Virtual Reality Exposure and Imaginal Exposure in the Treatment of Fear of Flying: A Pilot Study

Article *in* Behavior modification · April 2013

DOI: 10.1177/0145445513482969 · Source: PubMed

4 authors:

Mar Rus-Calafell
University of Oxford
43 PUBLICATIONS 472 CITATIONS

José Gutiérrez-Maldonado
University of Barcelona
170 PUBLICATIONS 2,234 CITATIONS

Cristina Botella
Universitat Jaume I
574 PUBLICATIONS 8,151 CITATIONS

Rosa M Baños
University of Valencia
426 PUBLICATIONS 6,204 CITATIONS

Virtual Reality Exposure and Imaginal Exposure in the Treatment of Fear of Flying: A Pilot Study

Mar Rus-Calafell, José Gutiérrez-Maldonado, Cristina Botella and Rosa M. Baños

Behav Modif 2013 37: 568 originally published online 12 April 2013
DOI: 10.1177/0145445513482969

Article

Behavior Modification
37(4) 568–590

DOI: 10.1177/0145445513482969
bmo.sagepub.com

Virtual Reality Exposure and Imaginal Exposure in the Treatment of Fear of Flying: A Pilot Study

Mar Rus-Calafell[1], José Gutiérrez-Maldonado[1], Cristina Botella[2] and Rosa M. Baños[3]

Abstract

Fear of flying (FF) is an impairing psychological disorder that is extremely common in developed countries. The most effective treatment for this particular type of phobia is exposure therapy. However, there are few studies comparing imaginal exposure (IE) and virtual reality (VR) exposure for the treatment of FF. The present study compared the effectiveness of these two approaches using two manualized interventions based on the exposure technique. Patients with FF (N = 15) were randomly assigned to either VR (n = 7) or IE therapy (n = 8), consisting of a total of eight sessions: two assessment sessions (pre-treatment and after the real flight) and six exposure therapy sessions, which were conducted twice a week. During each exposure session, subjective perceived anxiety was measured every 5 min. Participants were also asked to sit through a real flight immediately after the treatment. The results showed no differences between the two treatments in relation to reduced clinical symptomatology associated with the FF, although participants in the VR group experienced less anxiety during the real flight after treatment. Furthermore, at 6-month follow-up, danger expectations and flight anxiety continued to decrease in participants who

[1]University of Barcelona, Spain
[2]Jaume I University, Castellón de la Plana, Spain
[3]University of Valencia, Spain

Corresponding Author:
José Gutiérrez-Maldonado, Department of Personality, Assessment and Psychological Treatments, University of Barcelona, Paseo Valle de Hebrón, 171, 08035 Barcelona, Spain.
Email: jgutierrezm@ub.edu

had received the VR exposure therapy, and four of these seven participants took at least one more flight.

Keywords
fear of flying, virtual reality, imaginal exposure, presence, imaginal capability

Introduction

Fear of flying (FF) is considered by *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association [APA], 2000) to be a specific situational phobia. It is characterized by an excessive, irrational fear of planes or any related situations, which are avoided at all costs or endured with great distress. Moreover, it is a widespread problem affecting an estimated 10% to 40% of the population in industrialized countries (Botella, Osma, García-Palacios, Quero, & Baños, 2004). Approximately 20% of those who fly rely on alcohol or anxiolytics during the flight (Klein, 1998). Such a dependence on alcohol and the avoidance of flying can lead to serious vocational and social consequences.

A large number of treatment programs have been developed and analyzed, with the in vivo exposure technique proving to be the most efficacious in the treatment of FF (Emmelkamp & Kuipers, 1985; Marks, 1987; Öst, Brandberg, & Alm, 1997; Rothbaum et al., 2000). However, this technique has significant limitations such as the lack of control over the real situation, the lack of confidentiality, it is expensive and time-consuming for clinicians and patients, and the fact that people find it aversive. As these factors render the technique less practical, at least for the treatment of FF (Hodges, Watson, Kessler, Rothbaum, & Opdyke, 1996; North, North, & Coble, 1996, 1997; Rothbaum et al., 2000), many researchers have sought ways of making this method more accessible. One such alternative is imaginal exposure (IE; Bados & Genís, 1988; Capafóns, Sosa, & Viña, 1999; Solymon, Shugar, Bryntwick, & Solymon, 1973; Wiederhold & Wiederhold, 2003; Wiederhold, Wiederhold, Jang, Gevirtz, & Kim, 2002), in which exposure to the feared stimulus is achieved via the patient's imagination. However, some authors claim that this technique presents various deficiencies, in particular the inability of some people to fully recreate the reality of flying or being in an airport, thereby preventing them from fully reexperiencing the fear stimuli (North et al., 1996, 1997). Furthermore, it is very difficult, when using IE, to have control over what the patient is actually imagining; and also to get the patient to imagine all the aspects that are contained in the pathological structure of fear. If the fear structure is not activated, it cannot subsequently be modified by treatment (Wiederhold et al., 2002). In light of these limitations, attention has more recently turned to the use of virtual reality (VR). VR exposure is highly cost-effective, can faithfully reproduce the real experience of flying, and can be repeated endlessly in the therapist's office (Krijn et al., 2007). Furthermore, an effective virtual experience provides users with a sense of being physically immersed in the virtual environment, which therefore becomes more real (Krijn, Emmelkamp, Olafsson, & Biemond, 2004). Several case studies and $N = 1$ studies using VR applications for FF have been reported (Baños et al., 2002; Bornas, Fullana, Tortella-Feliu, Llabrés, & García de la Banda, 2001; Botella et al., 2004; Klein, 1998; North et al., 1996; Rothbaum, Hodges, Watson, Kessler, & Opdyke, 1996; Smith, Rothbaum, & Hodges, 1999; Wiederhold, Wiederhold, & Gevirtz, 1998), and five controlled studies using VR therapy for the treatment of FF have also been conducted to date (Maltby, Kirsch, Mayeres, & Allen, 2002; Mühlberger, Wiedeman, & Pauli, 2003; Rothbaum et al., 2000; Tortella-Feliu et al., 2011; Wiederhold et al., 2002).

Although VR exposure techniques have been used for the treatment of FF with encouraging results, to our knowledge, only one previous study has compared IE and VR exposure techniques. Wiederhold et al. (2002) split 30 participants into 3 groups: VR, VR with physiological feedback, and IE. Each group showed improvements in self-report questionnaire scores, and participants in the VR groups were able to fly without medication during a post-treatment examination period. Moreover, the analysis of physiological responses showed that both VR groups became much more physiologically aroused than did the IE group, with the authors suggesting that VR may help in the habituation process.

In light of the above, the aim of the present study was to compare the effectiveness of IE and VR exposure in the treatment of FF. A further objective was to explore certain individual characteristics in relation to treatment response. These aspects have not been included in previous studies. In the IE group, each participant's imaginal capacity was also considered and explored as an important feature of the individual undergoing treatment. As for the VR group, here the sense of presence and the reality judgment of the VR experience were taken into account in relation to treatment outcome. The main hypotheses of the study were therefore (a) participants' symptomatology related to the FF will decrease after treatment in both conditions of exposure, (b) participants in the VR exposure group will show a greater reduction of anxiety and units of subjective discomfort than will the IE exposure group, (c) treatment gains will be better maintained in the VR exposure group than in the IE exposure group, and (d) participants' imaginal capacity and sense of presence will be related to their improvement after treatment (i.e., the difference between pre- and post-treatment scores) in the respective conditions of exposure.

