

Stress resilience in virtual environments: training combat relevant emotional coping skills using virtual reality

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ABSTRACT

The incidence of posttraumatic stress disorder (PTSD) in returning OEF/OIF military personnel has created a significant behavioral healthcare challenge. This has served to motivate research on how to better develop and disseminate evidence-based treatments for PTSD. One emerging form of treatment for combat-related PTSD that has shown promise involves the delivery of exposure therapy using immersive Virtual Reality (VR). Initial outcomes from open clinical trials have been positive and fully randomized controlled trials are currently in progress to further investigate the efficacy of this approach. Inspired by the initial success of this research using VR to emotionally engage and successfully treat persons undergoing exposure therapy for PTSD, our group has begun developing a similar VR-based approach to deliver stress resilience training with military service members prior to their initial deployment. The STress Resilience In Virtual Environments (STRIVE) project aims to create a set of combat simulations (derived from our existing Virtual Iraq/Afghanistan PTSD exposure therapy system) that are part of a multi-episode interactive narrative experience. Users can be immersed within challenging combat contexts and interact with virtual characters within these episodes as part of an experiential learning approach for delivering psychoeducational material, stress management techniques and cognitive-behavioral emotional coping strategies believed to enhance stress resilience. The STRIVE project aims to present this approach to service members prior to deployment as part of a program designed to better prepare military personnel for the types of emotional challenges that are inherent in the combat environment. During these virtual training experiences users are monitored physiologically as part of a larger investigation into the biomarkers of the stress response. One such construct, Allostatic Load, is being directly investigated via physiological and neuro-hormonal analysis from specimen collections taken immediately before and after engagement in the STRIVE virtual experience. This paper describes the development and evaluation of the Virtual Iraq/Afghanistan Exposure Therapy system and then details its current transition into the STRIVE tool for pre-deployment stress resilience training. We hypothesize that VR stress resilience training with service members in this format will better prepare them for the emotional stress of a combat deployment and could subsequently reduce the later incidence of PTSD and other psychosocial health conditions.

1. 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. The stressful experiences that are characteristic of the OIF/OEF warfighting environments have produced significant numbers of returning SMs at risk for developing posttraumatic stress disorder (PTSD) and other psychosocial health conditions. In the first systematic study of OIF/OEF mental health problems, the results indicated that "...The percentage of study subjects whose responses met the screening criteria for major depression, generalized anxiety, or PTSD was significantly higher after duty in Iraq (15.6 to 17.1 percent) than after duty in Afghanistan (11.2 percent) or before deployment to Iraq (9.3 percent)" (p.13) (Hoge et al., 2004). Reports since that time on OIF/OEF PTSD and psychosocial disorder rates suggest even higher incidence rates (Fischer, 2012; Seal, Bertenthal, Nuber, Sen, & Marmar, 2007; Tanielian, et al., 2008). For example, as of 2010, the Military Health System recorded 66,934 active duty patients who have been diagnosed with PTSD (Fischer, 2012) and the Rand Analysis (Tanielian, et al., 2008) estimated that at a 1.5 million

deployment level, more than 300,000 active duty and discharged Veterans will suffer from the symptoms of PTSD and major depression. With total deployment numbers now having increased to over 2 million, the Rand Analysis likely underestimates the current number of service members who may require (and could benefit from) clinical attention upon the return home. These findings make a compelling case for a continued focus on developing and enhancing the availability of evidence-based treatments to address a mental health care challenge that has had a significant impact on the lives of our Service Members (SMs), Veterans and their significant others, who deserve our best efforts to provide optimal care.

