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# *Virtual Reality Exposure in the Treatment of Panic Disorder and Agoraphobia: A Controlled Study*†

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**The main goal of this study was to offer data about the efficacy of virtual reality exposure (VRE) in the treatment of panic disorder with or without agoraphobia (PDA). The study was a between-subject design with three experimental conditions (VRE group, *in vivo* exposure [IVE] group and waiting-list [WL] group) and repeated measures (pre-treatment, post treatment and 12 month follow-up). The treatment programmes lasted 9 weekly sessions. Thirty-seven patients meeting DSM-IV criteria for PDA participated in this study. The improvement achieved using virtual exposure was superior to a WL condition and similar to that achieved using IVE. Our results support the efficacy of VRE in the treatment of PDA at short and long term. The advantages of VRE for the treatment of PDA regarding cost-benefit issues are described. Copyright © 2007 John Wiley & Sons, Ltd.**

Panic disorder, with or without agoraphobia (PDA), is one of the most prevalent mental disorders in the general population. PDA also leads to numerous adverse consequences that undermine patients' quality of life (Schmidt & Telch, 1997). The efficacy of cognitive–behavioural treatment (CBT) programmes for the treatment of PDA has been widely demonstrated (i.e., Barlow, 2002; Barlow, Raffa, & Cohen, 2002; Gould, Otto, & Pollack, 1995), meeting the criteria set by the Task Force on Promotion and Dissemination of Psychological Procedures (American Psychological Association Task Force on Psychological Intervention Guidelines, 1995) necessary to be considered well-established treatments (i.e., Barlow et al., 2002; Botella, 2001). However, despite these promising findings, there are still limitations on the availability of these treatments, like difficulties that mental health practitioners encounter in the application of empirically validated programmes (Barlow, Levitt, & Bufka, 1999), the still reduced professional help-seeking behaviour in an important set of PDA sufferers (Bebbington et al., 2000) or the non-acceptance rates and difficulties in the application of some therapeutic strategies in these programmes.

One of the main ingredients of CBT for PDA is exposure. Despite the widely demonstrated efficacy of this technique, approximately 25% of patients do not benefit from *in vivo* exposure (IVE) because they find the procedure too aversive; either they do not accept it or they drop out of the programme (Marks, 1987, 1992). In some cases, although the patients accept involvement in IVE,

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this technique presents some limitations when it is applied outside the consultation room, including lack of privacy or a significant increase in the time dedicated to the therapy, and therefore its cost. These limitations make the suitable application of this technique difficult in some cases.

Researchers must develop methods of delivery of CBT programmes that will reach a higher number of patients without decreasing efficacy. They must go beyond what is called therapeutic efficacy in terms of the American Psychological Association Task force on Psychological Intervention Guidelines (1995) (axis 1), i.e., the therapeutic effectiveness, or clinical utility (axis 2).

In order to progress in this direction, some investigators are working on the use of technology in mental health. There is an increasing interest in exploring the utility of technological innovations for the assessment and treatment of mental disorders (i.e., Hofmann, 1999; Marks, 1999). One of the technological innovations that is providing promising efficacy data is virtual reality (VR). This technology is being used as a tool to deliver exposure in the treatment of anxiety disorders. VR is an emerging technology that allows the simulation of different real situations in a tridimensional computer-generated environment. The user can interact with this environment as if it is the real world. The idea behind the use of VR as an exposure technique for the treatment of anxiety disorders is that VR objects have similar characteristics than real objects to create in the user the illusion of being immerse, to interact and to accept the simulated environment as a real world. In the case of a phobic individual, the virtual environment can elicit a similar anxiety response than a real phobic situation (Moore, Wiederhold, Wiederhold, & Riva, 2002).

VR can be used to maximize the benefits of IVE or as an alternative for those individuals who do not accept IVE. There are an increasing number of studies that support the use of VR as an effective tool in the treatment of several specific phobias (i.e., Botella, Baños, Perpiñá, Villa, & Alcañiz, 1998; Emmelkamp et al., 2002; García-Palacios, Hoffman, Carlin, Furness, & Botella, 2002; Rothbaum, Hodges, Anderson, Price, & Smith, 2002; Wald & Taylor, 2000). VR has also been used in the treatment of other anxiety disorders, including posttraumatic stress disorder in Vietnam veterans or September 11 victims (Difede & Hoffman, 2002; Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001), and social phobia (Klinger et al., 2005) (see also Anderson, Jacobs, & Rothbaum, 2004; Krijn, Emmelkamp, Olafsson, & Biemond, 2004; Rothbaum, 2006; Wiederhold & Wiederhold, 2005, for a review). These studies show that virtual environments allow a high degree of control over the feared objects or situations, because using VR can prevent the occurrence of unpredictable events. This is not always possible with IVE. For instance, we can go to a shopping mall with a patient when we think it will be almost empty, yet find that it is crowded. The fact that events in VR are more predictable than *in vivo* can result in the patient being more willing to start the exposure programme. Furthermore, in contrast to *in vivo* situations, VR allows for an accurate gradation of the exposure to the feared object or situation. We can add more and more difficult feared cues to the computer-generated environment in a very progressive way. Also, we can repeat the same exposure task as many times as needed without having to wait for the real situation to happen. For example, with an individual with PDA, we can practice the same trip length in a bus (i.e., two stops) over and over without going through the entire trip sequence (i.e., 20 stops). This advantage facilitates 'overlearning', one of the processes that increases the efficacy of exposure (Marks, 1987). Also, VR offers a more confidential setting than IVE. Because the treatment takes place in the therapist's office, patients do not need to be afraid that their problem may be known.