Method

Participants

The inclusion criteria were as follows: participants had to be between 18 and 65 years of age, they had to undergo an interview with a clinician to determine whether they fulfilled specific *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; APA, 1994) criteria for specific situational phobia of flying, and they were required to purchase a flight ticket during the 15 days after the end of the treatment. Individuals were excluded in the following cases: women who were more than 4 months pregnant; having been diagnosed with panic disorder (with/without agoraphobia), obsessive-compulsive disorder, or psychotic disorder; already being involved in a therapeutic process for their FF; presently taking any psychotropic medication; or having ever experienced cardiorespiratory disease or an epilepsy attack. As a result, the final sample comprised 15 volunteers (13 women) with an average age of 36.6 years (*SD* = 12.9). All the participants included in the study met *DSM-IV-TR* criteria for specific situational phobia of flying. Participants were not taking any prescribed medication for their phobia. However, two of them did use anxiolytics when they had to fly.

Regarding the number of flights taken during the previous year, 13 of the 15 participants (86.7%) had taken fewer than two flights during this period, and 4 of them had never flown before. The other 2 participants, who reported having taken more than three flights (specifically, five and six flights), had done so for work purposes and because of a partner living in another city.

Measures

1. Anxiety Disorders Interview Schedule (ADIS-IV; DiNardo, Brown, & Barlow, 1994): This is a structured diagnostic interview designed to assess the history of occurrence of any anxiety disorder in accordance with *DSM-IV* criteria. For the purpose of this study, the specific phobias section was used.
2. Subjective Units of Discomfort (SUD) scale (Wolpe, 1969): During the exposure sessions, participants were asked to rate their anxiety level on an 11-point scale (0 = *no anxiety*, 10 = *extreme anxiety*). A SUD rating was taken every 5 min, regardless of the experimental condition to which the participant was assigned.
3. Beck Depression Inventory–II (BDI-II; Beck, Steer, Ball, & Ranieri, 1996): This is a 21-item self-report questionnaire on the characteristics and symptoms of depression, and it was included to control for

the participant's mood state or symptoms of depression. In the event that a participant presented such symptoms and scored above the lower cutoff for moderate depression (i.e., 17) on the BDI, this participant was excluded from the study. Cronbach's alpha for the BDI has been reported to be .92 for outpatients and .93 for college student samples (Beck et al., 1996).

4. The Questionnaire Upon Mental Imagery (QMI) Vividness of Imagery Scale (the experimental adaptation of the QMI, Richardson, 1969, developed by Lemos & Martínez, 1996): This consists of 35 brief descriptions of content that the person has to imagine using different sensory modalities. Some examples of the proposed images regarding each modality are visual (e.g., "the sun as it is sinking below the horizon"), auditory ("the mewing of a cat"), cutaneous ("the feel of sand"), kinetic ("reaching up to a high shelf"), gustatory ("taste of oranges"), olfactory ("the smell of new leather"), and organic ("the feeling of a sore throat"). Respondents rank these images on a 7-point Likert-type scale according to the vividness of their experience (1 = *maximum*, "Perfectly clear and as vivid as the actual experience" to 7 = *minimum*, "No image present at all, you only 'know' that you are thinking about the object"). The questionnaire has shown high internal consistency ($\alpha = .92$; Lee & Gretzel, 2010) and test–retest reliability ($r = .91$; Evans & Kamemoto, 1973).
5. Presence and Reality Judgment Questionnaire (PRJQ; Baños, Botella, García-Palacios, et al., 2000; Baños, Quero, & Salvador, 2005): A reduced version of the original 57-item questionnaire was used, with items regarding sensory characteristics that are not present in the VR environment (such as olfactory or taste) being removed to facilitate the assessment of the participant's reality judgment. The resulting 36-item PRJQ is a self-report questionnaire in which the person rates five aspects of the virtual experience: (a) emotional implication, (b) judgment of reality and sense of presence, (c) interaction and external correspondence, (d) interactions with formal variables, and (e) experience satisfaction. Some examples of items are as follows: "What I experienced produced some emotions in me (anxiety, happiness, sadness)" and "I felt I was 'in' the virtual world." This short version has been used in previous studies and has shown a high internal consistency ($\alpha = .82$; Baños et al., 2004).
6. Fear of Flying Questionnaire (FFQ; Bornas, Tortella-Feliu, García de la Banda, Fullana, & Llabrés, 1999): This is a 34-item self-report questionnaire in which the person rates his or her level of fear or discomfort in different flying-related situations (scale ranging from 0 to

9). The FFQ consists of three subscales assessing (a) anxiety during flight, (b) anxiety experienced before takeoff, and (c) anxiety experienced when observing either neutral or unpleasant flying-related situations. The questionnaire has shown high internal consistency (α = .97), test–retest reliability (r = .92), and is sensitive to treatment outcome (Bornas et al., 1999).

7. Fear of Flying Scale (FFS; Haug et al., 1987): This is a 21-item self-report scale in which the participant rates his or her level of anxiety in different flying-related situations (scale ranging from 1 to 4). It consists of three subscales assessing (a) flying-related anxiety situations, (b) typical moments before the flight, and (c) during the flight. The original version of the questionnaire has shown high internal consistency (α = .94).
8. Danger Expectations and Flying Anxiety Scales (DEFAS; Spanish adaptation by Sosa, Capafóns, Viña, & Herrero, 1995): This instrument consists of two subscales that use a 4-point Likert-type format (0 = *never*, 3 = *usually*). The first is a 9-item scale assessing danger expectations (frequency of catastrophic thoughts about the occurrence of potential dangers). The second consists of 10 items assessing the person's anxiety expectations (probability that he or she is going to experience unpleasant physiological symptoms during the flight). This questionnaire has shown high internal consistency (αs = .86 and .91 for each subscale, respectively), test–retest reliability (rs = .84 and .85 for each subscale, respectively), and good discriminant and concurrent validity (Sosa et al., 1995).
9. Life Interference Scale (LIS; adaptation from the ADIS-IV of DiNardo et al., 1994). This scale comprises three Likert-type scales (Severity, Interference, and a Global Score; range = 0-8) that are normally scored by the therapist. All the information compiled during the interview is used to generate a score for the impact of the FF on the individual's life (in terms of the degree of interference and severity in daily life). In the present study, the same version was used by the therapist and participants; thus, both assessed the degree of interference and severity in daily life.

Experimental Design

A repeated-measures design was used to analyze the effectiveness of each individual treatment. Participants were randomly assigned to one of two experimental conditions: the VR exposure group or the IE group.

Hardware

The hardware used consisted of a Pentium-based platform (Intel Core Duo 3000 GHz, 2-GHz RAM, graphic engine: Asus Extrem AX300 SE/T with 128-MB RAM), running with a Windows XP operating system. The display system consisted of a Head Mounted Display (HMD, 5DT model). A Tracker Intersense II 3D digitizer was used for head tracking, while a standard mouse was the tool for motion input. This hardware system was only used in the VR condition.

