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Using a Flexible Virtual Environment for Treating a Storm Phobia

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ABSTRACT

Most of the Virtual Environments (VE) currently available in the field of psychological treatments are designed to solve a specific problem (acrophobia, flying phobia, claustrophobia, etc.). Our research group has developed a versatile Virtual Reality (VR) system (an adaptive display) that could be useful for different problems. In previous studies, a VR application called "EMMA's world" was developed for the treatment of PTSD and pathological grief. The aim of the present work is to show the utility of this system for the treatment of a storm phobia. The patient was a 70 year-old woman, who was not familiar at all with computer technologies. As the patient was not able to confront even a virtual storm, the treatment was applied in two phases: *In vivo* exposure (exploding balloons), and exposure to VE simulating storms, rain, thunders and lightings. Results showed changes in the expected direction and were maintained at 6-month follow-up.

Keywords: *virtual reality exposure, adaptive display, psychological treatment, specific phobia.*

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1. Introduction

The first virtual reality (VR) application in Clinical Psychology was focused on the treatment of acrophobia. Rothbaum, Hodges, Kooper, Opdyke, Williford, & North (1995) published the first case study in which the patient overcame his fear of heights after being exposed to a virtual scenario which simulated acrophobic situations. Since then, numerous case studies with efficacy data about the use of VR for this or other specific phobias have been published: acrophobia (Choi, Jang, Ku, Shin, & Kim, 2001; North, North, & Coble, 1996); claustrophobia (Botella, Baños, Perpiña, Villa, Alcañiz, & Rey, 1998; Botella, Villa, Baños, Perpiñá, & García-Palacios, 1999); spiders phobia (Carlin, Hoffman, & Weghorst, 1997); flying phobia (Baños, Botella, Perpiñá, & Quero, 2001; Klein, 1999; North, North, & Coble, 1997; Rothbaum, Hodges, Watson, Kessler, & Opdyke, 1996; Wiederhold, Gervitz, & Wiederhold, 1998); driving phobia (Wald & Taylor, 2000), etc. Later controlled studies which demonstrate the efficacy of this new way of applying the exposure technique have been carried out: acrophobia (Emmelkamp, Bruynzeel, Drost, & Van der Mast, 2001; Emmelkamp, Krijn, Hulsbocsh, de Vries, Schummie & Van der Mast, 2002; Krijn, Emmelkamp, Olafsson & Biemond, 2004); claustrophobia (Botella, Baños, Villa, Perpiñá, & García-Palacios, 2000); spiders phobia (García-Palacios, Hoffman, Carlin, Furness, & Botella, 2002; Hoffman, García-Palacios, Carlin, & Botella, 2003); flying phobia (Botella, Osma, García-Palacios, Quero, & Baños, 2004; Maltby, Kirsch, Mayers, & Allen, 2002; Mühlberger, Wiedemann, & Pauli, 2003; Rothbaum, Hodges, Smith, Lee, & Price, 2000; Rothbaum, Hodges, Anderson, Price, & Smith, 2002; Wiederhold, 1999); driving phobia (Wald & Taylor, 2003; Walshe, Lewis, Kim, O'Sullivan, & Wiederhold, 2003). In short, in a decade the use of VR as a tool for the application of exposure in phobias has been notably developed and its use has been extended to other anxiety disorders and other psychological disorders (for a revision see: Anderson, Jacobs, & Rothbaum, 2004; Krijn et al., 2004; Pull, 2005; Rothbaum, 2006; Wierdehold & Wierderhold, 2004)

However, the point is that each research group has developed specific and different virtual environments to confront only one of these problems. A paradigmatic example in the matter would be the way in which the VR systems for the treatment of Post-traumatic Stress Disorder (PTSD) have been developed: the Vietnam VR world (Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001), the September 11th victims one (Difede & Hoffman, 2002), the Iraq war one (Rizzo et al, 2004), the one designed for motor vehicles victims (Walshe et al., 2003), and so on. However, this rationale can be problematic due to the high cost to apply these treatments in the daily clinical practice since many virtual environments are needed to treat diverse problems. Furthermore, it could be difficult for clinicians to use many of these systems since most of them are not compatible between them and most of the times they require different software and hardware. So far if a patient suffering from different disorders (for instance, panic disorder, PTSD and eating disorder with important body image problems) comes to our consulting room it is necessary to appeal to diverse VR systems designed to treat each one of these problems.

