

## An Adaptive Display for the Treatment of Diverse Trauma PTSD Victims

Cristina Botella, Ph.D.,<sup>1,2</sup> Azucena García-Palacios, Ph.D.,<sup>1,2</sup> Veronica Guillen, Ph.D.,<sup>3,4</sup>  
Rosa Maria Baños, Ph.D.,<sup>2,3</sup> Sgledad Quero, Ph.D.,<sup>1,2</sup> and Mariano Alcaniz, Ph.D.<sup>2,5</sup>

### Abstract

Posttraumatic stress disorder (PTSD) can develop after exposure to a terrifying event. People who suffer from PTSD experience hyperarousal and avoidance, and they reexperience symptoms that provoke distress and impairment in significant life areas. Cognitive behavior programs, including exposure therapy, are currently the treatment of choice for PTSD. Although these programs are effective, there is room for improvement; utilization of exposure therapy by clinicians is low, and attrition rates are high. Application of new technologies, especially virtual reality (VR), could help to overcome these issues. Several VR programs that address PTSD already exist. This study presents preliminary data on the efficacy of a VR adaptive display called EMMA's World, as applied in the treatment of diverse trauma PTSD victims. This VR program is unique; its flexibility allows it to be used to treat patients who suffer from PTSD due to different kinds of traumatic events. Results support the utility of EMMA's World in the treatment of PTSD.

### Introduction

POSTTRAUMATIC STRESS DISORDER (PTSD) is an anxiety disorder that can develop after exposure to a terrifying event or ordeal in which serious physical harm occurred or was threatened. Traumatic events that may trigger PTSD include violent personal assaults such as rape, terrorist incidents, natural or human-caused disasters, serious accidents, or military combat. People who suffer from PTSD often relive traumatic experiences through nightmares and flashbacks, have difficulty sleeping, and feel detached or estranged; furthermore, these symptoms can be of sufficient intensity and duration to significantly impair their daily lives. Cognitive behavior programs that include exposure-based techniques are currently the treatment of choice for PTSD. The treatment program for PTSD with the most empirical support is prolonged exposure (PE), developed by Foa and Rothbaum,<sup>1</sup> which involves imaginal exposure to the traumatic experience.

A significant empirical base supports the efficacy of exposure therapy, and numerous meta-analyses consistently prove its utility.<sup>2</sup> Nevertheless, exposure therapy is underutilized in clinical settings; as Richard and Gloster<sup>3</sup> note, this might be due to a "public relations" problem for this type of treatment.

Exposure therapy has been referred as "the cruelest cure"<sup>4</sup> because it purposefully evokes distress in patients. Furthermore, Olatunji et al.<sup>4</sup> have raised ethical concerns about the safety, tolerability, and humaneness of exposure therapy.

Data from a study by Becker et al.<sup>5</sup> confirm the limited use of exposure therapy, particularly among practitioners treating patients with PTSD. For example, Foy et al.<sup>6</sup> reported low utilization of exposure therapy for PTSD in veterans affairs (VA) clinics, which are major centers for PTSD treatment in the United States. Richard and Gloster<sup>3</sup> also found that exposure-based therapies were considered fairly aversive. Patients themselves have objected to such treatment; approximately 20% to 25% of people reject *in vivo* exposure because they consider it too aversive to confront feared situations.<sup>7</sup> New technologies, especially virtual reality (VR), could help overcome these issues. In fact, in Richard and Gloster's survey, VR exposure therapy was viewed as more acceptable, helpful, and ethical than traditional exposure-based therapies.<sup>3</sup>

There are already VR systems available for the treatment of PTSD. They are aimed at specific populations who have been victims of the same traumatic event, such as Vietnam War victims;<sup>8-9</sup> September 11 victims;<sup>10-11</sup> Iraq war victims,<sup>12</sup> and victims of motor vehicle accidents.<sup>13</sup> In this approach,

<sup>1</sup>Universitat Jaume I de Castellón, Spain.

<sup>2</sup>CIBER Fisiopatología Obesidad y Nutrición (CB06/03), Instituto Carlos III, Spain.

<sup>3</sup>Universidad de Valencia, Spain.

<sup>4</sup>Centro Clínico PREVI, Valencia, Spain.