Virtual Environments

The software used in the VR group was the Virtual Flight® program, designed by the research group of Botella and Baños. The software includes a clinician's manual, with a description of the treatment and the protocol for therapy (Baños, Botella, & Perpiñá, 2000). The program enables certain elements to be manipulated, such as the user's gender, weather conditions, the time of day or turbulence, which are essential for the success of exposure. In the present study, there were three virtual scenarios:

> The room: This environment enables users to interact with the usual stuff of his or her bedroom. They can also perform certain behaviors such as packing a suitcase or listening to news regarding air traffic or weather conditions. They can even obtain their boarding pass before going to the airport.
>
> The airport: This environment has been created to simulate the moments which typically precede the boarding of an aircraft. Users can watch other planes taking off, see the departures and arrivals board, listen to other people chatting about flying-related accidents, or walk along the air bridge to the plane's entrance.
>
> The plane: This is usually the most anxiety-producing environment, in which the user can hear all the usual plane sounds, listen to the radio, or read a magazine while waiting for the plane to start its engines. A crucial occurrence in this step of the process is take-off. The cabin crew's security instructions, followed by the captain greeting the passengers, lead to the plane's acceleration along the runway and, ultimately, take off. During the flight, conditions such as turbulence, the fastening of seatbelts, or the volume of music can be manipulated.

Treatment

After the pretreatment assessment session, participants completed six individual treatment sessions over a period of 3 weeks. The first session of both treatments included psycho-education and diaphragmatic breathing instruction (patients were asked to practice this technique between sessions as the unique homework during the treatment). At the beginning of each session, they were asked how many times they had practiced the diaphragmatic breathing and the length of that practice.

- The VR group used the HMD and the rest of the hardware for exposure to the virtual environments. Participants were seated on an office chair in front of the computer screen, and were then guided through the virtual scenarios by the therapist during the session. However, participants were also able to interact with the environment whenever they wanted to. The fear hierarchy for participants in this group was established according to the Virtual Flight® program.
- Participants in the IE group were also seated on an office chair, this time in front of the therapist, and their eyes were covered with an opaque mask (to ensure that the high fluorescent light of the laboratory could not disturb them). An IE protocol was designed to facilitate the IE (Rus-Calafell & Gutiérrez-Maldonado, 2009). Using a short story encompassing every possible environment for the exposure scenes—very similar to the virtual scenarios—the therapist is able to direct and control the exposure by adding all the details indicated by the participants. Before the exposure sessions, each participant in the IE group constructed an individualized fear hierarchy with the therapist's help.

In both groups, this hierarchy comprised certain items regarding behaviors related to preparing the trip at home (e.g., buying a ticket, packing a suitcase), things done at in the airport, and behaviors, sensations, or situations experienced in the plane. Some items from the FFQ scale were used to help establish the hierarchy: "Doing the check-in, at the airport's terminal"; "Being at home, ready to go ahead to the airport"; or "Suddenly, the plane makes unexpected moves." The main goal of both treatments was to place the individual in all the possible situations related to his or her FF. Participants were required to stay until they experienced a significant decrease in anxiety levels. The time spent in exposure and with the therapist was the same in both groups. Therefore, both treatments were identical except for the type of exposure: one group received IE and the other received VR exposure.

Procedure

Participants were recruited through an advert broadcast on a local radio station and printed in a local newspaper, as well as via posters put up around the campus of the University of Barcelona. About 20 people initially asked for treatment, although only 18 attended the pretreatment assessment session and only 15 met the inclusion criteria. The 3 participants were excluded due to the following reasons: agoraphobia (1), panic disorder without agoraphobia (1), and being currently in psychodynamic treatment for the FF (1). On arrival at the assessment session, participants were given information about the study and they signed a written consent form. Participants did not pay for the treatment, and neither were they financially compensated for taking part in it. The ADIS-IV and the Fear of Flying Interview–Brief Form were used to assess all the participants. Those who met the criteria for specific situational phobia (FF) according to *DSM-IV-TR*, as well as the inclusion criteria of the study, then completed the FFS (Haug et al., 1987), the FFQ (Bornas et al., 1999), and the DEFAS (Sosa et al., 1995).

The target behavior was then determined for each individual participant. Following the previous literature on FF treatment (Bornas, Tortella-Feliu, & Llabrés, 2006: Tortella-Feliu et al., 2011), participants were all told to buy a flight ticket to be used during the 15 days following the end of treatment. The flight destination was chosen by each patient. Buying the flight ticket was raised as a motivation to start and complete treatment.

Participants were then randomly assigned to one of the two experimental groups: the VR group (seven participants) or the IE group (eight participants). At the same time, participants were also randomly assigned to one of the two therapists, who had an equivalent amount of clinical experience; both had completed master's level studies in adult clinical psychology and they had been trained directly by the team of the Virtual Flight® program at the Jaume I University in the application of the VR treatment, as well as having received training in the IE treatment by the clinical psychology research team of Gutiérrez-Maldonado at the University of Barcelona. Each therapist applied both treatments and all the intervention sessions were recorded (with the participants' consent) to ensure the fidelity of the treatment.

All sessions were conducted in the VR Lab of the Faculty of Psychology (University of Barcelona). As noted above, each participant received an intake session consisting of psycho-education and diaphragmatic breathing instruction. In the first exposure session, participants in the VR group completed the PRJQ (Baños, Botella, García-Palacios, et al., 2000; Baños et al., 2005), while those in the IE group responded to the QMI Vividness of Imagery Scale (Richardson, 1969).

The exposure therapy sessions were then conducted, involving 60 to 75 min of exposure to the anxiety items listed in the hierarchy. A criterion applied by the therapists was that participants could only move on to the next item when their current anxiety level was reduced by 80%. Participants were not aware of this criterion. Every 5 min the therapist recorded the patient's subjective units of discomfort in a recording sheet. In the last session, instructions for the real flight were given to participants to prevent them resorting to security behaviors and planning their final exposure of the treatment.

After the real flight, participants were assessed again using the same questionnaires as in the pretreatment assessment session. They rated the anxiety felt before, during and after the flight in terms of SUD, appraised catastrophic thoughts during the flight, and discussed the effectiveness of the treatment. Participants were told that they would be called again for an assessment 6 months after finishing their treatment.

Statistical Analysis

Due to the limited sample size, nonparametric tests were applied to analyze the data. The SPSS Version 18.0 was used to compute the results. Change across the three assessment points was explored using the Wilcoxon signed-rank test (the nonparametric equivalent of the paired *t* test). In addition, the Mann-Whitney *U* test (the nonparametric alternative for the two independent [unpaired] samples Student's *t* test) was used if there was any significant difference between the two treatment conditions (VR and IE) after the treatment and at follow-up.

Results

The first step involved applying the Mann-Whitney *U* test and chi-square test to the demographic and severity variables prior to treatment. No pretreatment differences were found between the VR and IE groups in terms of age, sex, number of flights taken during the past year, or scores on the following scales: BDI, FFS, FFQ, DEFAS, ADIS-IV, and LIS (see Table 1).

The Wilcoxon signed-rank test was then applied to test the significance of the effectiveness data. As mentioned before, all participants were assessed 6 months after treatment to verify whether the outcomes were maintained or not. Table 2 shows these results.

