Journal of Anxiety Disorders 61 (2019) 18–26

Contents lists available at ScienceDirect

Journal of Anxiety Disorders

journal homepage: www.elsevier.com/locate/janxdis

A meta-analytic examination of attrition in virtual reality exposure therapy for anxiety disorders

Amanda A. Benbow, Page L. Anderson*

Department of Psychology, Georgia State University, USA

ARTICLE INFO

Keywords:
Virtual reality
In vivo exposure
Dropout
Attrition
Meta-analysis
Anxiety

ABSTRACT

A proposed advantage of virtual reality exposure therapy for anxiety disorders is that people will be less likely to drop out of treatment prematurely if the treatment involves facing one's fear in a virtual world rather than the real world, but this has yet to be empirically tested. The present meta-analyses assess the odds of dropout from virtual reality exposure therapy compared to *in vivo* exposure therapy, estimate the overall rate of dropout from virtual reality exposure treatment, and test potential moderating variables. The odds ratio meta-analysis indicated that there was no significant difference in the likelihood of attrition from virtual reality exposure therapy relative to *in vivo* exposure therapy. The overall attrition rate for virtual reality exposure therapy across 46 studies with a combined sample size of 1057 participants was 16%. This rate is slightly lower than other estimates of dropout from *in vivo* therapy and from cognitive-behavioral therapy for anxiety disorders. Incorporation of between-session intervention (*i.e.*, homework) was identified as a moderator; specifically, inclusion of between-session interventions in the treatment was associated with better retention. Overall, the findings of the present study indicate that virtual reality exposure and *in vivo* exposure therapy show similar rates of attrition.

1. Introduction

One of the potential advantages of virtual reality exposure therapy (VRET) for anxiety disorders is that there may be less attrition from treatment if the treatment involves facing one's fear in a virtual world rather than the real world (Meyerbröker & Emmelkamp, 2010; Opriş et al., 2012; Peñate Castro et al., 2014). Attrition has been defined as discontinuation of therapy before treatment has been completed and symptoms have been resolved (Swift & Greenberg, 2012). The negative impacts of attrition are widespread. The client, for example, may not receive the full benefit from therapy and may be discouraged from future treatment-seeking (Björk, Björck, Clinton, Sohlberg, & Norring, 2009; Lampropoulos, 2010). The therapist may lose revenue and experience feelings of rejection, failure, and demoralization, and society will continue to be negatively impacted by the burden associated with mental illness (Barrett, Chua, Crits-Christoph, Gibbons, & Thompson, 2008). Despite speculation that VRET may produce less attrition from treatment than *in vivo* exposure, only one study has tested this claim (Opriş et al., 2012). This study used a chi-square analysis to test differences in attrition rates across studies that included VRET and *in vivo* exposure and found no differences in attrition between groups (Opriş et al., 2012). This approach, however, is limited. The authors did not report an estimated prevalence rate for attrition, assign weights for studies, nor examine the heterogeneity in dropout rates, which was quite high. By assigning weights to studies, current meta-analytic strategies may allow for a more precise comparison of attrition from VRET and *in vivo* exposure therapy by controlling for differences in sampling error across studies.

Research shows that demographic factors, such as age, ethnicity, education, and socioeconomic status are associated with higher risk for dropout from psychotherapy among adults (Swift & Greenberg, 2012). There may be other factors specific to VRET that influence attrition, such as the disorder being treated or the number of VRET sessions. For example, individuals with panic disorder may be more likely to drop out of VRET if they experience physical symptoms of cybersickness than participants with other anxiety disorders. In addition, in some efficacy trials, participants receiving VRET are instructed not to engage in between-session activities, whereas other trials explicitly assign between-session homework, such as contact with feared stimuli in the real world, which may influence treatment retention. Better understanding of whether and how such differences explain heterogeneity of attrition rates from VRET could be used to inform strategies for improving treatment retention.

This is the first study to use meta-analysis to compare attrition from VRET to *in vivo* exposure therapy, to assess the overall prevalence of attrition from VRET for anxiety, and to explore potential moderator

* Corresponding author.
E-mail address: panderson@gsu.edu (P.L. Anderson).

https://doi.org/10.1016/j.janxdis.2018.06.006
Received 7 February 2018; Received in revised form 12 June 2018; Accepted 18 June 2018
Available online 21 June 2018

variables that contribute to variability in attrition from VRET. We hypothesize that the risk of attrition will be lower for VRET than for *in vivo* exposure therapy.

2. Method

2.1. Systematic review

2.1.1. Search protocol

Search procedures were conducted using PRISMA guidelines for systematic reviews and meta-analyses (Liberati et al., 2009). Candidate studies for inclusion in the meta-analysis were identified by an electronic search, which was completed in March 2017, of the following databases: Medline, PsychInfo, Academic Search Complete, and ScienceDirect. A Boolean search was conducted using combinations of the terms *virtual reality, VRE,* or *VRET* paired with *anxiety, anx*, exposure, phobia, specific phobia, public speaking, panic disorder, panic, agoraphobia, generalized anxiety disorder, GAD, generalized anxiety, SAD, social anxiety disorder, social phobia,* or *social anxiety*. The reference sections of eligible articles and relevant reviews were searched for studies to include in the analyses. In addition, researchers in the field were contacted and asked to share data from unpublished studies related to the present research. No unpublished data were shared; however, additional published studies (n = 2) were identified by these communications. An additional search was conducted using the ProQuest database to identify theses and dissertations which may fit the eligibility criteria. No relevant studies were found.

2.1.2. Study inclusion and exclusion criteria

Original reports of studies using VRET to treat anxiety among human participants published in English in peer-reviewed journals were included in this study.

Studies were excluded for several reasons. Participants under the age of 18 were excluded to increase homogeneity in the sample. Case studies, studies utilizing a within-subjects design, and studies reporting on only a single treatment session were excluded. In the case of multiple publications from the same study sample, the study with the largest sample size was included and the rest were excluded. Studies were excluded if there was not enough data to calculate attrition rates. For the comparison of attrition between VRET and *in vivo* exposure therapy, studies that did not include an in vivo exposure therapy comparison group within the same trial were excluded to increase comparability between treatment conditions and minimize heterogeneity among studies.

2.1.3. Selection of studies

A total of 1688 articles were identified by the search procedure, and 372 duplicates were removed. Subsequent review of study titles and abstracts led to the exclusion of 1208 articles, and an additional 62 were excluded following review of the full text (see Fig. 1). A total of 46 articles were included in the meta-analysis used to assess the prevalence of attrition from VRET for anxiety, which included a combined sample size of 1057 participants. Of the 46 studies, 13 were randomized clinical trials comparing VRET to *in vivo* exposure therapy. These 13 studies with a combined sample of 756 participants were used to test the hypothesis that there would be lower attrition among participants assigned to VRET relative to *in vivo* exposure therapy.

2.1.4. Data extraction

Attrition was operationalized as the number of participants randomized to a VRET or *in vivo* exposure treatment condition who did not complete the intended number of treatment sessions specified by the trial. Subsequently, the likelihood of attrition from VRET was compared to the likelihood of attrition from in vivo exposure therapy. To compare attrition in VRET to *in vivo* exposure therapy, a Mantel-Haenszel (MH) odds ratio was calculated using the number of participants who dropped out of treatment divided by the number of participants who completed treatment for each treatment group. The MH method is preferable when conducting a meta-analysis of rare events, such as attrition (Bradburn, Deeks, Berlin, & Localio, 2007). An odds ratio of 1 indicates no differences in attrition between treatment groups. An odds ratio significantly different from 1 indicates a significant difference in dropout between the two groups. Data on the prevalence of attrition were extracted by identifying the number of participants who dropped out from VRET and the total number of participants assigned to receive VRET after randomization. Higher scores reflect higher rates of dropout from VRET treatment.

