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Treatment of Flying Phobia using Virtual Reality: Data from a 1-Year Follow-up using a Multiple Baseline Design

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The present work is a new contribution about the short- and long-term efficacy of virtual reality (VR) exposure therapy for the treatment of flying phobia (FP). We present data from pre-treatment, post-treatment and 1-year follow-up assessments in a sample of nine participants using a multiple baseline design. The treatment programme included a main therapeutic component: VR exposure (six sessions), accompanied by one session of education about anxiety, flying and exposure. The VR software developed by our team is described. Our software included, besides the virtual scenario used by most researchers, the plane, two new scenarios: the room and the airport, developed to work with the patients anticipatory anxiety. The results obtained, at post-treatment and 1 year after the completion of the treatment, support the efficacy of VR in the treatment of flying phobia. VR produced an activation of the fear and avoidance structures and a progressive decrement of fear, avoidance and belief in catastrophic thoughts. The scores in other specific self-report meaures of flying phobia confirm these findings. After the treatment, all participants flew. Our data support the efficacy of VR for the treatment of flying phobia achieved by other studies. Our contribution to this field is the use of VR exposure as the only therapeutic component, the long-term efficacy data, and the use of VR software for the treatment of anticipatory anxiety. **Copyright © 2004 John Wiley & Sons, Ltd.**

INTRODUCTION

Flying Phobia (FP), is a Specific Phobia, Situational Type (DSM-IV, APA, 1994, 2000). FP can be defined as an intense and irrational fear regarding situations related to flying. Many individuals suffering this phobia report worry and fear from the moment they know they have to fly. This means days, weeks, and even months before flying. This phenomenon is known as anticipatory anxiety. Also, sometimes it is not necessary for the individual to fly to feel anxiety, that is, other situations like taking a friend or family member to the airport, listening to the plane engines, seeing a plane flying in the sky, or even watching a movie related to planes, provoke intense distress and suffering. The situations that the individual with FP avoids could be numerous and are not only related to the fact

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of sitting in a plane and flying, but also to other situations like purchasing the tickets, going to the airport, packing, watching movies or documentaries about planes or flying, etc.

An estimated 10–11% of the population experiences a specific phobia at some point in their lives, (American Psychiatric Association, 1994; Magee, Eaton, Wittchen, McGonagle, & Kessler, 1996). Epidemiological studies conducted in Europe (e.g. Ekeberg, Seeberg, & Ellertsen, 1989; Nordlund, 1983) and in the USA (Agras, Silvestre, & Oliveau, 1969) report that around 10% of the general population do not fly due to intense fear. In addition, 25% of the population that flies experiences intense distress during the flight. As we can see, some individuals do not avoid flying, despite the fact that they experience high anxiety. The studies reveal that almost 20% of people depend on alcohol or tranquilizers to overcome the fear of flying (Agras et al., 1969; Howard, Murphy, & Clarke, 1983; Klein, 1998).

The most effective psychological technique for the treatment of phobias is *in vivo* exposure (Emmelkamp & Kuipers, 1985; Marks, 1987; Öst, Brandberg, & Alm, 1997). This technique has demonstrated its efficacy in the treatment of many phobias (Barlow, Raffa, & Cohen, 2002; Grawe, Donati, & Bernauer, 1994; Reinecker, 1994) including FP (Haug et al., 1987; Öst et al., 1997). However, the lack of control over the real situation, the lack of confidentiality, as well as the high economical cost and the amount of time that this therapeutic strategy represents (using planes in real flights), makes *in vivo* exposure less accesible for clinicians who treat FP (Hodges, Watson, Kessler, Rothbaum, & Opdyke, 1996; North, North, & Coble, 1996). On the other hand, around 20–25% of people reject *in vivo* exposure because they find it too aversive to confront the feared situations (Garcia-Palacios et al., 2001; Marks & O'Sullivan,1992).

Given the limitations of applying *in vivo* exposure to FP, one of the treatments of choice for this problem has been imaginal exposure (Avero, Capafons, & López, 1993; Bados & Genis, 1988). However, this strategy also has important limitations, such as the difficulty in imagining the situations for some patients, the fact that the imagined scenes could not activate anxiety, or the possibility of cognitive avoidance while the patients are confronting the feared situations.

In summary, we can say that there is a high consensus in considering *in vivo* exposure as the treatment of choice for specific phobias (Barlow et al., 2002). However, it is important to work out a method to overcome the limitations of this strategy.

In recent years, several studies have been carried out to analyse the efficacy of VR as a new tool for applying exposure in FP. VR offers some advantages that could help to overcome some of the limitations of *in vivo* exposure (Botella, Baños, Perpinya, & Ballester, 1998; Botella et al., 2004). VR allows the perception of therapy as a safe and protected framework. Also, it allows the generation of multiple contexts or scenarios similar to reality with a high degree of control over the situations and it can become an intermediate step between the consultation room and the real world. VR offers a higher degree of confidentiality because exposure to the feared situations is conducted in the consultation room and it is not necessary to carry out the exposure task in public. As a exposure technique for FP, VR has a lower cost, in economical terms and regarding time, given that real flights are not needed. In addition, VR can be more immersive that imaginal exposure, because it is possible to activate several sensorial modalities (audio, visual, interoceptive, etc.). The degree of immersion that can be achieved with VR is an important benefit in general, but it is more important for those individuals who have difficulties in imagining the scenes that the therapist narrates. Also, with VR techniques, the therapist can see at the same time everything the patient is seeing in the virtual world. This way it is easier to identify which specific cue is provoking the anxiety response and work with it in therapy. All these features make VR an attractive technique to improve exposure.