<sup>5</sup>Instituto de bioingeniería y Tecnología Orientada al Ser Humano, Universidad Politécnica de Valencia, Spain.

the virtual environment is similar for all patients who are victims of a specific traumatic event. However, this approach is limited in the treatment of PTSD; people with this disorder may have suffered very different traumatic experiences (e.g., rape, physical or psychological abuse, terrorism, motor vehicle accident, child sexual abuse, tsunami, flooding).

Hence, a different approach for the treatment of PTSD has been proposed by Botella's team.<sup>14</sup> The goal is to employ virtual systems that can evoke different traumatic events in order to treat diverse trauma PTSD victims. EMMA's World is one such system; it is an adaptive and flexible VR program designed to treat emotional problems. It allows a therapist to customize clinically significant environments for each participant, which can vary according to the significance of the trauma for the individual; this is in contrast to other therapeutic VR approaches that focus on simulating the physical characteristics of the traumatic event with high realism. Rather than aiming for realism, EMMA's World employs customized symbols and personalized aspects to evoke emotional reactions in participants. This helps patients process their traumas emotionally, within a safe and protective environment. Preliminary data support the utility of EMMA's World for the treatment of stress-related disorders.<sup>15</sup> The current work presents the data obtained with PTSD patients.

## Method

### Participants

Participants were recruited from among patients who requested help at the Universitat Jaume I Emotional Disorders Clinic and at PREVI Clinical Center. The sample included in this study is a subsample from a wider study that explores the utility of new technologies in the treatment of stress-related disorders.

We established several inclusion and exclusion criteria: (a) meeting DSM-IV-TR criteria for PTSD; (b) age between 18 and 65 years; (c) for those taking medication, maintaining the type of medication and not increasing dosage during the study; (d) not having a diagnosis of psychosis or bipolar disorder; (e) not having a diagnosis of substance abuse or dependence, and (f) not suffering from a severe physical disease.

The sample comprised 10 participants (2 males, 8 females). Sixty percent were single, 30% married, and 10% divorced. Of the sample, 50% had a university degree, 40% had a high school education, and one patient (10%) had an elementary school education. The mean duration of the PTSD was 2.5 years ( $SD = 2.07$ ; range 1–7 years). Only two participants (20%) presented comorbidity with other Axis I disorders (dysthymia), and one participant was diagnosed with obsessive-compulsive personality disorder. Half of the sample was taking medication.

As for the traumas reported by the participants, they were different. Two of the participants had experienced a car accident, two suffered mobbing at the workplace, one was robbed in her shop, two were assaulted in the street, and three were victims of domestic violence. All participants read and signed a consent form before being involved in the study.

### Measures

Participants filled out a complete clinical assessment protocol. In this article, we report data from the measures more directly related to PTSD.

Clinician-Administered PTSD Scale (CAPS)<sup>16–17</sup>. This is a clinician-rated scale aimed at exploring traumatic events and symptoms associated with the traumas. It also allows a diagnosis of PTSD following DSM-IV-TR criteria to be made. Seventeen items assess DSM-IV criteria B, C, and D. Each item is rated on a 5-point scale to determine frequency and intensity. The instrument includes questions about the onset and duration of the symptoms and about distress and impairment in functioning. The CAPS allows a global rating of the validity of the responses and the severity of PTSD to be made. A number of studies have reported good reliability (internal consistency and interrater reliability) and convergent validity.<sup>18</sup> There are also data about treatment sensitivity.<sup>19</sup> The mean score for a PTSD sample was 45.9 ( $SD = 29.1$ ).<sup>20</sup>

Davidson Trauma Scale (DTS)<sup>21</sup>. This is a self-report scale measuring frequency and severity of PTSD symptoms. It includes 17 items corresponding to the symptoms included in the DSM-IV criteria. Each item is rated on a 5-point scale. The instrument offers a total score as well as subscale scores for frequency and severity. Several studies offer data on the good psychometric properties of this scale, reliability (internal consistency, test-retest reliability) and validity (convergent validity and treatment sensitivity).<sup>21,22</sup> The mean score for a clinical sample was 15.5 ( $SD = 13.8$ ).<sup>21</sup>

Posttraumatic Cognitions Inventory (PTCI)<sup>23</sup>. This self-report inventory includes 36 items that assess thoughts and beliefs related to a traumatic event. It is composed of three subscales: negative thoughts about oneself, negative thoughts about the world, and negative thoughts related to guilt. Items are rated on a 7-point scale from *totally agree* to *totally disagree*. The inventory offers a total score and a score for each subscale. The PTCI offers good internal consistency, test-retest reliability, and convergent validity.<sup>23</sup> In addition, factor analysis has confirmed a three-factor structure.<sup>23</sup> The mean score of a PTSD sample was 133 ( $SD = 44.17$ ).

