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The effects of a treatment based on the use of virtual reality exposure and cognitive-behavioral therapy applied to patients with agoraphobia[1]

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ABSTRACT. Exposure to virtual reality phobic environments was used with patients with chronic agoraphobia. The exposure to virtual stimuli has been verified as a useful procedure in treating phobic disorders. However, there are some specific problems with agoraphobia (determining phobic stimuli, avatars, etc.). The aim of this experimental study is to test a combined treatment, virtual reality exposure and cognitive-behavioral treatment (VRET), compared with a traditional cognitive-behavioral approach (CBT), in reducing agoraphobia symptoms. Two experimental groups were used. 15 patients with chronic agoraphobia received a VRET procedure (3D), and 13 received CBT. Both groups had 11 treatment sessions. The post-treatment measurements included a brief behavioral avoidance test (BAT). Results showed a significant improvement in agoraphobia symptoms (cognition, body sensation, level of anxiety, depression) in both groups. In general, this improvement remained three months later. Also, the BAT procedure indicated the ability of most patients to deal with a phobic environment. Additionally, the VRET

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group showed a slight amelioration of symptoms compared with the CBT group. These data are discussed in terms of the specific difficulties of VRET with agoraphobia, and the viability of our seven virtual environments to generate an acceptable exposure to phobic stimuli.

KEY WORDS. Virtual reality. Cognitive-behavioral treatment. Agoraphobia. Experimental study.

RESUMEN. La exposición a estímulos virtuales se ha verificado como un procedimiento útil en el tratamiento de los trastornos fóbicos. Sin embargo, existe una serie de problemas en la aplicación a la agorafobia (estímulos a utilizar, presencia de avatares, etc.). El propósito de este estudio experimental consiste en comparar la eficacia de un tratamiento combinado, exposición a la realidad virtual y tratamiento cognitivo conductual (VRET), con un acercamiento tradicional cognitivo-conductual (CBT). Quince pacientes con agorafobia crónica recibieron un tratamiento VRET en 3D y 13 pacientes recibieron un tratamiento CBT. Los dos grupos recibieron 11 sesiones. Las medidas postratamiento incluyeron un breve test de evitación conductual (BAT). Los resultados mostraron una significativa mejoría en los síntomas de la agorafobia (cogniciones, sensaciones corporales, nivel de ansiedad y depresión) para los dos grupos que, en general, permanecieron en un seguimiento a tres meses. Los BAT mostraron la capacidad de los pacientes para exponerse a los estímulos fóbicos. Adicionalmente, el grupo VRET mostró mayores mejorías, aunque ligeras, en comparación con el grupo CBT. Estos resultados se discuten en relación con las dificultades del VRET para la agorafobia y en relación con la viabilidad de los siete ambientes fóbicos virtuales para generar una exposición aceptable a los estímulos fóbicos.

PALABRAS CLAVE. Realidad virtual. Tratamiento cognitivo-conductual. Agorafobia. Estudio experimental.

Agoraphobia (with or without panic) has been described as the most complex phobia, the one most difficult to treat and the phobia that produces the highest level of incapacitation in human beings (Mathews, Gelder, and Jonhston, 1981). This incapacitation determines the lifestyle of the patients, affecting their entire daily functioning. Epidemiological studies have shown that the pervasive nature of this problem, together with its negative evolution, make agoraphobia a chronic disorder, if a patient does not receive suitable treatment (ESEMeD, 2004; World Health Organization, 2004). Thus, very frequently, agoraphobia patients require medication. Agoraphobics cope with phobic stimuli in several ways. These strategies can be summarized in four behavioral patterns: avoidance behaviors, escape behaviors; interoceptive avoidance (avoidance of situations that provoke physiological symptoms similar to panic symptoms); and partial coping behaviors (Baker, Patterson, and Barlow, 2002; Barlow and Craske, 1994; Otto, Safren, and Pollack, 2004).

Partial coping behaviors seem to be a particularly good predictor of the negative evolution of agoraphobia (Peñate, Pitti, Bethencourt, and Gracia, 2006; Pitti and Peñate,

2003, Pitti, Peñate, and Bethencourt, 2006). These strategies allow patients, under certain conditions, to cope with a phobic situation. They are frequently ritualistic behaviors, including superstitions, the presence of 'safety' people (family, sanitary staff, etc.), and even the use of certain substances or medicines. These strategies are learned, and tend to become more pervasive as, although they allow the person to confront the phobic environments, these behavior patterns become the only conditions under which the person with agoraphobia is able to deal with the phobic stimuli.