In the literature on the use of VR in phobias we find several case studies which showed preliminary data about the utility of VR exposure for FP (Kahan, Tanzer, Darvin, & Borer, 2000; Klein, 1998; North et al., 1997; Rothbaum, Hodges, Watson, Kessler, & Opdyke, 1998). More recently, several studies with larger samples reporting evidence of the efficacy of VR for the treatment of FP have appeared (Maltby, Kirsch, Mayers, & Allen, 2002; Mühlberger, Herrmann, Wiedemann, Ellgring, & Pauli, 2001; Mühlberger, Weidemann, & Pauli, 2002; Rothbaum, Hodges, Anderson, Price, & Smith, 2002; Rothbaum, Hodges, Smith, Lee, & Price, 2000; Wiederhold, Jang, Gevirtz, Kim, & Wiederhold, 2002).

The common elements of these studies are, on one hand, the use of VR exposure for the treatment of FP, and, on the other hand, that the samples of most of the studies were composed of clinical patients meeting the DSM-IV (APA, 1994) criteria

of specific phobia, situational type (FP). With regard to the differences among the studies, we can mention the software used for the exposure tasks, the components of the treatment programmes, the amount of exposure, the assessment measures used, and the inclusion of follow-up assessments. In the following paragraphs, we describe some of the differences in more detail, highlighting the contributions of our study.

The software used in these works placed the patient in the plane and the usual sequence of a flight was simulated (taking off, flight, and landing). Some circumstances could be manipulated like good or bad weather (Rothbaum & Hodges, 1997). The studies that have used the software designed by the Rothbaum and Hodges team (Kahan, et al., 2000; Klein, 1998; Rothbaum et al., 2002; Wiederhold, Gevirtz, & Wiederhold, 1998; Wiederhold et al., 2002), have not included the moments before the flight and important issues in FP such as anticipatory and vicarious anxiety. Dr Mülhberger and his team designed their own software that included similar elements. Finally, Dr Maltby and his team developed software with new elements: airport terminal, boarding area, going to the gate and entering the aircraft. In this case, some situations before the flight had been included with the aim of working on anticipatory anxiety.

Regarding the components included in the treatment programmes, before starting the virtual exposure component, most of the studies included different therapeutic components: Rothbaum et al. (2002) included several components in the first four 1-h sessions of the programme: brief breathing training, cognitive restructuring, thought-stopping, and hyperventilation exposure for those patients with a history of panic attacks. Wiederhold et al. (2002), dedicated two sessions prior to exposure to train the patients in diaphragmatic breathing which the patients can practice at home and in the second session. Mühlberger et al. (2001), included previous to exposure a long group session (4 h) in which the patients reported their flying experience and some educational issues were treated: psychological concept of anxiety including its cognitive, behavioural and physiological components; the physical basis of flying and safety measures regarding flights; and cognitive restructuring. In the second study by this team (Mühlberger et al., 2002) the educational component is delivered using a manual and in addition, participants received a 50-min session of cognitive therapy. Maltby et al. (2002), used a 90-min session before starting the exposure component with the following contents: rationale of VR exposure, anxiety management skills (imaginal and progressive muscle relaxation, development of rational responses to counter irrational thoughts and images about flying); educational handout about safety measures and the mechanics of flying and finally, patients carried out a cognitive discussion with the therapist and practiced relaxation techniques.

As we can see, there is variability in the contents of the different treatment programmes before introducing the virtual exposure component. There are also differences in the duration and the mode of delivery of those contents.

The results found in these studies support the efficacy of VR exposure in the treatment of flying phobia. VR exposure was more effective than a waiting list condition (Mühlberger et al., 2002; Rothbaum et al., 2000); attention-placebo (Maltby et al., 2002); relaxation (Mühlberger et al., 2001); cognitive therapy alone (Mühlberger et al., 2001); and imaginal exposure (Wiederhold et al., 2002). Also, VR exposure was as effective as *in vivo* exposure (Rothbaum et al., 2000). The therapeutic achievements were maintained at different follow-up assessments that ranged from 3 to 12 months (only one of the studies offer data from a 1-year follow-up i.e. Rothbaum et al., 2002). There is only one study (Maltby et al., 2002) in which although efficacy differences were found between a VR exposure group and an attention-placebo group at post-treatment, these differences disappeared at 6-month follow-up.