Although VR exposure (VRE) has some advantages, one of its potential disadvantages is its financial cost. However, the cost of VR equipments is going down dramatically and will continue to go down. The cost of our first VR equipment in 1996 was around 150.000 euros. The cost of our last VR equipment was around 6.000 euros. Although it can seem an important amount of money, the reduction in other costs (i.e., time and money spent in trips by the therapist and/or the patient) makes VR an affordable alternative.

In a previous study, Botella, Villa, Baños, Perpiñá, and García-Palacios (1999) applied a VR programme to the treatment of claustrophobia in a patient with a PDA diagnosis (at that time, we had not yet developed the VR environments specifically for PDA). Although VRE has been restricted to claustrophobic situations, one of the main results is the generalization of the therapeutic gains to other agoraphobic behaviours not specifically treated. This finding has encouraged us to design a VRE treatment for PDA. Our VR programme for PDA includes several VR scenarios that simulate a wide number of agoraphobic



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situations, and it offers the additional advantage of inducing bodily sensations similar to those experienced in panic attacks (PA) by means of sound and visual effects. This allows for the application of interoceptive and situational exposure simultaneously.

There are some preliminary data that support the efficacy of VRE in the treatment of PDA. Some studies offer descriptions and non-controlled data on the use of VR in panic and agoraphobic avoidance in non-clinical populations (Moore et al., 2002; North, North, & Coble, 1996; Vincelli, Choi, Molinari, Wiederhold, & Riva, 2000). There are some works about VR and PDA with clinical populations: non-controlled studies (Botella et al., 2002; Jang, Ku, Shin, Choi, & Kim, 2000; Villa, Botella, Garcia-Palacios, & Osma, in press) and a study that compared the efficacy of a VR CBT programme with a standard CBT programme and a waiting-list (WL) condition (Vincelli et al., 2003). They reported that both treatment groups improved significantly. However, this study presented some methodological limitations that make it difficult to draw strong conclusions from it. It is not clear how much improvement in the VR group can be attributed to the VRE or to the IVE, given that the participants assigned to the VR condition also received instructions to practice IVE between sessions.

After reviewing the literature, we can see that there are no well-controlled data with clinical populations to determine the efficacy of VR in the treatment of PDA. Besides, none of the studies reviewed include follow-up assessments. The aim of the present work was to offer controlled data about the short- and long-term efficacy and effectiveness of VRE in the treatment of this disorder, comparing VRE, IVE and a WL condition. Furthermore, this is the first study showing controlled efficacy data from 1 year follow-up of a VR treatment programme for PDA.

## METHOD

### *Participants*

The study was carried out at the Jaume I University Emotional Disorders Clinic. Some of the participants came voluntarily to our clinic for treatment, and others were referred from public mental health services. Inclusion criteria for the participants were the following: 18 years of age or older, met DSM-IV (American Psychiatric Association, 2000) criteria for the diagnosis of PDA as principal diagnosis and in the case of taking medication for PDA, did not increase or modify the kind of medication during the study. Exclusion criteria were psychosis, severe organic illness, or substance abuse or dependence. All participants signed a consent form approved by the university Human Subjects Committee giving permission to use their clinical data for research purposes. Forty-six people were screened for the study; nine of them were excluded for different reasons. Therefore, data from 37 Caucasian participants were included in this study. The mean age of the sample was 34.7 years old (standard deviation [SD] = 12.31) ranging from 18 to 72. Most of the sample (70.3%) were female, and the remaining 29.7% were male; 26.5% were single, 70.6 married or partnered and 2.9% divorced. With regard to the level of education, 26.5% had an elementary level; 47% had a high school education level, and 26.5% had a university degree. Most of the sample received a diagnosis of panic disorder with agoraphobia (82.9%), and the rest (17.1%) had a diagnosis of panic disorder without agoraphobia. Regarding other diagnoses, eight patients (21.6%) presented axis I co-morbidity, and four (10.81%) presented axis II co-morbidity. Finally, 66.6% of the sample was taking medication for their problem.

### *Measures*

The assessment protocol was designed following the guidelines of the National Institutes of Health Consensus Development Conference on the Treatment of Panic Disorder held in October 1991 and reported by Shear and Maser (1994). In this section we describe briefly the instruments of our assessment protocol.