The comparison of pre- and posttreatment scores on the three self-report questionnaires revealed a significant improvement in symptomatology in the IE group (total score on the FFS [FFSt]: $Z = 2.24$, $p < .05$; total score on the FFQ [FFQt]: $Z = 2.52$, $p < .05$; total score on the DEFAS [DEFASt]: $Z = 2.11$, $p < .05$). However, there were no significant differences between posttreatment scores and those reported immediately after the real flight. Neither there were any differences when comparing the scores obtained after the real flight and at follow-up. The VR group also showed a significant improvement in

Table 1. Comparison of Pretreatment Scores in the VR and IE Groups.

	VR group (n = 7)	IE group (n = 8)	
Variable	*M* (*SD*)	*M* (*SD*)	Significance
Age	37.14 (14.28)	36.13 (12.59)	(Z = 0.11) .95
Sex (% female)[a]	85.7 (87.5)		(χ^2 = 0.10) .91
Flights last year	1.86 (1.95)	2.13 (2.95)	(Z = 0.35) .77
BDI	2.43 (3.4)	4.75 (5.9)	(Z = 0.66) .53
FFS pre	60.71 (7.13)	63.75 (7.68)	(Z = 0.93) .39
FFQ pre	207.14 (28.55)	206.88 (20.55)	(Z = 0.23) .86
DEFAS pre	49.36 (9.4)	53.63 (10.32)	(Z = 0.69) .53
ADIS_fear	6.53 (0.78)	6.88 (0.83)	(Z = 1.29) .23
ADIS_avoidance	6.14 (0.64)	5.90 (1.19)	(Z = 1.58) .15
ADIS_interference	5.83 (0.96)	5.99 (1.31)	(Z = 0.23) .86
LIS_severity	7.03 (0.98)	7.14 (0.93)	(Z = 1.49) .43
LIS_interference	6.48 (0.83)	6.53 (1.02)	(Z = 0.74) .58

Note: VR = virtual reality; IE = imaginal exposure; BDI = Beck Depression Inventory; FFS pre = pretreatment score on the Fear of Flying Scale; FFQ pre = pretreatment score on the Fear of Flying Questionnaire; DEFAS pre = total pretreatment score on the Danger Expectations and Flying Anxiety Scale; ADIS-IV = Anxiety Disorders Interview Schedule–IV; LIS (therapist scores) = Life Interference Scale.
[a]% variables: using χ^2.
*p < .05.

phobia-related symptomatology between the pretreatment and posttreatment assessments (FFSt: $Z = 1.86$, $p < .05$; FFQt: $Z = 2.36$, $p < .05$; DEFASt: $Z = 2.37$, $p < .05$). However, in contrast to the IE participants, the VR group continued to show improvement after the real flight on the FFQt ($Z = 2.03$, $p < .05$), and the comparison of scores recorded immediately after the real flight and at follow-up also revealed significant differences on the DEFASt ($Z = 2.02$, $p < .05$).

Application of the Mann-Whitney *U* test confirmed that there were no significant differences between the self-report questionnaire scores of the two groups at each measurement point. Thus, both treatments were capable of reducing symptomatology in the same way (see Figure 1). However, when comparing the SUD experienced before and during the real flight, significant differences were found between the groups (see Figure 2). Specifically, the VR group had significantly lower scores than the IE group on subjective anxiety before ($Z = 2.22$, $p < .05$) and during the flight ($Z = 2.70$, $p < .01$).

The Wilcoxon signed-rank test was also applied to test the significance of the clinical improvement, severity, and interference. Chi-square tests

Table 2. Comparison of Pretreatment, Posttreatment, and Follow-Up Measures in the VR and IE Groups.

	VR group (n = 7)			IE group (n = 8)		
	M (SD)	Significance	Effect size	M (SD)	Significance	Effect size
FFSt						
Pre-treatment	60.71 (7.13)			63.75 (7.68)		
Post-treatment	49.29 (14.52)	(Z = 1.86) .043*	0.61	49.63 (15.43)	(Z = 2.24) .025*	0.56
After real flight	43.14 (8.21)	(Z = 1.16) .10		44.75 (12.5)	(Z = 1.14) .14	
6-month follow-up	41.67 (10.15)	(Z = 0.10) .917		46.43 (8.77)	(Z = 0.67) .498	
FFQt						
Pre-treatment	207.14 (28.55)			206.88 (20.55)		
Post-treatment	146.14 (45.15)	(Z = 2.36) .018*	0.61	147.38 (52.25)	(Z = 2.52) .012*	0.56
After real flight	114.29 (38.95)	(Z = 2.032) .042*	0.52	148 (45)	(Z = 0.56) .57	
6-month follow-up	109.83 (29.8)	(Z = 0.36) .713		157.57 (36.39)	(Z = 0.73) .463	
DEFASt						
Pre-treatment	49.86 (9.45)			53.63 (10.02)		
Post-treatment	39 (9.67)	(Z = 2.37) .018*	0.61	39.5 (9.7)	(Z = 2.11) .035*	0.56
After real flight	35.86 (8.35)	(Z = 1.58) .128		41 (10.42)	(Z = 0.42) .67	
6-month follow-up	32.83 (8.03)	(Z = 2.02) .043*	0.52	40.14 (12.93)	(Z = 0.21) .833	

Note: VR = virtual reality; IE = imaginal exposure; FFSt = total score on the Fear of Flying Scale; FFQt = total score on the Fear of Flying Questionnaire; DEFASt = total score on the Danger Expectations and Flying Anxiety Scale.
*p < .05.

were run to assess the differences between groups regarding flights taken after the treatment and at 6-month follow-up, use of medication, and diagnostic status. After the treatment, ADIS-IV main ratings (fear, avoidance, and interference) improved significantly in the VR group. The IE group showed a significant improvement in the degree of fear and avoidance. Regarding the degree of interference and severity, the results revealed differences between pre- and posttreatment scores on the LIS. In the VR group, the therapist and the patients reported a significant decrease of severity and interference in the patient's daily life after the treatment. However, in the IE group, the therapist's scores showed a significant decrease in severity and interference after the treatment, but patients' scores showed a significant improvement only in severity. Differences between

