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VR PTSD Exposure Therapy Results with Active Duty OIF/OEF Combatants

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Abstract. Post Traumatic Stress Disorder (PTSD) is reported to be caused by traumatic events that are outside the range of usual human experience including military combat, violent personal assault, being kidnapped or taken hostage and terrorist attacks. Reports indicate that at least 1 out of 6 Iraq War veterans are exhibiting symptoms of depression, anxiety and PTSD. Virtual Reality exposure therapy has been previously used for PTSD with reports of positive outcomes. This paper will present a brief description of the USC/ICT *Virtual Iraq/Afghanistan* PTSD therapy application and present clinical outcome data from active duty patients treated at the Naval Medical Center-San Diego (NMCSD) as of October 2009. Initial outcomes from the first twenty patients to complete treatment indicate that 16 no longer meet diagnostic criteria for PTSD at post treatment. Research and clinical tests using the *Virtual Iraq/Afghanistan* software are also currently underway at Weill Cornell Medical College, Emory University, Fort Lewis and WRAMC along with 20 other test sites.

Keywords. PTSD, Virtual Reality, Exposure Therapy

Introduction

War is perhaps one of the most challenging situations that a human being can experience. The physical, emotional, cognitive and psychological demands of a combat environment place enormous stress on even the best-prepared military personnel. Such stressful experiences that commonly occur in combat environments have a considerable likelihood for producing significant numbers of returning soldiers at risk for developing PTSD. The data coming from both survey studies and anecdotal observations indicate that a large number of returning military personnel from the Iraq/Afghanistan conflicts are reporting symptoms that are congruent with the diagnosis of PTSD [1-3].

Among the many approaches that have been used to treat PTSD, cognitive-behavioral treatment (CBT) with Prolonged Exposure (PE) appears to have the best-documented therapeutic efficacy [4-5]. PE is a form of individual psychotherapy based

on Foa and Kozak's [6] emotional processing theory, which posits that PTSD involves pathological fear structures that are activated when information represented in the structures is encountered. These fear structures are composed of harmless stimuli that have been associated with danger and are reflected in the belief that the world is a dangerous place. Successful treatment requires emotional processing of the fear structures in order to modify their pathological elements so that the stimuli no longer invoke fear. Imaginal exposure entails engaging mentally with the fear structure through repeatedly revisiting the traumatic event in a safe environment. In practice, a person with PTSD typically is guided and encouraged by the clinician gradually to *imagine, narrate and emotionally process* the traumatic event within the safe and supportive environment of the clinician's office. This approach is believed to provide a low-threat context where the patient can begin to therapeutically process the emotions that are relevant to the traumatic event as well as de-condition the learning cycle of the disorder via a habituation/extinction process. Expert treatment guidelines for PTSD published for the first time in 1999 recommended that CBT with PE should be the first-line therapy for PTSD [4]. The comparative empirical support for exposure therapy was also recently documented in a review by the Institute of Medicine at the National Academies of Science of 53 studies of pharmaceuticals and 37 studies of psychotherapies used in PTSD treatment [5]. The report concluded that while there is not enough reliable evidence to draw conclusions about the effectiveness of most PTSD treatments, there is sufficient evidence to conclude that exposure therapies are effective in treating people with PTSD.

While the efficacy of imaginal PE has been established in multiple studies with diverse trauma populations, many patients are unwilling or unable to effectively visualize the traumatic event. This is a crucial concern since avoidance of cues and reminders of the trauma is one of the cardinal symptoms of the DSM diagnosis of PTSD. In fact, research on this aspect of PTSD treatment suggests that the inability to emotionally engage (*in imagination*) is a predictor for negative treatment outcomes [7]. To address this problem, researchers have recently turned to the use of Virtual Reality (VR) to deliver exposure therapy (VRET) by immersing clients in simulations of trauma-relevant environments in which the emotional intensity of the scenes can be precisely controlled by the clinician. In this fashion, VRET offers a way to circumvent the natural avoidance tendency by directly delivering multi-sensory and context-relevant cues that evoke the trauma without demanding that the patient actively try to access his/her experience through effortful memory retrieval. Within a VR environment, the hidden world of the patient's imagination is not exclusively relied upon and VRET may also offer an appealing, non-traditional treatment approach that is perceived with less stigma by "digital generation" service members and veterans who may be reluctant to seek out what they perceive as traditional talk therapies. Previous successful research applying VRET for the treatment of PTSD has been detailed elsewhere [10-11].