Despite these promising results, we would like to highlight the fact that most studies included other therapeutic components beside VR exposure, such as cognitive therapy and anxiety management strategies. It could be argued that the efficacy of the treatment programmes could be due not only to VR exposure but, also to the effects of the other therapeutic components. Mühlberger et al. (2002) compared the efficacy of VR exposure plus cognitive therapy versus cognitive therapy alone and found that VR exposure plus cognitive therapy was more effective than cognitive therapy alone. However, this study did not include a VR exposure-alone condition. Also, although most studies included a follow-up assessment, only one (Rothbaum et al., 2002) presented data at 1-year follow-up.

In this study we have considered several issues not included in the studies described above. First, an important clinical feature of FP, anticipatory

anxiety, was taken into account in the design of the VR exposure programme. DSM-IV (APA, 1994) criteria for specific phobia, highlight the importance of this aspect as a source of distress and impairment. Therefore, in the design of our virtual environments we included two virtual scenarios that were relevant to anticipatory anxiety: a room and the airport. In these scenarios the patient can confront stimuli and situations that trigger anxiety before actually flying, such as packing, listening to the radio and hearing news about the weather or the air traffic conditions, watching planes taking off and landing, listening to announcements in the airport about flight departures, etc. With these scenarios we have at our disposal a larger number of phobic situations and elements which allows the feared situations to be graded in a more ecological way; also, it facilitates a larger number of exposure tasks that helps to generalize the therapeutic gains and, at the same time, to build a greater sense of self-efficacy in the patient to manage the situations before the flight (in many cases these situations are the most feared by the patients with FP).

Another charasteristic of our study is that we only included a session of education about anxiety and exposure and the active component of our programme was six sessions of VR exposure. We have highlighted the value of VR exposure by not including cognitive therapy and other anxiety management techniques like breathing training, thought-stopping etc. In our study we are interested in testing the efficacy of VR exposure and because of that we have not included other therapeutic components.

As in other studies, we have included a real flight without the company of the therapist at the post-treatment assessment. The destination of the flight was chosen by each patient. We consider that a real flight is a key test to assess to what extent the therapeutic goals have been achieved.

A final contribution of our work is to show long-term effectivenes (1-year follow-up) of VR exposure for flying phobia. There is only one study that offers data from a 1-year follow-up (Rothbaum et al., 2002).

The aim of this work is, on one hand to show if the software developed activates anxiety in a sample of patients with FP and if a treatment programme based specifically on VR exposure is able to produce decrements in measures of fear, avoidance and belief in catastrophic thoughts regarding FP. On the other hand, we offer data about long-term efficacy, at 1-year follow-up.

METHOD

Participants

The sample was composed of nine participants recruited among the people who had asked for help to overcome the fear of flying at the Jaume I University Center for Emotional Disorders. Seven (70%) were women and two (30%) men. All participants met DSM-IV (APA, 1994) criteria for Specific phobia situational type (flying phobia). Two patients also suffered from panic disorder and two other presented with panic disorder plus agoraphobia. The mean age was 33.33 years (SD = 9.49 years) ranging from 24 to 52 years. All participants but one had a college degree. The mean duration of the phobia was 5.67 years (SD = 5.03 years). None of the participants was taking prescribed medication as a treatment for their phobia. Only one of the participants had flown before starting the treatment. The rest completely avoided this activity. The participant who had flown experienced a high degree of anxiety and discomfort during the flights and used several safety behaviours (she never got up, nor put her feet on the floor during the flight). In Table 1 we show the participants target behaviours and the beliefs associated with their fear of flying.

Measures

Anxiety Disorders Interview Schedule (ADIS-IV; Brown, Di Nardo, & Barlow, 1994)

ADIS-IV 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.

Avoidance and Fear Scale (AFS; adapted from Marks & Mathews, 1979)

The patient and the therapist establish four behaviours or situations that the patient avoids because of panic and agoraphobia. He rates the level of avoidance on a 0–10 scale where 0 = I never avoid it and 10 = I always avoid it; and the level of fear on another 0–10 scale, where 0 = No fear and 10 = Extreme fear.

Degree of Belief in Catastrophic Thoughts (DBCT)

The main catastrophic thoughts related to panic attacks in target behaviours or situations are specified. The degree of belief in those thoughts are assessed on a scale ranging from 0 to 10, where 0

Table 1. Target behaviours and the beliefs associated with the fear of flying among the participants

Part.	Target behaviour	Catastrophic thoughts
P1	Be able to fly	'The pilot will perform a strange operation and we will crash. Everybody will die. It will be a terrible moment from the time you know you are falling till you actually crash'
P2	Be able to fly alone	'I will have a panic attack, nobody will help me, it will be embarrasing'; 'the plane will crash and get on fire'; 'The pilot won't brake on time and we will crash'
P3	Be able to fly	'I will have a panic attack, I will lose control'; 'We will crash and die'
P4	Be able to fly	'We will have an accident. It will be very hard the moment when you know you are going to die'
P5	Be able to fly	'Flying is not safe, we will have an accident'
P6	Be able to fly	'I will lose control, I'm terrified about heights, we will fall'
P7	Be able to stand up, walk and unfasten the seatbelt	'I'm terrifed of turbulences, I will get hurt'; 'The others will notice I'm panicking' in the plane
P8	Be able to fly	'I will get dizzy, I will have a panic attack'
P9	Be able to fly	'The plane will fall in the ocean and nobody will find us'

means that the patient does not believe the thought at all, and 10 means that the patient believes that the thought is totally true.