Recently, there has been a rapid growth in the use of new technologies in psychological treatment. The idea of using virtual reality (VR) technology for the treatment of psychological disorders was first developed by the Human-Computer Interaction Group of Clark University in Atlanta (North and North, 1994; North, North, and Coble, 1996). They coined the term Virtual Reality Exposure Therapy (VRET), and used this therapy with a patient with fear of flying, in a single-case design. They obtained significant clinical results, diminishing phobic reactions. Since then, the use of this technology has been applied to a variety of problems, such as panic disorder, depression, or eating disorders (Wiederhold and Wiederhold, 2004). Nevertheless, the greatest volume of research has been carried out into treatment of different phobias: the environments and stimuli constructed by virtual reality technology have become a useful procedure to expose patients to phobic stimuli similar to real situations.

The bases for the use of VR in the treatment of phobias are similar to those of traditional psychological therapies founded on the model of emotional processing of fear (Foa and Kozak, 1986). These psychological treatments have the following elements in common: control of feared stimuli, exposure to these stimuli, and coping with them. These common elements are the central mechanisms of the therapeutic change (Baker *et al*., 2002). The treatment goal, according to this approach, consists of teaching the person to reprocess the information derived from phobic stimuli, in an adaptive way. In that sense, treatment needs to replicate the environmental contingencies that evoke emotional non-adaptive responses (Salas-Auvert and Felgoise, 2003). Thus, studies about empirically supported therapies for phobias have identified exposure-based treatment and cognitive-behavioral therapy (where exposure is a central element) as efficient therapies (Butler, Chapman, Form, and Beck, 2006; Chambless *et al*., 1996, 1998; Gros and Antony, 2006). However, there is a paradoxical situation: the therapy phase, where patients must cope with real phobic stimuli (*in vivo* exposure), poses a great therapeutic limitation (Botella *et al.*, 2002). When patients with phobias are exposed to objects, places or situations, they face difficulties related with levels of fear, time, emotional distress, *etc.* Thus, patients may refuse to participate or to continue in the therapy phase. These limitations have stimulated the development of new, alternative methods of *in vivo* exposure (*v.g*., Méndez, Orgilés, and Espada, 2004). In this sense, the phobic environments designed by virtual reality techniques are a useful tool for exposing patients to phobic stimuli similar to those present in real environments.

The first studies using VRET with phobic disorders were single-case designs (Botella *et al*., 1998; Klein, 2000; North, and Coble. 1998; Wiederhold, Gevirtz, and Wiederhold, 1998). These studies reported positive results with both experimental and clinical

improvement, which led to new studies being designed. These included experimental group designs, and increased the diversity of the phobic stimuli treated. VRET has been applied to claustrophobia (Botella, Baños, Villa, Perpiñá and García-Palacios, 2000), fear of flying (Maltby, Kirsch, Mayers, and Allen, 2002; Mülberger, Herrmann, Wiedemann, Elgring, and Pauli, 2001; Mülberger, Wiedemann, and Pauli, 2003), fear of snakes (García-Palacios, Hoffman, Carlin, Furness III, and Botella, 2002), social phobia (Anderson, Zimand, Hodges, and Rothbaum, 2005; Harris, Kemmerling, and North, 2002; North *et al.,* 1998), and agoraphobia (Botella *et al.,* 2004; Choi *et al.,* 2005; North *et al.,* 1996; Vincelli *et al.,* 2003). The conclusions of these reports indicated that the virtual stimuli used to expose patients with phobias were as efficient as traditional cognitive-behavioral treatments (Glantz, Rizzo, and Graap, 2003; Krijin, Emmelkamp, Olafsson, and Biemond, 2004; Pull, 2005; Riva, 2003).

In spite of this, VRET is still at an early stage of development, and several questions remain unsolved or require new experimental designs, such as: the quality of virtual reality environments (especially the sensation of presence and the familiarity of stimuli), the type of disorder, the type of sample (students, patients, *etc*.), the number and length of sessions, combined use with other procedures, type of dependent variables (particularly measures related with real coping such us the Behavioral Avoidance Tests, BAT), and follow-up procedures.