1. Brief *Virtual Iraq* System Description

With this history in mind, the USC Institute for Creative Technologies (ICT) has created an immersive virtual reality system for exposure therapy with combat-related PTSD. The treatment environment is based on a creative approach to recycling virtual assets that were initially built for the commercially successful X-Box game and tactical

training simulation scenario, *Full Spectrum Warrior*. As well, other existing and newly created assets available to ICT have been integrated into this rapidly evolving application. The *Virtual Iraq* application (and the new *Virtual Afghanistan* scenario) consists of a series of virtual scenarios designed to represent relevant contexts for VR exposure therapy, including middle-eastern themed city and desert road environments (See Figures 1-2). In addition to the visual stimuli presented in the VR HMD, directional 3D audio, vibrotactile and olfactory stimuli of relevance can be delivered. The presentation of additive, combat-relevant stimuli in the VR scenarios can be controlled by a therapist via a separate "wizard of oz" Clinical Interface (Figure 3), while in full audio contact with the patient. The clinical interface is a key feature in that it provides a clinician with the capacity to customize the therapy experience to the individual needs of the patient. The clinician can place the patient in VR scenario locations that resemble the setting in which the traumatic events initially occurred and can gradually introduce and control real time "trigger" stimuli (visual, auditory, olfactory and tactile) as is required to foster the anxiety modulation needed for therapeutic habituation. More system details can be found in Rizzo et al. [12].

Figure 1. Virtual Iraq City

Figure 2. Virtual Afghan Roadway

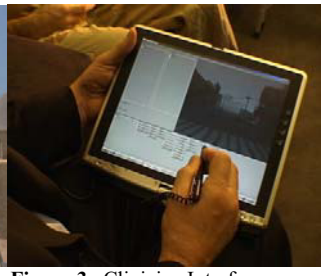

Figure 3. Clinician Interface

2. Results

2.1. Initial Assessment of Service Member (SMs) Acceptance of VR in Treatment

User-centered design feedback needed to iteratively evolve the system was gathered from a system deployed in Iraq with an Army Combat Stress Control Team and from returning Iraq War veterans in the USA. The user-centered results indicated that *Virtual Iraq* was capable of producing the level of "presence" in Iraq-experienced SMs that was believed to be required for exposure therapy. However, successful clinical implementation also requires patients to accept the approach as a useful and credible behavioral health treatment. To address this issue, a survey study with 325 Army Service Members (SMs) from the Madigan Army Medical Center/Fort Lewis deployment screening clinic was conducted to assess knowledge of current technologies and attitudes towards the use of technology in behavioral healthcare [13]. One section of the survey asked these active duty SMs to rate on a 5-point scale how willing they would be to receive mental health treatment ("Not Willing at All" to "Very Willing") via traditional approaches (e.g. face-to-face counseling) and a variety of technology-oriented delivery methods (e.g. website, video teleconferencing, use of VR). Eighty-three percent of participants reported that they were neutral-to-very willing to use some form of technology as part of their behavioral healthcare, with 58% reporting some willingness to use a VR treatment program. Seventy-one percent of SMs were

equally or more willing to use some form of technological treatment than solely talking to a therapist in a traditional setting. Most interesting is that 20% of SMs who stated they were not willing to seek traditional psychotherapy, rated their willingness to use a VR-based treatment as neutral to very willing. One possible interpretation of this finding is that a subgroup of this sample of SMs with a significant disinterest in traditional mental health treatment would be willing to pursue treatment with a VR-based approach. It is also possible that these findings generalize to SMs who have disengaged from or terminated traditional treatment.

2.2. Results from a Clinical Trial using Virtual Iraq at the NMCSD/Camp Pendleton

The *Virtual Iraq/Afghanistan* system built from this user-centered design process has been tested in an open clinical trial with PTSD-diagnosed active duty SMs at NMCSD and Camp Pendleton. The Office of Naval Research funded the initial system development of *Virtual Iraq* along with this initial trial to evaluate the feasibility of using VRET with active duty participants. The participants were SMs who recently redeployed from Iraq and who had engaged in previous PTSD treatments (e.g., group counseling, SSRIs, etc.) without benefit. The standard treatment protocol consisted of 2X weekly, 90-120 minute sessions over five weeks that also included physiological monitoring (HR, GSR and respiration) as part of the data collection. However, in this open clinical trial, elements of the protocol were occasionally modified (i.e., adjusting the number and timing of sessions) to meet patients' needs and thus these data represent an uncontrolled feasibility trial. The VRET exposure exercises followed the principles of graded prolonged behavioral exposure and the pace was individualized and patient-driven. The first VRET session consisted of a clinical interview that identified the index trauma, provided psychoeducation on trauma and PTSD, and instruction on a deep breathing technique for general stress management purposes. The second session provided instruction on the use of Subjective Units of Distress (SUDS), the rationale for prolonged exposure (PE), including imaginal exposure and in-vivo exposure. The participants also engaged in their first experience of imaginal exposure of the index trauma and an in-vivo hierarchical exposure list was constructed, with the first item assigned as homework. Session three introduced the rationale for VRET and the participant experienced the VR environment without recounting the index trauma narrative for approximately 25 minutes with no provocative trigger stimuli introduced. Sessions four through ten focused on the participant engaging in the VR while recounting the trauma narrative. Generally, participants were instructed that they would be asked to recount their trauma in the first person, as if it were happening again with as much attention to sensory detail as they could provide. Using clinical judgment, the therapist might prompt the patient with questions about their experience or provide encouraging remarks as deemed necessary to facilitate the recounting of the trauma narrative. The treatment included homework, such as requesting the participant to listen to the audiotape of their exposure narrative from the most recent session as a form of continual exposure for processing the index trauma to further enhance the probability for habituation to occur. Self-report measures were obtained at baseline and prior to sessions 3,5,7,9,10 and one week and three months post treatment to assess in-treatment and follow-up symptom status. The measures used were the PTSD Checklist-Military Version (PCL-M) [14], Beck Anxiety Inventory (BAI) [15] and Patient Health Questionnaire-Depression (PHQ-9) [16].