At the same time there is a powerful rationale for developing methods that promote psychological fitness within the military with the same vigor that has been traditionally applied to physical fitness (Casey, 2011). Evidence of this can be seen in the funding and resources applied to the creation of stress resilience training programs such as the U.S Army's Comprehensive Soldier Fitness (CSF) program (Cornum et al., 2011). The core motive with such efforts is to provide resilience training that would serve to reduce the later incidence of PTSD and other psychological health conditions upon redeployment home (e.g., depression, suicide, substance abuse). Recent reports of CSF longitudinal outcomes over 18 months with 22,000 soldiers have produced positive outcomes (Lester et al., 2011), but this report has been criticized for its exclusive reliance on self-report data and on other methodological grounds (PBS, 2011). Regardless of those academic "battles", the post-deployment psychological health statistics are alarming and provide a compelling justification for continued efforts to better prepare SMs for the onslaught of emotional challenges that they may face during a combat deployment. This paper will detail our initial efforts to develop, implement and evaluate a virtual reality exposure therapy (VRET) system for PTSD treatment and then discuss our ongoing efforts to retool the VR system assets into a system that could be used for resilience training prior to a combat deployment. The STress Resilience In Virtual Environments (STRIVE) project builds on the Virtual Iraq/Afghanistan simulations developed for VRET, to create a series of immersive virtual interactive narrative episodes that present exemplars of the types of emotional challenges that SMs may face during a deployment. Within those digital contexts, a virtual human agent "mentor" delivers emotional coping strategies that leverage psychoeducational and stress reduction tactics, along with on-the-spot cognitive behavioral appraisal training designed to enhance coping skills for use when and if the SM is confronted with similar challenges during a combat deployment. The paper will conclude with a discussion of the biological markers of the stress response that we are measuring in the STRIVE project.

2. CLINICAL VIRTUAL REALITY

Concurrent with the start and progression of the OEF/OIF conflicts, a virtual revolution has taken place in the use of Virtual Reality (VR) simulation technology for clinical and training purposes. Technological advances in the areas of computation speed and power, graphics and image rendering, display systems, body tracking, interface technology, haptic devices, authoring software and artificial intelligence have supported the creation of low-cost and usable VR systems capable of running on a commodity level personal computer. VR allows for the precise presentation and control of stimuli within dynamic multi-sensory 3D computer generated environments, as well as providing advanced methods for capturing and quantifying behavioral responses. These characteristics serve as the basis for the rationale for VR applications in the clinical assessment, intervention and training domains. The unique match between VR technology assets and the needs of various clinical treatment and training approaches has been recognized by a number of scientists and clinicians, and an encouraging body of research has emerged that documents the many clinical targets where VR can add value to clinical assessment and intervention (Holden, 2005; Parsons and Rizzo, 2008; Rizzo et al., 2011a; Riva, 2011; Rose, Brooks and Rizzo, 2005). To do this, VR scientists have constructed virtual airplanes, skyscrapers, spiders, battlefields, social settings, beaches, fantasy worlds and the mundane (but highly relevant) functional environments of the schoolroom, office, home, street and supermarket. Emerging R & D is also producing artificially intelligent virtual human agents that are being used in the role of virtual patients for training clinical skills to novice clinical professionals (Lok et al., 2007; Rizzo et al., in press) and as anonymous online healthcare support agents (Rizzo et al., 2011b). This convergence of the exponential advances in underlying VR enabling technologies with a growing body of clinical research and experience has fueled the evolution of the discipline of Clinical Virtual Reality. And this state of affairs now stands to transform the vision of future clinical practice and research to address the needs of both civilian and military populations with clinical health conditions.

3. VIRTUAL IRAQ/AFGHANISTAN EXPOSURE THERAPY SYSTEM

Among the many approaches that have been used to treat persons with PTSD, graduated exposure therapy appears to have the best-documented therapeutic efficacy (Rothbaum, 2001; Bryant et al., 2005). Such treatment typically involves the graded and repeated imaginal reliving and narrative recounting of the

traumatic event within the therapeutic setting. This approach is believed to provide a low-threat context where the client can begin to confront and therapeutically process the emotions that are relevant to a traumatic event as well as de-condition the learning cycle of the disorder via a habituation/extinction process. While the efficacy of imaginal exposure has been established in multiple studies with diverse trauma populations (Rothbaum, et al., 2000, 2001, 2002), many patients are unwilling or unable to effectively visualize the traumatic event. In fact, avoidance of reminders of the trauma is inherent in PTSD and is one of the cardinal symptoms of the disorder.