### Devices

Two PCs, a large projection screen, two projectors, a wireless pad, and a speaker system were used in this study. PC1 had the graphical outputs from its graphics card connected to two projectors with a resolution of 1024×768 pixels and a power of 2000 lumens. They were used to project the VR environment onto a horizontal metacrilate screen of 4×1.5 meters that was placed in the middle of the room. A wireless pad was placed on a table on the other side of the room, and the participant sat next to it. From this perspective, the participant could see the virtual environment as well as interact and navigate using the wireless pad. The therapist sat next to PC2, which was placed close to the participant. From this PC, the application and the features of the virtual environment that were shown to the participant could be controlled. In the first stages of therapy, the participant learned how to navigate and interact with the system by practicing in a neutral VR environment.

### Treatment

The treatment was cognitive behavior therapy (CBT), specifically, an adaption of PE.<sup>1</sup> The components included in the CBT condition were education, breathing training, cog-

nitive restructuring, in vivo exposure, and imaginal exposure. In the CBT + EMMA condition, exposure therapy for processing the trauma was conducted using EMMA's World, a VR adaptive display. The total duration of the treatment was 9 weekly sessions (3 for the educational component, 5 for imaginal/VR exposure, and 1 for relapse prevention). Exposure sessions lasted approximately 90 minutes. In all cases, for ethical reasons, participants who needed more sessions could receive treatment for 3 additional weeks, as recommended by Foa and Rothbaum.<sup>1</sup>

Four therapists participated in both the assessment and treatment; all were experienced in the application of CBT programs and were either doctors or Ph.D. students. All clinicians were trained in the delivery of the treatment protocols. To ensure treatment integrity and adherence to the treatment protocol, senior therapists supervised the treatment sessions by reviewing video recordings of some of the sessions.

#### Procedure

Individuals who requested help at the Universitat Jaume I Emotional Disorder Clinic or PREVI Clinical Center and presented PTSD symptoms were invited to participate in the study. Those who showed interest were interviewed in order to confirm the diagnosis and establish if they met the inclusion and exclusion criteria. During this interview, the psychologists explained the scope of the study and asked the individuals to read and sign the consent form. All participants included in the study signed the consent form. In the second and third interviews, a clinical assessment was completed. Participants were then randomly assigned to one of the two treatment conditions: CBT treatment versus CBT + EMMA treatment. The treatment lasted 9 to 12 weeks; participants completed a posttreatment assessment at the conclusion.

#### VR condition

In this study, we used EMMA's World, a VR system designed to promote emotional processing. It was designed in a Fifth Framework Programme EU Project (IST-2001-39192-EMMA). EMMA is an adaptive display that includes elements such as EMMA's Room and the Book of Life. EMMA's room is an architectural structure with different elements. On one side, it has a virtual screen with a list of icons showing different elements that the users can manipulate: 3D objects, music, sounds, images, colors, videos and texts. These elements can be activated on different stands around the room. With the help of the therapist, patients can choose elements

that best reflect their emotional states and that represent parts of the traumas. In addition, they can introduce personal items, such as pictures they can bring to the sessions.

The Book of Life is a virtual book in which patients can represent different moments, people, or situations related to the traumatic events. The book has an index and different chapters to be defined and completed by the patient. The aim is to help the patient remember the traumatic event and to process the emotions associated with the trauma by exposing the patient to symbols that represent it.

EMMA's World also includes several landscapes surrounding EMMA's room that were chosen for their ability to evoke different emotions, including a green and sunny prairie, a beach, a snowy landscape, and a desert. The VR world also allows the user to alter the time of the day, the weather, and more with the aim of reflecting the emotions that the patient is feeling during the treatment.