In order to test potential moderators of attrition from VRET, studies were coded with regard to the demographic characteristics of the participants who did not complete the treatment, the disorder being treated (specific phobia, social anxiety disorder, panic disorder with agoraphobia, agoraphobia, generalized anxiety disorder), whether or not VRET was used as a stand-alone treatment or in combination with other cognitive-behavioral interventions, inclusion of between-session intervention (*i.e.*, homework), and the number of VRET sessions. When reported by the study, reasons for dropout were noted. All data were coded by the first author, and the second author coded a subset (n = 10) of randomly selected studies from the 46 articles included in the prevalence analysis, six of which were randomized controlled trials. Inter-rater reliability was 90.9% across all data coded, with 100% agreement on attrition data between raters.

2.1.5. Assessment of study quality

A tool designed to assess risk of bias developed by the Cochrane Collaboration (Higgins et al., 2011) was used to assess the quality of the trials included in the analysis. Studies are coded as having a “high” or “low” risk for various types of bias due to different aspects of study quality. When there is not enough information to evaluate bias, the risk is coded as “unclear.” Studies were coded for selection bias (how participants are assigned to conditions), diagnostic methods (information on the diagnostic assessor and their training, on the reliability of the diagnoses made, blinding of assessors, methods used), and treatment adherence (using manualized treatments, therapist training, and assessment of treatment adherence through supervision, checklists, and/or independent ratings based on review of recorded sessions). Other forms of bias described by the tool were not assessed because it was either not possible (*e.g.*, therapists could not be blinded to the type of treatment they administered) or relevant for the research question (*e.g.*, blinding of treatment outcome assessment).

2.2. Meta-analyses

All analyses were conducted using Comprehensive Meta-analysis software (Comprehensive Meta-Analysis, 2013). An α level of 0.05 was used in all analyses. A random-effects model was used to calculate summary estimates for all moderator analyses because of high variability among studies (*e.g.*, differences in clinical disorder being treated, number of VRET sessions, *etc.*). One event rate (reflecting dropout from a VRET treatment) or odds ratio (comparing dropout from VRET to *in vivo* exposure therapy) was calculated per study. Variability in event rates or odds ratios was assessed *via* the Q statistic (Hedges & Olkin, 1985) and the I^2 statistic (Cooper, 2010). An I^2 of 25%, 50%, or 75% reflect a low, moderate, or high percentage of between-studies variability, respectively (Higgins & Thompson, 2002). Publication bias was assessed *via* a funnel plot, which plots the standard error from each study against the study’s event rate or odds ratio. Asymmetry suggests that publication bias may be present. The Duval & Tweedie trim-and-fill procedure was then used to calculate an adjusted summary estimate based on the likely number of missing studies (Duval & Tweedie, 2000).

2.2.1. Calculation of moderator analyses

Subgroup meta-analyses using Q tests were used to test potential

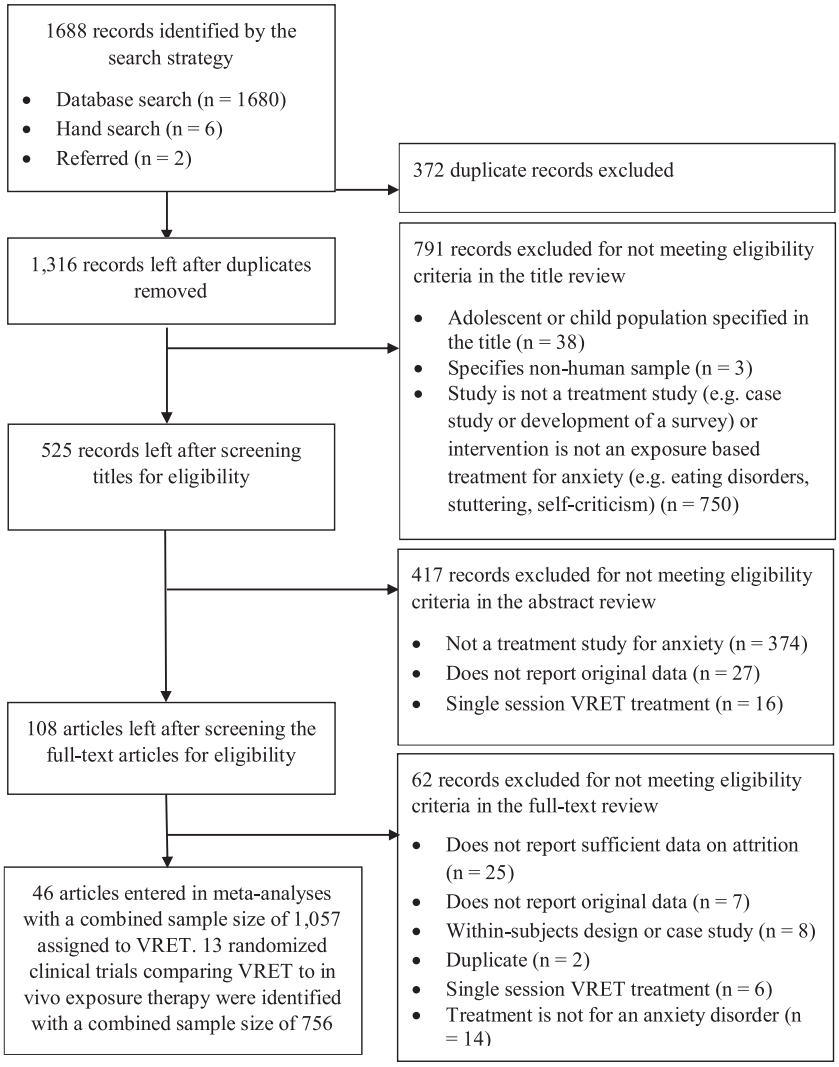

Fig. 1. PRISMA flow chart detailing the process of study identification.

moderating variables that could account for variability in dropout rates among the included studies. Subgroups were only included when there were ≥3 studies within a subgroup. All subgroup analyses did not assume pooled estimates of τ^2. The following moderating variables were assessed: demographic variables (*e.g.*, gender); disorder being treated (agoraphobia, panic disorder with agoraphobia, social anxiety disorder, and specific phobia); VRET as a stand-alone treatment or in combination with other cognitive-behavioral interventions; and inclusion of between-session intervention (*i.e.*, homework). A meta-regression analysis using a method-of-moments model was used to test the number of VRET exposure sessions as a possible source of between-studies heterogeneity.

3. Results

A total of 13 studies with a combined sample size of 756 participants randomly assigned to receive either VRET or *in vivo* exposure therapy were used to compare the likelihood of attrition from VRET and *in vivo* exposure therapy. The majority of randomized clinical trials comparing VRET to *in vivo* exposure were rated as "unclear" with regards to quality in terms of selection bias (n = 7, 54%), diagnostic methods (n = 6, 46%), and treatment adherence (n = 6, 46%) Fig. 2.