If we analyze the use of VRET in agoraphobia, the results are unclear or inconsistent. Thus, the initial work of North *et al.* (1996) reported an efficient application of VRET, but they did not provide either BAT or follow-up data. The worst outcomes were reported by Jang, Ku, Shin, Choi, and Kim (2000), who failed to provide a convincing sense of presence in the virtual environment. However, recent studies have provided better results. Studies such us that reported by Botella *et al.* (2004), Choi *et al*. (2005) or Vincelli *et al.* (2003) have shown the efficiency of VRET with patients with agoraphobia, including BAT and Follow-up, especially when VR is combined with cognitive-behavioral procedures. Moreover, these studies indicate that VRET can have additional advantages compared with traditional psychological treatment: there are more guaranties of exposure (due to its use in a controlled situation), more possibilities of interoceptive exposure to panic physiological signals, it can be an intermediate step, especially for patients who refuse to expose to real environments, and it has formal advantages, because VRET needs less time of application (Botella *et al.,* 2004; Vincelli *et al.,* 2003). However, some difficulties specific to agoraphobia disorder still remain unsolved (Botella *et al.,* 2004; Glantz *et al.,* 2003; Vincelli *et al.,* 2003): the presence of avatars in virtual environments is relevant in agoraphobia. As occurs in social phobia, the interaction with human beings in different contexts produces an important part of anxiety responses. Thus, the presence of avatars is necessary to create more realistic environments. Another problem is that in agoraphobia there is not one precise stimulus that provokes the anxiety crisis (as in specific phobias), but several environments, which are not always the same from one patient to other. Furthermore, exposure is a complex task for patients with severe agoraphobia (when patients have difficulties in just leaving their homes).

This experimental study (Montero and León, 2007) aims to provide information about some of these problems. The objectives are to test the efficacy of a combined therapeutic program, VRET and cognitive-behavioral therapy, compared with the efficacy of a traditional cognitive-behavioral approach. These programs were applied to a sample of patients with chronic agoraphobia (two or more years under psycho-active drug treatment). VRET was carried out with seven virtual environments that represent possible phobic stimuli for agoraphobia patients (a square and a street, an airport building and plane, a bank office, an elevator and underground car park, a beach, a highway, and a cableway). Some of the environments can be modified according to the number of persons in them (25 persons maximum), time of day, and climate. A 3D presentation will be used to create a better sense of presence. The report was edited according to the norms established by Ramos-Álvarez, Valdés-Conroy, and Catena (2006).

Method

Participants

Thirty seven patients with a diagnosis of agoraphobia (with/without panic disorder) participated in the study. They were sent to the Psychiatry Service of the University Hospital of the Canary Islands (Hospital Universitario de Canarias, HUC) by mental health community units. There were 27 women and 10 men. Mean age was 38 years (range: 17 to 60). The average time of evolution of agoraphobia was 10 years (range: 2 to 41). These participants were assigned to two experimental groups: cognitive-behavioral treatment (CBT) and combined treatment of cognitive-behavioral and VR treatment (VRET). The assignment took into account both gender and time of evolution of the disorder. The sample was distributed as shown in Table 1.

TABLE 1. Distribution of agoraphobia patients into two groups of treatment: cognitive-behavioral treatment (CBT) and combined treatment of cognitive-behavioral and RV treatment (VRET), according to gender, age and time of disorder evolution.

Treatment group	*N*	*Gender*		*Age*	*Years of disorder*
		Male	*Female*	*Mean / range*	*Evolution mean / range*
CBT	16	4	12	38.50 / 27-58	7.50 / 2-41
VRET	21	6	15	35 / 17-60	9 / 2-39

All treatment sessions were carried out by an experienced clinical psychotherapist (trained in cognitive-behavioral therapies), and two helpers (graduate psychologists).

Materials and apparatus

A variety of different instruments were used to assess and verify the diagnosis of agoraphobia, to determine the anxiety level of the virtual environments for each patient, and to assess therapeutic progress. Similarly, seven different virtual environments were developed. These environments represented seven possible phobic stimuli for patients with agoraphobia.

To verify the diagnosis of agoraphobia in the patients from the HUC psychiatry service, two instruments were administered:

- The *Composite International Diagnostic Interview (CIDI,* 2.1). CIDI-2.1 was elaborated in 1997 by the World Health Organization, and this interview has remained with similar contents, with slight changes (Kessler and Üstün, 2004). It is a structured interview for major mental disorders, according to CIE-10 criteria (World Health Organization, 1992). Mental disorders are estimated both for lifetime and 12-month prevalence. We adapted CIDI only to those questions and criteria related with agoraphobia
- *Cuestionario de Agorafobia* (Agoraphobia Questionnaire) (Echeburúa and Corral, 1995). This questionnaire measures a general level of agoraphobia, with 69 items, Likert scale. It is divided in two parts: the first part examines manifest behavior, cognitions, and psycho-physiology reactions, related to agoraphobic situations (both, alone or with other people). The second part examines the response variations as a function of factors that increase and decrease agoraphobic behavioral patterns. The authors describe appropriate psychometric properties for agoraphobia severity and for the selection of target-behaviors in agoraphobia disorders.

To determine the level of anxiety elicited by the virtual environments, patients were asked to rate each environment according to their ability to cope with it, both alone or accompanied. A seven-point scale was used 0 (*no problem to cope with*) 7 (*unable to cope with*). At the same time, two physiological measures were taken to verify the subjective anxiety reported for each environment: cardiac pulse and skin conductance level. Both measures were assessed by a biofeedback system, PowerLab 16SP model (AD Instruments).