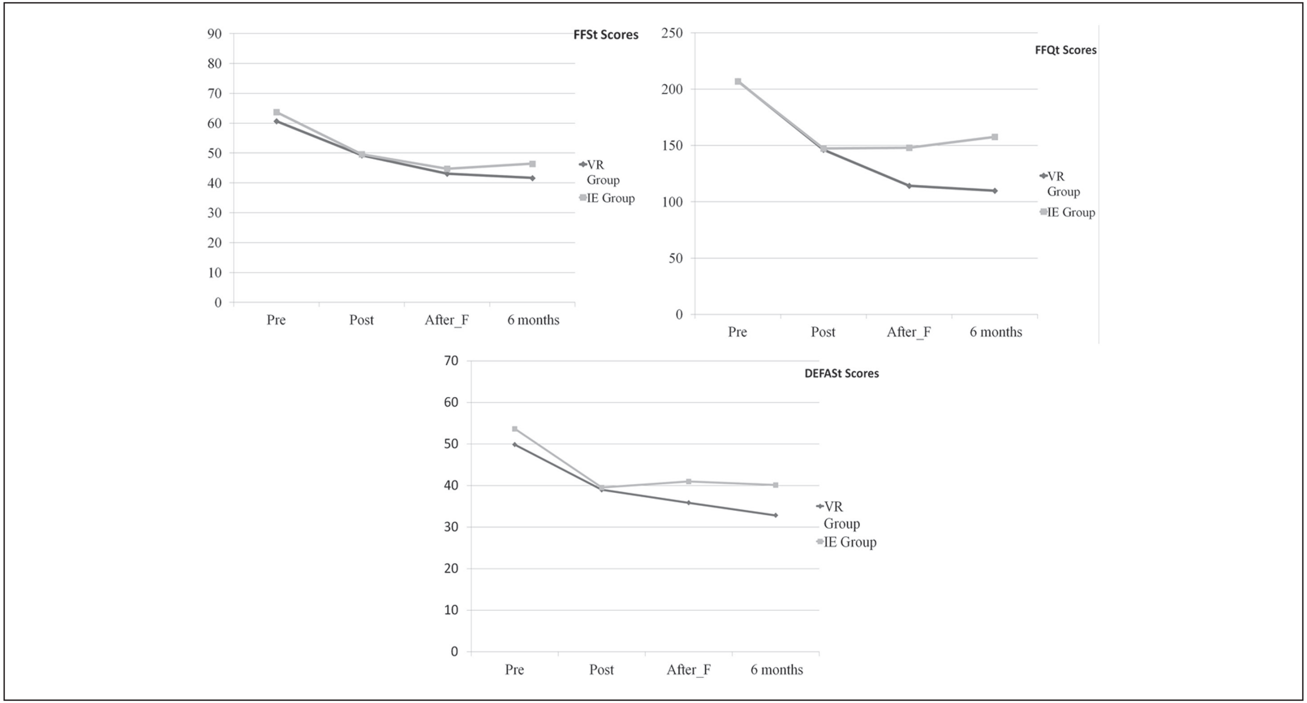

Figure 1. Pattern of decrease.
Note: FFS = Fear of Flying Scale; FFQ = Fear of Flying Questionnaire; DEFAS = Danger Expectations and Flying Anxiety Scale; FFSt = total score on the FFS; VR = virtual reality; IE = imaginal exposure; pre = pre-treatment; post = post-treatment; After_F = after the real flight; 6 months = 6 months follow-up; FFQt = total score on the FFQ; DEFASt = total score on the DEFAS. Decrease of the self-report questionnaire scores (FFS, FFQ, DEFAS) of the two groups at each measurement point.

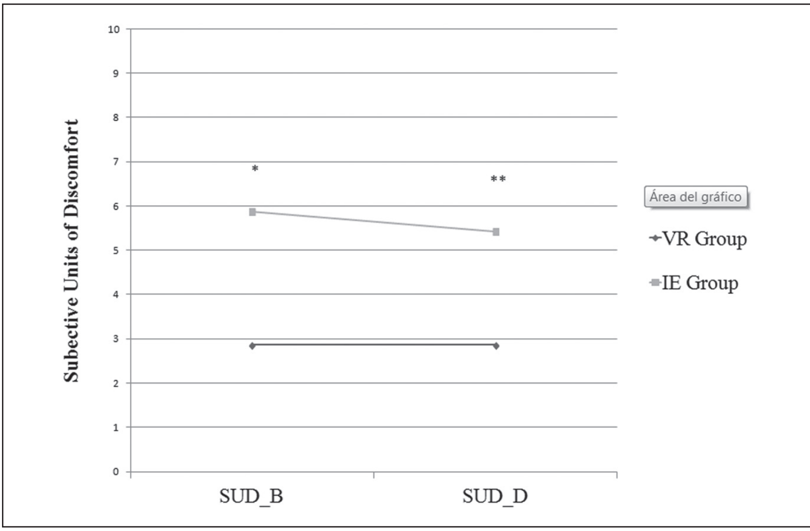

Figure 2. Subjective Units of Discomfort in the VR and IE groups before and during the real flight.
Note: VR = virtual reality; IE = imaginal exposure; SUD_B = subjective units of discomfort before the real flight; SUD_D = subjective units discomfort during the real flight; 0 = *no anxiety*; 10 = *maximum anxiety*. $^{*}p < .05$; $^{**}p < .01$.
$p < .05$.

groups regarding the number of participants who took a flight after the treatment were not significant. However, none of the IE group participants took another flight during the 6 months after treatment, while four of the seven VR participants took at least one flight during this period; this difference was statistically significant. Finally, there was no significant difference between groups in the number of patients becoming free of diagnosis for specific situational phobia after treatment (see Table 3).

Finally, correlation analysis was applied to assess, in the IE group, the participants' capacity for imagination, as scored by the QMI, and, in the VR group, their sense of presence and reality judgment, as scored by the PRJQ (Factor 2: judgment of reality and sense of presence). First, the difference between pre- and posttreatment scores was calculated to determine the objective effect of the treatment, after which Spearman's rho was computed. The highest correlation values corresponded to the IE group, and the sign of these coefficients was negative (see Table 4). Although not statistically significant, there was a medium–high correlation between the capacity for imagination and the effect of treatment.

Table 3. Clinical Improvement in the Anxiety Disorders Interview and the Schedule and LIS, and Flights Taken and Diagnosis Status at Post-Treatment.

	VR group (n = 7)			IE group (n = 8)		
	Pre-*M* (*SD*)	Post-*M* (*SD*)	Significance	Pre-*M* (*SD*)	Post-*M* (*SD*)	Significance
ADIS-IV						
Fear	6.53 (0.78)	1.71 (0.95)	.018*	6.88 (0.83)	3.50 (1.90)	.035*
Avoidance	6.14 (0.64)	1.01 (0.57)	.016*	5.90 (1.19)	3.02 (2.01)	.076
Interference	5.83 (0.96)	1.98 (0.58)	.018*	5.99 (1.31)	2.61 (1.49)	.046*
LIS						
Severity_therapist	7.03 (0.98)	2.34 (0.86)	.018*	7.14 (0.93)	3.67 (1.16)	.031*
Interference_therapist	6.48 (0.83)	2.01 (0.68)	.024*	6.53 (1.02)	2.12 (1.97)	.046*
Severity_patient	7.14 (1.06)	2.71 (0.75	.017*	7.63 (0.51)	3.63 (1.84)	.016*
Interference_patient	6.86 (1.15)	1.14 (1.46)	.016*	6.38 (1.99)	4.13 (1.88)	.091
Flights[a]						
After_treatment		7 (100%)		7 (87.5%)		.333
Medication		0 (0%)		1 (12.5%)		.333
After_6months		4 (57.1%)		0 (0%)		.013*
Diagnosis status[a]						
No diagnosis		7 (100%)		6 (75%)		.155

Note: VR = virtual reality; IE = imaginal exposure; ADIS-IV = Anxiety Disorders Interview–IV; LIS = Life Interference Scale.
[a]Comparisons between groups using χ^2.
*$p < .05$.