To address this problem, researchers have recently turned to the use of VR to deliver Exposure Therapy (VRET) by immersing users in simulations of trauma-relevant environments in which the emotional intensity of the scenes can be precisely controlled by the clinician in collaboration with the patients' wishes. In this fashion, VRET offers a way to circumvent the natural avoidance tendency by directly delivering multi-sensory and context-relevant cues that aid in the confrontation and processing of traumatic memories 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 treatment option that is perceived with less stigma by "digital generation" SMs and Veterans who may be more reluctant to seek out what they perceive as traditional talk therapies.

These ideas have been supported by three reports in which patients with PTSD were unresponsive to previous *imaginal* exposure treatments, but went on to respond successfully to VR exposure therapy (Difede & Hoffman, 2002; Difede et al, 2006; Rothbaum, Hodges, Ready, Graap & Alarcon, 2001). As well, VR provides an objective and consistent format for documenting the sensory stimuli that the patient is exposed to that is not possible when operating within the unseen world of the patient's imagination. Based on this, the University of Southern California Institute for Creative Technologies developed a "Virtual Iraq/Afghanistan" simulation that is being used in a variety of clinical trials to investigate the efficacy of this form of treatment (see Figure 1).



Figure 1. *Virtual Iraq/Afghanistan: Middle Eastern City and Desert Road HUMVEE scenarios.*

The treatment environment consists of a series of virtual scenarios designed to represent relevant contexts for VR exposure therapy, including city and desert road environments. In addition to the visual stimuli presented in the VR head mounted display, directional 3D audio, vibrotactile and olfactory stimuli of relevance can be delivered. Stimulus presentation is controlled by the clinician via a separate "wizard of oz" interface, with the clinician in full audio contact with the patient. User-Centered tests with the application were conducted at the Naval Medical Center–San Diego and within an Army Combat Stress Control Team in Iraq. This feedback from non-diagnosed personnel provided information on the content and usability of our application that fed an iterative design process leading to the creation of the current clinical scenarios. A detailed description of the Virtual Iraq/Afghanistan system and the methodology for a standard VRET clinical protocol can be found elsewhere (Rothbaum, Difede, & Rizzo, 2008).

Initial clinical tests of the system have produced promising results. In the first open clinical trial, analyses of 20 active duty treatment completers (19 male, 1 female, Mean Age=28, Age Range: 21-51) produced positive clinical outcomes (Rizzo et al., 2011a). For this sample, mean pre/post PCL-M (Blanchard et al., 1996) scores decreased in a statistical and clinically meaningful fashion: 54.4 (SD =9.7) to 35.6 (SD = 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; 16 of the 20 completers no longer met PCL-M 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 (pre-scores = 49, 46, 42, 36, 38) and reported decreased values at post treatment (post-scores = 23, 19, 22, 22, 24,

respectively). Mean Beck Anxiety Inventory (Beck et al., 1988) scores significantly decreased 33% from 18.6 (SD = 9.5) to 11.9 (SD = 13.6), ($t=3.37$, $df=19$, $p < .003$) and mean PHQ-9 (Kroneke and Spitzer, 2002) (depression) scores decreased 49% from 13.3 (SD= 5.4) to 7.1 (SD = 6.7), ($t=3.68$, $df=19$, $p < .002$). The average number of sessions for this sample was just under 11. Results from uncontrolled open trials are difficult to generalize from and we are cautious not to make excessive claims based on these early results. However, using an accepted military-relevant diagnostic screening measure (PCL-M), 80% of the treatment completers in the initial VRET sample showed both statistically and clinically meaningful reductions in PTSD, anxiety and depression symptoms, and anecdotal evidence from patient reports suggested that they saw improvements in their everyday life. These improvements were also maintained at three-month post-treatment follow-up.

Other studies have also reported positive outcomes. Two early case studies reported positive results using this system (Gerardi et al., 2008; Reger & Gahm, 2008). Following those, another open clinical trial with active duty soldiers ($n=24$) produced significant pre/post reductions in PCL-M scores and a large treatment effect size (Cohen's $d = 1.17$) (Reger et al., 2011a). After an average of 7 sessions, 45% of those treated no longer screened positive for PTSD and 62% had reliably improved. Three randomized controlled trials (RCTs) are ongoing with the *Virtual Iraq/Afghanistan* system with active duty and Veteran populations. Two RCTs are focusing on comparisons of treatment efficacy between VRET and prolonged imaginal exposure (PE) (Reger & Gahm, 2010, 2011b) and VRET compared with VRET + a supplemental care approach (Beidel, Frueh & Uhde, 2010).

