Virtual reality exposure for trauma and stress-related disorders for city violence crime victims

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ABSTRACT

The criminal violence is attached with mental health problems as depression and substance use and abuse. However one of most important psychological problems linked with the victims of violence is Posttraumatic Stress Disorder (PSTD) and Acute Stress Disorder (ASD). In Mexico, according to the ICESI in 2012, 11% (6,800/for each 100 thousands of habitants) of the population over 18 years experienced a crime. One in four of the people victim of violence develops PSTD symptoms. Due to this socially relevant problem and based on the efficacy of Virtual Reality (VR) treatments, it is important to design treatments involving the use of VR because it can help overcome some of the limitations of traditional therapy using exposure. The present study shows preliminary results of efficacy or virtual reality treatment for PTSD and ASD for crime violence. The clinical sample was conformed for 9 participants from city of Mexico, 6 participants with PTSD diagnoses and 3 participants with ASD diagnoses, aged between 18 and 65. All participants gave informed consent to participate. Treatment was delivered in 90 min individual sessions conducted once a week. Three virtual scenarios for PTSD exposure treatment were used. Improvement was seen in measures of stress, anxiety and depression in both treatment groups, which confirms the clinical efficacious for this technique to treat stress-related disorders.

1. INTRODUCTION

In Mexico crime rates are extremely high: 21.3% of the population over 18 years has suffered from a crime and 86.3% of the population feels unsafe. In recent years, Mexico experienced a dramatic increase in violence. The number of homicides, assault, kidnapping, threats, disappearances, extortions, attacks on civilians, journalists, public officials, human rights advocates, and deaths of bystanders increased substantially. The "National Survey of Urban Public Safety" (ENSU, for its acronym in Spanish, 2013) reported that in the month of September this year (2013) 68% of the population over age 18, considered that living in their own town is highly unsafe, because in the last three months they have witnessed and / or heard of alcohol consumption on the streets (70%), victims of theft or robbery (66.2%) and urban vandalism (56.1%), on the other hand there is a wide variety of factors that children, youth and adults are exposed to, which are highly dangerous, and need to be taken into account in order to create preventive or intervention strategies.

Accordingly, Posttraumatic Stress Disorder (PTSD) and Acute Stress Disorder (ASD) rates caused by criminal violence such as assault, kidnapping or express kidnapping are quite high and continue to increase. The violent situation that exists in the country has generated among survivors fear and insecurity, thus increasing the chances of developing acute stress disorder or posttraumatic stress disorder. This has increased the need for intervention programs for this population. Problems and the consequences related, leading the population to a hopeless sense of fear and insecurity and their repercussions are associated with the PTSD and ASD. Traditional exposure therapies are often difficult to conduct and financially unavailable to most Mexicans; so this new exposure technique using virtual reality environments (VRE) seems a potential tool, which permits both patients and therapists more control and better results. Based on the effectiveness of participants' preference and acceptance for this innovative intervention in a previous controlled study using virtual reality for the treatment of victims, we conduct a study offering treatment at the School of Psychology in Mexico City (Cárdenas, de la Rosa, Flores and Durán, 2013; De la Rosa and Cárdenas, 2012).

The prevalence of PTSD and ASD requires attention because those who suffer from these disorders have elevated degrees of anxiety, fear and avoidance, thereby interfering in personal development and everyday life.

Nowadays there are effective cognitive-behavior therapy (CBT) treatments for PTSD and ASD (Paunovic and Öst, 2001; Tarrier, Liversidge and Gregg, 2006). These treatments employ exposure techniques that help patients to overcome the presence of feared objects or situations related to the traumatic event. Prolonged exposure (PE) is the preferred exposure technique for treating PTSD (Foa, Keane and Friedman, 2000). However this technique is poorly used in clinic treatments (Becker, Zayfert and Anderson, 2004; Van Minnen, Hendriks and Olff, 2010). The low use of these treatments is due to cognitive avoidance of patients to recall traumatic memories and the difficulty for some patients to engage in imaginal exposure.