Subjective Units of Disconfort Scale (SUDS; Wolpe, 1969)

Participants were asked to rate their anxiety level on an 11-point scale (0, 'No anxiety'; 10, 'Extreme anxiety') during the exposure sessions.

Danger Expectations and Flying Anxiety Scales (DEFAS; Sosa, Capafons, Viña, & Herrero, 1995)

These scales are an adaptation of the 'Expectative Scale for Fear of Flying' (ESFF; Gursky & Reiss, 1987). It has been validated in a Spanish population. This instrument consists of two subscales in a 4-point Likert format (0, 'Never'; 3, 'Most times'). The first is a nine-item scale assessing danger expectations (frequency of catastrophic thoughts about the occurrence of possible dangers). The second, consists of 10 items assessing the person's anxiety expectations (probability of experiencing unpleasant physiological symptoms during the flight). The DEFAS has shown high internal consistency, test–retest reliability, and good discriminant and concurrent validity (Sosa, Capafóns, Viña, & Herrero, 1995).

Fear of Flying Questionnaire (FFQ; Bornas & Tortella-Feliu, 1995)

This is a 34-item self-report questionnaire on which the person rates his/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 (16 items); (b) anxiety experienced before take-off (13 items); and (c) anxiety experienced when observing either internal or unpleasant flying-related situations (five items). The questionnaire has shown high internal consistency, test–retest reliability, good discriminant validity, and it is sensitive to treatment outcome (Bornas & Tortella-Feliu, 1995).

Beck Depression Inventory (BDI; Beck, 1978)

This is one of the most widely used inventories for evaluating the presence of depressive symptoms. It is a 21-item self-report questionnaire. Scores of 10 or less are considered normative.

State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970)

In this study only the 20-item Trait Anxiety Scale was used. The Anxiety Trait is defined as a relatively stable anxiety apprehension by which participants differ in their tendency to perceive situations as threatening and consequently, to increase their state of anxiety. The scale has 20 items, half of them formulated in a positive way and the other half in a negative way. The score is shown on a 4-point intensity scale.

Maladjustment Scale (MS; Echeburúa, Corral, & Fernández-Montalvo, 2000)

This instrument assesses the impairment that the problem causes in several areas of the participant's life using an 11-point scale (0, 'None'; 10,

'Extreme'). Only rates on global impairment were used in this study. The scale has shown high internal consistency, discriminant and concurrent validities, and it is sensitive to treatment outcome. (Echeburúa et al., 2000).

Apparatus

The hardware used consisted of a Pentium-based platform (Intel Pentium III, 450 Mhz, 128 Mb RAM, graphic engine: Riva TNT2 with 64 Mb RAM) running windows NT/2000 from a Microsoft Corp. operating system. The display system consisted of a head-mounted display. We have used for the first time the HMD model V6 from Virtual Research but after performing several tests on the sense of presence using different hardware configurations, we decided to use a cheaper HMD, the virtual I/O Glasses. We used for this display device a stereoscopic display mode since it has been observed that stereoscopy provides a good sense of depth to the user, and hence increases the patient's sense of presence in the virtual environment (VE). An Intersense II 3D digitizer was used for head tracking. As a motion input device we used a standard mouse.

Virtual Environments

The software developed include some elements in order to increase the degree of reality judgment and the difficulty of the feared situation: user's gender; weather conditions (good weather/bad weather/bad weather with thunders and lighting; day or night; turbulence. The software include three VR scenarios.

The Room

This is a scenario designed to work with anticipatory anxiety. The patient is in a bedroom and he/she can conduct some behaviours usually associated with the days or hours before the flight: packing, listening to news regarding the air traffic and the weather conditions, and taking his/her ticket to go to the airport.

The Airport

In this scenario we can simulate the hours and minutes previous to the flight. The patient can listen to and see on the board flight announcements, knowing that his/her flight is close; he/she can listen to some people chatting about flying; it is also possible to see and hear planes taking off and landing. Finally the patient can walk to one of the airport gates, walk along the finger and enter the aircraft.

The Plane

Here the patient is seated on the plane close to the window with a person beside him/her. The patient can listen to the radio or read a magazine while waiting for the plane to start the engines. Then, the flight process begins with the following sequence: (1) the flying safety measures are displayed on the screen in front of the user; (2) the captain welcomes the passengers and reports information about the altitude and the weather conditions during the flight; (3) taking off: after the instruction to fasten the seatbelts, the sound of the engines becomes louder and the plane starts taxiing; the plane then accelerates and takes off; (4) flight: during the flight we can change the weather conditions, generate thunder, lighting, and turbulence; (5) landing: the flight attendant informs passengers about the proximity of landing and asks them to fasten their seatbelts. Then, the plane initiates the landing procedure until it arrives at the gate.