To assess treatment efficacy, the following instruments were used:

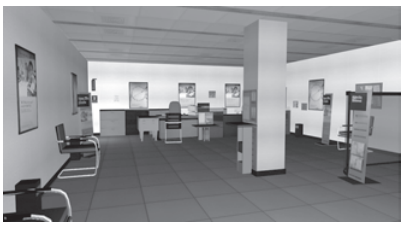
- Agoraphobic Cognition Questionnaire (ACQ) (Chambless, Caputo, Bright, and Gallagher, 1984). This instrument was developed to assess 'fear to fear'. Specifically, the ACQ assesses catastrophic thoughts about both the physical and social consequences of panic attack. It contains 14 items. Response choice ranged from 1 *(I never think this)* to 5 *(always).* The Spanish translation of this scale was used (Comeche, Diaz, and Vallejo, 1995).
- Body Sensation Questionnaire (BSQ) (Chambless *et al*., 1984). This is a 17-item questionnaire, related to physical and physiological body responses. Respondents are asked about the level of fear that these sensations provoke in them, on a five-point scale: 1 (*not worried*) to 5 (*extremely*). Again, the Spanish translation of this scale was used Comeche *et al.,* 1995).

– Beck Anxiety Inventory (Beck and Steer, 1990). This is a self-administered inventory to assess the general level of anxiety. The 21 items reflect physiological reactions, somatic complaints, and cognitions about the anxiety crisis. The scale must be responded to according to occurrence in the last week, on a four-point scale (from no to very).
– Beck Depression Inventory-II (BDI-II, Beck, Steer, and Brown, 1996). This is the second version of a 21-item inventory developed to assess depression severity. The current version is adapted to the DSM-IV criteria for depression (American Psychiatric Association, 1994), and allows appraisal of four categories of depression (no, mild, moderate, and severe).
– Subjective Unit of Anxiety (SUA). The environments were rated on a ten-point scale: 0 (*no anxiety*), and 10 (*maximum level of anxiety*). These measurements were taken at the end of all sessions.
– Behavioral Avoidance Test. Additionally, another measurement was taken: at the end of the program, patients were encouraged to cope with a real scenario similar to the virtual environment entitled 'square and street'. Patients were accompanied by a therapist helper to this real street, and were asked to walk there for ten minutes (maximum). They were informed that if they felt anxious they could return to where the helper was waiting (they could also refuse to carry out the task). A time measurement (minutes in the street) was taken.

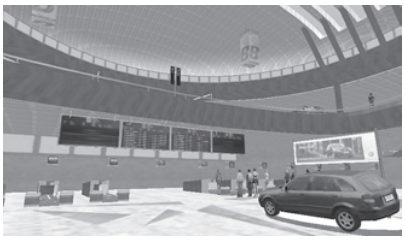
Virtual environments. Seven virtual environments were developed to reflect seven possible phobic stimuli for agoraphobia patients: a square and street, an airport building and plane, a bank office, an elevator and underground car park, a beach, a highway, and a cableway. These environments are designed on OpenGL, and based on a Torque engine (Garage Games). In Figure 1 there is a picture of each environment.

FIGURE 1. Photographs of the seven virtual environments designed.

Square and street



Bank office



Airport building

Underground car park

Cableway

Highway

Beach

The Nvidia Quadro FX3000O was used as graphical support due to the need to move among large spaces and textures in a realistic way. A projection system formed by two video-projectors (F1Design with 3000 lumens and 1024 x 768 resolutions) were also used. These videos project a linearly polarized image for each eye on the same zone of the screen and the patient uses glasses with polarized filters to produce a 3D effect. The image is projected onto a special screen, with a surface of 2.5m x 2m. The screen and the rest of the components are installed in a dark room to produce the maximum sensation of presence.

The patient has a wireless joystick to move around the virtual environments. Likewise, there is a DTS 7.1 audio system installed with 7 loudspeakers and subwoofer, to generate 3D sound (surround). The systems are controlled by an Intel PIV computer.

Design

An experimental group design was used, with measures at three stages: pre-treatment, post-treatment, and 3 months follow-up. The experimental groups were composed of patients with agoraphobia. The independent variable was type of treatment. One group received cognitive-behavioral treatment (CBT) and the second group received a combined treatment of cognitive-behavioral treatment and VR exposure (VRET). Both treatment programs had 11 sessions, with duration of 35-45 minutes per session.Sessions were conducted individually by the same therapist at the rate of one session per week. The outline of the programs is summarized in Table 2.

TABLE 2. Development of the session-by-session contents of both CBT treatment group and VRET treatment group.