A total of 46 studies with a combined sample size of 1057 participants were used to estimate the weighted overall attrition rate from VRET. Details of the studies are reported in Table 1. Most studies

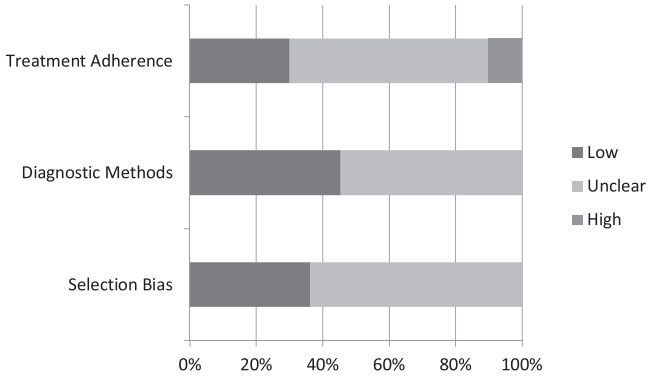

Fig. 2. Risk of bias graph. Judgments of risk bias are presented as percentages across all included studies.

indicated that their participants met diagnostic criteria for an anxiety disorder (n = 42 studies), but 4 studies described results from a sample with sub-threshold symptoms. Participants were treated for symptoms of agoraphobia (n = 6 studies), generalized anxiety disorder (n = 1 study), panic disorder with agoraphobia (n = 4 studies), social anxiety disorder or public speaking anxiety (n = 12 studies), and specific phobia (n = 23 studies). The studies were about evenly split as to whether VRET was delivered as stand-alone treatment (n = 22), or in

Table 1
Characteristics of the 46 studies included in the meta-analyses (Anderson et al., 2013, 2005; Botella et al., 2007; Bouchard et al., 2006, 2017; Choi et al., 2005; de Quervain et al., 2011; Emmelkamp et al., 2002; García-Palacios et al., 2002; Gebara et al., 2016; González Lorenzo et al., 2011; Harris et al., 2002; Herrmann et al., 2017; Hoffman et al., 2003; Kampmann et al., 2016; Klinger et al., 2005; Krijn et al., 2004; Krijn, Emmelkamp, Ólafsson, Bouwman et al., 2007, Krijn, Emmelkamp, Ólafsson, Schuemie et al., 2007; Levy et al., 2016; Malbos et al., 2013; Maltby et al., 2002; Meyerbröker et al., 2013; Meyerbröker and Emmelkamp, 2010; MMeyerbröker, Morina et al., 2011; Meyerbröker, Powers et al., 2011; Michaliszyn et al., 2010; Morina et al., 2015; Pelissolo et al., 2012; Peñate Castro et al., 2014; Peñate Castro et al., 2008; Pérez-Ara et al., 2010; Repetto et al., 2013; Ressler et al., 2004; Robillard et al., 2010; Rothbaum et al., 2006; Rothbaum et al., 2000; Rothbaum and Hodges, 1995; Roy et al., 2003; Tart et al., 2013; Tortella-Feliu et al., 2011; Triscari et al., 2015; Wallach et al., 2009; Walshe et al., 2003; Wiederhold et al., 2002; Yuen et al., 2013; Znaidi et al., 2006).

Article	Dx	Clinical Dx?	# of VRET Sessions	Type of VRET Treatment	VRET Completed	In Vivo Completed	VRET D/O	In vivo D/O	HW
Anderson et al. 2013	SAD	Yes	4	VRET+CBT	32	32	10	6	1
Anderson et al. 2005	SAD	Yes	4	VRET+CBT	10		0		1
Botella et al. 2007	PD	Yes	6	VRET+CBT	12	12	0	0	0
Bouchard et al. 2006	SP	Yes	3	VRET+CBT	11		0		0
Bouchard et al. 2017	SAD	Yes	8	VRET+CBT	24	28	6	10	0
Choi et al. 2005	PD	Yes	4	VRET+CBT	20	20	0	0	-
de Quervain et al. 2011	SP	Yes	3	VRET only	40		2		-
Emmelkamp et al. 2002	SP	Yes	3	VRET only	17	16	5	6	0
Garcia-Palacios et al. 2002	SP	Yes	4	VRET only	12		0		-
Gebara et al. 2016	SAD	Yes	5	VRET only	21		1		-
González-Lorenzo et al. 2011	A	Yes	8	VRET+CBT	19	20	3	2	-
Harris et al. 2002	SAD	No	4	VRET only	8		2		-
Herrmann et al. 2017	SP	Yes	2	VRET only	20		2		-
Hoffman et al. 2003	SP	Both	3	VRET only	24		0		-
Kampmann et al. 2016	SAD	Yes	7	VRET only	24	24	6	4	0
Klinger et al. 2005	SAD	Yes	12	VRET only	18	18	0	0	1
Krijn et al. 2004	SP	Yes	3	VRET only	17		12		0
Krijn et al. 2007a	SP	Yes	4	VRET only	33	27	17	3	0
Krijn et al. 2007b	SP	Yes	4	VRET+CBT	26		7		0
Levy et al. 2016	SP	Yes	6	VRET only	6		0		-
Malbos et al. 2013	A	Yes	8	VRET or VRET+CBT	18		1		0
Maltby et al. 2002	SP	Yes	4	VRET+CBT	20		2		-
Meyerbröker et al. 2013	A	Yes	6	VRET+CBT	16	15	8	7	-

(*continued on next page*)

Table 1 (*continued*)

Meyerbröker et al. 2010	SP	Yes	4	VRET only	49		18		-
Meyerbröker et al. 2011	A	Yes	6	VRET+CBT	11		6		-
Michaliszyn et al. 2010	SP	Yes	6	VRET+CBT	16	16	2	2	-
Morina et al. 2015	SAD	No	2	VRET only	16		0		-
Pelissolo et al. 2012	PD	Yes	12	VRET only	33	34	10	10	1
Peñate Castro et al. 2014	A	Yes	8	VRET+CBT	23	14	7	16	-
Peñate Castro et al. 2008	A	Yes	8	VRET+CBT	15	13	5	3	1
Pérez-Ara et al. 2010	PD	Yes	6	VRET+CBT	29		0		-
Repetto et al. 2013	GAD	Yes	8	VRET only	17		1		1
Ressler et al. 2004	SP	Yes	2	VRET only	27		1		1
Robillard et al. 2010	SAD	Yes	16	VRET+CBT	14	16	0	0	-
Rothbaum et al. 2006	SP	Yes	4	VRET+CBT	36	37	5	5	1
Rothbaum et al. 2000	SP	Yes	4	VRET+CBT	15	15	3	1	1
Rothbaum et al. 1995	SP	Yes	7	-	17		3		-
Roy et al. 2003	SAD	Yes	8	VRET only	4	6	0	0	1
Tart et al. 2013	SP	Yes	2	VRET only	26		3		-
Tortella-Feliu et al. 2011	SP	Yes	6	VRET+CBT	17		1		0
Triscari et al. 2015	SP	Yes	-	VRET+CBT	21	22	0	0	-
Wallach et al. 2009	SAD	-	8	VRET+CBT	28		6		1
Walshe et al. 2003	SP	Yes	12	VRET+CBT	7		0		1
Wiederhold et al. 2002	SP	Yes	6	VRET only	9		0		1
Yuen et al. 2013	SAD	Yes	10	VRET+CBT	12		2		1
Znaidi et al. 2006	SP	Yes	9	VRET only	8		2		-

Note. Only the first author is cited to denote records. Dash indicates that data were not reported. Highlighted items include an *in vivo* exposure condition and were included in the odds ratio meta-analysis. In the HW column, a 1 indicates that between-session interventions were assigned as part of the treatment and a 0 indicates that between-session intervention was discouraged or not included.
Dx = diagnosis, D/O = drop out, HW = between-session intervention, SAD = social anxiety disorder, PD = panic disorder with agoraphobia, SP = specific phobia, A = agoraphobia, GAD = generalized anxiety disorder.