In summary, the various symbols (3D objects, sounds, music, colors, images, etc.) and landscapes are designed to reflect the patients' emotions and help them to confront, manage, and process negative experiences in a therapeutic and safe environment. VR environments, and especially EMMA's World, are designed to create a context wherein the patient feels present, augmenting the sensation of being in a protected environment. A more detailed description of EMMA can be found in Botella et al.<sup>14</sup>

#### Results

We conducted a nonparametric test to evaluate the efficacy of the treatment programs (CBT and CBT + EMMA). Means and standard deviations of the key measures at pretreatment and posttreatment are found in Table 1.

Regarding the CBT condition, there was a decrease in the CAPS scores (intensity and frequency) from pretest to posttest. However, a Wilcoxon test showed that these differences were not statistically significant. As for the scores on the DTS, a Wilcoxon test showed significant differences from pretest to posttest both in frequency ( $Z = 2.032, p < 0.04$ ) and severity ( $Z = 2.032, p < 0.04$ ). Finally, a decrease in the PTCI from pretest to posttest was also significant ( $Z = 2.032; p < 0.04$ ).

Regarding the CBT + EMMA condition, reductions from pretest to posttest in the CAPS scores were significant both in frequency ( $Z = 2.032, p < 0.04$ ) and intensity ( $Z = 2.032; p < 0.04$ ). Changes from pretest to posttest in the DTS were also significant: frequency ( $Z = 2.032, p < 0.04$ ) and severity ( $Z = 2.032, p < 0.04$ ). We obtained the same results on the scores of the PTCI ( $Z = 2.032; p < 0.04$ ).

We also conducted Mann-Whitney tests to compare the scores of the various measures between the two treatment

TABLE 1. KEY VARIABLES FOR CBT + EMMA VERSUS CBT

	CBT + EMMA		CBT	
	Pretest M (SD)	Posttest M (SD)	Pretest M (SD)	Posttest M (SD)
CAPS: frequency	41.00 (10.88)	9.60 (6.65)	40.50 (3.41)	7.25 (7.50)
CAPS: intensity	40.80 (6.97)	11.60 (7.70)	40.00 (2.16)	8.00 (9.76)
DTS: frequency	49.00 (20.65)	13.00 (8.60)	33.20 (12.51)	10.40 (8.47)
DTS: severity	45.20 (20.20)	12.60 (8.84)	31.40 (15.20)	10.80 (11.10)
PTCI	180.0 (53.59)	88.40 (29.50)	126.6 (31.77)	73.20 (23.58)

CAPS, Clinician-Administered PTSD Scale; DTS, Davidson Trauma Scale; PTCI, Posttraumatic Cognition Inventory.

conditions at pretest and posttest. We did not obtain any significant differences between the treatment conditions in any assessment period.

### Discussion

The results indicate that CBT augmented with EMMA's World was as effective as the gold standard for treatment of PTSD. As for the intensity and frequency of the symptoms measured by the CAPS scores, participants in the EMMA's World condition achieved even better results than those receiving the traditional treatment, although these differences were not significant. Therefore, our findings, although preliminary, are promising regarding the utility of VR for the treatment of PTSD.

In recent years, different VR applications have demonstrated their utility for the treatment of PTSD. However, EMMA's World can be much more flexible than these other virtual systems, which increases its clinical utility. Because the application permits customization of the environments according to the needs and preferences of users, it can be applied to a wide variety of problems. As in this study, it is possible to use EMMA's World with patients who have suffered various traumas (car accidents, mobbing, assaults, domestic violence, etc.).