### *Diagnosis*

*Anxiety Diagnostic Interview Schedule IV (Di Nardo, Brown, & Barlow, 1994)*

This is a semi-structure interview designed to carry out a differential diagnosis of the anxiety disorders included in the DSM. It has been revised several times, and this last version was adapted for the DSM-IV (APA, 2000) criteria. Several studies show an inter-rater reliability from satisfactory to excellent when it is used by expert clinicians who are familiar with the DSM diagnostic criteria (Di Nardo, Moras, Barlow, Rapee, & Brown, 1993).



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### *Treatment Efficacy Measures*

*Fear and Avoidance Scales (Adapted from Marks & Mathews, 1979)*

The patient and the therapist establish three target behaviours or situations that the patient avoids and that he/she would like to overcome at the end of the treatment. The patient rates the level of avoidance in a 0–10 scale where 0 is 'I never avoid it', and 10 is 'I always avoid it'; and the level of fear in another 0–10 scale, where 0 is 'no fear', and 10 is 'extreme fear'. The main catastrophic thoughts related to PAs in target behaviours or situations are also specified. The degree of belief in those thoughts is assessed in a scale ranged from 0 to 10 where 0 means that the patient does not believe the content of the thought at all, and 10 means that the patient believes that the thought is totally true.

*PA Record*

Participants record the occurrence of PAs daily. The patient specifies PAs and other anxiety episodes, type of PA (unexpected or cued by a situation), duration of PA, the level of anxiety before, during and at the end of the episode, and severity of the PA.

*Panic Disorder Severity Scale (PDSS; Shear et al., 1992)*

This instrument is a clinical scale that assesses important features of panic disorder and agoraphobia: panic frequency, distress caused by the PA, severity of anticipatory anxiety, situational avoidance, interoceptive avoidance, and social and work impairment. The authors of this scale reported a mean of 1.59 (SD = 0.43) for the total score in a sample of panic disorder without agoraphobia or with moderate agoraphobia.

*Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986)*

This questionnaire includes 16 items that assesses anxiety sensitivity. The content of the items, rated in 0–5 scales includes concern about the possible adverse consequences of the anxiety symptoms. The mean in a sample of individuals without agoraphobia or with moderate agoraphobia was 32.1 (SD = 11.3) (Rapee, Brown, Antony, & Barlow, 1992). In a Spanish sample of individuals suffering PDA, the mean was 32.8 (SD = 10.7). The Spanish version also offered similar psychometric properties than the English version, and it was useful to discriminate between panic disorder and other anxiety disorders (Sandín, Chorot, & McNally, 1996, 2001).

*Agoraphobia Subscale (Ag) of the Fear Questionnaire (FQ; Marks & Mathews, 1979)*

The FQ is a 24-item self-report measure that was designed specifically to monitor change in patients with phobias. It contains three five-item subscales (agoraphobia, blood/injury and social phobia), a global distress index and a five-item anxiety/depression scale. In this study, we did not use the blood/injury and social phobia scales. Means for a phobic sample were 47 (SD = 19.3) for the total score, 17 (SD = 10.0) for agoraphobia, 22 (SD = 9.1) for anxiety/depression and 5.5 (SD = 2.7) for the global phobic rating.

*Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961)*

Adapted by Conde and Franch (1984) for the Spanish population, BDI is one of the most used instruments to assess depression symptoms. It includes 21 items. Each item offers four possible answers. The participant has to choose the statement that better describes his/her mood state. This instrument assesses mainly cognitive aspects of depression, as well as behavioural and physiological symptoms. Scores of 10 or less are considered normative.

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

This instrument assesses the level of impairment that the problem causes in different life areas (work, social life, leisure, partner, family and global impairment) using 0–5 scales where 0 is 'not impaired', and 5 is 'severely impaired'. This scale offers good psychometric properties, and it is sensitive to the effects of the treatment. We only used the global impairment item as a measure of perceived impairment in this study.

*Clinician Global Impression (CGI, adapted from Guy, 1976)*

The therapist assessed at the end of every session the global severity of the patient in a scale from 1 to 6 where 1 is 'normal'; 2 is 'slightly disturbed'; 3 is 'moderately disturbed'; 4 is 'quite disturbed'; 5 is 'severely disturbed', and 6 is 'very seriously disturbed'.

### *Measures regarding Expectations and Satisfaction about the Treatment*

Following Borkovec and Nau (1972), we designed a questionnaire to measure the expectations about the exposure (*in vivo* or virtual) treatment before



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starting it. The questions were about how logical the treatment seems, to what extend it could satisfy the patient, if the patient would recommend this treatment to other people, if it could be useful to treat other problems, the usefulness for the patient's problem and to what extent it could be aversive. The questions were rated using 0–10 scales. The patients answered these questions during the session when exposure was introduced (after they were given a rationale about *in vivo* or virtual exposure, but before starting the first exposure task). The patients filled out the same questions at post test and at follow-up in order to assess the satisfaction with exposure.

### *Experimental Conditions, Treatment and Therapists*

The design was a between-subject design with three experimental conditions: IVE, VRE and WL. It included repeated measurement (pre-treatment, post treatment and 12 month follow-up).