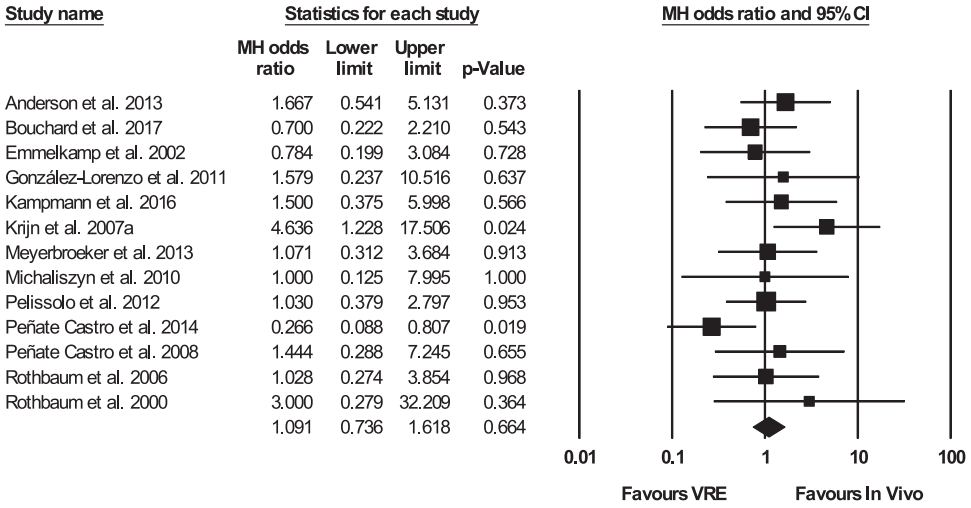

Fig. 3. Forest plot of odds ratios comparing attrition from VRET and *in vivo* exposure therapy. An odds ratio significantly higher or lower than 1 indicates increased and decreased likelihood of dropout in VRET compared to *in vivo* exposure therapy, respectively.

combination with other cognitive-behavioral interventions (n = 24). Some studies included between-session interventions (n = 14 studies), but others explicitly discouraged exposure or other homework between sessions (n = 10 studies), and the remaining studies did not clearly indicate whether between session interventions were used. The number of VRET exposure sessions ranged from 2-16. None of the studies described the demographic characteristics of participants who dropped out of treatment.

3.1. Comparing attrition from VRET and in vivo exposure therapy

The odds of attrition from VRET compared to attrition from *in vivo* exposure therapy ranged from 0.70 to 4.64, and the summary MH odds ratio was 1.09 (p = 0.66), indicating no difference in the average likelihood of dropout from VRET compared to *in vivo* exposure therapy (see Fig. 3). Heterogeneity in effect sizes among studies was low (I^2 = 9.86, suggesting 9.86% of the variability among effects sizes is due to differences between-studies) and was not significant (Q = 13.31, p = 0.35). If any one study were removed from the analysis, MH odds ratios ranged from 0.96 to 1.30 (all p's > 0.05) which indicates that no one study dominated the overall effect size.

Asymmetry was detected in the funnel plot, and the Duval and Tweedie's trim-and-fill procedure identified five potential missing studies for correction of the summary MH odds ratio. The adjusted odds ratio was 0.78 and was not significantly different from 1. Moderator analyses were not conducted due to the lack of significant heterogeneity in odds ratios across studies.

3.2. Estimating the prevalence of attrition from VRET

Across 46 studies, the prevalence of attrition from VRET ranged from 1.7% (Pérez-Ara et al., 2010) to 41.4% (Krijn et al., 2004). The weighted summary prevalence rate of attrition from VRET was 16.0% with a 95% confidence interval of 12.9%–19.7%. None of the studies appeared to dominate the overall effect size. Asymmetry was observed in the funnel plot, and the Duval and Tweedie's trim-and-fill procedure identified 19 potential missing studies for correction of the summary prevalence rate. The adjusted prevalence rate was 21.1% with a 95% confidence interval ranging from 16.9% to 26.0%.

Heterogeneity of the weighted summary prevalence rate was low to moderate (I^2 = 39.61) and significant (Q = 74.52, p < 0.01), indicating significant differences in attrition rates among individual studies. Thus, attrition from VRET may be better understood by testing potential moderators.

3.3. Moderator analyses

Subgroup meta-analyses were used to explore factors one might expect to be related to attrition from VRET based on prior literature (*e.g.*, demographic factors) or on characteristics of studies that may be uniquely affected by VRET (*e.g.*, disorder being treated). One significant moderator variable was identified: between-session intervention (Q = 4.64, p = 0.03). Studies that included between-session interventions reported significantly lower dropout rates (17.1%) relative to those that discouraged between-session intervention (25.2%). Disorder being treated and inclusion of other cognitive-behavioral interventions in addition to VRET did not significantly influence heterogeneity in rates of attrition (both p's > .05). A meta-regression analysis was used to assess the relation between number of exposure sessions and dropout. The relation was not significant (p = .99).

3.4. Reasons for dropout

Table 2 summarizes the reasons for dropout from VRET and *in vivo* exposure therapy among the studies that reported this information. Many studies, however, did not report reasons for dropout and, of those that did, many did not include reasons for dropout from all of the participants that did not complete treatment. The most commonly reported reason for dropout from VRET across studies was failure to immerse in the VRET environment (39 participants across studies). Other elements unique to VRET that contributed to dropout included cybersickness (6 participants across studies), vision complications such as the need to wear glasses, myopia, or astigmatism (4 participants across studies), and discomfort with communicating with a therapist that the participant could not see (1 participant). The most commonly reported reason for dropout from *in vivo* exposure across the included studies was fear of exposure to the feared stimulus (8 participants across studies). Notably, fear of exposure was only reported by two participants assigned to a VRET condition. In contrast, eight participants assigned to an *in vivo* treatment dropped out due to fear of exposure.

4. Discussion

Contrary to hypotheses, VRET did not produce lower risk of attrition than *in vivo* exposure therapy among people treated for anxiety disorders. This finding seems to cast doubt on one of the purported advantages of VRET - that people being treated for anxiety disorders will be less likely to drop out of treatment prematurely if the treatment

Table 2
Reported reasons for dropout from VRET and *in vivo* exposure therapy described in studies included in the meta-analyses, and the total number of participants who provided these reasons for dropout across studies.