Virtual reality exposure technique (VRET) can help to overcome some restrictions of traditional exposure therapy (in-vivo or imagined) (Botella, Baños, et al, 2006). VRET can simulate the traumatic situation with a high sense of reality; therefore this can help patients regardless of their ability for imaginal engagement. Another benefit is that therapists can control the characteristics of the situation presented to the patient. These aspects could reduce cognitive avoidance in order to increase the emotional engagement during exposure (Botella, Quero, Serrano, Baños and García-Palacios, 2009).

There are several studies supporting the effectiveness of VR for the treatment of PTSD in different populations (Difede and Hoffman, 2002; McLay, Wood, Weebb-Murphy, Spira, Wiederhold, Pyne et al, 2011; Rizzo, Pair, McNermey, Eastlund, Manson, Gratch et al, 2004; Rothbaum, Hodges, Ready et al, 2001) with survivors of the war, active soldiers and victims of terrorism attacks. In Mexico the development of such systems is non-existent, and its empirical validation is emerging, which gives evidence of the relevance of the study in our socio-cultural context.

Based on this socially relevant problem and centered on the efficacy of previous studies for war violence, our research team initiated a project supported by the National Science and Technology Council, and the municipal government of Ciudad Juarez in Mexico, which purpose was to evaluate the efficacy of a treatment program for PTSD through virtual reality exposure in criminal violence victims and eyewitnesses in Ciudad Juarez. The study reveals a treatment success rate of 80% clinical levels of PTSD and depression were significantly reduced and their level of anxiety was measurably reduced from their pretreatment assessment to post treatment assessment (Cárdenas et al, 2013).

Data obtained from pilot clinical trial in Ciudad Juarez (Cárdenas and de la Rosa, 2012) and a case study in assault with violence in Mexico city (Cárdenas and de la Rosa, 2011a), showed the application of the VR prolonged exposure (PE) technique was effective in reducing symptoms of re-experiencing, avoidance and hyper arousal, which confirms the clinical preference for this technique to treat PTSD. The participant informed feeling comfortable with technology as well as experiencing an improvement in functioning in many areas of his life as a result of treatment. It's relevant to point out previous studies focused to criminal violence in the north part of the country, however it is necessary to inquire about studies supporting the efficacy and clinical relevance of the use of virtual reality to treat PTSD in other types of violent crime in big cities, such as Mexico City, where delinquent acts are increasing and the prevalence of robbery with violence, kidnapping and express kidnapping against civilians is a dramatic reality.

2. METHOD

2.1 Objective

Determinate the efficacy of virtual reality exposure in PTSD and ASD treatment programs for city violence crime victims.

2.2 Participants

The open clinical sample was conformed for participants aged between 18 and 65 years victims and witnesses of assault, kidnapping and criminal violence, who ask to voluntary join the study for psychological services to overcome the PSTD or ASD. The following were inclusion criteria for study participation: a) participants hat to meet criteria for DSM-IV for PTSD with a CAPS score at least 40 (with symptoms rated over the past week) or criteria for ASD with score at least 20 (with symptoms rated over the past week) by: violent assault, "express", kidnapping and/ or kidnapping, b) be between 18 and 65 years of age, and c) voluntary participation in study. The exclusion criteria were a) currently receiving other psychological and/ or pharmacological treatment for PTSD, b) history of or current clinical evidence of severe physical illness or psychoses, c) presence of prominent suicidal ideation, d) not taking psychotropic medication, and e) alcohol and drug abuse.

Nine participants completed treatment, 2 female with a mean age of 36.5 years (*SD*=14.4) and 7 males with a mean age of 34.7 (*SD* =16.39). Suitable participants gave their written consents and were assigned in two types of treatment depending on their initial assessment: prolonged virtual reality exposure for PTSD (n= 6) and

prolonged virtual reality treatment for acute stress disorder (n=3). Treatment was delivered between 6 and 10, 90- minute individual sessions conducted once a week. Therapist will use three scenarios for virtual exposure: streets of Mexico City scenario, which includes a pedestrian bridge, an assault/robbery scene and a kidnapping room, in order to expose the patient to the memories of the trauma (Cárdenas and de la Rosa, 2012) that allowed us to recreate situations involving the traumatic event.