The treatment programme included the most important components of the most influential theoretical models of panic disorder and agoraphobia, the Clark's cognitive component (Salkovskis & Clark, 1991) and the Barlow's interoceptive and situational exposure component (Barlow & Craske, 1994). The treatment was composed of three modules delivered in nine sessions (weekly 1 hour sessions): (1) education about anxiety and PDA, cognitive restructuring and breathing training (two sessions); (2) exposure to internal and external stimuli (IVE or VRE) (six sessions); and (3) relapse prevention (one session). The difference between the two treatment conditions was the exposure component, which was delivered *in vivo* in the IVE group and in a computer-generated environment in the VRE group.

Nine therapists participated in this study. All of them were psychologists; five of them had Ph.D. degrees, and four were Ph.D. students. The therapists were well trained in CBT programmes for PDA. Treatment adherence across the therapists was ensured by a specific training in the treatment programmes. Also, the complete team held weekly meetings to supervise the ongoing treatment of all patients.

### *Procedure*

After an initial screening, two assessment sessions were carried out to confirm the diagnosis of PDA, to assess if they met the inclusion criteria, to complete the measures related with the target behaviours and to review the self-report questionnaires filled at home. The first session was recorded for further independent assessment. From this session, the patient recorded panic frequency, severity and anticipatory anxiety in the PA record. After this pre-treatment assessment, the participants were randomly assigned to each of the three experimental conditions. Both the participants and the therapists in the treatment conditions were blind to the condition to which they were assigned until the exposure component was applied. All participants in the treatment conditions were assessed at post treatment 1 week after the treatment completion.

### *Apparatus and Software*

The devices used were a Pentium III (1000 KHZ, 256 MB of random access memory and CD-ROM drive) and an AGP graphics card, 64 MB, with support for OpenGL and with support for a 60 Hz rest frequency at 640 × 480 resolution. The patient visual device was a V6 (Virtual Research) head mounted display, and the psychologist visual device was a 17″ monitor. The patient tracker device was an InterTrax 2. The patient navigation and interaction device was a mouse, and the psychologist interaction device was the keyboard. Finally, the patient audio device were V6 headphones, and the psychologist audio devices were standard headphones. The software used run in Microsoft Windows (95, 98, ME, 2000 or NT 4.0 [with Service Pack 6]).

### *Virtual Environments for the Treatment of PDA*

The VR programme is called Panic-Agoraphobia and it has six virtual environments: the training room, the house, the subway, the bus, the shopping mall and the tunnel (see Figure 1). In each scenario, exposure to external and interoceptive stimuli can be conducted simultaneously. The bodily sensations that can be simulated are (1) palpitations and breathing difficulties with three levels of intensity (mild, moderate and accelerated); (2) visual effects: tunnel vision, blurred vision and double vision. On the other hand, the difficulty of each scenario can be graded using some modulators that allow establishing flexible virtual exposure hierarchies (i.e., number of people present, length of the trips, difficulties like problem with the credit card at the