Reason for dropout from VRET	*n*
Inability to immerse	39
Scheduling conflicts	8
Relocation	7
Medical condition	6
Side effects (*e.g.* cybersickness)	6
Glasses interfered with VR/myopia/astigmatism	4
Perceived unhelpfulness of treatment	4
Personal reasons	4
Emotional difficulty of treatment	3
Perceived increase in symptoms	3
Desire to be in *in vivo* condition	2
Fear that VRET would increase symptoms	2
Perceived poor match between trauma memory and VRET	2
Symptom improvement	2
Uncomfortable communicating with therapist the participant could not see	1

Reason for dropout from *in vivo*	*n*
Did not want to do *in vivo* exposure	8
Desire to be in VRET condition	5
Relocation	4
Group treatment too challenging	2
No longer interested	2
Scheduling conflicts	1
Other psychological problems	1
Financial reasons	1
Perceived increase in symptoms	1

involves facing one's fear in a virtual world rather than the real world. It is worthwhile to consider, however, that the analysis comparing attrition from VRET and *in vivo* exposure therapy only included studies that used random assignment to determine which treatment participants received. It is possible that, given a choice, more people in the community would choose VRET over *in vivo* exposure therapy, and that people who choose VRET would be more likely to complete treatment compared to those who aren't given a choice. Research studies using surveys to assess treatment preferences demonstrate that, when given the choice between VRET and *in vivo* exposure, the majority of respondents prefer VRET (Garcöa-Palacios, Hoffman, KwongSee, Tsai, & Botella, 2001; García-Palacios, Botella, Hoffman, & Fabregat, 2007). Given that clients are more likely to stay in a treatment of their choosing (Steidtmann et al., 2012), people seeking treatment may be more likely to seek out and stay in VRET compared to *in vivo* exposure therapy. This is an empirical question for future research. The increasing commercial availability of VR technology urges future research to examine attrition from VRET in naturalistic clinical settings – and even self-guided treatments. Nevertheless, results from this study show that there are no differences in attrition from VRET and *in vivo* exposure therapy.

Across all studies testing VRET for anxiety disorders (not just RCTs), an analysis using 46 studies with a combined sample size of 1057 participants yielded an estimated dropout rate of 16.0% from VRET. This attrition rate is slightly lower than the estimated attrition rates reported in a review of cognitive-behavioral treatment for anxiety disorders (Fernandez, Salem, Swift, & Ramtahal, 2015) and in a meta-analysis of dropout from traditional therapy (Swift & Greenberg, 2012) - 19.6% and 19.7%, respectively.

The estimated attrition rate from VRET was characterized by substantial heterogeneity, suggesting that identifying moderators is needed to better characterize attrition from VRET. With one exception, each of the potential moderators we examined did not explain a significant portion of the variability in attrition, including type of disorder (*e.g.*, specific phobia, social anxiety disorder); VRET as a stand-alone treatment or combined with other cognitive-behavioral techniques; and the number of VRET sessions. Surprisingly, the number of exposure sessions also did not explain heterogeneity in dropout rates (one might expect higher rates of attrition from treatments with more sessions). However, review of individual studies suggests that attrition often took place early in treatment, even before exposure sessions began. For example, of the two participants who dropped out of a study conducted by de Quervain et al. (2011), one dropped out between the first and second session and another dropped out (presumably early in treatment) due to dizziness experienced during VRET. If most attrition from VRET occurs early on, then interventions designed to improve VRET treatment retention need to be delivered at the beginning of treatment. This could involve identification of individuals who are not suited to VRET (*e.g.* lack of immersion in the virtual environment) and/or use of a phase-based approach that initially emphasizes psychoeducation, rapport building, and tolerance of negative emotion prior to engaging in VRET. Such an approach could increase clients' beliefs of the credibility of exposure and increase willingness to face their fears.

Even though rates of attrition from VRET and *in vivo* exposure were similar, the reasons for dropping out of each treatment were quite different. The most common reason for discontinuing *in vivo* exposure was fear of exposure. It is possible that VRET may, indeed, be less intimidating than *in vivo* exposure for some individuals. The most common reason participants reported for discontinuing VRET, however, was the inability to immerse in the VRET environment. In order to improve immersion, virtual environments may be designed to maximize presence, defined as the client's ability to interpret virtual stimuli as real (Diemer, Alpers, Peperkorn, Shiban, & Mühlberger, 2015). For example, a sense of presence is positively related to the number of anxiety-provoking stimuli present in the virtual environment (Price & Anderson, 2007). Immersion may be improved by using environments that emphasize symbolism over realism. For example, "EMMA's WORLD" (Baños et al., 2011) encourages participants to personalize emotional virtual elements of an adaptive display. Future research on methods to improve treatment retention in VRET should also focus on methods to limit side-effects such as cybersickness, another commonly reported reason for attrition.

There was one significant moderator of attrition from VRET: dropout rates were lower among studies that included some form of between-session intervention (17.1%) compared to studies that did not (25.2%). Better retention may be due to the fact that treatments incorporating between-session interventions produce more improvement during treatment (see Mausbach, Moore, Roesch, Cardenas, & Patterson, 2010 for a meta-analysis on the relation betweensession interventions and outcome). Inclusion of between-session interventions may also provide additional opportunities for collaboration between the client and the therapist, thus improving the quality of the working alliance and therapeutic engagement (Cronin, Lawrence, Taylor, Norton, & Kazantzis, 2015). Common factors, like the working alliance, have been shown to predict dropout within traditional psychotherapy (*e.g.* Johansson & Eklund, 2006), but research on the association between the working alliance and dropout from VRET has not been published to date.

An important limitation of this study is inability to evaluate individual study quality as a moderator of attrition. The vast majority of quality ratings in this study were "unclear", which precluded our ability to evaluate the extent to which study quality explained variability in attrition rates. Publication bias, which can occur because studies reporting null and/or negative findings are less likely to be published in peer-reviewed journals (Hopewell, Loudon, Clarke, Oxman, & Dickersin, 2009), may have played a role in this study, as we found higher rates of attrition from VRET after adjusting for publication bias. Therefore, it is possible that the attrition rate for VRET reported herein is too low.

Another important limitation is the inability to evaluate demographic characteristics as a moderator of attrition from VRET because

research shows that age, ethnicity, education, and socioeconomic status are associated with higher risk for dropout from psychotherapy (Swift & Greenberg, 2012). Unfortunately, not a single study used in this meta-analysis reported the demographic characteristics of participants who dropped out from treatment, consistent with a review showing that most treatment studies report very limited demographic information about their participants (see Johnson & Anderson, 2016, for a review). Attrition itself is a rare event, and minority groups are under-represented in treatment research, so meta-analysis is an ideal tool to test whether attrition differs across participants with different demographic characteristics, which has significant implications for public health. We therefore encourage researchers to describe participants who do and do not complete treatment in more detail.

Despite these limitations, the present study is the first to use meta-analytic techniques to compare dropout rates in VRET to *in vivo* exposure, to assess the prevalence of attrition in VRET, and evaluate potential moderators of attrition from VRET.

References[1]

*Anderson, P. L., Price, M., Edwards, S. M., Obasaju, M. A., Schmertz, S. K., Zimand, E., ... Calamaras, M. R. (2013). Virtual reality exposure therapy for social anxiety disorder: A randomized controlled trial. *Journal of Consulting and Clinical Psychology, 81*(5), 751–760. http://dx.doi.org/10.1037/a0033559751.

*Anderson, P. L., Zimand, E., Hodges, L. F., & Rothbaurn, B. O. (2005). Cognitive behavioral therapy for public-speaking anxiety using virtual reality for exposure. *Depression and Anxiety, 22*(3), 156–158. http://dx.doi.org/10.1002/da.20090.