Discussion

The purpose of this study was to determine whether VR and IE exposure techniques were effective in treating FF. As hypothesized, scores on the three self-reported questionnaires used (FFS, FFQ, and DEFAS) indicated that both groups improved and evolved similarly over time (post-treatment and follow-up). Analysis of the scores obtained immediately after the real flight and 6 months after treatment revealed that the VR group continued to improve on some of the measures (FFQt), whereas IE group did not. This decrease in FF-related symptomatology when using VR has been reported in a number of studies that have used such advanced technology to remedy this phobia (Krijn et al., 2007; Maltby et al., 2002; Mühlberger et al., 2003; Mühlberger, Herrman, Wiedeman, Ellgring, & Pauli, 2001; Rothbaum et al., 2000, 2002; Wiederhold et al., 2002; Wiederhold & Wiederhold, 2003).

Table 4. Results of the Correlation Analysis for Capability of Imagination, Presence, and the Effects of Treatment in the VR and IE Groups.

	PRJQ	QMI	
	ρ	ρ	Significance
VR group			
Dif. FFS	.45		.30
Dif. FFQ	−.09		.84
Dif. DEFAS	.23		.21
IE group			
Dif. FFS		−.52	.14
Dif. FFQ		−.52	.18
Dif. DEFAS		−.46	.24

Note: PRJQ = Presence and Reality Judgment Questionnaire; QMI = Vividness of Imagery Scale; ρ = Spearman's rho; FFS = Fear of Flying Scale; FFQ = Fear of Flying Questionnaire; DEFAS = Danger Expectations and Flying Anxiety Scale; Dif. FFS = FFS pretreatment score − FFS posttreatment score; Dif. FFQ = FFQ pretreatment score − FFQ posttreatment score; Dif. DEFAS = DEFAS pretreatment score − DEFAS posttreatment score.

Other self-reported measures and clinicians' considerations revealed differences between the two treatment conditions. Posttreatment interviews showed that patients in the VR group showed an improvement in the ADIS-IV main scores (fear, avoidance, and interference). However, patients in the IE group did not improve in avoidance. This pattern may reflect the fact that, even though the symptomatology reported by the patients in the IE group decreased, participants did not feel confident enough to take a real flight in the near future (reflecting a certain level of avoidance).When analyzing the LIS, the participants in the VR group and the therapist agreed that the degree of severity and interference in the patient's daily life had decreased. In the IE group, while the therapist recorded a decrease in severity and interference, patients only reported a significant improvement for severity, not for interference. Significantly, all the patients in the VR group did not meet criteria for specific phobia (situational) after the treatment, but only six of the eight participants in the IE group.

Although most of the self-report questionnaire scores showed no differences between the groups at the end of the treatment, the analysis of the subjective anxiety experienced when actually flying revealed that participants who had received the VR treatment felt significantly less anxiety than did those in the IE group. This is a significant feature that distinguishes the two treatments. Thus, and in line with our second hypothesis, the reduction in the interference of fear and avoidance in the participant's life, as well as the decrease in subjective anxiety during the real flight, were greater for participants in the VR condition than for those who received IE. Moreover, further examination of the participants' behavior revealed a number of highly interesting points: In the VR group, all participants flew without the need for medication or alcohol, whereas one of the eight participants in the IE group was unable to fly and another required medication (two 5 mg tablets of an anxiolytic, Diazepam) to do so. This means that only in the VR treatment program did 100% of participants make the real flight, which we consider to be a meaningful measure of improvement. It is also important to note that at 6-month follow-up, four participants from the VR group had taken a second flight. Furthermore, although there were two participants who were used to flying for personal and work reasons, four participants (two of them in the VR condition) had never flown before. These results are very similar to those obtained by Wiederhold et al. (2002), who showed that both kinds of exposure (IE and VR) could reduce the symptomatology associated with FF, as measured by self-report questionnaires. However, in their study, only 10% of participants in the IE group were able to fly without medication or alcohol, as opposed to 80% in the VR group. They also included a third group, which received VR plus physiological feedback, in which 100% of participants flew without any medication or alcohol. It should be noted that although the conditions tested in the study of Wiederhold et al. are the same as in the present trial, they did not require their participants to take a final flight (they merely recommended it). This may be significant when it comes to interpreting the outcomes of the two treatments. Indeed, some significant reductions in symptomatology were found among VR and IE participants after the flight and the final exposure session, so it may be that the flight per se is necessary to establish and generalize the improvement initiated by exposure.

Although the results show that both kinds of exposure are equivalent as regards improving FF-related symptomatology by the end of the treatment, there are important differences in terms of efficiency, control, and requirements. As has been shown in previous studies (Botella et al., 2004; Maltby et al., 2002; Mühlberger et al., 2001; Mühlberger et al., 2003; Wiederhold et al., 2002), VR allows the individual to have better control over the situation—very similar to in vivo exposure—and does not require the therapist to control the individual's immersion in the VR. Furthermore, the manipulation and inclusion of key elements during exposure are possible, thanks to this technology, which also provides a more objective experience for the individual than does IE. Interestingly, the therapists who were in charge of the treatment sessions stated that IE is much more stressful and exhausting for them than VR exposure. The clinicians reported that IE required more involvement on their part in the guidance of the exposure and that it was much more difficult to conduct cognitive therapy for catastrophic thoughts or anxiety expectations.

Regarding the fourth hypothesis, the correlation results show that imaginal capacity is more decisive in relation to the application of treatment than the degree of presence and the reality judgment of participants. Thus, a person with a poor capacity for imagination may be unable to undergo an IE session. In other studies of treatment for anxiety disorders, such as post-traumatic stress disorder (PTSD), IE has been considered to provide a low-threat context in which the patient can begin to process the emotions that are relevant to the traumatic event, as well as to decondition the learning cycle of the disorder via a habituation/extinction process (Pair et al., 2006). However, when comparing IE and VR in the treatment of PTSD, authors such as Difede and Hoffman (2002) have attributed the greater success of VR exposure over IE to the high realism of the virtual images compared with the mental images that the patient might generate in imagination. In the present study, and despite the well-controlled narration for IE, the participants could easily avoid imagining the most threatening or disturbing components of their FF (airplane noise or turbulence) so as to prevent the anxiety response. These results highlight the need for further investigation into the role of imaginal capacity and patients' cognitive avoidance during IE. The difference with VR exposure is that this technology enables the clinician to control other actions, such as avoidance behaviors, and it increases the likelihood of catastrophic thoughts because the patient is already immersed in that simulated situation. Furthermore, it has been shown that the VR approach is well accepted by those individuals who suffer specific phobias, and it could help increase the number of people who seek exposure therapy, as compared with in vivo exposure (García-Palacios, Botella, Hoffman, & Fabregat, 2007).

Conclusion

In conclusion, it can be stated that under the same conditions of application and when self-reported measures are considered, both IE and VR exposure were effective in treating FF. However, the maintenance of outcomes and the perceived interference of fear in the participant's life are not the same in the two conditions: VR exposure seems to offer better results in this sense.

Moreover, IE may be limited by the imaginal capacity of the participant. This can make the elicitation of anxiety responses and their habituation more difficult, which in turn could influence the anxiety experienced during the real flight. It may be that this form of exposure would need more sessions to successfully reduce anxiety levels. By contrast, VR exposure is able to elicit these responses, and its immersive environments allow better control over the exposure process. Continuing advances in VR technology, along with concomitant system-cost reductions, have helped to develop more usable and accessible VR systems that can target a wide range of physical, psychological, and cognitive rehabilitation concerns (Rizzo & Kim, 2005). Its ecological validity also means that VR exposure can be regarded as an effective and efficient alternative for treating the FF.