Experimental Design

A between subjects multiple baseline design was chosen in this study (Hersen & Barlow, 1984). Concretely, we used a non-concurrent multiple baseline across-individuals design (Watson & Workman, 1981) given that the subjects did not come to our clinic at the same time. Three baseline periods (1, 2 and 3 weeks) were established and the participants were randomly assigned to them. The participants recorded on a daily basis the degree of fear, avoidance and belief in catastrophic thoughts regarding the target behaviours established during the pre-treatment assessment related to their flying phobia. Participants 3, 7 and 8 were assigned to a 1-week baseline period, P1, P2 and P9 were assigned to a 2-week baseline period; and P4, P5 and P6 to a 3-week baseline period.

Procedure

The patients asked for help to overcome their fear of flying at the Jaume I University Emotional Disorders Clinic. After a first intake, the patients went through a pre-treatment assessment consisting of two 60- to 90-min sessions. First, a diagnostic interview was carried out to explore if the patients met DSM-IV criteria of Specific phobia, situational type

(flying phobia) and other additional psychological problems. Then the target behaviours were established and the patients completed the other self-report measures. After this process, the patients were randomly assigned to one of the three baseline conditions (1, 2, or 3 weeks). The patients recorded fear, avoidance and belief in catastrophic thoughts related to the target behaviours on a daily basis during the baseline period. This record was maintained throughout the entire process until the post-treatment assessment, and, also before and after each VR exposure session. After the pre-treatment assessment and before starting the treatment the patients were asked to bring a flight ticket in order to take a flight 5 months after the post-treatment assessment (without the help of a therapist). The clinicians encouraged the patients to fly right after completion of treatment. The flight destination was chosen by each patient. This was a condition of starting the treatment. This way the flight ticket purchase became a motivational element in order to start the treatment and, also, the information recorded by the patient on a daily basis was more objective, given that they had a real expectation to fly. An independent diagnostic assessment was carried out by a different clinician in each case to confirm the diagnosis in a 45- to 60-min session. After this assessment phase was completed, the treatment began. The treatment programme consisted of one 45- to 60-min psychoeducational session, and six 45- to 60-min VR exposure sessions. During the post-treatment assessment the patients completed the same measures as at the pre-treatment assessment and it was also recorded whether the patients carried out a real flight. Finally, a 12-month follow-up assessment was established where the patients completed the same instruments.

Treatment

The treatment protocol included a main component: VR exposure. In the first session, patients received educational information about fear, anxiety and phobias (three dimensions of anxiety, survival role of anxiety, description and consequences of avoidance, relationship between the three dimensions of anxiety); safety measures and the mechanics of flying; and rationale about exposure and advantages of virtual reality. The following sessions were devoted to virtual exposure to the different virtual scenarios progressing from the easiest to the most difficult situations. The main goal of these sessions was to stay in the situation until the patient experienced a significant decrease in anxiety. Three therapists with clinical experience, mainly in the treatment of anxiety disorders, carried out the treatments. The therapists were supervised by more experienced clinical psychologists.

RESULTS

In Figures 1, 2 and 3 the ratings of fear, avoidance and belief in catastrophic thoughts regarding the target behaviours throughout the process are shown, including the baseline period, the treatment (divided into the first session devoted to education and the next six sessions dedicated to VR exposure), the post-treatment and the 1-year follow-up. Figure 1 includes the mean ratings of the three patients assigned to the 1-week baseline period; Figure 2 shows the mean ratings of patients belonging to the 2-week baseline; and Figure 3 offers the mean ratings of the three patients in the 3-week baseline period. In all figures each point during the baseline represents the mean score of 3 days. Each point during the treatment means the mean ratings corresponding to each treatment session. The post-treatment and follow-up are represented by only one point each belonging to the post-treatment or follow-up session.

We can see that the ratings during the baseline period do not change in all baseline conditions. When the educational information is introduced we can see a slight reduction in the measures. The introduction and practice of VR exposure means an important reduction in fear, avoidance and belief

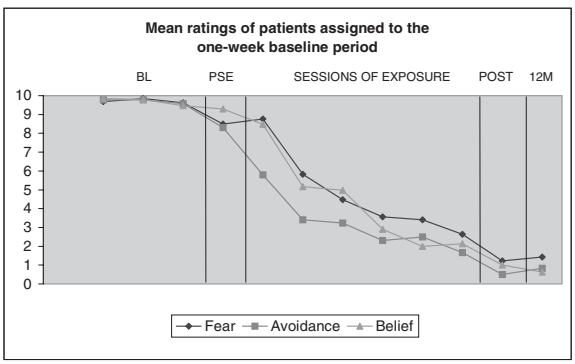


Figure 1. Mean ratings in fear, avoidance and belief in catastrophic thoughts regarding the target behaviours throughout the study for the three patients assigned to the 1-week baseline period