Baños, R. M., Guillen, V., Quero, S., García-Palacios, A., Alcaniz, M., & Botella, C. (2011). A virtual reality system for the treatment of stress-related disorders: A preliminary analysis of efficacy compared to a standard cognitive behavioral program. *International Journal of Human-Computer Studies, 69*(9), 602–613. http://dx.doi.org/10.1016/j.ijhcs.2011.06.002.

Barrett, M. S., Chua, W. J., Crits-Christoph, P., Gibbons, M. B., & Thompson, D. (2008). Early withdrawal from mental health treatment: Implications for psychotherapy practice. *Psychotherapy: Theory, Research, Practice, Training, 45*(2), 247–267. http://dx.doi.org/10.1037/0033-3204.45.2.247.

Björk, T., Björck, C., Clinton, D., Sohlberg, S., & Norring, C. (2009). What happened to the ones who dropped out? Outcome in eating disorder patients who complete or prematurely terminate treatment. *European Eating Disorders Review, 17*(2), 109–119. http://dx.doi.org/10.1002/erv.911.

*Botella, C., García-Palacios, A., Villa, H., Baños, R. M., Quero, S., Alcañiz, M., & Riva, G. (2007). Virtual reality exposure in the treatment of panic disorder and agoraphobia: A controlled study. *Clinical Psychology & Psychotherapy, 14*(3), 164–175. http://dx.doi.org/10.1002/cpp.524.

*Bouchard, S., Côté, S., St-Jacques, J., Robillard, G., & Renaud, P. (2006). Effectiveness of virtual reality exposure in the treatment of arachnophobia using 3D games. *Technology & Health Care, 14*(1), 19–27.

*Bouchard, S., Dumoulin, S., Robillard, G., Guitard, T., Klinger, E., Forget, H., ... Roucaut, F. X. (2017). Virtual reality compared with in vivo exposure in the treatment of social anxiety disorder: Three-arm randomized controlled trial. *The British Journal of Psychiatry,* 1–8. http://dx.doi.org/10.1192/bjp.bp.116.184234.

Bradburn, M. J., Deeks, J. J., Berlin, J. A., & Localio, A. R. (2007). Much ado about nothing: A comparison of the performance of meta-analytical methods with rare events. *Statistics in Medicine, 26*(1), 53–77. http://dx.doi.org/10.1002/sim.2528.

*Choi, Y.-H., Vuncelli, F., Riva, G., Wiederhold, B. K., Lee, J.-H., & Park, K.-H. (2005). Effects of group experiential cognitive therapy for the treatment of panic disorder with agoraphobia. *CyberPsychology & Behavior, 8*(4), 387–393. http://dx.doi.org/10.1089/cpb.2005.8.387.

Comprehensive Meta-Analysis (2013). *Comprehensive meta-analysis (version 2).* Englewood, NJ: Biostat.

Cooper, H. (2010). *Research synthesis and meta-analysis: A step-by-step approach.* Washington, DC: Sage.

Cronin, T. J., Lawrence, K. A., Taylor, K., Norton, P. J., & Kazantzis, N. (2015). Integrating between-session interventions (homework) in therapy: The importance of the therapeutic relationship and cognitive case conceptualization. *Journal of Clinical Psychology, 71*(5), 439–450. http://dx.doi.org/10.1002/jclp.22180.

*de Quervain, D. J. F., Bentz, D., Michael, T., Bolt, O. C., Wiederhold, B. K., Margraf, J., ... Wilhelm, F. H. (2011). Glucocorticoids enhance extinction-based psychotherapy. *Proceedings of the National Academy of Sciences of the United States of America, 108*(16), 6621–6625. http://dx.doi.org/10.1073/pnas.1018214108.

Diemer, J., Alpers, G. W., Peperkorn, H. M., Shiban, Y., & Mühlberger, A. (2015). The impact of perception and presence on emotional reactions: A review of research in virtual reality. *Frontiers in Psychology, 6*, 1–9. http://dx.doi.org/10.3389/fpsyg.2015.00026.

Duval, S., & Tweedie, R. (2000). Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics, 56*, 455–463. http://dx.doi.org/10.1111/j.0006-341X.2000.00455.x.

*Emmelkamp, P. M. G., Krijn, M., Hulsbosch, A. M., De Vries, S., Schuemie, M. J., & Van der Mast, C. A. P. G. (2002). Virtual reality treatment versus exposure in vivo: A comparative evaluation in acrophobia. *Behaviour Research and Therapy, 40*(5), 509–516. http://dx.doi.org/10.1016/S0005-7967(01)00023-7.

Fernandez, E., Salem, D., Swift, J. K., & Ramtahal, N. (2015). Meta-analysis of dropout from cognitive behavioral therapy: Magnitude, timing, and moderators. *Journal of Consulting and Clinical Psychology, 83*(6), 1108–1122. http://dx.doi.org/10.1037/ccp0000044.

García-Palacios, A., Botella, C., Hoffman, H., & Fabregat, S. (2007). Comparing acceptance and refusal rates of virtual reality exposure vs. In vivo exposure by patients with specific phobias. *Cyberpsychology & Behavior, 10*(5), 722–724. http://dx.doi.org/10.1089/cpb.2007.9962.

*García-Palacios, A., Hoffman, H., Carlin, A., Furness Iii, T. A., & Botella, C. (2002). Virtual reality in the treatment of spider phobia: A controlled study. *Behaviour Research & Therapy, 40*(9), 983. http://dx.doi.org/10.1016/S0005-7967(01)00068-7.

García-Palacios, A., Hoffman, H., KwongSee, S., Tsai, A., & Botella, C. (2001). Redefining therapeutic success with virtual reality exposure therapy. *CyberPsychology and Behavior, 43*, 341–348. http://dx.doi.org/10.1089/109493101300210231.

*Gebara, C. M., de Barros-Neto, T. P., Gertsenchtein, L., & Lotufo-Neto, F. (2016). Virtual reality exposure using three-dimensional images for the treatment of social phobia. *Revista Brasileira de Psiquiatria, 38*(1), 24–29. http://dx.doi.org/10.1590/1516-4446-2014-1560.

*González Lorenzo, M., Peñate Castro, W., Pitti González, C. T., Bethencourt Pérez, J. M., de la Fuente, Portero, J. A., ... Gracia Marco, R. (2011). Efficacy of virtual reality exposure therapy combined with two pharmacotherapies in the treatment of agoraphobia. *International Journal of Clinical and Health Psychology, 11*(2), 189–203.

*Harris, S. R., Kemmerling, R. L., & North, M. M. (2002). Brief virtual reality therapy for public speaking anxiety. *CyberPsychology & Behavior, 5*(6), 543–550. http://dx.doi.org/10.1089/109493102321018187.

Hedges, L. V., & Olkin, I. (1985). *Statistical methods for meta-analysis.* Orlando, FL: Academic Press.

*Herrmann, M. J., Katzorke, A., Busch, Y., Gromer, D., Polak, T., Pauli, P., ... Deckert, J. (2017). Medial prefrontal cortex stimulation accelerates therapy response of exposure therapy in acrophobia. *Brain Stimulation, 10*(2), 291–297. http://dx.doi.org/10.1016/j.brs.2016.11.007.

Higgins, J. P. T., & Thompson, S. G. (2002). Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine, 21*, 1539–1558. http://dx.doi.org/10.1002/sim.1186.