A third RCT (Difede, Rothbaum & Rizzo, 2010) is investigating the additive value of supplementing VRET and imaginal PE with a cognitive enhancer called D-Cycloserine (DCS). DCS, an N-methyl-d-aspartate partial agonist, has been shown to facilitate extinction learning in laboratory animals when infused bilaterally within the amygdala prior to extinction training (Walker, Ressler, Lu, and Davis, 2002). The first clinical test in humans that combined DCS with VRET was performed by Ressler et al. (2004) with participants diagnosed with acrophobia ($n=28$). Participants who received DCS + VRET experienced significant decreases in fear within the virtual environment 1 week and 3 months post-treatment, and reported significantly more improvement than the placebo group in their overall acrophobic symptoms at 3 month follow-up. This group also achieved lower scores on a psychophysiological measure of anxiety than the placebo group. The current multi-site PTSD RCT will test the effect of DCS vs. placebo when added to VRET and PE with active duty and veteran samples ($n=300$).

4. STRESS RESILIENCE IN VIRTUAL ENVIRONMENTS (STRIVE)

The current urgency in efforts to address the psychological wounds of war in SMs and Veterans has also driven an emerging focus within the military on emphasizing a proactive approach for better preparing service members for the emotional challenges they may face during a combat deployment to reduce the potential for later adverse psychological reactions such as PTSD and depression. This focus on resilience training prior to deployment represents no less than a quantum shift in military culture and can now be seen emanating from the highest levels of command in the military. For example, in an American Psychologist article, Army General George Casey (2011) makes the case that "...soldiers can "be" better before deploying to combat so they will not have to "get" better after they return." (p. 1), and he then calls for a shift in the military "...to a culture in which psychological fitness is recognized as every bit as important as physical fitness." (p. 2). This level of endorsement can be seen in practice by way of the significant funding and resources applied to a variety of stress resilience training programs across all branches of the U.S. Military (Luthar, Cicchetti & Becker, 2000; Hovar, 2010).

Resilience is the dynamic process by which individuals exhibit positive adaptation when they encounter significant adversity, trauma, tragedy, threats, or other sources of stress (McEwen & Stellar, 1993). The core aim of resilience training is to promote psychological fitness and better prepare service members for the psychological stressors that they may experience during a combat deployment. Perhaps the program that is attempting to influence the largest number of SMs is the Comprehensive Soldier Fitness (CSF) program (Cornum, Matthews & Seligman, 2011). This project has created and disseminated training that aims to improve emotional coping skills and ultimate resilience across all Army SMs. One element of this program draws input from principles of cognitive-behavioral science, which generally advances the view that it is not the event that causes an emotion, but rather how a person appraises the event (based on how they think about the event) that leads to the emotion (Ortony, Clore & Collins, 1988). From this theoretical base, it then follows that internal thinking or appraisals about combat events can be "taught" in a way that leads to more healthy and resilient reactions to stress. This approach does not imply that people with effective coping skills do not feel some level of "rational" emotional pain when confronted with a challenging event that would

normally be stressful to any individual. Instead, the aim is to teach skills that may assist soldiers in an effort to cope with traumatic stressors more successfully.