What is stated in this work is to follow a somehow different rationale, instead of taking the patient to different specific virtual worlds, would it be possible to go and back from the “real world” to the “virtual world”? That is, as it occurs in the real world, would it be possible that in that complex virtual world the participant could go to many different places and could experience many diverse events and situations?. Would it also be possible that this virtual environment could protect users in every moment and allow them to experience every situation without risk as current VR systems do now? Finally, and giving a step beyond the traditional VR systems, it would be possible that that virtual world were designed in order to be adapted to the *user’s needs*. That is, to work in the line defended by Schmeisser (2004) regarding an *adaptive display*: “Dream of a display that pays attention to the viewer”, a system that was able to automatically adjust its contents to the constantly changing state of the observer.

Trying to progress in this line of work our group has developed a VR system initially designed for the treatment of PTSD (the EMMA’s World developed within the European Project EMMA IST-2001-39192). This system is able to adapt in a dynamic way to every user’s needs, regardless of the type of trauma suffered by the person. Results obtained so far indicate that the system is efficacious for this type of problem (Botella, et al., 2005). Furthermore it can be perfectly adapted for the treatment of other type of problems. By now we have already used it successfully for the treatment of pathological grief (Baños, et al., 2005; Botella, et al., 2005), adjustment disorders and phobia of darkness in children. The aim of this work is to show the utility of this adaptive display for the treatment of a very severe and interfering storm phobia with many years of history in an old woman who was not familiar at all with computer technologies.

2. Participant's description

R.A is a 70 year-old woman suffering from a storm specific phobia according to DSM-IV criteria (APA, 2004). The problem began when she was a child; she always avoided storms and constantly asked her mother about how the weather was going to be like. At home she was protected and she did not go to school when it was raining. The problem continued during adolescence. The patient reports that this phobia has interfered in different areas of her life: family, work, partner relationships, social life and leisure time. Since always the distress and fear has been very high. At a work level, if there was bad weather she did not go to work and, if the storm started during work she went to the bathroom until the storm ended. With her boyfriends, they could not go out when there was bad weather. If she decided to travel she had to check previously and constantly the weather and temperature in order to avoid summer storms. If she was with her friends and started to rain, they had to take her home in a hurry and she closed her eyes and presented physical symptoms (heart beatings, sweating, trembling, suffocation, mouth dryness and fear dying). In the assessment moment, to solve her problem and every time that it rained or storms were announced, the patient entered inside a wardrobe she had at home wearing earphones with a very loud music and a mobile phone and she waited until any of her friend ring her when the storm was finished. In those moments the patient had panic attacks and prayed for the storm to stop.

R.A had previously received psychiatric and psychological treatments (Gestalt and Psychodynamic approaches) for this problem; however, her problem did not improve.

3. Assessment

The assessment was carried out in 2 sessions. In session 1 the Anxiety Disorders Interview Schedule (ADIS-IV) (DiNardo, Brown & Barlow, 1994) was applied. During session 2 the participant answered the following measures: *Anxiety Sensitivity Index* (ASI), (Peterson & Reiss, 1987); *Cardiac Anxiety Questionnaire* (Eifert et al., 2000); Degree of fear, avoidance and belief in the negative thought using 0-10 scales and *Maladjustment Scale* (Adapted from Echeburúa, Corral, & Fernández-Montalvo, 2000). Furthermore, during VR exposure sessions the patient was asked to inform periodically her level of anxiety, the sense of presence she felt in the virtual environment and the reality judgement she attributed to the virtual experience. These questions were answered in a 0-10 scale. Finally, 6 months after treatment the patient was asked again to inform the degree of fear, avoidance and belief in the negative thought regarding her target-behaviours.

4. Hardware description

The configuration used different devices: two PCs, a big screen where the environment was projected, two projectors, a wireless pad (Logitech Wingman) and a system of speakers (Logitech x-530).

The PC1 has the graphical outputs from its graphic card connected to two projectors, which are used to project the environment in a metacrilate screen (4 x 1.5 m). The projectors have a resolution of 1024x768 pixels, and a power of 2000 lumens. However, they have been regulated for a power of 1000 lumens in order to be comfortable for the user. Specifically, the main characteristics of this PC1are the following:

- Processor: AMD XP-3000+
- Hard disk: 120 GB
- Graphic card: Nvidia 6600 AGP 128 MB.
- RAM: 512 MB.
- A network card for connecting to the other PC.
- Operating system: Windows 2000.