Higgins, J. P., Altman, D. G., Gøtzsche, P. C., Jüni, P., Moher, D., Oxman, A. D., ... Sterne, J. A. (2011). The cochrane collaboration's tool for assessing risk of bias in randomised trials. *BMJ, 343*, d5928. http://dx.doi.org/10.1136/bmj.d5928.

*Hoffman, H. G., García -Palacios, A., Carlin, A., Furness Iii, T. A., & Botella-Arbona, C. (2003). Interfaces that heal: Coupling real and virtual objects to treat spider phobia. *International Journal of Human-Computer Interaction, 16*(2), 283–300. http://dx.doi.org/10.1207/S15327590IJHC1602_08.

Hopewell, S., Loudon, K., Clarke, M. J., Oxman, A. D., & Dickersin, K. (2009). Publication bias in clinical trials due to statistical significance or direction of trial results. *Cochrane Database of Systematic Reviews, 1*(MR000006), http://dx.doi.org/10.1002/14651858.MR000006.pub3.

Johansson, H., & Eklund, M. (2006). Helping alliance and early dropout from psychiatric out-patient care. *Social Psychiatry and Psychiatric Epidemiology, 41*(2), 140–147. http://dx.doi.org/10.1007/s00127-005-0009-z.

Johnson, S. B., & Anderson, P. L. (2016). Don't ask, don't tell: A systematic review of the extent to which participant characteristics are reported in social anxiety treatment studies. *Anxiety, Stress, & Coping, 6*, 589–605. http://dx.doi.org/10.1080/10615806.2016.1138289.

*Kampmann, I. L., Emmelkamp, P. M. G., Hartanto, D., Brinkman, W.-P., Zijlstra, B. J. H., & Morina, N. (2016). Exposure to virtual social interactions in the treatment of social anxiety disorder: A randomized controlled trial. *Behaviour Research & Therapy, 77*, 147–156. http://dx.doi.org/10.1016/j.brat.2015.12.016.

*Klinger, E., Bouchard, S., Légeron, P., Roy, S., Lauer, F., Chemin, I., ... Nugues, P. (2005). Virtual reality therapy versus cognitive behavior therapy for social phobia: A preliminary controlled study. *Cyberpsychology & Behavior, 8*(1), 76–88. http://dx.doi.org/10.1089/cpb.2005.8.76.

*Krijn, M., Emmelkamp, P. M. G., Biemond, R., de Wilde de Ligny, C., Schuemie, M. J., & van der Mast, C. A. P. G. (2004). Treatment of acrophobia in virtual reality: The role of immersion and presence. *Behaviour Research & Therapy, 42*(2), 229. http://dx.doi.org/10.1016/S0005-7967(03)00139-6.

*Krijn, M., Emmelkamp, P. M. G., Ólafsson, R. P., Bouwman, M., van Gerwen, L. J., Spinhoven, P., & van der Mast, C. A. P. G. (2007). Fear of flying treatment methods: Virtual reality exposure vs. cognitive behavioral therapy. *Aviation, Space, and Environmental Medicine, 78*(2), 121–128.

*Krijn, M., Emmelkamp, P. M. G., Ólafsson, R. P., Schuemie, M. J., & Van Der Mast, C. A. P. G. (2007). Do self-statements enhance the effectiveness of virtual reality exposure therapy? A comparative evaluation in acrophobia. *CyberPsychology & Behavior, 10*(3), 362–370. http://dx.doi.org/10.1089/cpb.2006.9943.

Lampropoulos, G. K. (2010). Type of counseling termination and trainee therapist–client agreement about change. *Counselling Psychology Quarterly, 23*(1), 111–120. http://dx.doi.org/10.1080/09515071003721552.

*Levy, F., Leboucher, P., Rautureau, G., & Jouvent, R. (2016). E-virtual reality exposure therapy in acrophobia: A pilot study. *Journal of Telemedicine & Telecare, 22*(4), 215–220. http://dx.doi.org/10.1177/1357633X15598243.

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., ... Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *Plos Medicine, 6*(7), e1000100. http://dx.doi.org/10.1371/journal.pmed.

[1] References marked with an asterisk indicate studies included in the meta-analyses.