The STRIVE project has evolved from the Virtual Iraq/Afghanistan VRET system and aims to foster stress resilience by creating a set of combat simulations that can be used as contexts for SMs to experientially learn stress reduction tactics and cognitive-behavioral emotional coping strategies prior to deployment. This approach involves immersing and engaging SMs within a variety of virtual “mission” episodes where they are confronted with emotionally challenging situations that are inherent to the OEF/OIF combat environment. Interaction by SMs within such emotionally challenging scenarios aims to provide a more meaningful context in which to engage with psychoeducational information and to learn and practice stress reduction tactics and cognitive coping strategies that are believed to psychologically prepare a SM for a combat deployment. To accomplish this, STRIVE is being designed as a 30-episode interactive narrative in VR, akin to being immersed within a “Band of Brothers” type storyline that spans a typical deployment cycle. Within these episodes, SMs will get to know the distinct personalities of the virtual human characters in their squad and interact within an immersive digital narrative that employs cinematic strategies for enhancing engagement with the evolving storyline (e.g., strategic use of narration, montage shots, dynamic camera direction). At the end of each of the graded 10-minute episodes, an emotionally challenging event occurs, designed in part from feedback provided by SMs undergoing PTSD treatment (e.g., seeing/handling human remains, death/injury of a squad member, killing someone, the death/injury of a civilian child). At that point in the episode, the virtual world “freezes in place” and an intelligent virtual human “mentor” character emerges from the midst of the chaotic VR scenario to guide the user through stress-reduction psychoeducational and self-management tactics, as well as providing rational restructuring exercises for appraising and processing the virtual experience. The stress resilience training component is drawing on evidence-based content that has been endorsed as part of standard classroom-delivered DOD stress resilience training programs, as well as content that has been successfully applied in non-military contexts (e.g., humanitarian aid worker training, sports psychology).

In this fashion, STRIVE provides a digital “emotional obstacle course” that can be used as a tool for providing context-relevant learning of emotional coping strategies under very tightly controlled and scripted simulated conditions. Training in this format is hypothesized to improve generalization to real world situations via a state dependent learning component (Godden & Baddeley, 1980) and further support resilience by leveraging the learning theory process of latent inhibition. Latent inhibition refers to the delayed learning that occurs as a result of pre-exposure to a stimulus without a consequence (Feldner, Monson & Friedman, 2007; Lubow & Moore, 1959). Thus, the exposure to a simulated combat context is believed to decrease the likelihood of fear conditioning during the real event (Sones, Thorp & Raskind, 2011).

5. STRESS BIOMARKERS AND ALLOSTATIC LOAD

The STRIVE project also incorporates a novel basic science protocol. While other stress resilience efforts typically incorporate one or two biomarkers of stress and or resilience, the STRIVE projects will measure what we refer to as the “physiological fingerprint of stress,” commonly called Allostatic Load (AL). The theoretical construct of AL, initially developed by one of the STRIVE collaborators, Bruce McEwen, is a measure of cumulative wear and tear on physiological symptoms due to chronic stress (McEwen & Stellar, 1993). As a theoretical construct, it is a preliminary attempt to formulate the relationship between environmental stressors and disease, by hypothesizing mechanisms whereby multiple kinds of stressors confer risk simultaneously in multiple physiological systems. The construct of AL is based on the widely accepted response called allostasis. Sterling and Eyer (1988) defined allostasis as the body’s set points for various physiological mechanisms, such as blood pressure or heart rate, which vary to meet specific external demands, e.g., emotional stress. McEwen and Stellar (1993) furthered our understanding of allostasis by broadening its scope. Rather than discuss allostasis in terms of a single set point that changed in response to a stressor, they described allostasis as the combination of all physiological coping mechanisms that are required to maintain equilibrium of the entire system. Thus, allostasis is the reaction and adaptation to stressors by multiple physiological systems that brings the system back to equilibrium. The related concept of homeostasis refers specifically to system parameters essential for survival (McEwen, 2002). To place AL into the context of allostasis, allostasis does not always proceed in a normal manner. Any of the major physiological systems (e.g., inflammatory, metabolic, immune, neuroendocrine, cardiovascular, respiratory) in the process of responding to stress can exact a cost, or an allostatic load, that can result in some form of physiological or psychological disturbance. McEwen (2000) identified four types of AL. The first is frequent activation of allostatic systems; (2) is a prolonged failure to shut off allostatic activity after stress; (3) is a lack of adaptation to stress, and (4) is an inadequate response of allostatic systems leading to elevated activity of other, normally counter-regulated allostatic systems after stress (e.g., inadequate secretion of

glucocorticoid resulting in increased cytokines normally countered by glucocorticoids). Any of these types of AL intervene with the normal stress response of allostasis thus increasing AL. This will increase one's risk for disease in the long-term and may preclude the short-term development of physical hardiness and psychological resilience.