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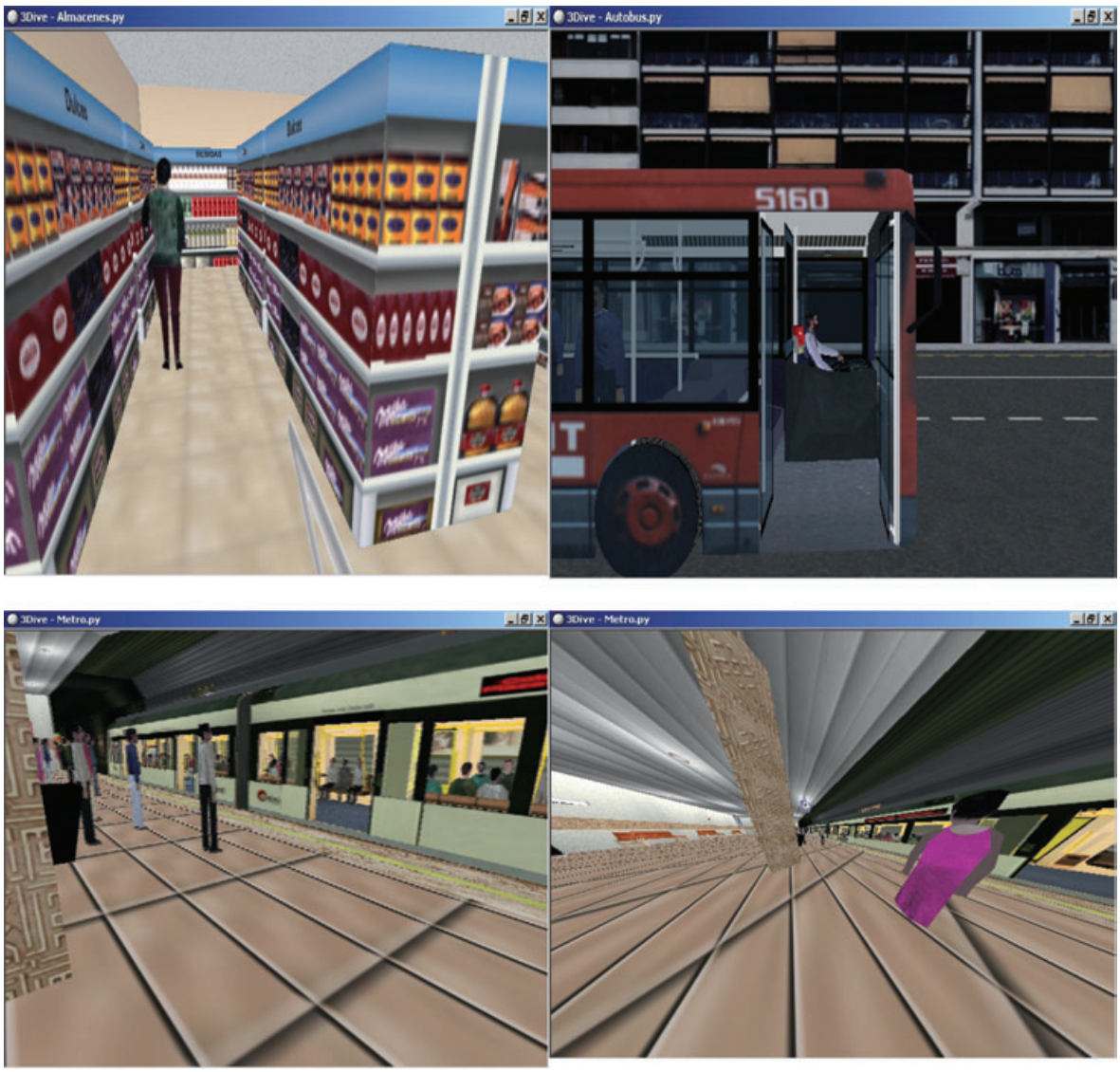


Figure 1. Screen shots of the virtual reality scenarios: a narrow corridor at the supermarket of a mall, being in line to pay at the mall, taking the bus, taking the underground train and tunnel vision effect at the underground train station

shopping mall or the elevator suddenly stopped between two floors etc.). This possibility increases the likelihood of obtaining significant exposure hierarchies for each patient, and allows the progressive and controlled exposure to the feared situations, important issues to be considered in exposure therapy. Also, each action in the VR world can be repeated as long as needed for each patient. For more information about our VR programme, see Botella et al. (2004).

## RESULTS

### *Pre-Treatment Comparisons*

No differences between the three groups were found at pre-treatment in any of the demographic and clinical variables. As for the independent assessment, there was a 100% agreement between the assessors and the independent assessors regarding the diagnosis of the participants.



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Table 1. Mean and standard deviation (SD) of the outcome measures at pre-treatment, post treatment and 12 month follow-up

| Measure | | IVE $n = 12$ | VRE $n = 12$ | WL $n = 13$ |
|---|---|---|---|---|
| | | Mean (SD) | Mean (SD) | Mean (SD) |
| Fear related with main target behaviour | Pre-test | 7.92 (2.57) | 8.83 (2.08) | 9.23 (1.42) |
| | Post test | 1.83 (2.25) | 1.33 (1.67) | 7.00 (3.58) |
| | Follow-up | 1.17 (1.64) | 0.75 (1.29) | |
| Avoidance related with main target behaviour | Pre-test | 8.55 (2.89) | 8.25 (2.53) | 9.00 (1.96) |
| | Post test | 2.08 (3.00) | 1.17 (1.85) | 6.31 (3.95) |
| | Follow-up | 0.92 (1.51) | 0.67 (1.07) | |
| Belief related with main target behaviour | Pre-test | 8.42 (1.93) | 8.17 (2.04) | 8.92 (1.75) |
| | Post test | 2.00 (2.37) | 1.42 (1.68) | 6.39 (3.18) |
| | Follow-up | 1.17 (1.40) | 0.75 (1.06) | |
| Anxiety Sensitivity Index | Pre-test | 31.33 (11.87) | 34.17 (15.89) | 33.08 (10.31) |
| | Post test | 10.67 (4.54) | 14.75 (5.86) | 31.92 (10.24) |
| | Follow-up | 16.42 (7.42) | 14.25 (10.46) | |
| Panic Disorder Severity Scale | Pre-test | 1.75 (0.85) | 2.04 (0.66) | 1.90 (0.53) |
| | Post test | 0.88 (0.59) | 0.77 (0.61) | 1.81 (0.53) |
| | Follow-up | 0.42 (0.54) | 0.49 (0.41) | |
| Fear Questionnaire-agoraphobia | Pre-test | 14.58 (11.80) | 16.27 (14.19) | 20.54 (13.41) |
| | Post test | 4.25 (6.35) | 6.82 (7.61) | 20.23 (12.80) |
| | Follow-up | 4.42 (5.47) | 3.73 (5.48) | |
| Beck Depression Inventory | Pre-test | 14.25 (11.88) | 14.83 (10.23) | 13.00 (11.49) |
| | Post test | 7.92 (5.84) | 5.50 (6.36) | 12.23 (8.84) |
| | Follow-up | 6.33 (4.31) | 4.91 (4.17) | |
| Maladjustment Scale-global | Pre-test | 3.64 (2.01) | 2.92 (1.31) | 3.25 (0.75) |
| | Post test | 1.55 (1.13) | 1.00 (0.95) | 2.58 (1.24) |
| | Follow-up | 0.45 (0.68) | 0.67 (1.07) | |
| Clinician Global Impression | Pre-test | 4.92 (1.38) | 4.92 (1.88) | 5.25 (2.05) |
| | Post test | 1.83 (1.27) | 1.92 (1.51) | 5.00 (2.17) |
| | Follow-up | 1.17 (0.39) | 1.33 (0.89) | |

