The use of VR exposure in the treatment of motor vehicle PTSD: A case-report

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Abstract

Posttraumatic Stress Disorder (PTSD) is a psychiatric diagnosis with 8 – 40% prevalence in Motor Vehicle Accident (MVA) survivors. This paper reports on a case study about a subject that underwent a VR exposure program designed to reduce PTSD symptomatology that was developed after a violent MVA. The VR world consisted of a 4 lane highway setup with traffic on both ways that was displayed to the patient through a 295 X 225 cm Translucid Screen. In the 4 sessions, the participant, a 42-year-old female, was driven down the highway by a therapist. The intensity of anxiety cues was raised throughout the sessions. The patient had to overcome events such as traffic intensity variation, tunnels and crossings. From HADS questionnaire, very high anxiety and depression scores were reported. IES results also indicated a reduction in intrusion and avoidance scores, even though the subject remains within the severe PTSD cohort. Physiological measures such as ECG and GSR pointed out a reduction in psychophysiological activity.

Keywords: PTSD, VR, exposure, motor vehicle accident

Introduction

In Portugal, Motor Vehicle Accidents (MVA) are a serious public health problem. On average, for a driving qualified population of more than 5 million people, 40,000 MVAs are registered per year in Portugal (DGV, 2005). Though decreasing in death toll, 1,094 deaths from MVA were registered in 2005. This fact propels this country to the leading position as far as MVA is concerned in the European context, having the first highest death per capita rating in the western European Union. Regrettably, this is not the only concern with MVA consequences. The numbers related to small and severe physical injuries are also alarming, 50,000 Portuguese, around 0.5% of the Portuguese population, are victims of MVA. It is estimated that MVAs cost between 2 and 3% of Portuguese GDP.

The consequences of MVA, are not circumscribed to physical injuries. Phobia, Acute Stress Disorder (ASD) and Post-traumatic Stress Disorder (PTSD) are some of the possible consequences from a traumatic MVA experience. The consequences of a MVA can also include depression and panic attack (Blanchard et al, 1995; Mayou, Bryant & Ehlers, 2001).

Albuquerque, et al. (2003), developed a community study in which 5.6% of the individuals exposed to serious MVA present PTSD symptoms. Blanchard & Hickling (1997) estimate that 8 to 40% of MVA victims present PTSD. Pires & Maia (2006) presented results in which they suggest that on the first post accident evaluation (3/4 days), 55% of the 42 subjects presented PTSD symptoms. Four months past the accident, the percentage was reduced to 31%, even though 7.1% of the subjects presented more symptoms than in the first evaluation. Furthermore, they found a significant correlation between the perception of fear at the moment of the accident and PTSD symptoms.

The most common therapy for the treatment of PTSD is exposure therapy, as suggested by the International Society for Traumatic Stress Studies (Foa et al, 2000). Traditionally, imagination exposure, in the impossibility of in vivo exposure such as in the MVA cases, is the chosen technique used by psychotherapists. However, more often than not, patients with severe anxiety disorders are not willing to cooperate with the therapist when asked to imagine the situation that induced the trauma. By itself, the avoidance of recalling the traumatic experience is a PTSD symptom. On the other hand, some of them are not able or not willing to engage emotionally which may reduce therapy success (Jaycox, Foa & Morral, 1998).

This brings about a new challenge to psychotherapists, as traditional techniques may not deliver the expected results. An alternative to in vivo and to imagination
exposure may reside in Virtual Reality Exposure (VRE). The use of VRE, despite being in its infancy, is not a novel technique within the anxiety disorder therapies milieu. In fact, for more than a decade, VR is being used to treat patients with acrophobia (Emmelkamp et al, 2001), arachnophobia (Garcia-Palacios et al, 2002; Carlin, Hoffman & Weghorst, 1997), claustrophobia (Botella, 2000) and fear of flying (Rothbaum et al, 2000), among other pathologies. Even where PTSD is concerned, there are several studies published. Difede et al (2002) studied patients with PTSD from World Trade Center attacks, Josman (2005) patients with PTSD from suicide bomb attacks in Israel, Rizzo et al. (2006), soldiers that had returned from Iraq with PTSD and Gamito et al. (2005) reported a case study with an Angola Veteran. However, studies are missing when it comes to the use of VRE on MVA patients. In this way, this paper reports an ongoing study about a patient that developed PTSD after a traumatic MVA.