	Sessions										
	1º	2º	3º	4º	5º	6º	7º	8º	9º	10º	11º
CBT	PE	AMT	AMT	IVE	IVE	IVE	IVE	IVE	IVE	IVE	IVE
VRET	PE	AMT	AMT	IVE	VRE	IVE	VRE	IVE	VRE	IVE	VRE

Notes. PE: psycho-education about agoraphobia. AMT: anxiety management training. IVE: encouragement of *in vivo* exposure with AMT. VRE: virtual reality exposure.

The first three sessions were identical for both the CBT group and the VRET group.

Session 1 was a psycho-educational session about agoraphobia. The therapist explained the concept of agoraphobia; its origins and determinants; its cognitive, motor and physiological symptoms and its development and course. Finally, she discussed the particular nature of agoraphobia for each patient. In sessions 2 and 3, patients were instructed in an anxiety management program, similar to that of Craske, Barlow, and Meadows (2000): identification of phobic situations, management of negative activation (training in controlled breathing[3] and relaxation), and cognitive restructuring and self-instructions in the management of thoughts and irrational ideas (especially catastrophic thoughts). Interoceptive exposure was also trained.

The remaining 8 sessions were specific to each treatment group: IVE was used in the CBT group. In these sessions, patients were encouraged to confront phobic environments, and to use AMT to cope with phobic stimuli. In the following sessions, patients discussed with the therapist about his/her weekly work in coping with phobic situations. For the VRET group there was a combination of both IVE sessions and VRE sessions. In the VRE sessions patients were exposed to the four virtual environments that had produced most anxiety in a previous test. The exposure took 15-20 minutes, combined with the use of AMT to cope with the anxiety situation. Strategies of partial coping style received special attention from the therapist.

As dependent variables, the following data were collected: cognitive and overt behaviors related with agoraphobia (AGF questionnaire), agoraphobic cognitions (ACQ), subjective body sensations (BSQ), general anxiety (BAI), general depression (BDI-II), SUA average, and BAT. Measurements were taken before treatment began (pre), immediately after the treatment finished (post), and at 3 months (follow-up). SUA-measurements were taken in each session. In the VRET group these measures corresponded to the virtual environments of the VRE sessions, or, for the IVE sessions, were

[3] Especially, we take into account data provided by Bornas *et al.* (2006).

related to *in-vivo* exposure in previous days (if this had taken place). In the CBT group these measures only corresponded to *in-vivo* exposure in previous days. BAT measures were collected at the end of the treatments.

Due to the fact that the patients with chronic agoraphobia were referred to the service with some pharmacological treatment (or self-medicated), all patients were matched in psycho-active drugs, by the administration of paroxetine, according to APA guide (2004). Pharmacological discontinuation was assessed by the psychiatry service from post-treatment until three months follow-up.

Procedure

An information campaign was carried out among the mental health units of the island of Tenerife. The campaign provided information about the existence of a special service in the Hospital Universitario de Canarias (HUC) for the treatment of agoraphobia. Psychiatrists and psychologists were asked to send anyone with chronic agoraphobia (at least two years of treatment) to this service.

As soon as a patient was referred to the service, assistants were instructed to administer the CIDI interview (agoraphobia contents) and the *Cuestionario de Agorafobia*. If the patient met the CIE-10 diagnostic criteria for agoraphobia, he/she was informed about the protocol to follow: progressive discontinuation of the current medication (if it was necessary), and administration of paroxetine. One month later the person would be included in one of the two groups of treatment (CBT and VRET). This assignment took into account both gender and years of evolution of agoraphobia.

If the person accepted, they signed the consent form, and the assistants began with the administration of pre-treatment measures. In addition, patients in the VRET group were trained in the use of the VR system and, once they controlled the system, they were asked to rate (0 to 7, alone or accompanied by someone) the anxiety level of each one of the seven VR environments. In the CBT group, patients were asked to identify and to describe their most phobic situations.

Once the therapy sessions had started, if the therapist detected symptoms of psychosis, dementia, alcoholism or severe personality disorders, these patients were excluded.

Results

Eight patients dropped out for different motives (no motivation, non-agreement with therapy procedure, expectancies, etc.) or due to the therapist's decision, according to the criteria described above. These eight patients correspond to four males and four females; two had an agoraphobia evolution time (chronic level) of between 2-5 years, three between 6-10 years, and three more than 10 years. By treatment, three correspond to CBT, and five to VRET. At follow-up, one VRET patient refused to come. In this sense, the final sample was composed of 13 patients in the CBT group and 15 patients in the VRET group.