2.3 Measures

The following measures were employed:

- *Clinician Administered PTSD Scale, (*CAPS-1; Blake, Weathers and Nagy, 1990). The CAPS-1 is a structured interview developed to test the presence of the 17 DSM-IV-TR criteria for PTSD (re-experimentation, avoiding and hyperactivation). Each symptom is scored on two dimensions: frequency and intensity. Both scales are to be rated on a 5-point scale, ranging from 0 (never and not at all) to 4 (every day and extremely). We used a Mexican version (Palacios, 2002), which inter rater reliability for all three subscales is good (r = 0.851). The cutoff point established for the diagnosis of PTSD is 40 on the global scale.
- *Posttraumatic Stress Symptom Scale, Self Report* (PSS-SR) is a 17 item self-report questionnaire that measures the frequency of PTSD symptoms (Foa, Riggs, Dancu and Rothbaum, 1993). Each item corresponds to one of the DSM-IV-TR criteria for PTSD, and has three subscales: Reexperiencing, avoidance and arousal symptoms. The Mexican version (Almanza, Páez, Hernández, Barajas and Nicolini, 1996) has a Cronbach's alpha of 0.85. The cutoff proposed by the authors is 18 points.
- *State-Trait Anxiety Inventory* (STAI; Spielberger and Diaz, 1975). It consists of two self-rating scales, each scale composed with20 items, which measure two dimensions of anxiety: trait and state. The Mexican version has a Cronbach's alpha of 0.86 for trait scale and 0.54 for state scale.
- *Beck Depression Inventory* (BDI, Beck, 1961) is a 21 item self report that measures affective-cognitive and vegetative-somatic symptoms. The inventory is to be rated of 0-3-point scale, ranging from 0 (no depressive symptoms), 2 (moderate symptom) and 3 (serious symptom). The cutoff point for diagnosis is 14. The Mexican version (Jurado et al, 1998) has a Cronbach's alpha of 0.94.
- *Treatment satisfaction questionnaire* (Borkovec and Nau, 1972; adapted by Botella et al*,* 2009) is a 4 items questionnaire that informs the level of treatment satisfaction, ranging from 1 (none) to 10 (pretty).

The development of the PTSD and ASD virtual reality system models (Cárdenas and de la Rosa, 2011b) was based on the most frequent unsafe locations reported by residents of Mexico City. The system was divided into three interactive environments: the streets of City of Mexico (Fig. 1), an assault/robbery scene in a pedestrian bridge (Fig. 2), a kidnapping vehicle (taxi / wagon) (Fig. 3), and a kidnapping room (Fig. 4). These VREs were considered the social and cultural context appropriate for the target users of the system.

2.4 Design

The experimental design was an open clinical trial with replications, within subject repeated measures (pretreatment and post treatment) (Kazdin, 2007).

2.5 Sample

A non-probability sample was drawn, intentional, subject-type (Kerlinger, 1988).

2.6 Procedure

Participants were administered the measures or interviews at pretreatment and posttreatment, by a licensed clinical psychologist. In the initial interview, participants were informed about the study and treatment. Participants were screened to determine eligibility and provided informed consent for participation. Participants who met initial screening criteria were further evaluated by the CAPS (Blake et al, 1990), Posttraumatic Stress Symptom Scale (Foa et al, 1993), and Self Reports: State-Trait Anxiety Inventory (Spielberger et al, 1975) and Beck Depression Inventory (Beck, 1961). After that were assigned to one of the two treatment conditions: (a) prolonged virtual reality exposure for PTSD and (b) prolonged virtual reality treatment for acute stress disorder. The procedure was carried out in the psychological assistance center at the Psychology school of the National Autonomous University of Mexico.

The treatment program was delivered between 6 and 10; 90- minute individual sessions conducted once a

week by three clinical psychologists, one-woman and two men, under the supervision of a more experienced psychotherapist. Therapists were trained in both treatment protocols and the use of virtual reality systems. Treatment success was based on the ability to show a clinically meaningful improvement (30 percent or greater reduction in PTSD symptoms on the Clinician Administered PTSD Scale (CAPS) over the course of 12 weeks.