VRE = virtual reality exposure. IVE = *in vivo* exposure. WL = waiting list.

### *Pre-Post Comparisons between the Three Experimental Conditions*

In Table 1, we display the mean and SDs of the different conditions for each outcome measures at pre-treatment, post treatment and 12 month follow-up, and in Table 2, we offer the effect size and power of the pre-post comparisons. Repeated measures analyses of variance (ANOVAs) revealed that time effects were significant for all measures: fear, $F(1, 34) = 134.302$, $p < 0.0001$; avoidance, $F(1, 34) = 98.51$, $p < 0.0001$; belief in catastrophic thought, $F(1, 34) = 121.05$, $p < 0.0001$; ASI, $F(1, 34) = 85.83$, $p < 0.0001$; PDSS, $F(1, 34) = 68.21$, $p < 0.0001$; FQ-agoraphobia, $F(1, 33) = 24.54$, $p < 0.0001$; BDI, $F(1, 34) = 18.65$, $p < 0.001$; MS global impairment, $F(1, 33) = 45.99$, $p < 0.0001$; and CGI, $F(1, 33) = 117.23$, $p < 0.0001$. Condition × time interactions were also significant for all measures: fear, $F(2, 34) = 11.28$, $p < 0.0001$; avoidance, $F(2, 34) = 6.49$, $p < 0.002$; belief in catastrophic thought, $F(2, 34) = 8.29$, $p < 0.001$; ASI, $F(2, 34) = 18.55$, $p < 0.0001$; PDSS, $F(2, 34) = 15.16$, $p < 0.0001$; FQ-agoraphobia, $F(2, 33) = 5.88$, $p < 0.01$; BDI, $F(2, 34) = 3.99$, $p < 0.05$; MS global impairment, $F(2, 33) = 3.79$, $p < 0.05$; and CGI, $F(2, 33) = 22.793$, $p < 0.0001$. Pairwise comparisons revealed that VRE and IVE conditions did not differ in any outcome variable, and that subjects in the active treatments improved significantly more than subjects in the WL condition in all the outcome measures.

### *Follow-Up Comparisons for the Two Treatment Conditions*

ANOVAs from post test to follow-up between IVE and VRE revealed a time effect for four of the outcome variables: belief in catastrophic thought, $F(1, 22) = 4.48$, $p < 0.05$ ($\eta p^2 = 0.42$, power = 0.968);



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Table 2. Effect size and power for all analysed measures in the pre-post comparisons

| Variable | Pre-post | | | |
|---|---|---|---|---|
| | Time | | Interaction | |
| | Partial Eta squared ($\eta p^2$) | Power | Partial Eta squared ($\eta p^2$) | Power |
| Fear related with main target behaviour | 0.798 | 1.000 | 0.399 | 0.987 |
| Avoidance related with main target behaviour | 0.743 | 1.000 | 0.276 | 0.880 |
| Belief related with main target behaviour | 0.781 | 1.000 | 0.328 | 0.946 |
| Anxiety Sensitivity Index | 0.716 | 1.000 | 0.522 | 1.000 |
| Panic Disorder Severity Scale | 0.667 | 1.000 | 0.471 | 0.998 |
| Fear Questionnaire-agoraphobia | 0.426 | 0.998 | 0.263 | 0.843 |
| Beck Depression Inventory | 0.354 | 0.987 | 0.190 | 0.675 |
| Maladjustment Scale-global | 0.582 | 1.000 | 0.187 | 0.651 |
| Clinician Global Impression | 0.780 | 1.000 | 0.580 | 1.000 |

Note: The partial Eta squared ($\eta p^2$) is one of the most commonly used measures of effect size in analysis of variance, and it can be interpreted as the proportion of variance in the dependent variable that is attributable to the effect (in this case, time and interaction effects).