From a conceptual standpoint, the construct of AL is still undergoing development. More recent AL models posit the interaction of biomarkers on multiple levels. Juster et al., (2009) theorize that by measuring multi-systemic interactions among primary mediators (e.g., levels of cortisol, adrenalin, noradrenalin) and relevant sub-clinical biomarkers representing secondary outcomes (e.g., serum HDL and total cholesterol), one can identify individuals at high risk of tertiary outcomes (e.g., disease and mental illness). Yet we argue this approach does not fully encapsulate the dynamic, nonlinear, evolving, and adaptive nature of the interactions between these biomarkers. Moreover, these markers are not purely physiological. Psychological processes, including appraisal of and reactions to various stressors, e.g., resilience, may constitute a separate but interdependent subsystem in the allostatic model. We support a case-based approach to analysis, which acknowledges that each allostatic system is unique in its configuration based on differences in (1) environmental context, including the user's socioeconomic status and availability of psychosocial resources; (2) regulation and plasticity of bio-allostatic systems; (3) regulation and plasticity of what we term psycho-allostatic systems; (4) psychology, including personality and appraisal of stressors; (5) environmental stressors, which range from biological to sociological; and (6) health outcomes. For STRIVE, AL will be measured via the capture and integration of complex biomarkers known to indicate physiological dysfunction and normal function for numerous physiological systems (e.g., immune, cardiovascular, metabolic).

In a first study of its kind, we will determine if AL can predict acute response to stress (e.g., EEG, GSR, ECG, pupil dilation, etc.), when participants are exposed to the stressful VR missions. Further analyses will determine if AL can predict participants' responses to virtual mentor instructions on how the participants can cope with stress through stress resilience training. If we find that AL is capable of predicting either short-term response to stress or the ability to learn stress resilience, there would be numerous implications for the future use of AL, including identification of leadership profiles and for informing the development of appropriate training systems for all SMs. Pilot research on this project is ongoing at the Immersive Infantry Training center at Camp Pendleton and the status of that work will be presented at the ICDVRAT conference.

6. CONCLUSIONS

The STRIVE program is designed to both create a VR application for enhancing SM stress resilience and to provide a highly controllable laboratory test bed for investigating the stress response. Success in this area could have significant impact on military training and for the prevention of combat stress related disorders. Another option for use of the STRIVE system could involve its application as a VR tool for emotional assessment at the time of recruitment to the military. The large question with such an application involves whether it would be possible (and ethical) to assess prospective SMs in a series of challenging combat-relevant emotional environments delivered in the STRIVE system, to predict their potential risk for developing PTSD or other mental health difficulties based on their verbal, behavioral and physiological/hormonal reactions recorded during these virtual engagements. To use such information for recruitment decisions would require a change from current military thinking, where doctrine dictates that anyone can be made into an infantryman. However, practical implementation of such an approach could advise that those who display reactions that predict them to be most at risk to have a negative stress reaction post-combat, could either be assigned non-combat duties, not accepted into the services, or more preferably, presented with the opportunity to participate in a stress resilience training program that could minimize their identified risk to post-trauma dysfunction. This is not a new concept. Since the early days of the Army Alpha/Beta, assessments have been routinely conducted that are designed to predict what role is best suited to the unique characteristics and talent of a given recruit. Moreover, potential recruits are not accepted into the military for many reasons that are more easily measurable (e.g., having a criminal record, poor physical fitness, significant health conditions).

For this effort, the pragmatic challenge would be in the conduct of prospective longitudinal validation research. This would require the initial testing of a large number of SMs within standardized virtual simulations (i.e., STRIVE), to record and measure reactions for establishing a baseline and for also determining if advanced data mining procedures could detect whether consistent patterns of responding do in fact exist. SMs in this large sample could then be closely monitored for their mental health status during and after their deployment. Once a large enough sample of SMs were identified as having stress related problems, it would be possible to go back to their physiological and behavioral data from the earlier simulation experience and analyze for a consistent reactivity pattern that could differentiate this group and then serve as a marker for predicting problems in future recruits. The challenges for conducting this type of research are