VR systems for PTSD present similar advantages over VR systems designed for the treatment of other disorders,<sup>24-26</sup> such as the possibility of an accurate gradation of the exposure tasks, confidentiality, and the possibility of overcoming the difficulty in imagining that some patients present. For example, the significance of the approach of Difede and Hoffman's team<sup>10-11</sup> is that they are treating patients who did not respond to traditional imaginal exposure. In addition, in the specific case of PTSD, applying VR can overcome some of the limitations of traditional CBT. As for PE, which efficacy data indicate is the treatment of choice for PTSD,<sup>27</sup> it is not used by the clinicians,<sup>5</sup> and it is viewed very cautiously by patients and therapists. VR could help to overcome these reservations. In any case, despite the "bad press" that PE can elicit, data indicate that there is no difference in attrition rates among several CBT programs such as PE, cognitive therapy, stress inoculation training, and eye movement desensitization and reprocessing (EMDR) for the treatment of PTSD; this indicates the tolerability of exposure therapy.<sup>28</sup> It is important to stress the effectiveness of exposure therapy; it is one of the great success stories within the field of mental health.<sup>4</sup> It is therefore ethically imperative to offer and disseminate well-established treatments such as exposure. Although no difference among different treatments for PTSD was detected in the Hembree et al. study, the average rate of attrition was 20.5% for exposure treatments, 22.1% for cognitive therapy or stress inoculation training, 26.9% for combinations of exposure and other CBT techniques, and 18.9% for EMDR. These high numbers indicate that there is still room for improvement in these treatments. Any effort to decrease these attrition rates will be welcome in the field. It is less urgent to neutralize unrealistic fears of harming patients with PE than it is to make this treatment more accepted and easier to apply.

This study has several limitations, the most significant of which is that the data obtained are very preliminary. In addition, the sample is small, and we were therefore unable to perform parametric tests. Also, although we included a

comparison group (CBT), we did not include a control condition such as a waiting list. Finally, we reported only short-term efficacy data. We need studies with larger samples and longer assessment periods to further test the efficacy of EMMA's World for the treatment of PTSD.

VR can contribute to improve the clinical utility or axis two;<sup>29</sup> it can help increase the acceptance of exposure therapy and help patients who do not respond to traditional treatment. The preliminary results of the use of VR for treating PTSD are encouraging.<sup>30</sup> It remains to be seen, however, what the appropriate applications of the technology will be, such as whether or not there is a significant advantage to using this technology compared to other strategies and what factors may contribute to its effectiveness.

### Disclosure Statement

No competing financial interests exist.

### References

1. Foa EB, Rothbaum BO. (1998) *Treating the trauma of rape*. New York: Guilford.
2. Deacon BJ, Abramowitz JS. Cognitive and behavioral treatment for anxiety disorders: A review of meta-analytic findings. *Journal of Clinical Psychology* 2004; 60:429-41.
3. Richard DCS, Gloster AT. (2007) Exposure therapy has a public relations problem: a dearth of litigation amid a wealth of concern. In Richard DCS, Lauterbach D, eds. *Comprehensive handbook of the exposure therapies*. New York: Academic Press, pp. 409-25.
4. Olatunji BO, Deacon BJ, Abramowitz JS. The cruelest cure? Ethical issues in the implementation of exposure-based treatments. *Cognitive & Behavioral Practice* 2009; 16:172-80.
5. Becker CB, Darius E, Schaumberg K. An analog study of patient preferences for exposure versus alternative treatments for posttraumatic stress disorder. *Behaviour Research & Therapy* 2007; 45:2861-73.
6. Foy DW, Kagan B, McDermott C, et al. Practical parameters in the use of flooding for treating chronic PTSD. *Clinical Psychology & Psychotherapy* 1996; 3:169-75.
7. Marks IM, O'Sullivan G. Drugs and psychological treatments for agoraphobia/panic and obsessive-compulsive disorder. A review. *British Journal of Psychiatry* 1988; 153:650-58.
8. Rothbaum BO, Hodges L, Ready D, et al. Virtual reality exposure therapy for Vietnam veterans with posttraumatic stress disorder. *Journal of Clinical Psychiatry* 2001; 62:617-22.
9. Rothbaum BO, Ruel AM, Litz BT, et al. (2004) Virtual reality exposure therapy of combat-related PTSD: a case study using psychophysiological indicators of outcome. In Taylor S, ed. *Advances in the treatment of posttraumatic stress disorder: cognitive-behavioral perspectives*. New York: Springer.
10. Difede J, Hoffman H. Virtual reality exposure therapy for World Trade Center post-traumatic stress disorder: a case report. *CyberPsychology & Behavior* 2002; 5:529-35.
11. Difede J, Cukor J, Jayasinghe N, et al. Virtual reality exposure therapy for the treatment of posttraumatic stress disorder following September 11, 2001. *Journal of Clinical Psychiatry* 2007; 68:1639-47.
12. Gerardi M, Rothbaum BO, Ressler K, et al. Virtual reality exposure therapy using a virtual Iraq: case report. *Journal of Traumatic Stress* 2008; 21:209-13.
13. Walshe DG, Lewis EJ, Kim SJ, et al. Exploring the use of computer games and virtual reality in exposure therapy for