The PC2 is the host of the therapist’s application and controls the features of the virtual environment that is shown to the patient. The characteristics of this PC2 are the following:

- Processor: PIII 800.
- Hard disk: 40 GB.
- Graphic card: Nvidia GeForce II MX.
- RAM: 256 MB.
- A network card for connecting to the other PC.
- Operating system: Windows 2000.

Both PCs have installed the software Brainstorm eStudio, which has been used for developing the application.

5. EMMA's world description

In the "EMMA's world", the patient visualizes a virtual environment where a series of tools are available and they can be selected based on the therapist's instructions. In this work we are going to focus exclusively on the tools related to the virtual environments (for a more detailed description see Rey, Montesa, Alcañiz, Baños, & Botella, 2005). There are five different pre-defined scenarios or 'landscapes' available: a desert, an island, a threatening forest, a snow-covered town and a meadow (see Figure 1). The specific use of these scenarios will depend on the specific objectives of the therapeutic session and can be selected by the therapist in real time. Initially, the environments have been designed to be related to different emotions. For example, the desert can be related to rage, the island can be used to induce relaxation, the threatening forest can be related to anxiety, the snow-covered town can be used to reflect a sad mood, and the meadow can be used to induce happiness.

Figure 1: The different aspects of the virtual environment: the meadow, the desert, the island, the snow-covered town and the threatening forest.

Apart from this large-scale control (changing the entire aspect of the outer part of the virtual environment) the therapist can also make modifications in the scenario and graduate their intensity. Different effects can be applied to the environment: a rainbow can appear; it can start to rain or to snow; an earthquake can be generated; the hour of the day (and the corresponding illumination) can change. All these effects can be launched from the same interface, and the therapist can control both the appearance and disappearance of the effect, as well as the intensity with which the effect is shown.

In the present work we use different scenarios in which we included a storm with lightings, thunders of different intensity, and we varied the time of the day (with more o less illumination, being at day or at night). Specifically, the patient was exposed to the meadow and the therapist provoked the effects (e.g., thunders, day or night, etc.) depending on the patient's exposure hierarchy using the control panel of the PC2. Figure 2 shows different moments of the treatment sessions.

Figure 2: Some pictures of the treatment sessions, showing differences in the effects included in environments.

6. Treatment

The treatment consisted of a total of 7 sessions: 2 psychoeducation sessions (1 hour), 3 in vivo exposure sessions which consisted of exploding balloons (1 hour and a half) and 2 intensive VR exposure sessions with a duration of one hour and one hour and a half respectively. Next the specific agenda of each session is presented:

<u>*Session 1:*</u> *Educational component:* What is anxiety? Differences between fear, anxiety and phobia. Adaptive anxiety versus disturbing anxiety. Anxiety manifestation. Triple response system: physical, cognitive and behavioural.

<u>*Session 2:*</u> *Educational component:* What is a storm? How storms are formed? What are thunders and lightings? Why they occur? The importance of these atmospheric phenomena.

Session 3: What is exposure? Advantages and disadvantages. Constructing the hierarchy. Exposure to items 3 and 4 of the hierarchy. Homework assignments: exploding balloons with the same size used in therapy and not entering her wardrobe when it rained. In Table 1 the hierarchy used for in vivo exposure is presented.

ITEM	SITUATION	SUDs
1	To talk with a deflated balloon during the therapy session	1
2	To have a small inflated balloon in therapy	2
3	The patient has to prick a small balloon with a pin.	3
4	The patient has to prick a medium size balloon with a pin.	4
5	The therapist prick a medium size balloon at any time without warning	5
6	The therapist explodes a small firecracker in the park 10 meters away form the patient.	6
7	The therapist explodes a small firecracker in the park 1 meter away from the patient.	7
8	The patient explodes the small firecracker	8
9	The patient has to prick a big balloon with a pin.	9
10	The therapist pricks a big balloon at any time without warning.	10

Table 1: Hierarchy for in vivo exposure

Session 4: Homework review. Continuing with the exposure to the hierarchy: items 5, 6 and 7. Homework assignments.

Session 5: Homework review. Continuing with the exposure to the hierarchy: items 8, 9 and 10. Homework assignments.

