, stigma around seeking mental health treatment, and the fact that active duty military personnel cannot be compensated for participation) do not appear to be specific to VRET, there is currently no evidence to support whether engaging in VRET may be more acceptable or less stigmatizing than traditional exposure therapy.

Second, VRET may provide greater verisimilitude to traumatic scenarios, which could foster more rapid and clinically significant extinction/habituation to both discrete and contextual stimuli. Although this is an empirical question, VRET as a tool that can be used to augment exposure scenarios has the potential to aid patients who have trouble visualizing trauma stimuli or who have strong avoidant tendencies. VRET may be particularly practical for combat Veterans because it provides access to visual and auditory stimuli rarely encountered outside of theaters of war (e.g., gunfire, explosions) while in a physically safe setting. Whether such sensory-focused exposure has benefits above and beyond (or in combination with) imaginal exposure has yet to be established. Limiting cognitive avoidance is an important consideration in using exposure therapy. While elimination of cognitive avoidance cannot be assured in VRET (or any other exposure treatment), VRET may provide a vehicle through which patients can be systematically exposed to visual/sensory stimuli. Certainly, clinicians should carefully assess whether patients are engaging in VRET as a "game," which could be conceptualized as cognitive avoidance. Additional considerations for clinicians new to using VRET are that excessive focus on the VRET equipment could come at the expense of the therapeutic relationship.

The present study is the first systematic CONSORT review of VRET for PTSD to objectively evaluate the methodological quality of the existing literature (CONSORT guidelines; Boutron et al., 2008; Schulz, Altman, & Moher, 2010). Although preliminary findings suggest some positive results for VRET as a form of exposure treatment for PTSD, additional research using well-specified randomization procedures, assessor blinding, and monitoring of treatment adherence is warranted. Movement toward greater standardization of treatment manuals, virtual environments, and equipment would further facilitate interpretation and consolidation of this literature.

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