Figure 1. *City view.*

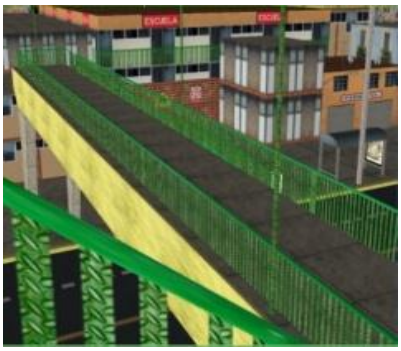

Figure 2. *Bridge view.*

Figure 3. *Taxi view.*

Figure 4. *Kidnapping room view*

2.7 Treatment – PTSD Treatment

Treatment integrity was controlled by PTSD treatment manual adapted for Mexican population (Rothbaum, Difede and Rizzo, 2008). The first therapy session included a presentation of the treatment rationale, education about the disorder, common reactions to trauma, information gathering and breathing relaxation training. Session 2 and 3 focused on traumatic memories, within which the utility of exposure therapy was explained as a medium to confront feared memories and for the processing of the memory. The subsequent sessions (4-10) consisted of 30-45 min. virtual reality exposure: patients are asked to talk about the traumatic event in first person and in present tense, recollecting as many sensory details as vividly as possible. During the exposure, the patient is asked, every 5 min intervals, to report subjective units of distress (SUDS) rating over a scale ranging from 0 to 10. Each exposure session is audiotaped and patients are instructed to listen to the tape at home once a week. From the 4th session onwards in vivo exposure to fearful stimuli associated with the trauma is presented, such like visiting trauma-related places. The final session incorporates relapse prevention techniques and at the conclusion, all participants are requested to complete the questionnaires administered during the initial assessment sessions.

2.8 Treatment – ASD Treatment

Treatment integrity was controlled by ASD treatment manual adapted for Mexican population (Bryant, 2007). The treatment consists in a cognitive-behavioral intervention of 6 weekly sessions of 90 minutes. The first session is focused on explaining the treatment rationale and techniques used, psychoeducation about symptoms and common reactions to trauma, and also training in breathing exercises. The second session focuses on the explanation of the ABC cognitive model for the management of negative automatic thoughts related to trauma,

and also to explain the exposure therapy using VR; once the technique is explained the first immersion follows. The third session is focused on explaining In Vivo exposure therapy and the hierarchy of stressful situations is performed, followed by cognitive therapy and exposure through virtual reality. Sessions 4 and 5 continue with prolonged exposure and cognitive therapy, also progress In Vivo Exposure through hierarchies is reviewed. In the sixth and final session the last revision of In Vivo exposure and cognitive therapy is performed, in addition relapse prevention and the post-treatment sessions are scheduled. During exposure therapy, SUDS are used to monitor, from 1 to 10, the levels of anxiety perceived by the patient.

3. RESULTS

3.1 Primary outcome measure

The goal of the study was to identify which treatment resulted in a greater percentage of individuals with a clinically meaningful reduction in PTSD and ASD. This was determined by examining differences in CAPS scores at initial assessment and then at the post-treatment assessment in PTSD prolonged virtual reality exposure and ASD prolonged virtual reality exposure. Scores on the CAPS can range from 0 to 136, with scores above 40 considered clinically significant for PTSD (Weathers, Keane and Davidson, 2001). An improvement of 30 percent or greater on the CAPS is considered a clinically significant change.

3.2 Virtual reality treatment effect: PTSD and ASD

Descriptive statistics for the two scales (CAPS and PTSD symptom scale) are presented in Table 1, which indicates there has been improvement in symptoms for both conditions. All 9 participants who participated in study were assessed with the CAPS at the postassessment, and all of them showed a 30 percent or greater improvement in the CAPS. Two-way analysis of variance showed a significant effect of time (pre- vs. post-treatment, $p<0.001$), but not group ($p>0.05$). There was a significant time-by-group interaction ($p<0.05$). Repeated measures analyses showed that treatment was successful in reducing PTSD and ASD symptoms from pre-treatment to post-treatment.

Data showed statistical difference from pre-test to post-test in PTSD virtual reality exposure treatment group in the *Clinician Administered PTSD Scale* (CAPS) ($T_{(2, 19)} = 4.31$, $p = 0.001$).