Table 3. Expectations and satisfaction with the exposure component

| | Expectations Pre-test | | Satisfaction Post test | | Satisfaction Follow-up | |
|---|---|---|---|---|---|---|
| | IVE | VRE | IVE | VRE | IVE | VRE |
| Logic | 8.64 (1.63) | 9.00 (1.48) | 9.63 (0.50) | 9.08 (1.31) | 8.91 (1.14) | 8.75 (1.29) |
| Satisfaction | 8.28 (1.68) | 8.25 (2.77) | 9.64 (0.67) | 9.33 (0.88) | 8.37 (1.21) | 9.00 (0.85) |
| Recommendation to others | 8.45 (1.63) | 8.42 (1.78) | 9.73 (0.47) | 9.67 (0.49) | 9.19 (0.60) | 8.73 (1.10) |
| Utility for other problems | 7.36 (1.50) | 8.33 (1.50) | 8.45 (1.57) | 9.17 (0.94) | 9.09 (0.83) | 9.08 (0.79) |
| Utility for patient's problem | 8.27 (1.62) | 8.08 (2.02) | 8.55 (0.82) | 8.08 (1.44) | 8.82 (0.75) | 8.50 (1.09) |
| Aversiveness | 3.55 (2.84) | 3.08 (2.89) | 2.18 (1.47) | 2.00 (1.70) | 1.45 (1.29) | 1.75 (1.22) |

IVE = *in vivo* exposure. VRE = virtual reality exposure.

PDSS, $F(1, 22) = 15.94$, $p < 0.001$($\eta p^2 = 0.17$, power = 0.525); MS global impairment, $F(1, 21) = 9.56$, $p < 0.01$ ($\eta p^2 = 0.31$, power = 0.838); and CGI, $F(1, 22) = 6.14$, $p < 0.05$ ($\eta p^2 = 0.22$, power = 0.659). As it can be seen in Table 1, patients continued improving significantly in these measures from post test to 12 month follow-up. In the other measures, the outcomes achieved at post test were maintained at 12 month follow-up. With regard to the differences between the two treatment conditions, we did not find any significant difference in any of the outcome measures (no significant time × condition interaction). Both treatments were equally efficacious.

### *Acceptance of the Exposure Component*

Participants evaluated both VRE and IVE very positively (see Table 3). There were no significant statistical differences between the groups in any of the items of the expectation and satisfaction questionnaire at pre-test, post test or follow-up. VRE obtained the same evaluation as IVE.

### *Free of Panic Status*

On the other hand, if we consider being free of panic, or present a reduction of 50% in panic frequency (Clum, 1989) at post treatment as a criterion of clinical improvement, 100% of subjects in IVE, 90.9% in VRE and 28.57% in WL groups met these criteria at the end of the treatment. At follow-up, 90% in IVE and 91.6% in VRE met the criteria of panic-free status.

## DISCUSSION

This study showed that VRE is an efficacious component in the treatment of PDA. The results achieved by a programme including VRE are



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similar to the results achieved by a programme including the gold standard exposure for this disorder—IVE. VRE was one of the components of a multicomponent programme with other active ingredients like cognitive therapy. On the other hand, most of the treatment sessions (six out of nine) were devoted to VRE, this component was the main ingredient of our VR treatment programme.

One of the limitations of our study is the small sample size that cannot be sufficient to truly test the differential effectiveness between IVE and VRE. However, the power achieved in our statistical analysis supports our findings. In any case, to confirm the validity of our results, we compared our findings with the results achieved by other controlled studies testing the efficacy of CBT programmes including exposure for PDA. The scores of our sample at pre-treatment in the measures related with PDA fell inside the range of pathology. Using a benchmarking strategy (McFall, 1996) to compare our results with other studies, the percentage of patients in our VRE group meeting criteria of recovery (scoring normal range of functioning at post treatment and follow-up) was similar to the ones achieved for other controlled studies testing the efficacy of well-established CBT programmes (Barlow, Craske, Cerny, & Klosko, 1989), and the efficacy of different applications of these programmes to maximize cost-benefit issues, like group CBT (Telch et al., 1993), and CBT for patients from community mental health centres (Garcia-Palacios et al., 2002; Wade, Treat, & Stuart 1998). Table 4 offers such comparisons regarding three important features of PDA: panic frequency, anxiety sensitivity and agoraphobic avoidance. The outcomes achieved by our CBT programme including VRE were similar to the outcomes achieved by other efficacy studies.

At the end of the treatment, significant differences were found in important measures of panic and agoraphobia in the two treatment conditions as compared to a WL. At 12 month follow-up, the outcomes achieved were maintained. The contribution of this work is that VRE can be efficacious at short and long term not only in the treatment of specific phobias, but also in the treatment of a more complex disorder, PDA.