Initial analyses of results from the first 20 *Virtual Iraq* treatment completers (19 male, 1 female, Mean Age=28, Age Range: 21-51) have indicated positive clinical outcomes. For this sample, mean pre/post PCL-M scores decreased in a statistical and clinically meaningful fashion; Mean (standard deviation) values went from 54.4 (9.7) to 35.6 (17.4). Paired pre/post t-test analysis showed these differences to be significant ($t=5.99$, $df=19$, $p < .001$). Correcting for the PCL-M no-symptom baseline of 17 indicated a greater than 50% decrease in symptoms and 16 of the 20 completers no longer met DSM criteria for PTSD at post treatment. Five participants in this group with PTSD diagnoses had pre-treatment baseline scores below the conservative cutoff value of 50 (prescores= 49, 46, 42, 36, 38) and reported decreased values at post treatment (postscores= 23, 19, 22, 22, 24, respectively). Individual participant PCL-M scores at baseline, post treatment and 3-month follow-up are in Figure 4. For this same group, mean Beck Anxiety Inventory scores significantly decreased 33% from 18.6 (9.5) to 11.9 (13.6), ($t=3.37$, $df=19$, $p < .003$) and mean PHQ-9 (depression) scores decreased 49% from 13.3 (5.4) to 7.1 (6.7), ($t=3.68$, $df=19$, $p < 0.002$) (see Figure 5).

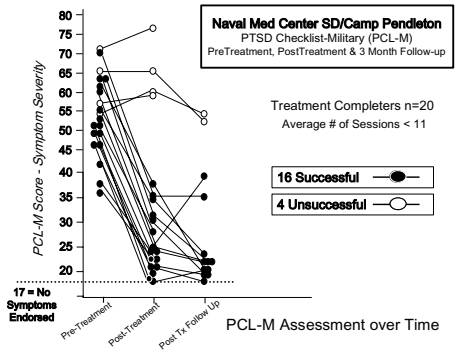

Figure 4. PTSD Checklist scores across treatment

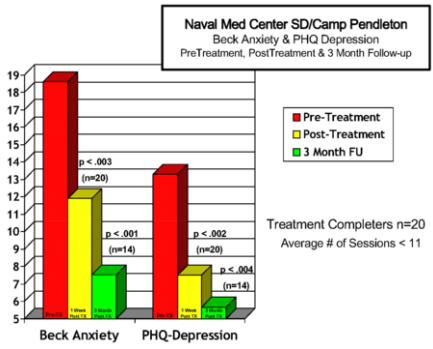

Figure 5. BAI and PHQ-Depression scores

The average number of sessions for this sample was just under 11. Also, two of the successful treatment completers had documented mild and moderate traumatic brain injuries, which suggest that this form of exposure can be usefully applied with this population. In spite of these initial positive results for treatment completers, challenges existed with dropouts from this active duty sample. Seven participants who were assessed and approved for the study failed to appear at the first session, six attended the first session and dropped out prior to formal commencement of VRET at session four, and seven dropped out at various points following session four. While some of these active duty participants left due to transfers and other reasons beyond their control, these dropout numbers are concerning and we intend to examine all data gathered from this subset of the total sample to search for discriminating factors.