Session 6: Homework review. Virtual exposure (two 90 minutes intervals with a 30 minutes break)

Session 7: Homework review. Virtual exposure

7. Results

Table 2 shows an important decrease in the scores obtained by the participant for all questionnaires from pre- to post-treatment: anxiety sensitivity, cardiac anxiety, and in the interference caused by the problem in different life areas and in general.

Questionnaire		Pre-treatment	Post-treatment
Anxiety Sensitivity Index		23	8
Cardiac Anxiety Questionnaire		25	16
Maladjustment Scale:	Work	5 (a lot)	0 (nothing)
	Social life	5 (a lot)	2 (something)
	Leisure time	5 (a lot)	2 (something)
	Partner relationship	5 (a lot)	0 (nothing)
	Family life:	5 (a lot)	2 (something)
	Global scale:	5 (a lot)	2 (something)

Table 2: Scores obtained in the Questionnaires before and after treatment.

On the other hand, Tables 3, 4 and 5 show the scores obtained by the participant during the three VR exposure sessions regarding the level of subjective anxiety (SUDs), the sense of presence and the attribution of reality to the virtual experience.

Time	Anxious element	Presence	Reality judgement	SUDs
10.00	Walking without rain	6	6	4
10.05	Drizzling	7	6	6
10.10	Moderate rain	7	7	7
10.20	One lightning	7	7	8
10.30	Moderate rain	7	9	7
10.40	Moderate rain	7	9	6
10.50	Gets dark	10	10	10
11.00	Strong rain	10	10	9
11.10	Strong storm	10	10	10
11.20	Strong storm	10	10	8
11.30	Strong storm	10	10	6

Table 3: Recording of 1st VR exposure session (1st interval).

Time	Anxious element	Presence	Reality judgement	SUDs
12.00	Walking	10	10	0
12.05	Rain and	10	10	5
12.10	Moderate rain	10	10	6
12.20	Moderate rain	10	10	7
12.30	Moderate rain	10	10	8
12.40	Strong rain	10	10	7
12.50	Strong storm	10	10	6
13.00	Maximum storm &	10	10	9
13.10	Maximum storm &	10	10	9
13.15	Maximum storm &	10	10	8
13.20	Maximum storm &	10	10	6
13.30	Strong storm	10	10	4

Table 4: Recording of 2nd VR exposure session (2nd interval after 30 minutes break).

Time	Anxious element	Presence	Reality judgement	SUDs
16.00	Walking	4	4	0
16.05	Rain and a thunder	5	10	5
16.10	Moderate rain	7	10	6
16.20	Moderate rain	10	10	6
16.30	Moderate rain	10	10	5
16.40	Beach with rain	10	9	7
16.50	Beach with rain	10	10	6
17.00	Maximum storm &	10	10	7
17.10	Maximum storm &	10	10	5
17.15	Maximum storm &	10	10	3
17.20	Maximum storm &	10	10	1
17.30	Strong storm	10	10	1

Table 5: Recording of 3rd VR exposure session.

Lastly, results obtained for the level of fear, avoidance and the degree of belief in the negative thought ("I am going to die because of the physical sensations experienced during a storm") related with each of the three target-behaviours are presented in Figures 3, 4 and 5. As can be observed, a notable decrease of all these clinical variables is produced at post-treatment, and this change is maintained at 6-moth follow-up.

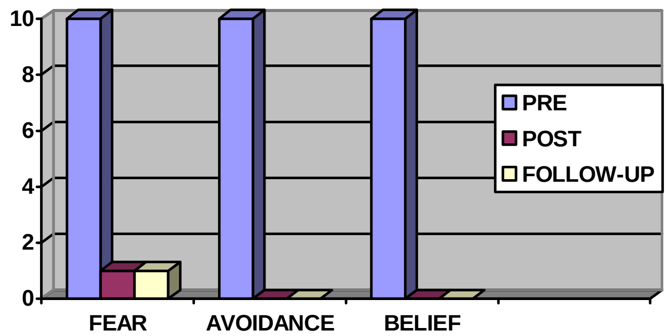

Figure 3: Target-behaviour 1- Confronting a storm at home without entering inside her wardrobe and without wearing earphones.