We were very careful in screening possible side effects in the virtual condition (e.g., dizziness, unsteady feelings, nausea etc.), asking the patients and making sure that these symptoms disappeared before the patient left the clinic, or making sure that the patient did not get involve in any activity

Table 4. Percentage of patients situated within the range of normal functioning at post treatment

| Variable | Criterion of recovery | Present study VRE | | Present study IVE | | Barlow, Craske, Cerny, & Klosko, 1989 | Telch et al., 1993 | Wade, Treat, & Stuart, 1998 | García-Palacios et al. (2002) |
|---|---|---|---|---|---|---|---|---|---|
| | | Post | FU | Post | FU | Post | Post | Post | Post |
| PAs | Panic = 0 | 90.9 | 91.6 | 100 | 90.0 | 84.6 | 85.3 | 87.2 | 90.9 |
| Anxiety sensitivity | ASI < 27 | 91.6 | 91.6 | 91.6 | 83.3 | – | 97.1 | – | – |
| Avoidance | FQ-Ag < 12 | 75.0 | 75.0 | 83.3 | 68.5 | – | 85.3 | 67.6 | 60.9 |

Note: Recovery criteria are based on well-accepted norms reported in the literature (Wade et al., 1998; Kendall & Grove, 1988). The criteria used were (1) frequency of zero PAs in the past week, (2) score below 27 on the ASI, (3) score below 12 on the Agoraphobia Scale of the FQ.
ASI = Anxiety Sensitivity Index. FQ-Ag = Fear Questionnaire-Agoraphobia Subscale. VRE = virtual reality exposure. IVE = *in vivo* exposure. Post = post treatment. FU = follow-up. PA = panic attack. FQ = Fear Questionnaire.



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that could be influenced by these symptoms. Only one of the patients showed some cybersickness symptoms in the first VR session, but these disappeared in the following sessions.

The positive opinion that participants had of exposure, both *in vivo* and virtual, was notable. In both conditions, the participants indicated that the exposure component received was logical for them; they experienced high satisfaction with the treatment; they would recommend it to a friend; it was useful for overcoming their problem, and finally, they thought it could be useful for other psychological conditions.

With the aim of isolating the effect of VRE, the participants were not given self-exposure instructions between sessions in any of the treatment conditions. This could be a limitation of our study, given that it may have threatened the efficacy of IVE that usually is applied with self-exposure instructions. However, both the VRE and the IVE groups achieved high percentages of improvement regarding several criteria (improvement rated by the patient, clinical judgement and percentage of panic free at post treatment). On the other hand, the scores in the main panic and agoraphobia measures at post treatment in both treatment conditions (PDSS, ASI and FQ-Ag) fell outside the range of pathology (i.e., the mean achieved at post treatment are below the mean of a clinical population). Conversely, the scores of the WL group at post treatment fell within the range of pathology. Besides, the treatment achievements were maintained at 12 month follow-up. These results offer support for the efficacy of our treatment programmes. However, we think that between sessions, exposure is useful. We have developed a compact disc that the patients can take home in order to reproduce the virtual scenarios to conduct the VRE tasks previously practiced in the consultation room (Alcañiz et al., 2003), and we are currently testing its efficacy in pilot studies.

In summary, our findings regarding the efficacy of VRE in the treatment of PDA are promising. Despite the fact that our study overcomes some of the methodological limitations that other works testing VR for PDA presented (i.e., Vincelli et al., 2003), we will exercise caution in our statements regarding the efficacy of VR, given that our study has some limitations, as the small sample size, the absence of behavioural measures of outcomes (despite our confirmation that the generalization of outcomes to real situation was a fact at the post-test and follow-up assessments in all cases), the lack of information about the amount of interoceptive exposure that each group received and the absence of a comparison of the subjective levels of distress during the IVE versus the VRE that confirmed that both treatment conditions provoked the same levels of anxiety.

Most of the work in this field still remains. It will be necessary to replicate these findings in larger samples, validate the virtual interoceptive exposure component, and evaluate the efficacy and effectiveness of the VR self-exposure programme at home. It is also necessary to include in the recent theoretical framework for VR anxiety research the results about the psychological variables that play a role in the reality judgement regarding virtual environments and that facilitate the activation of emotions in the virtual world (Baños et al., 2000). That way, we will have more knowledge about the mechanisms of action of VR, and we will be able to specify the parameters to maximize the efficacy of this new tool and make more reliable predictions.

We would like to point out that VRE is not proposed as a substitute for IVE, but is a new way of applying a well-established technique. For instance, VRE may be applied in those cases where the patient is too afraid of confronting the real situations. Also, VR can be a good alternative in mental health centres where it would be difficult to conduct IVE tasks, e.g., public mental health units where the number of patients is so high that it is difficult for the clinicians to programme IVE tasks with the patients. Interoceptive avoidance is an important feature of PDA (Sandin, 2005). Our VR programme allows conducting interoceptive and situational exposure simultaneously without leaving the consultation room with the same efficacy (at short and long-term) than IVE and interoceptive exposure conducted separately.

Finally, we would like to highlight that the main contribution of this work is to present long-term efficacy data (1 year follow-up) of VRE for PDA. Most of the studies testing VRE included comparisons from pre-treatment to post treatment in the field of specific phobias. There are a few studies with 1 year follow-up data (i.e., Rothbaum et al., 2002; Rothbaum et al., 2006). This is the first work presenting 1 year follow-up data of VRE for the treatment of a more complex anxiety disorder, PDA.

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