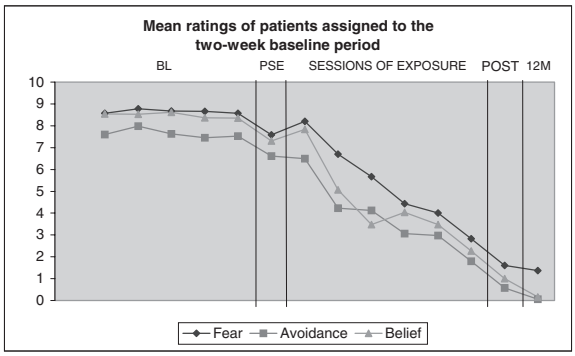


Figure 2. Mean ratings in fear, avoidance and belief in catastrophic thoughts regarding the target behaviours throughout the study for the three patients assigned to the 2-week baseline period

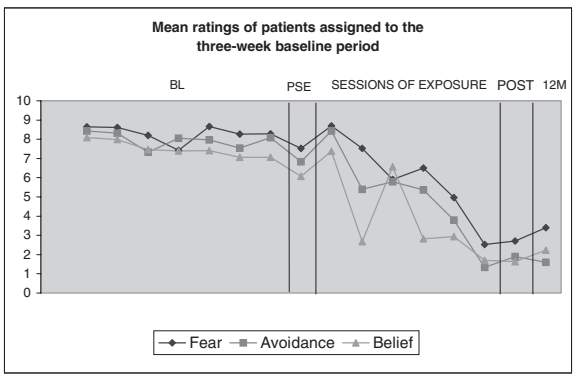


Figure 3. Mean ratings in fear, avoidance and belief in catastrophic thoughts regarding the target behaviours throughout the study for the three patients assigned to the 3-week baseline period

in catastrophic thoughts related to flying in all conditions. If we compare the pre-treatment and the post-treatment ratings we can see that important reduction. Finally, we can see that the improvement achieved at post-test is maintained at 1-year follow-up.

In Figure 4 the reduction of fear, avoidance and belief in catastrophic thoughts achieved after each session with VR exposure is shown, indicating that our VR programme was able to provoke anxiety responses and reduce them. We can see that as long as exposure progresses, the degree of fear, avoidance, and belief in catastrophic thoughts before the exposure sessions decreases. Also, the ratings decrease from the beginning to the end of each session. Finally, a significant improvement is achieved from the first to the last VR exposure session in all measures.

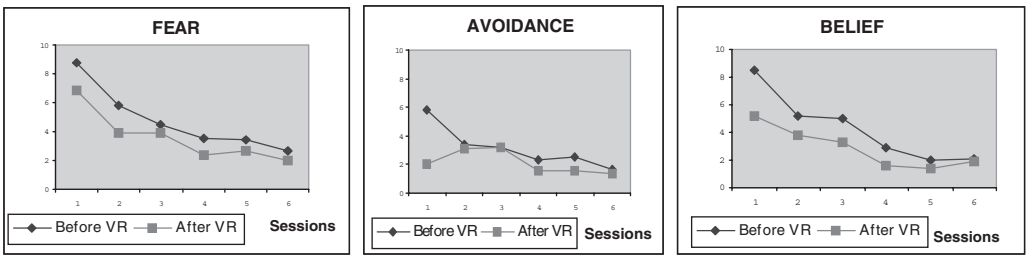
We carried out non-parametrical statistics (Wilcoxon signed-rank tests) to analyse the significance of the efficacy data. With regard to fear, avoidance and belief in catastrophic thoughts we found statistically significant differences from pre-test to post-test (fear, $Z = -2.66$, $p < 0.01$; avoidance, $Z = -2.66$, $p < 0.01$; belief in catastrophic thoughts, $Z = -2.66$, $p < 0.01$) and from pre-test to follow-up (fear, $Z = -2.66$, $p < 0.01$; avoidance, $Z = -2.66$, $p < 0.01$; belief in catastrophic thoughts, $Z = -2.66$, $p < 0.01$). We did not find differences in these variables from post-test to follow-up. The tests also reveal differences between pre-treatment and post-treatment regarding the impairment caused by the phobia measured by the Maladjustment Scale ($Z = -2.38$, $p < 0.05$). The differences from pre-test to follow-up were also significant ($Z = -2.4$, $p < 0.05$); and we did not find differences between post-treatment and follow-up assessment (see Table 2).

We can also see (Table 3) that the scores of the participants in most flying phobia self-report measures showed a significant decrease from pre-test to post-test (DEFAS: danger expectations, n.s.; DEFAS anxiety expectations: $Z = -2.67$, $p < 0.01$; FFQ before flying, $Z = -2.55$, $p < 0.05$; FFQ during flight, $Z = -2.66$, $p < 0.01$; FFQ observing flight-related situations, $Z = -2.66$, $p < 0.01$). The differences between the pre-test and the follow-up assessment are all significant (DEFAS: danger expectations, $Z = -2.17$, $p < 0.05$; DEFAS anxiety expectations, $Z = -2.67$, $p < 0.01$; FFQ before flying, $Z = -2.55$, $p < 0.05$; FFQ during flight, $Z = -2.55$, $p < 0.01$; FFQ observing flight-related situations, $Z = -2.55$, $p < 0.01$). Finally, the statistics revealed no differences between the post-treatment and the follow-up in most variables but one, Anxiety expectation of the DEFAS ($Z = -1.98$, $p < 0.05$). We can see that the improvement continues in this measure from post-test to follow-up.