None of the χ^2 associated to those variables was statistically significant, according to drop out or not: for gender, $\chi^2_{(1)} = 2.53$; chronic level (the three levels mentioned), $\chi^2_{(2)} = .38$; and treatment, $\chi^2_{(1)} = .2$.

A preliminary t-test was carried out to contrast pre-treatment measures between both groups of treatment. No mean differences were found between CBT and VRET groups in the following measures:

- Cognitive and overt behaviors related with agoraphobia (AGF questionnaire). CBT: M = 90.07 *(SD* = 27.05); VRET: M = 103.86 (SD = 31.18); t_{26} = -1.24.
- Agoraphobic cognitions (ACQ). CBT: M = 36.48 (SD = 6.85); VRET: M = 35.02 (SD = 9.82); t_{26} = -.45.
- Body sensations (BSQ). CBT: M = 50.52 (SD = 11.42); VRET: M = 55.72 (SD = 15.21); t_{26} = -1.01
- General anxiety (BAI). CBT: M = 32.53 (SD = 8.86); VRET: M = 31.06 (SD = 16.43); t_{26} = -.29.
- General depression (BDI-II). CBT: M = 27.31 (SD = 10.66); VRET: M = 27.47 (SD = 10.34); t_{26} = -.04.

These results indicate that the two groups did not differ previous to the intervention.

A second group of statistical analyses was carried out to contrast, separately, pre-post and follow-up results. A t-test for dependent measures was used. Data are summarized in Table 3.

TABLE 3. Comparison of pre-post-follow-up scores in CBT group (n = 13).

Dependent variables	*Pre-treatment*	*Post-treatment*	*Follow-up*	*t*	
	M (SD)	*M (SD)*	*M (SD)*	Pre-post	Pre-follow-up
AGF	90.07 (27.05)	60.22 (16.09)	55.04 (32.27)	3.56**	4.06**
ACQ	36.48 (6.85)	24.73 (6.99)	30.88 (9.73)	4.40***	1.88
BSQ	50.52 (11.42)	36.35 (9.26)	45.08 (11.93)	4.58***	1.19
BAI	32.53 (8.86)	21.96 (12.11)	21.96 (11.39)	3.61**	2.93*
BDI-II	27.31 (10.66)	14.55 (10.27)	17.46 (10.09)	3.78**	2.59*

Notes. AGF: agoraphobia questionnaire. ACQ: agoraphobic cognitions questionnaire. BSQ: body sensations questionnaire. BAI: Beck Anxiety Inventory. BDI: Beck Depression Inventory.

*** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$

The results show significant effects for all measures in pre-post analysis. This indicates that CBT has improved the adjustment level in patients with agoraphobia in overt behaviors, cognitions, and somatic sensations. There was even an improvement in both the general anxiety and depression scores. However, at follow-up some of these gains were lost. Especially body sensations and agoraphobic cognitions, which return to initial levels. Nevertheless, the general measures (agoraphobia, anxiety, and depression levels) maintained a slight but significant improvement.

When we analyzed the same data for VRET, the results seem to be better, especially at follow-up. Table 4 summarizes these data.

TABLE 4. Comparison of pre-post-follow-up scores in VRET group *(n* = 15).

Dependent variables	*Pre-treatment*	*Post-treatment*	*Follow-up*	*t*	
	M (SD)	*M (SD)*	*M (SD)*	Pre-post	Pre-follow-up
AGF	103.12 (30.26)	63.86 (24.13)	63.37 (4.36)	3.67**	5.07***
ACQ	35.02 (9.82)	20.60 (4.51)	29.26 (2.56)	6.16***	2.25*
BSQ	55.72 (15.21)	36.80 (9.39)	42.62 (9.17)	3.95**	3.34**
BAI	31.06 (16.43)	14.60 (5.57)	20.97 (3.03)	4.06***	2.41*
BDI-II	27.47 (10.34)	12.41 (5.37)	19.01 (1.66)	5.20***	3.22**

Notes. AGF: agoraphobia questionnaire. ACQ: agoraphobic cognitions questionnaire. BSQ: body sensations questionnaire. BAI: Beck Anxiety Inventory. BDI: Beck Depression Inventory.
*** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$

As we can observe, the scores on all measures were lower, both at post-treatment and at follow-up. Now, the gains lost at three months are not as statistically powerful as to eliminate the improvements achieved. Another interesting point for us is the continuous decrease in standard deviations across the three time measures, which could be indicating that VRET obtains significant improvements for most of the patients.

Taking into account these results, a new t-test was carried out to compare the CBT group with the VRET group at post measures and at follow-up. But all comparisons yielded no significant differences in the improvements of the two groups, both at post-treatment and at follow-up. However, due to the size of the groups, the effect size (Cohen's d) of these comparisons was calculated (Table 5).