Methodology
The participant was a 42-year-old Portuguese woman. The patient met DSM-IV (APA, 1994) criteria for PTSD with depressive symptoms. Prior to trial, the participant was in psychotherapy and was medicated with Fluoxetina, Clobozam and Lorazepam, with stable medication 3 months before VR exposure.

Participant was exposed through a 295 X 225 cm Translucid Screen installed in the Neurophysiology Service of the Hospital of Júlio de Matos. A wide lens XGA VPLPX 41 Sony projector and a Creative 5.1 surround sound system plugged to a P4 3.4 GHz with a 7800 GT graphic board were in use. The patient was seated on a chair positioned over a platform coupled with a set of 2 Aura bass shakers. The projected VR world was developed using Valve graphic editor Hammer and consisted of a driving environment where the subject was driven through a highway scenario. Throughout 4 sessions, the participant was exposed to increasingly anxiety triggering events such as horns, an increasing proximity to the surrounding buildings, increasing traffic and highway obstacles (i.e. driving trough tunnel) (Figure 1).

Figure 1: VR world highway

While electrodes for EEG (Electroencephalography), GSR (Galvanic Skin Response) and ECG (Electrocardiography) where put in place, the patient engaged in dialogue counseling with her therapist assistant. This dialogue was maintained during exposure and at the end of sessions. On these two situations, the therapist also asked the patient to control her anxiety levels using anxiety management techniques learned in psychotherapy. Besides EEG, GSR and ECG recordings, video imagery was also registered.

Besides psychophysiological records, data was collected through clinical and self-report measures, namely, the Clinician-administered Impact of Events Scale (IES; Horowitz, Wilner & Alvarez, 1979); and ITC Sense of Presence Inventory (ITC-SOPI; Lessiter et al. 2001). PTSD was diagnosed through a structured clinical interview for DSM-IV. Self-report measures were applied before first session and after final session (4th session)

This protocol used the same graded exposure approach as in other PTSD studies in which VRE was applied (Rothbaum et al, 2001; Gamito et al., 2005). Nevertheless, as literature is absent on the existence of VR worlds developed to treat MVA PTSD patients, a new setup and new cues were needed. This VR world is available on request from the Laboratory of Computing Psychology, at Universidade Lusófona de Humanidades e Tecnologias (Lisbon). However, in order to unleash its full potential
and customizable capabilities, the requesters must have Half-life2 software (in order to present the scenario) and Hammer World Editor (in order to edit it).

Table 1. Virtual Reality Exposure sessions

<table>
<thead>
<tr>
<th>Sessions</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Driving in a low intensity traffic highway</td>
<td>Driving in a medium intensity traffic highway</td>
<td>Driving in a high intensity traffic highway</td>
<td>Driving in a high intensity traffic highway with reduction of field of view</td>
</tr>
<tr>
<td>Duration (min.)</td>
<td>20</td>
<td>22</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>Trigger</td>
<td>No trigger</td>
<td>Horns</td>
<td>Horns + crossover</td>
<td>Horns + crossover + narrowing field of view</td>
</tr>
</tbody>
</table>

Note:
Low intensity traffic: approximately 10 vehicles;
Medium intensity traffic: approximately 50 vehicles;
High intensity traffic: approximately 150 vehicles;
High intensity traffic with reduction of field of view: approximately 150 vehicles with addition of buildings close to the highway.

Results and discussion
Results, for psychometric measures, were divided into different moments, pre treatment and post treatment assessments. Since this study was a single subject trial, no statistical inferential analyses were performed. As can be seen in the tables below, scores on self-report measures decreased from pre treatment to the post treatment assessment (4 sessions). Accordingly, reported anxiety and depression scores (HADS), evidenced a decrease in these dimensions between pre and post treatment assessments (Table 1).

Table 1. Total scores for Anxiety and Depression in the initial and final assessment.

<table>
<thead>
<tr>
<th>HADS</th>
<th>Initial assessment</th>
<th>Final assessment</th>
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</thead>
<tbody>
<tr>
<td>Anxiety</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>Depression</td>
<td>17</td>
<td>16</td>
</tr>
</tbody>
</table>

The same pattern was observed for symptoms related to PTSD; in a pre treatment stage the patient related 31 for Intrusion and 31 for Avoidance behaviours with a total score of 62 corresponding to a severe condition. In the post treatment stage, scores showed a decrease in these symptoms with 27 for Intrusion, 21 for Avoidance and a total score of 48, however, still corresponding to a severe PTSD condition (Table 2).