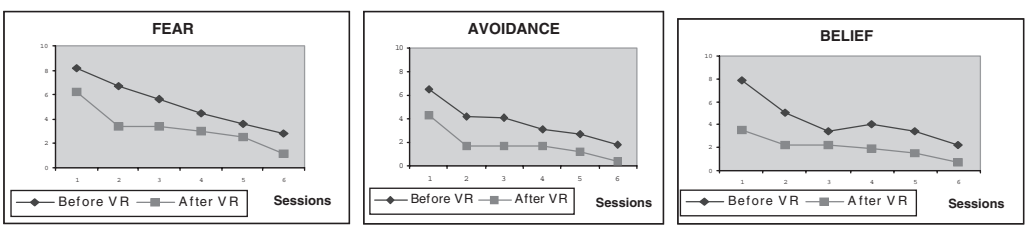
Regarding the general anxiety (STAI-T) and depression (BDI) measures, we can see in Table 3 that our participants did not present high scores at pre-treatment in these variables. Because of that we did not find significant reductions from pre-test to follow-up. We only found a significant decrease in the BDI from pre-test to post-test ($Z = -2.03$, $p < 0.05$).

Only three patients dropped out of the study before starting the treatment in the assessment phase. All patients who started the treatment finished it and came to the follow-up assessment. All participants (100%) were able to fly in the 5 months after the completion of treatment.

1-Week baseline condition:



2-week baseline condition:



3-week baseline condition:

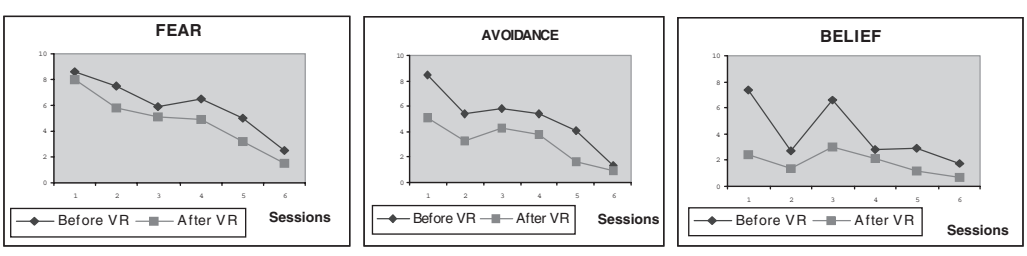


Figure 4. Mean ratings in fear, avoidance and belief in catastrophic thoughts before and after the VR sessions for the participants in each baseline condition

Table 2. Target behaviours measures and impairment

		Pre-treatment	Post-treatment	Follow-up
AFS	Fear	8.89 (1.50)	1.84 (1.49)	2.06 (2.35)
	avoidance	8.35 (2.00)	0.98 (1.25)	0.83 (1.43)
DBCT	Belief	8.50 (2.25)	1.21 (1.19)	1.01 (1.94)
MS		4.66 (2.12)	1.88 (1.96)	0.55 (1.01)

Means and standard deviations. AFS, Avoidance and Fear Scale; DBCT, Degree of Belief in Catastrophic Thoughts; MS, Maladjustement Scale.

DISCUSSION

In the present work we have described the results obtained in a sample of nine participants with Flying Phobia who were treated with a virtual reality exposure programme.

We can say that the software designed for the treatment of flying phobia was able to activate the participants' anxiety. The patients experienced from moderate to high levels of anxiety during the VR exposure sessions. The increment in the anxiety levels was related to the different VR scenarios, the

Table 3. Mean scores in flying phobia self-reports questionnaires

		Pre-treatment	Post-treatment	Follow-up
DEFAS	Danger expectations	17.66 (3.77)	14.44 (4.42)	13.33 (2.64)
	Anxiety expectations	27.33 (5.24)	19.33 (5.89)	16.55 (5.38)
FFQ	Before flying	90.77 (20.62)	35.33 (20.67)	37.88 (31.06)
	During flying	112.55 (16.37)	56.77 (26.16)	57.77 (33.76)
	Observing flying-related situations	37.77 (9.52)	18.55 (10.81)	15.11 (11.94)
STAI-T		25.00 (7.96)	21.66 (7.58)	21.77 (5.54)
BDI		6.55 (3.43)	3.55 (3.16)	3.44 (3.12)

DEFAS, Danger Expectations and Flying Anxiety Scales; FFQ, Fear of Flying Questionnaire; STAI-T, State/Trait Anxiety Inventory-Trait; BDI, Beck Depression Inventory.

anxiety-provoking elements introduced, and the characteristics of the participants.