3. Conclusions

The positive clinical outcomes observed from our initial 20 treatment completers are encouraging, although we are cautious not to make excessive claims based on these early results. At the current time we are continuing to gather data and feedback from

patients regarding the therapy and the *Virtual Iraq/Afghanistan* environment in order to continue our iterative system development process. And in fact, we recently released an updated version of the system in October 2008 with added functionality that has its design "roots" from feedback acquired from these initial patients and the therapists who have used the system thus far. It should also be noted that this project is currently in an open clinical trial phase. As such, we intend to use such initial results to develop, explore and test hypotheses as to how we can improve assessment, treatment, and most importantly, determine what patient characteristics may predict who will benefit from VR exposure therapy and who may be best served by other approaches. Other clinical trials are currently underway at Ft. Lewis, Emory University, Weill Cornell Medical College, Walter Reed Army Medical Center and 20 other sites to assess this approach.

REFERENCE:

[1] Hoge, C.W., Castro, C.A., Messer, S.C., McGurk, D., Cotting, D.I. and Koffman, R.L. (2004). Combat Duty in Iraq and Afghanistan, Mental Health Problems, and Barriers to Care. *New England Journal of Medicine*, 351(1):13-22.

[2] Seal, K.H., Bertenthal, D., Nuber, C.R., Sen, S. & Marmar, C. (2007). Bringing the War Back Home: Mental Health Disorders Among 103,788 US Veterans Returning From Iraq and Afghanistan Seen at Dept. of Veterans Affairs Facilities. *Arch Intern Med 167*, 476-482.

[3] Tanielian, T., Jaycox, L.H., Schell, T.L., Marshall, G.N., Burnam, M.A., Eibner, C., Karney, B.R., Meredith, L.S., Ringel, J.S. et al. (2008). Invisible Wounds of War: Summary and Recommendations for Addressing Psychological and Cognitive Injuries. *Rand Report* Retrieved 04/18/2008, from: http://veterans.rand.org/

[4] Foa, E. B., Davidson, R. T. and Frances, A. (1999). Expert Consensus Guideline Series: Treatment of Posttraumatic Stress Disorder. *American Journal of Clinical Psychiatry, 60,* 5-76.

[5] Institute of Medicine Committee on Treatment of Posttraumatic Stress Disorder (2007), Treatment of Posttraumatic Stress Disorder: An Assessment of the Evidence. ISBN: 0-309-10925-6, 200 pages, Downloaded on 10/24/2007 from: http://www.nap.edu/catalog/11955.html

[6] Foa, E. B. and Kozak, M. J. (1986). Emotional processing of fear: exposure to corrective information. *Psychological Bulletin, 99*(1), 20-35.

[7] Jaycox, L.H., Foa, E.B., & Morral, A.R. (1998). Influence of emotional engagement and habituation on exposure therapy for PTSD. *Journal of Consulting and Clinical Psychology* 66: 186–192.

[8] Rothbaum, B., Hodges, L., Ready, D., Graap, K. & Alarcon, R. (2001). Virtual reality exposure therapy for Vietnam veterans with posttraumatic stress disorder. *Journal of Clinical Psychiatry* 62: 617-622.

[9] Bryant, R.A. (2005). Psychosocial Approaches of Acute Stress Reactions. *CNS Spectrums, 10*(2), 116-122.

[10] Rothbaum, B.O., Meadows, E.A., Resick, P., et al. (2000). Cognitive-behavioral therapy. In: Foa, E.B., Keane, M., Friedman, M.J. (eds.), *Effective treatments for PTSD.* New York: Guilford, pp. 60–83.

[11] Difede, J., Cukor, J., Jayasinghe, N., Patt, I., Jedel, S., Spielman, L., et al. (2007). Virtual Reality exposure therapy for the treatment of posttraumatic stress disorder following September 11, 2001. *Journal of Clinical Psychiatry, 68,* 1639-1647.

[12] Rizzo, A.A., Reger, G., Gahm G., Difede, J. & Rothbaum, B.O. (2008). Virtual Reality Exposure Therapy for Combat Related PTSD. In: *The Neurobiology of PTSD*, Shiromani, P., Keane, T. & LeDoux, J. (Eds.) (in press).

[13] Reger, G. M., Gahm, G. A., Rizzo, A. A., Swanson, R.A. & Duma, S. (in press). Soldier Evaluation of the Virtual Reality Iraq. *Telemedicine and e-Health*.

[14] Blanchard, E.B., Jones-Alexander, J., Buckley, T.C. and Forneris, C.A. (1996). Psychometric properties of the PTSD Checklist (PCL). *Behaviour Research and Therapy, 34*(8), 669-673.

[15] Beck, A.T., Epstein, N., Brown, G. and Steer, R.A. (1988). An inventory for measuring clinical anxiety: psychometric properties *Journal of Consulting and Clinical Psychology, 56*(6), 893-897.

[16] Kroenke K, Spitzer RL. (2002). The PHQ-9: A new depression and diagnostic severity measure. *Psychiatric Annals, 32*, 509-521.