1000100.
*Malbos, E., Rapee, R. M., & Kavakli, M. (2013). A controlled study of agoraphobia and the independent effect of virtual reality exposure therapy. *Australian & New Zealand Journal of Psychiatry, 47*(2), 160–168. http://dx.doi.org/10.1177/0004867412453626.
*Maltby, N., Kirsch, I., Mayers, M., & Allen, G. J. (2002). Virtual reality exposure for the treatment of fear of flying: A controlled investigation. *Journal of Consulting & Clinical Psychology, 70*(5), 1112–1118. http://dx.doi.org/10.1037/0022-006X.70.5.1112.
Mausbach, B. T., Moore, R., Roesch, S., Cardenas, V., & Patterson, T. L. (2010). The relationship between homework compliance and therapy outcomes: An updated meta-analysis. *Cognitive Therapy and Research, 34*(5), 429–438. http://dx.doi.org/10.1007/s10608-010-9297-z.
Meyerbröker, K., & Emmelkamp, P. M. G. (2010). Virtual reality exposure therapy in anxiety disorders: A systematic review of process-and-outcome studies. *Depression and Anxiety, 27*, 933–944. http://dx.doi.org/10.1002/da.20734.
*Meyerbröker, K., Morina, N., Kerkhof, G. A., & Emmelkamp, P. M. G. (2013). Virtual reality exposure therapy does not provide any additional value in agoraphobic patients: A randomized controlled trial. *Psychotherapy & Psychosomatics, 82*(3), 170–176. http://dx.doi.org/10.1159/000342715.
*Meyerbröker, K., Morina, N., Kerkhof, G., & Emmelkamp, P. M. G. (2011). Virtual reality exposure treatment of agoraphobia: A comparison of computer automatic virtual environment and head-mounted display. *Annual Review of CyberTherapy and Telemedicine, 9*, 41–45.
*Meyerbröker, K., Powers, M. B., van Stegeren, A., & Emmelkamp, P. M. G. (2011). Does yohimbine hydrochloride facilitate fear extinction in virtual reality treatment of fear of flying? A randomized placebo-controlled trial. *Psychotherapy & Psychosomatics, 81*(1), 29–37. http://dx.doi.org/10.1159/000329454.
*Michaliszyn, D., Marchand, A., Bouchard, S., Martel, M.-O., & Poirier-Bisson, J. (2010). A randomized, controlled clinical trial of in virtuo and in vivo exposure for spider phobia. *CyberPsychology, Behavior & Social Networking, 13*(6), 689–695. http://dx.doi.org/10.1089/cyber.2009.0277.
*Morina, N., Brinkman, W. P., Hartanto, D., Kampmann, I. L., & Emmelkamp, P. M. G. (2015). Social interactions in virtual reality exposure therapy: A proof-of-concept pilot study. *Technology & Health Care, 23*(5), 581–589. http://dx.doi.org/10.3233/THC-151014.
Opriş, D., Pintea, S., García-Palacios, A., Botella, C., Szamosközi, Ş., & David, D. (2012). Virtual reality exposure therapy in anxiety disorders: A quantitative meta-analysis. *Depression and Anxiety, 29*, 85–93. http://dx.doi.org/10.1002/da.20910.
*Pelissolo, A., Zaoui, M., Aguayo, G., Yao, S. N., Roche, S., Ecochard, R., ... Cottraux, J. (2012). Virtualreality exposure therapy versus cognitive behavior therapy for panic disorder with agoraphobia: Arandomized comparison study. *Journal of Cybertherapy and Rehabilitation, 5*(1), 35–43.
*Peñate Castro, W., Roca Sanchez, M. J., Pitti González, C. T., Bethencourt, J. M., de la Fuente Portero, J. A., & Gracia Marco, R. (2014). Cognitive-behavioral treatment and antidepressants combined with virtual reality exposure for patients with chronic agoraphobia. *International Journal of Clinical and Health Psychology, 14*(1), 9–17. http://dx.doi.org/10.1016/S1697-2600(14)70032-8.
*Peñate Castro, W., Pitti, C. T., Bethencourt, J. M., de la Fuente, J., & Gracia, R. (2008). The effects of a treatment based on the use of virtual reality exposure and cognitive-behavioral therapy applied to patients with agoraphobia. *International Journal of Clinical and Health Psychology, 8*(1), 5–22.
*Pérez-Ara, M. A., Quero, S., Botella, C., Baños, R., Andreu-Mateu, S., García-Palacios, A., ... Bretón-López, J. (2010). Virtual reality interoceptive exposure for the treatment of panic disorder and agoraphobia. *Studies in Health Technology and Informatics, 154*, 77–81. http://dx.doi.org/10.3233/978-1-60750-561-7-77.
Price, M., & Anderson, P. (2007). The role of presence in virtual reality exposure therapy. *Journal of Anxiety Disorders, 21*(5), 742–751. http://dx.doi.org/10.1016/j.janxdis.2006.11.002.
*Repetto, C., Gaggioli, A., Pallavicini, F., Cipresso, P., Raspelli, S., & Riva, G. (2013). Virtual reality and mobile phones in the treatment of generalized anxiety disorders: A phase-2 clinical trial. *Personal & Ubiquitous Computing, 17*(2), 253–260. http://dx.doi.org/10.1007/s00779-011-0467-0.
*Ressler, K. J., Rothbaum, B. O., Tannenbaum, L., Anderson, P., Graap, K., Zimand, E., ... Davis, M. (2004). Cognitiveenhancers as adjuncts to psychotherapy: Use of d-cycloserine in phobic individuals to facilitateextinction of fear. *Archives of General Psychiatry, 61*(11), 1136–1144. http://dx.doi.org/10.1001/archpsyc.61.11.1136.
*Robillard, G., Bouchard, S., Dumoulin, S., Guitard, T., & Klinger, E. (2010). Using virtual humans to alleviate social anxiety: Preliminary report from a comparative outcome study. *Annual Review of Cybertherapy and Telemedicine,* 57–60. http://dx.doi.org/10.3233/978-1-60750-561-7-57.
*Rothbaum, B. O., & Hodges, L. F. (1995). Effectiveness of computer-generated (virtual reality) graded exposure in the treatment of acrophobia. *American Journal of Psychiatry, 152*(4), 626.
*Rothbaum, B. O., Anderson, P., Zimand, E., Hodges, L., Lang, D., & Wilson, J. (2006). Virtual reality exposure therapy and standard (in vivo) exposure therapy in the treatment of fear of flying. *Behavior Therapy, 37*(1), 80–90. http://dx.doi.org/10.1016/j.beth.2005.04.004.
*Rothbaum, B. O., Hodges, L., Smith, S., Lee, J. H., & Price, L. (2000). A controlled study of virtual reality exposure therapy for the fear of flying. *Journal of Consulting and Clinical Psychology, 68*(6), 1020–1026. http://dx.doi.org/10.1037/0022-006X.68.6.1020.
*Roy, S., Klinger, E., Légeron, P., Lauer, F., Chemin, I., & Nugues, P. (2003). Definition of a VR-based protocol to treat social phobia. *CyberPsychology & Behavior, 6*(4), 411. http://dx.doi.org/10.1089/109493103322278808.
Steidtmann, D., Manber, R., Arnow, B. A., Klein, D. N., Markowitz, J. C., Rothbaum, B. O., ... Kocsis, J. H. (2012). Patient treatment preference as a predictor of response and attrition in treatment for chronic depression. *Depression and Anxiety, 29*(10), 896–905. http://dx.doi.org/10.1002/da.21977.
Swift, J. K., & Greenberg, R. P. (2012). Premature discontinuation in adult psychotherapy: A meta-analysis. *Journal of Consulting and Clinical Psychology, 80*(4), 547–559. http://dx.doi.org/10.1037/a0028226.
*Tart, C. D., Handelsman, P. R., DeBoer, L. B., Rosenfield, D., Pollack, M. H., Hofmann, S. G., ... Smits, J. A. J. (2013). Augmentation of exposure therapy with post-session administration of d-cycloserine. *Journal of Psychiatric Research, 47*(2), 168–174. http://dx.doi.org/10.1016/j.jpsychires.2012.09.024.
*Tortella-Feliu, M., Botella, C., Llabrés, J., Bretón-López, J. M., del Amo, A. R., Baños, R. M., ... Gelabert, J. M. (2011). Virtual reality versus computer-aided exposure treatments for fear of flying. *Behavior Modification, 35*(1), 3–30. http://dx.doi.org/10.1177/0145445510390801.
*Triscari, M. T., Faraci, P., Catalisano, D., D'Angelo, V., & Urso, V. (2015). Effectiveness of cognitive behavioral therapy integrated with systematic desensitization, cognitive behavioral therapy combined with eye movement desensitization and reprocessing therapy, and cognitive behavioral therapy combined with virtual reality exposure therapy methods in the treatment of flight anxiety: A randomized trial. *Neuropsychiatric Disease & Treatment, 11*, 2591–2598. http://dx.doi.org/10.2147/NDT.S93401.
*Wallach, H. S., Safir, M. P., & Bar-Zvi, M. (2009). Virtual reality cognitive behavior therapy for public speaking anxiety: A randomized clinical trial. *Behavior Modification, 33*(3), 314–338.
*Walshe, D. G., Lewis, E. J., Kim, S. I., O'Sullivan, K., & Wiederhold, B. K. (2003). Exploring the use of computer games and virtual reality in exposure therapy for fear of driving following a motor vehicle accident. *CyberPsychology & Behavior, 6*(3), 329–334. http://dx.doi.org/10.1089/109493103322011641.
*Wiederhold, B. K., Jang, D. P., Gevirtz, R. G., Kim, S. I., Kim, I. Y., & Wiederhold, M. D. (2002). The treatment of fear of flying: A controlled study of imaginal and virtual reality graded exposure therapy. *IEEE Transactions on Information Technology in Biomedicine, 6*(3), 218–223. http://dx.doi.org/10.1109/TITB.2002.802378.
*Yuen, E. K., Herbert, J. D., Forman, E. M., Goetter, E. M., Comer, R., & Bradley, J.-C. (2013). Treatment of social anxiety disorder using online virtual environments in second life. *Behavior Therapy, 44*(1), 51–61. http://dx.doi.org/10.1016/j.beth.2012.06.001.
*Znaidi, F., Viaud-Delmon, I., & Jouvent, R. (2006). Generic virtual reality treatment applied to space-related phobias. *Annual Review of CyberTherapy and Telemedicine, 4*, 175–179.