VR exposure was effective for the treatment of flying phobia in our sample. The participants achieved an important improvement regarding their avoidance and fear. They were able to control their anxiety levels, experiencing significant reductions in the degree of fear, avoidance, belief in catastrophic thoughts, and impairment and distress caused by the flying phobia as well as a significant reduction in their scores on the flying phobia questionnaires.

All participants (100%) were able to fly in the 5 months after the completion of treatment. Also, the flights were confronted with greater control over the anxiety symptoms and the catastrophic thoughts. None of the participants took any medication or other substances (alcohol) to control their anxiety during the flight. The sense of self-efficacy and satisfaction (reported verbally by the patients) increased dramatically in comparison with previous flying experiences. Once this established flight was performed, the participants were encouraged to fly again during the follow-up period. Most patients have reported more flights during this period with mild symptoms (see scores at 1-year follow-up assessment). The benefits were maintained at long-term, at 1-year follow-up assessment in all participants but one, participant 4. Despite the fact that she flew at post-treatment and she reported that it was a good experience, we could not see that this improvement was maintained at follow-up. There is a possible reason for this result. After the treatment she became pregnant and went through a high-risk pregnancy that kept her in bed for most of the time over several months. She could not fly again for this medical reason and maybe she could not strengthen the improvement she had achieved.

None of the participants needed additional VR exposure sessions, nor received any other treatment from post-treatment to follow-up. We can conclude that the goals of our study were achieved.

Our data support the findings obtained by other researchers regarding the use of VR for the treatment of flying phobia (Maltby et al., 2002; Mühlberger et al., 2001; Mühlberger et al., 2002; Rothbaum et al., 2002; Wiederhold et al., 2002). However, we would like to highlight the contributions of our study to this literature. These studies have included in their treatment programmes a higher number of active therapeutic components than VR exposure, namely, cognitive therapy and other anxiety management strategies (breathing training, relaxation, thought-stopping, etc.) Our study only included an active therapeutic component: VR exposure. We did not include cognitive therapy or other anxiety management techniques. We only included a session of education as a rationale for the VR exposure component.

Another contribution is the software designed for our team that has included new and important elements which help to activate the anxiety response in a more meaningful way for flying phobia sufferers. We have taken into account important issues such as anticipatory anxiety (two scenarios of our software are dedicated to this) or vicarious anxiety (including comments by other people or news about flying). We have also included a wide range of elements in order to have a broader number of possibilities for all patients (bad or good weather, turbulences, storms, night or day, seeing planes taking off and landing, listening to different sounds like plane engines, the announcement of flights, conversations about flying, the safety measures, etc.). The only other software that has included some elements related to anticipatory anxiety is that used in the Maltby et al. (2002) study. However, the results of this study showed that at 6-month follow-up there were no differences between the VR exposure group and the attention placebo group.

Most studies included a real flight at post-treatment as a behavioural measure of the efficacy of the programmes (Maltby et al., 2002; Rothbaum et al., 2002; Wiederhold et al., 2002). Our study also included a real flight at post-treatment. Our results regarding this issue are very encouraging, 100% of the participants flew. Only one of the studies reviewed reported such good results. In the Wiederhold et al. (2002) study, 100% of the participants from a VR plus physiological feedback condition flew after the treatment.

Finally, our study and the Rothbaum et al. (2002) study are the only ones that show long-term efficacy at 1-year follow-up. These are important data to support the efficacy of VR exposure in the treatment of flying phobia

We would like to mention some of the limitations of our study. Our sample was small. The reason for choosing a multiple baseline design was to show with a greater degree of clinical detail than found in other studies, whether the therapeutic gains could be due to VR exposure alone. We already had some evidence from other studies about the efficacy of VR exposure for the treatment of flying phobia compared to control conditions and we were interested in a more clinical approach that gave us information about more subtle changes due to different issues that VR exposure involves such as introducing new elements, new scenarios, etc. Also, the multiple baseline periods established could be considered as a control condition. We were interested in observing the effects of VR exposure alone along several exposure sessions. A single case baseline design could show this information.

Another limitation is that as in most of the other studies, we did not included a real or virtual flight at pre-treatment. We only recorded whether the patients would or would not fly before starting the treatment. We think that a behavioural test at pre-treatment is an interesting contribution. However, we would like to mention that the therapist has to be aware that if the patient agrees to fly, the degree of control over that situation is low because the patient does not yet have the therapeutic tools to confront the situation and there is a risk of sensitization. One solution could be to include a virtual behavioural test, that way the degree of control is higher and the situation could be less aversive for the patient.

We can conclude that VR exposure alone was effective in the treatment of flying phobia in our sample, and the improvement was maintained in the long term. This study adds empirical evidence to the efficacy of this new tool to conduct exposure. VR allows the application of exposure in a more efficient way, with a high degree of control over the feared situations, more confidentiality and with a good cost–effect balance (saving time and money for therapists and patients). In the future VR may become a familiar tool for mental health professionals. However, despite the promising results, more controlled studies are needed with larger samples to establish VR as a useful tool for phobias and other psychological problems.

Finally, we consider it essential to continue in the design and testing of effective and efficient treatment protocols that become useful tools to achieve better and faster results for our patients.

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