Table 1. *Mean, standard deviations results obtained for PTSD symptoms.*

Measure	Virtual reality exposure treatment (VRET) (n = 6)	
	Pre-treatment	Post-treatment
	M (SD)	M (SD)
CAPS	79.2 (29.9)	7.9 (6.1)
CAPS Re-experiencing	24.2 (9.3)	2.8 (3.1)
CAPS Avoidance	32. 2 (13.2)	2.3 (1.8)
CAPS Hyperarousal	24.1 (9.2)	2.8 (2.3)
PTSD Symptom Scale	32.5 (9.3)	5.7 (3.4)

Regarding the *PTSD Symptom Scale,* as shown in Figure 5 and 6, scores by participants showed significant differences between pre-treatment and posttreatment and also in both treatment groups. The same occurred for the *state anxiety* (T =2.3, p = 0.01) (Figure 7) and the *depression* measure (T = 1.5, p = 0.01) (Figure 8).

Finally, in the results from the *Treatment satisfaction questionnaire*, all participants obtained significant changes in these variables after treatment, which demonstrates improvement for both treatment conditions.

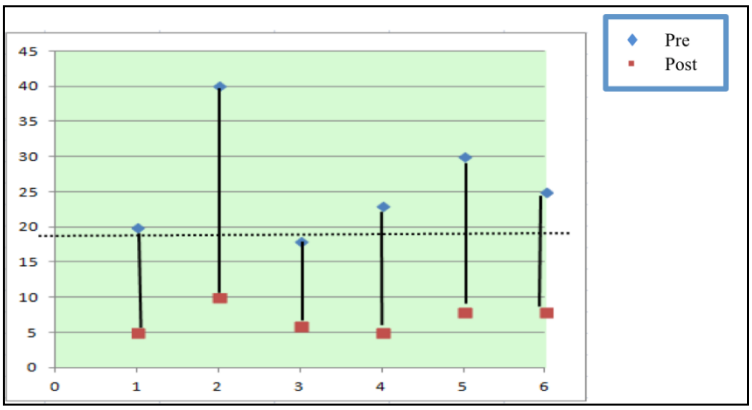

Figure 5. *Data obtained for PTSD symptoms in the VRET (n=6).*

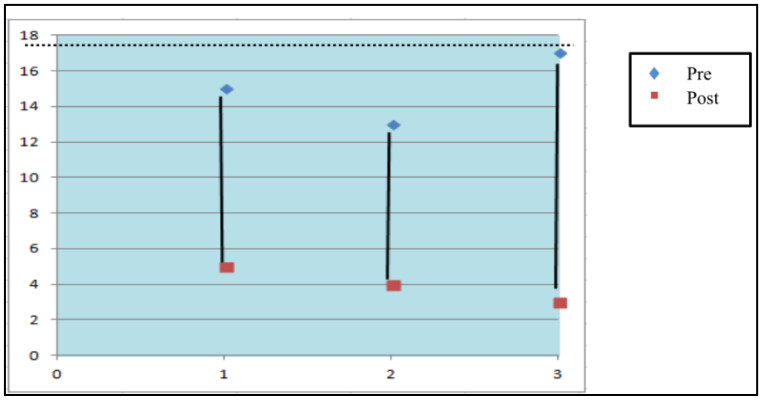

Figure 6. *Data obtained for ASD symptoms in the VRET (n=3).*

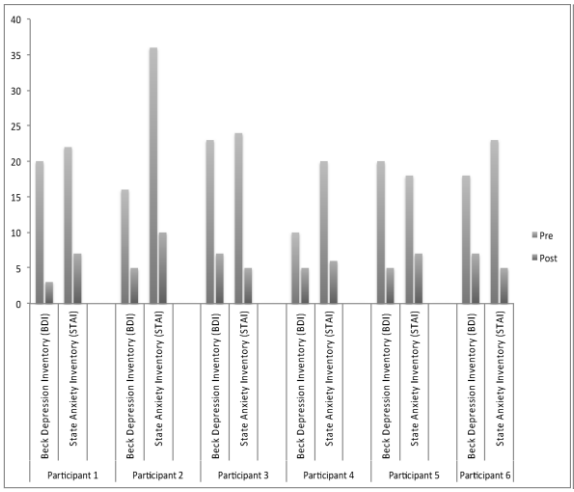

Figure 7. *State anxiety and depression measures in the PTSD.*

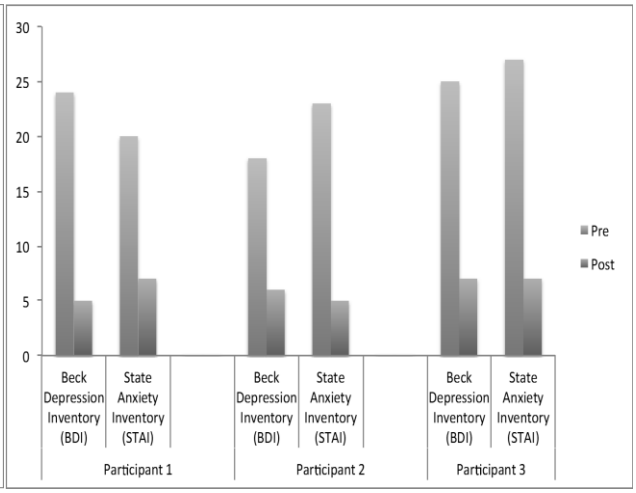

Figure 8. *State anxiety and depression measures in the ASD.*

4. CONCLUSIONS

The primary goal of this study was to examine the efficacy of virtual reality exposure in two treatments: PTSD and ASD. Results indicate that 100 percent of participants who received VRT showed a clinically significant (>30 percent) improvement in their PTSD symptoms after 12 weeks of treatment.

The response rates seen here are similar to those reported in previous, single-group design studies that have investigated VR-based therapies (Gahm, Reger, Ingram, Reger and Rizzo, 2013; Opriş, Pintea, García-Palacios, Botella, Szamosközi and David, 2012) as well as for other forms of exposure therapy for PTSD.

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From data obtained from a case study (Cárdenas and de la Rosa, 2011a) and pilot open clinical trial, application of the VR exposure technique was effective in reducing symptoms of re-experiencing, avoidance and hyper arousal, which confirms the clinical preference for this technique to treat PTSD and ASD. The participant informed the therapists of feeling comfortable with the technology, as well as experiencing an improvement in functioning in many areas of his life as a result of treatment.

Improvement was seen in the intragroup measures of PTSD, anxiety and depression for both groups receiving treatment. Data confirm the results of background studies regarding the effectiveness of treatment using virtual reality, supporting the generalizability of empirically validated treatments that have shown effectiveness and efficiency in the treatment of victims of such violence in the Mexican population.