There are some limitations to the present study, the main one being the small sample size. The requirement to board a real flight as a condition to participate in the study may have contributed to this limitation (due to the cost involved). However, as already noted, it seems convenient to encourage the participant to take a flight as a complement to and motivation for increasing adherence to treatment, as otherwise some of them may agree to undergo treatment but put off taking an actual flight, thereby reinforcing avoidance and preventing the extinction of the learning fear (Lissek et al., 2005). Moreover, some authors have claimed that, even though exposure-based treatments should be the treatment of choice for specific phobia, if the patient lacks the motivation or courage to accept complete exposure (including in vivo exposure), other treatments may provide a suitable alternative (Kanwal, Rajender, & Grover, 2008). In fact, we believe that even it would also be useful to include a pretreatment flight (as a behavioral avoidance test) to evaluate and register certain behavioral measures, such as the participant's level of control over the situation. Furthermore, the inclusion of a method to report SUD during the real flight, rather than reporting them retrospectively in the postflight assessment session, could improve the reliability of the measure. The use of other technologies, such as text messages or online report scales, could help overcome this limitation. Another limitation of the study is the predominance of women in the sample. However, as Alonso et al. (2004) pointed out in the European Study of the Epidemiology of Mental Disorders (ESEMeD) study, the lifetime prevalence of specific phobia is greater in females (10.3%) than in males (4.9%), such that the characteristics of the sample may be reflecting the gender distribution of the disorder.

New information and communication technologies are constantly being perfected, and the quality of virtual environments now provides more realistic environments and allows for more manipulations to be made. Moreover, some recent studies of the implementation of VR in the clinical setting have shown that the system costs of virtual environments are falling rapidly (Rizzo & Kim, 2005). Improving these environments and making sure they enable significant reductions in symptomatology is one aspect that needs to be addressed by future research. It is also necessary to test further applications of VR for the treatment of mental disorders to develop empirically supported interventions.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was partially supported by a government grant awarded to the BIEN-E-STAR group (SEJ2006-14301/PSIC; Ministry of Education and Science).

References

Alonso, J., Angermeyer, M. C., Bernert, S., Bruffaerts, R., Brugha, T. S., & Bryson, H., . . . ESEMedD/MhEDEA 2000 Investigators. (2004). Prevalence of mental disorders in Europe: Results from the European Study of the Epidemiology of Mental Disorders (ESEMeD project). *Acta Psychiatrica Scandinavica Supplementum*, *420*, 21-27.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.

Bados, A., & Genís, F. (1988). Tratamiento de una fobia a volar [Treatment of flying phobia]. In D. Macià & F. X. Méndez (Eds.), *Aplicaciones clínicas de la evaluación y modificación de conducta* (pp.40-55). Madrid, Spain: Pirámide.

Baños, R. M., Botella, C., Alcañiz, M., Liaño, V., Guerrerero, B., & Rey, B. (2004). Immersion and emotion: Their impact on the sense of presence. *CyberPsychology & Behavior*, *7*, 734-741.

Baños, R. M., Botella, C., García-Palacios, A., Villa, H., Perpiñá, C., & Alcañiz, M. (2000). Presence and reality judgment in virtual environments: A unitary construct. *CyberPsychology & Behavior*, *3*, 327-335.

Baños, R. M., Botella, C., & Perpiñá, C. (2000). *Fobia a volar: Manual de tratamiento mediante realidad virtual* [Flying phobia: The virtual reality treatment manual]. Valencia, Spain: Promolibro.

Baños, R. M., Botella, C., Perpiñá, C., Alcañiz, M., Lozano, J., Osma, J., & Gallardo, M. (2002). Virtual reality treatment of flying phobia. *IEEE Transactions on Information Technology in Biomedicine*, *6*, 206-212.

Baños, R. M., Quero, S., & Salvador, S. (2005). The role of presence and reality judgment in virtual environments in clinical psychology. In A. Bullinger, B. Wiederhold, U. Meise, & F. Mueller-Spahn (Eds.), *Applied technologies in medicine and neuroscience* (pp.21-33). Innsbruck, Tyrol, Austria: Verlag Integrative Psychiatrie.

Beck, A. T., Steer, R. A., Ball, R., & Ranieri W. (1996). Comparison of Beck Depression Inventories-IA and-II in psychiatric outpatients. *Journal of Personality Assessment*, *67*, 588-597.

Bornas, X., Fullana, M. A., Tortella-Feliu, M., Llabrés, J., & García de la Banda, G. (2001). Computer-assisted therapy in the treatment of flight phobia: A case report. *Cognitive and Behavioral Practice*, *8*, 234-240.
Bornas, X., Tortella-Feliu, M., García de la Banda, G., Fullana, M. A., & Llabrés, J. (1999). Validación del Cuestionario de Miedo a Volar [Factorial validation of the Fear of Flying Questionnaire]. *Análisis y Modificación de Conducta*, *25*, 885-907.
Bornas, X., Tortella-Feliu, M., & Llabrés, J. (2006). Do all treatments work for flight phobia? Computer-assisted exposure versus a brief multicomponent nonexposure treatment. *Psychotherapy Research*, *16*, 41-50.
Botella, C., Osma, J., García-Palacios, A., Quero, S., & Baños, R. (2004). Treatment of flying phobia using virtual reality: Data from 1-year follow-up using multiple baseline design. *Clinical Psychology & Psychotherapy*, *11*, 311-323.
Capafóns, J. I., Sosa, C. D., & Viña, C. M. (1999). A reattributional training program as a therapeutic strategy for fear of flying. *Journal of Behavior Therapy and Experimental Psychiatry, 30*, 259−272.
Difede, J., & Hoffman, H. G. (2002). Virtual reality exposure therapy for World Trade Center post-traumatic stress disorder: A Case report. *CyberPsychology & Behavior*, *5*, 529-535.
DiNardo, P., Brown, T., & Barlow, D. (1994) *Anxiety Disorders Interview Schedule for DSM-IV: Life Version (ADIS-IV-L)*. Albany, NY: Graywind Publications.
Emmelkamp, P., & Kuipers, A. (1985). Groups therapy of anxiety disorders. In D. Hupper & S. Ross (Eds.), *Handbook of behavioral group therapy* (pp. 443-472). New York, NY: Plenum.
Evans, I. M., & Kamemoto, W. (1973). Reliability of a short form of Betts' Questionnaire on Mental Imagery: Replication. *Psychological Reports*, *33*, 281-282.
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 phobia. *CyberPsychology & Behavior*, *10*, 722-724.
Haug, T., Brenne, L., Johnsen, B. H., Berntzen, K. G., Götestam, K. G., & Hughdal, K. (1987). A three-system analysis of fear of flying: A comparison of a consonant vs a non-consonant treatment method. *Behavior Research and Therapy*, *25*, 187-194.
Hodges, L. F., Watson, B., Kessler, B., Rothbaum, O., & Opdyke, D. (1996). Virtually conquering of fear of flying. *IEEE Transactions on Information Technology in Biomedicine*, *16*, 46-49.
Kanwal, K., Rajender, G., & Grover, N. (2008). Management of specific phobias. *Journal of Mental Health & Human Behavior*, *13*, 17-26.
Klein, R. A. (1998). Virtual reality exposure therapy (fear of flying): From a private practice perspective. *CyberPsychology & Behavior*, *1*, 311-316.
Krijn, M., Emmelkamp, M., Olafsson, R., & Biemond, R. (2004). Virtual reality exposure therapy of anxiety disorders: A review. *Clinical Psychology Review*, *24*, 259-281.
Krijn, M., Emmelkamp, M., Olafsson, R., Bouwam, M., Van Gerwen, L., Spinhoven, P., & Van der Mast, C. (2007). Fear of flying treatment methods: Virtual reality

exposure vs. cognitive behavioral therapy. *Aviation, Space, and Environmental Medicine*, *78*, 121-128.