TABLE 5. Effect size (Cohen's d) for CBT group VRET group comparison at post-treatment and follow-up measures.

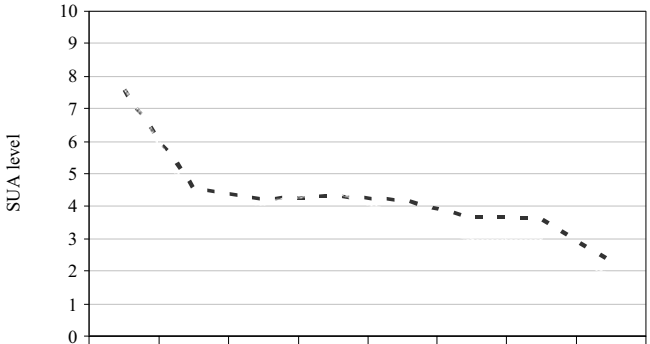
Dependent measures	*VRET-CBT*	
	Post-treatment	*Follow-up*
AGF	-.18	-.36
ACQ	.7	.23
BSQ	.05	.23
BAI	.78	.12
BDI-II	.26	.21

Notes. AGF: agoraphobia questionnaire; ACQ: agoraphobic cognitions questionnaire; BSQ: body sensations questionnaire; BAI: Beck Anxiety Inventory ; BDI: Beck Depression Inventory.
*** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$

The main effect sizes were at post-treatment, where agoraphobic cognition and general anxiety are close to a large effect. These effects were moderate at follow-up. In this sense, in general, the VRET group showed greater improvement than CBT group, except for the general agoraphobia score, where the CBT group had moderate but better gains.

Figure 2, the SUA levels per session, represents the evolution of average anxiety across the eight treatment sessions.

FIGURE 2. Graphical representation of Subjetive Units of Anxiety (SUA) evolution in eight specific treament sessions for both CBT group and VRET group.



	4	5	6	7	8	9	10	11
CBT	7.56	4.56	4.19	4.28	4.17	3.64	3.58	2.26
VRET	7.58	4.22	4.04	4.46	3.62	2.93	2.93	1.79

Sessions

There is a clear decline of SUA scores, session by session. Both treatment groups reduced their subjective appraisal of anxiety sensation when patients were exposed to VR environments or when they recall the anxiety experienced in *in vivo* exposure. There was an increase in anxiety in the first half of the treatment programs, but in subsequent sessions the SUA continued to diminish. The anxiety reported was similar in both groups, with a slight improvement in the VRET group (CBT begins with an average of 7.56 and finishes with an average of 2.26, 4.30 points of gain in a ten-point scale; instead, VRET begins with a score of 7.58 and finishes with a score of 1.79, a gain of 5.79 points).

Two final results refer to external validity criteria: the BAT test, and pharmacological discontinuation. As has been pointed out, the BAT test consisted in exposing agoraphobia patients to an average street, similar to that included in the virtual environment 'a square and a street'. Helpers asked patients to walk alone in this real environment for about 10 minutes (they could refuse to do this or could stop when they wished). If they acquiesced, the time in minutes was measured. T-test procedure failed to provide statistical significance (CBT = 6.23 (4.55), VRET = 8.53 (3.5), $t_{26} = -1.51$). But, if we examine the patients who spent ten minutes in contrast with the patients who refused to cope, results were the following: for the CBT group, 6 patients spent ten minutes (46.20%), 4 refused (30.8%), 2 patients spent 8 minutes and one patient spent 5 minutes. For VRET group, 12 patients spent ten minutes (80%), 2 refused (13.30%), and one patient spent 8 minutes (6.70%).

Pharmacological changes (decrease of dosage or discontinuation of paroxetine) was appraised by the psychiatry service from the end of treatment until three-months follow-up. Three patients (23.10%) of CBT treatment group had begun to discontinue the use of paroxetine, and in contrast, six VRET patients (40%) had begun to discontinue.

Discussion

The application of VR for treating different phobias is today something more than a promising psychotherapy tool. The empirical findings of the last fifteen years have consolidated VR as a useful exposure technique. Its efficiency is comparable with that of cognitive-behavioral treatments (Glantz *et al.,* 2003; Gros and Antony, 2006; Krijin *et al.,* 2004; Pull, 2005; Riva, 2003), and, when VR is combined with cognitive-behavioral treatments, its efficacy increases (Botella *et al.,* 2004; Choi *et al.,* 2005; Vincelli *et al.,* 2003). Nevertheless, there are some specific problems in the application of VRET, especially with agoraphobia. There is no unique stimulus that elicits anxiety levels, thus, there is a problem about which environments to design; and the presence or absence of avatars is an important element of anxiety crises. In that sense, virtual environments must include different phobic stimuli, and different avatars (open and closed spaces, streets and squares, people and cars, environments with and without people, etc.). These environments can provide appropriate feared stimuli for agoraphobia patients. There are, however, considerable advantages to the use of VRET; there are more guaranties of exposure with VRET, especially with chronic and severe agoraphobia (patients who stay at home most of the time); there are more possibilities of interoceptive exposure; and VRET requires less application time (compared with *in vivo* exposure). (Botella *et al.,* 2004; Glantz *et al.,* 2003; Vincelli *et al.,* 2002).