Participants showed lower scores on the subscale of avoidance symptoms, implying a greater ability from the participant's to generalize what they learned during the virtual reality therapy session to everyday life situations. This confirms the findings of Botella, Quero, Serrano, Baños and García-Palacios (2009) and Rizzo, Gerardi, Rothbaum, Ressler and Heekin (2008) on the contribution of virtual reality to reduce cognitive avoidance and therefore enhance the generalization of change in the exposure to real stimuli. Therefore, the results suggest exploring in future studies the mechanisms and moderators of clinical change that explain the effectiveness of exposure through virtual reality technologies and its differential impact on reducing post-traumatic symptoms.

Regarding the satisfaction of the participants once concluded the treatment; there were no difference in preference between the VRET condition and the IET condition. Participants consider both treatments useful and would recommend it to a friend or family member to address de issue of PTSD. However, there were significant differences in the in the degree of aversion evaluated by the participants, which is consistent with the stated by García-Palacios, Botella, Hoffman and Fabregat (2007) and Rizzo *et al*. (2008) by affirming that is easier for participants to take the first step to face their fear when they can do it through virtual environments.

In particular, the creation of VR environments for these manifestations of violence offers many advantages ranging from cost savings, design of safe treatment environments, stimulus control, and feedback for both patient and clinician. Additionally, their validation represents a great impact in our country as well as support for the dissemination of empirically validated interventions for the treatment of pathological grief, PTSD and adaptive disorders highly related to these new threats to psychological wellbeing.

Although these initial results are promising, the study conducted was limited. Unfortunately, the sample size was too small, not blinded assessment, did not have a control group that allowed for a wide variety of possible treatments, and did not include long-term follow up.

Finally, it is noted that the study population has individual characteristics that made difficult to recruit the sample and therefore it was not possible to work with larger groups of people. Most participants had economic problems that prevented them from going to therapy, some were involved in legal proceedings that forced them to continually confront the memory of the traumatic event and led to treatment discontinuation.

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