Lee, W., & Gretzel, U. (2010).Tourism students' mental imagery ability: Implications for multimedia learning environments. *Journal of Teaching in Travel & Tourism*, *10*, 289-311.

Lissek, S., Powers, S. A., McClure, E. B., Phelps, E. A., Woldehawariat, G., Grillon, C., & Pine, D. S. (2005). Classical fear conditioning in the anxiety disorders: A meta-analysis. *Behavior Research and Therapy*, *43*, 1391-1424.

Maltby, N., Kirsch, I., Mayeres, M., & Allen G. J. (2002). Virtual reality exposure therapy for the treatment of fear of flying: A controlled investigation. *Journal of Consulting and Clinical Psychology*, *70*, 1112-1118.

Marks, I. M. (1987). *Fears, phobias and rituals*. Oxford, UK: Oxford University Press.

Mühlberger, A., Herrman, M., Wiedeman, G., Ellgring, H., & Pauli, P. (2001). Repeated exposure of flight phobics to flights in virtual reality. *Behaviour Research and Therapy*, *39*, 1033-1050.

Mühlberger, A., Wiedeman, G., & Pauli, P. (2003). Efficacy of a one-session virtual reality exposure treatment for fear of flying. *Psychotherapy Research*, *13*, 323-336.

North, M. M., North, S. M., & Coble, J. R. (1996). Virtual environments psychotherapy: A case study of fear of flying disorder. *Presence: Teleoperators and Virtual Environments*, *5*, 1-5.

North, M. M., North, S. M., & Coble, J. R. (1997). Virtual reality therapy for fear of flying. *American Journal of Psychiatry*, *154*, 130-142.

Öst, L. G., Brandberg, M., & Alm, T. (1997). One versus five sessions of exposure in the treatment of flying phobia. *Behaviour Research and Therapy*, *35*, 987-996.

Pair, J., Allen, B., Dautricourt, M., Treskunov, A., Liewer, M., Graap, K., & Rizzo, A. (2006). A virtual reality exposure therapy application for Iraq War post traumatic stress disorder. *Proceedings of the IEEE Virtual Reality Conference, 2006*, 67-72. doi:10.1109/VR.2006.23

Richardson, A. (1969). *Mental imagery*. New York, NY: Springer.

Rizzo, A., & Kim, G. J. (2005). A SWOT analysis of the field of virtual reality rehabilitation and therapy. *Presence: Teleoperators and Virtual Environments*, *14*, 119-146.

Rothbaum, B. O., Hodges, L., Anderson, P., Hwan Lee, J., Smith, S., & Price, L. (2000). A controlled study of virtual reality exposure therapy for the fear of flying. *Journal of Consulting and Clinical Psychology*, *68*, 1020-1026.

Rothbaum, B. O., Hodges, L., Anderson, P., Price, L., & Smith, S. (2002). Twelve-month follow-up of virtual reality and standard exposure therapies for the fear of flying. *Journal of Consulting and Clinical Psychology*, *70*, 428-432.

Rothbaum, B. O., Hodges, L., Watson, B. A., Kessler, C. D., & Opdyke, D. (1996). Virtual reality exposure therapy in the treatment of fear of flying: A case report. *Behavior Research and Therapy*, *34*, 477-481.

Rus-Calafell, M., & Gutiérrez-Maldonado, J. (2009). *Manual de exposición en imaginación para el tratamiento de la fóbia a volar* [Imaginal exposure treatment manual for flying phobia]. Departamento de Personalidad, Evaluación y Tratamientos Psicológicos, Universitat de Barcelona, Spain.

Smith, S., Rothbaum, B. O., & Hodges, L. F. (1999). Treatment of fear of flying using virtual reality exposure therapy: A single case study. *Behavior Therapist*, *22*, 154-158.

Solymon, L., Shugar, R., Bryntwick, S., & Solymon, C. (1973). Treatment of fear of flying. *American Journal of Psychiatry*, *130*, 423-427.

Sosa, C. D., Capafóns, J. I., Viña, C. M., & Herrero, M. (1995). La evaluación del miedo a viajar en avión: Estudio psicométrico de dos instrumentos de tipo autoinforme (DEFAS) [The assessment of fear of flying: A psychometric study of two self-reported scales (DEFAS)]. *Psicología Conductual*, *3*, 133-158.

Tortella-Feliu, M., Botella, C., Llabrés, J., Bretón, J. M., Riera del Amo, A., Baños, R., & Gelabert, J. M. (2011). Virtual reality versus computer-aided exposure treatments for fear of flying. *Behavior Modification*, *35*, 3-30. doi:10.1177/0123456789123456

Wiederhold, B. K., & Wiederhold, M. D. (2003). Three-year follow-up for virtual reality exposure for fear of flying. *Cyberpsychology & Behavior*, *6*, 441-445.

Wiederhold, B. K., Wiederhold, M. D., & Gevirtz, R. (1998). Fear of flying: A case report using virtual reality therapy with physiological monitoring. *CyberPsychology & Behavior*, *1*, 93-98.

Wiederhold, B. K., Wiederhold, M. D., Jang, D., Gevirtz, R., & Kim, S. (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*, 218-223.

Wolpe, J. (1969). *The practice of behavior therapy*. New York, NY: Pergamon.

Author Biographies

Mar Rus-Calafell, MSc, is a clinical psychologist and a PhD candidate at the University of Barcelona. She is also a member of the Research Group of the Virtual Reality Lab. The focus of her research is the application of virtual reality–based instruments to the assessment and treatment of aspects of human cognition, schizophrenia, and anxiety disorders.

José Gutiérrez-Maldonado PhD, is a full professor of psychopathology and the director of the Virtual Reality Lab at the University of Barcelona. He has worked on the design and validation of virtual reality–based instruments for the assessment and treatment of mental disorders such as anxiety disorders, eating disorders, addictions, chronic pain, and schizophrenia.

Cristina Botella PhD, is a full professor of clinical psychology and the director of the Emotional Disorders Clinic at Jaume I University (Castellón). Her research is focused on the design and application of new technologies for the treatment of emotional disorders.

Rosa M. Baños PhD, is a full professor of psychopathology at the University of Valencia. Her research focuses on the application of virtual reality to clinical psychology and the development of new treatments based on this technology.