- fear of driving following a motor vehicle accident. *CyberPsychology & Behavior* 2003; 6:329-34.
14. Botella C, Quero S, Lasso de la Vega N, et al. (2006) Clinical issues in the application of virtual reality to treatment of PTSD. In Roy M, ed. *Novel approaches to the diagnosis and treatment of posttraumatic stress disorder*. NATO Security Through Science series, vol. 6. Amsterdam: IOS Press.
  15. Baños RM, Botella C, Guillen V, et al. An adaptive display to treat stress-related disorders: EMMA's World. *British Journal of Guidance & Counselling* 2009; 37:347-56.
  16. Blake DD, Weather FW, Nagy LM, et al. (1998) *Clinician-administered PTSD scale for DSM-IV*. Boston: National Center for PTSD, Behavioral Science Division.
  17. Blake DD, Weathers FW, Nagy LM, et al. The development of a clinician administered PTSD scale. *Journal of Traumatic Stress* 1995; 8:75-90.
  18. Weathers FW, Litz BT. Psychometric properties of the Clinician-Administered PTSD Scale, CAPS-1. *PTSD Research Quarterly* 1994; 5:2-6.
  19. Frueh BC, Turner SM, Beidel DC, et al. Trauma management therapy: a preliminary evaluation of a multi-component behavioral treatment for chronic combat-related PTSD. *Behaviour Research & Therapy* 1996; 34:533-43.
  20. Blanchard EB, Jones-Alexander J, Buckley TC, et al. Psychometric properties of the PTSD Checklist (PCL). *Behaviour Research & Therapy* 1996; 34:669-73.
  21. Davidson JR, Book SW, Colket JT, et al. Assessment of a new self-rating scale for posttraumatic stress disorder. *Psychological Medicine* 1997; 27:153-60.
  22. Zlotnick C, Davidson J, Shea MT, et al. Validation of the Davidson Trauma Scale in a sample of survivors of childhood abuse. *Journal of Nervous & Mental Disease* 1996; 184:255-7.
  23. Foa EB, Ehlers A, Clark DM, et al. The Posttraumatic Cognition Inventory (PTCI): development and validation. *Psychological Assessment* 1999; 11:303-14.
  24. Botella C, Quero S, Baños R, et al. Virtual reality and psychotherapy. *Studies in Health Technology & Informatics* 2004; 99:37-54.
  25. Wiederhold BK, Wiederhold MD. A review of virtual reality as a psychotherapeutic tool. *CyberPsychology & Behavior* 1998; 1:45-52.
  26. Zimand E, Rothbaum B, Tannenbaum L, et al. Technology meets psychology: integrating virtual reality into clinical practice. *Clinical Psychologist* 2003; 56:5-11.
  27. Foa EB, Keane TM, Friedman MS, eds. (2000) *Practice guidelines from the International Society for Traumatic Stress Studies: effective treatments for PTSD*. New York: Guilford.
  28. Hembree EA, Foa EB, Dorfan NM, et al. Do patients drop out prematurely from exposure therapy for posttraumatic stress disorder? *Journal of Traumatic Stress* 2003; 16:555-62.
  29. American Psychological Association Task Force on Psychological Intervention Guidelines. (1995) *Template for developing guidelines: interventions for mental disorders and psychological aspects of physical disorders*. Washington, DC: American Psychological Association.
  30. Reger GM, Gahm GA. Virtual reality exposure therapy for active duty soldiers. *Journal of Clinical Psychology* 2008; 64:940-6.

Address correspondence to:  
Dr. Cristina Botella  
Universitat Jaume I  
Psicología Bàsica  
Avda. Sos Baynat s/n  
Castellon, Comunitat Valenciana  
Spain 12071

E-mail: botella@psb.uji.es