Table 2. Total scores for Anxiety and Depression in the initial and final assessment.

<table>
<thead>
<tr>
<th>IES</th>
<th>Initial assessment</th>
<th>Final assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrusion</td>
<td>31</td>
<td>27</td>
</tr>
<tr>
<td>Avoidance</td>
<td>31</td>
<td>21</td>
</tr>
<tr>
<td>Total score</td>
<td>62</td>
<td>48</td>
</tr>
</tbody>
</table>

Table 3 presents the reduction on the scores for HADS and IES.

Table 3. Scores reduction proportion.

<table>
<thead>
<tr>
<th>Measures</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety (HADS)</td>
<td>-16</td>
</tr>
<tr>
<td>Depression (HADS)</td>
<td>-6</td>
</tr>
<tr>
<td>IES Total Score</td>
<td>-22</td>
</tr>
<tr>
<td>Intrusion</td>
<td>-13</td>
</tr>
<tr>
<td>Avoidance</td>
<td>-32</td>
</tr>
</tbody>
</table>
Psychophysiological records, namely ECG (Electrocardiogram) and GSR (Galvanic Skin Response), showed a decreased global pattern of physiological activity. Within each session, psychophysiological measures were evaluated in four different moments, in a stage before virtual exposure (baseline), in the initial stage of the virtual exposure, 10 minutes after the beginning and at the end of the session (around 20 minutes after beginning). These results are presented in Chart 1 for ECG and in Chart 2 for GSR.

Chart 1: ECG data

![Estimated Marginal Means of ECG](image)

From charts analysis, a reduction on every measured dimension was observed. However, in session 2 the subject presented a larger increase on the autonomic reactivity than previous and later sessions. However, no significant differences were found between sessions, for ECG and GSR values. In fact, through ANOVA of Repeated Measures, the test values for ECG and GSR were, respectively, F(3) = 3.222; p = .075 and F(3) = 1.363; p = .315.

Nonetheless, a within sessions analysis showed significant differences (F(3) = 9.217; p = .012) between moments of exposure for ECG. In this way, patient heart rate was significantly higher ten minutes after beginning the VRE, following which a significant decrease was reported (see Chart 3). No significant differences were found for GSR.

Through observational methods, a decrease in observable emotional reactions (e.g. crying) between sessions was also reported. On first two initial sessions, patient revealed extreme anticipatory anxiety reactions, which were decreasing in intensity during treatment.
The results of this case study indicate a slight decrease of the anxiety and depression symptoms after a 4-session treatment. Furthermore, the observational results derived from the video recording analysis strengthen the indications given by HADS questionnaire. Patient non-verbal behaviour showed clear reduction in agitation and rejection behaviour as the sessions progressed. In the 4th session, the patient mentioned a predisposition towards driving. The predisposition is at least a relevant sign, even though the results from the IES indicate only a small decrease in the PTSD related Avoidance and Intrusion symptoms, since the subject is still in the severe PTSD cohort.

Also, psychophysiological measures pointed towards these results. Heart rate reduction (considered to be an important marker) from session 1 to session 4 may indicate a reduction in the anxiety and PTSD symptoms. This evidence was also referred to by other authors (Foa & Kozac, 1986; Wilhelm et al, 2005). Moreover, the fact that the psychophysiological activation has increased from the first to the second session, and progressed downwards afterward, is congruent with the results of the therapeutic process.

These results are in consonance with results from other studies that use VR exposure techniques to treat PTSD. Concerning war veterans, a decrease of 34% and of between 15% and 67% on PTSD symptoms, was, respectively, found in two studies with American Vietnam combatants that were exposed to VR worlds (Rothbaum et al., 1999; Rothbaum et al., 2001). In one case report from one Portuguese veteran, a decrease of 14% on Avoidance and Intrusion criteria was observed (Gamito, et al., 2007). However, further studies are needed in order to fully assess VRE within MVA PTSD patients. With the knowledge learned it is now possible to open this protocol to other patients with this pathology.

References