In this paper we have presented a study of the application of VRET with patients with chronic agoraphobia, using seven different environments and with different numbers of avatars. Preliminary results show the efficiency of both VRET and CBT treatment procedures. This efficiency was still maintained at 3-month follow-up. Efficacy was contrasted at statistical significance and clinical efficiency (BAT). When we compare the efficiency of VRET combined with CBT, in contrast with the use of CBT alone, results show similar or better outcomes for VRET. This is a relevant practical issue, because exposure is a difficult task in cases of severe agoraphobia, such as that of the patients in this study. VR can be an intermediate and useful step to clinical amelioration of anxiety symptoms, and to coping with feared environments.

However, there are some critical elements to be pointed out. The similar or better outcomes of VRET can be seen in all dependent measures except one: general agoraphobia score. In this variable the CBT group has obtained greater gains. This is apparently contradictory since the results from similar measures (agoraphobic cognitions, interoceptive sensations, BAT, etc.) have gone in the opposite direction. Ruling out measurement error, our explanation would refer to the higher initial levels of general agoraphobia in the VRET group. Although there was no significant difference at pre-period, the mean score of the VRET group is more than ten points higher than the CBT group, and this could have clinical implications. In any case, CBT still is a powerful strategy for agoraphobia disorder (*v.g.,* Espada, Van der Hofstadt, and Galván, 2007).

Another apparently contradictory result is the slight increase in SUA in the intermediate sessions (both in the CBT and VRET groups). These increases were clinically irrelevant, since the levels of anxiety decreased steadily in the following sessions. We do not have a plausible explanation for these intermediate SUA levels, but the therapist did notice that patients experienced an increase in anxiety levels to the phobic stimuli when they began to confront them. Thus, it is possible that although in the intermediate sessions patients were able to cope with feared environment, those initial situations could have involved an increase in subjective anxiety level.

The BAT measure used is another critical element. We used exposure to a single i*n vivo* environment (walking along a street). This was similar to one of the virtual environments ('a square and a street') and most of the patients managed to stay there for the ten minutes established, especially in the VRET group. These data could be interpreted as indicating a high level of clinical amelioration, but we must be cautious about this, because, although this environment is a typical phobic stimulus for many patients with agoraphobia, this is not the case for all patients. Besides, it was not possible to expose the patients to the most feared virtual environment, the cableway. On the other hand, the near presence of an assistant could have favored coping behaviors. Thus, although we do take into account the clinical relevance of this outcome, BAT measures for agoraphobia must also take into account the specific BATs for the specific feared environments in each case, and there must be more accurate BAT procedures.

Pharmacological discontinuation is another critical issue in clinical efficacy. In this question, our results are clearly modest: less than half the participants have begun to discontinue medication. But we must take into account that these participants were severe and chronic agoraphobia patients, with an extensive history of pharmacological treatment. It is possible that their treatments were modified during that history and conditioned responses associated to medication could have been established. Thus, discontinuation would suppose an enormous challenge in their lives. Any changes, therefore, would need more time to be apparent in terms of the effectiveness of the psychotherapy. Further follow-up will test this explanation. In any case, new studies with an experimental group with paroxetine, but without psychological treatment, would be able to detect the real pharmacological discontinuation level at three months of follow-up. Also, a group without psycho-active drugs would be useful to further clarify the role of the psychological treatment. There are, however, problems with this, due to the fact that most patients (if not all patients) with a diagnosis of chronic agoraphobia are medicated. Perhaps acute agoraphobia groups would be an alternative solution.

In summary, we have presented the results of the use of VR combined with cognitive - behavioral therapy in the treatment of chronic agoraphobia. The results show the statistical and clinical efficiency of this procedure, both in the post-treatment and in follow-up. These results are similar or better than those obtained with cognitive behavioral therapy alone. Besides, VRET supposes an important additional advantage for chronic agoraphobia patients due to their special initial difficulties with *in vivo* exposure. However, new developments are needed, such as the design of a number of virtual environments that gather all the possible phobic stimuli for agoraphobia; the development of more accurate BAT procedures, and the incorporation of new experimental groups such as pharmacological treatment alone and psychological treatment without medication.

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