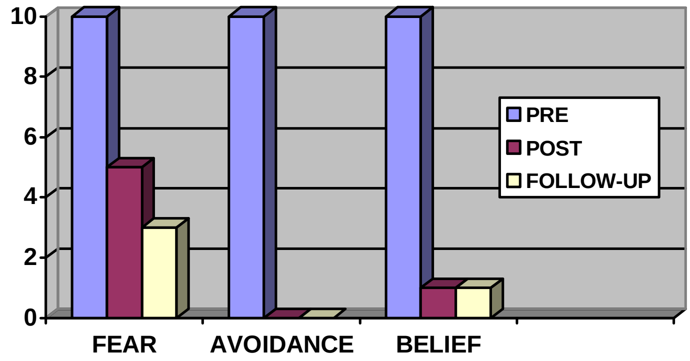

Figure 4: Target-behaviour 2- Confronting a storm at a friend's house without entering the bathroom and without wearing earphones.

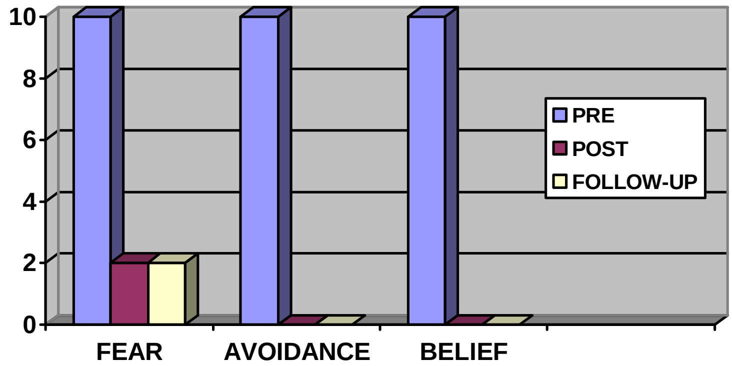

Figure 5: Target-behaviour 3- Confronting a strong rain in a journey without entering inside a bathroom and without wearing earphones, being able to go for a walk in the street.

8. Discussion

Firstly, the positive results obtained in this case report suggest a high potential of VR for the treatment of storm phobia. At the end of the treatment the patient was able to confront the situations related to storms feared at pre-treatment and this improvement was maintained at 6-month follow-up, that is, she continued confronting her target-behaviours, coping with storms in different contexts with very low levels of anxiety. On the other hand, and regarding effectiveness or the Axis II of the Guidelines for Empirically Validated Treatments (APA, 1995), the participant not only overcame her problem but she was very satisfied with the received treatment. At all time the patient reported that she liked the system and that she found the virtual reality procedure very useful. During therapy she even stated that after so many years suffering this problem for her this treatment had been an excellent solution. In this study we only used self-report measures and we did not included physiological data. This could be a limitation of the study but results available for this case indicated a significant improvement.

Another interesting result in this study is the presence and reality judgment scores reported by the participant. The patient reported a high sense of presence and reality attribution along all VR treatment sessions. All these results are showing that these computer technologies have been useful for an old participant. In this point, it must be pointed out that the patient did not use a HMD, but she visualized the environment on a big screen. No negative side effects or problems with the use of the VR system were reported by the participant. Ten years ago one of the problems with the use of VR was its possible negative side effects, mainly cybersickness. However, after ten years of experience acquired by other researchers and also from our own experience it can be pointed out that these symptoms have not been a big problem. Patients do not experience this syndrome as often as it was predicted. The number of persons who have not been able to get immersed for a while in a virtual scenario due to this problem is minimal.

Finally, this treatment has used an adaptive display. As it has been mentioned before, most of the virtual environments currently available in the field of psychological treatments have been designed and developed to solve a specific problem. The EMMA's world is demonstrating that can be useful to treat different problems, like PTSD (Botella et al, 2005) pathological grief (Baños et al., 2005; Botella et al., 2005), and now storm-phobia. But even more, we have observed that the use of an adaptive display like EMMA's world gives rise to a dynamic of generation of new ideas and possibilities of use on the part of the clinicians as they have been working with the system. As it has been already pointed out, in the future it might be possible that "a complex and versatile virtual world" could be available and that each researcher and clinician could add richer elements and working possibilities and utilities. This would allow us to work with our patients alternatively in the "real world" or the "virtual world" in a way that facilitates the progress in overcoming problems. This virtual world might also be dynamically adjusted to every user's needs. Even more, it might be that in a near future the limitation that presents the adaptive display used in this work could be overcome, and the "adaptation" of the system could not be "mediated by the clinician", but adjusted in each case and in each moment according to the user's needs.

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