also significant beyond the pragmatics of conducting costly longitudinal research. These would include the pressure that an all-volunteer service puts on the military to attract and maintain sufficient numbers, the traditional view that all recruits can be trained to success, and the potential that some future service members could be misidentified as high risk (false positives) and be denied access to joining the military. This further suggests that in addition to simply identifying the emotional and physiological profile associated with long-term stress-related dysfunction, a further step would be to tailor stress resilience training for specific emotional and physiological profiles. More extensive and in-depth stress resilience training programs could then be clearly proposed for those identified as at risk for PTSD and other psychosocial health conditions. And, the implications for research into individual susceptibility to stress related disorders could have ramifications beyond the military community. As we have seen throughout history, innovations that emerge in military healthcare, driven by the urgency of war, typically have a lasting influence on civilian healthcare long after the last shot is fired.

7. REFERENCES

- A T Beck, N Epstein, G Brown and R A Steer (1988), An inventory for measuring clinical anxiety: psychometric properties, *Journal of Consulting and Clinical Psychology*, **56**, 6, pp. 893-897.
- D C Beidel, B C Frueh and T W Uhde (2010), Trauma Management Therapy for OIF/OEF Veterans. Department of Defense United States Army Military Operational Medical Research Program: http://www.psych.ucf.edu/faculty_beidel.php
- E B Blanchard, J Jones-Alexander, T C Buckley and C A Forneris (1996), Psychometric properties of the PTSD Checklist (PCL), *Behaviour Research and Therapy*, **34**, 8, pp. 669-673.
- R A Bryant (2005), Psychosocial Approaches of Acute Stress Reactions, *CNS Spectrums*, **10**, 2, pp. 116-122.
- G W Casey (2011), Comprehensive soldier fitness: A vision for psychological resilience in the U.S. Army, *American Psychologist*, **66**, 1, pp. 1-3.
- R Cornum, M D Matthews, and M E P Seligman (2011), Comprehensive Soldier Fitness: Building resilience in a challenging institutional context, *American Psychologist*, **66**, 1, pp. 4-9.
- J Difede & H Hoffman (2002), Virtual reality exposure therapy for World Trade Center Post Traumatic Stress Disorder, *Cyberpsychology and Behavior*, **5**, 6, pp. 529-535.
- J 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.
- J Difede, B O Rothbaum and A Rizzo (2010-2013), Enhancing Exposure Therapy for PTSD: Virtual Reality and Imaginal Exposure with a Cognitive Enhancer. Randomized Controlled Trial: <http://clinicaltrials.gov/ct2/show/NCT01352637>
- M T Feldner, C M Monson and M J Friedman (2007), A critical analysis of approaches to targeted PTSD prevention: current status and theoretically derived future directions, *Behav. Modification*, **31**, pp. 80-116.
- H Fischer (2010 December 4), United States military casualty statistics: Operation New Dawn, Operation Iraqi Freedom, and Operation Enduring Freedom, Congressional Research Service 7-5700:RS22452. Retrieved from: <http://openocrs.com/document/RS22452/>
- M Gerardi, B O Rothbaum, K Ressler, M Heekin and A A Rizzo (2008), Virtual Reality Exposure Therapy Using a Virtual Iraq: Case Report, *Jour. of Traumatic Stress*, **21**, 2, pp. 209-213.
- D R Godden and A D Baddeley (1980), When Does Context Influence Recognition Memory? *British Journal of Psychology*, **71**, pp. 99-104.
- C W Hoge, C Castro, S Messer, D McGurk, D I Cotting & R L Koffman (2004), Combat Duty in Iraq and Afghanistan, Mental Health Problems, and Barriers to Care, *New England Jour. of Med.*, **351**, 1, pp. 13-22.
- M K Holden (2005), Virtual Environments for Motor Rehabilitation: Review, *CyberPsych. and Behav.*, **8**, 3, pp. 187-211.
- R Juster, B S McEwen and S J Lupien (2009), Allostatic load biomarkers of chronic stress and impact on health and cognition, *Neuroscience and Biobehavioral Review*, **35**, pp. 2-16.
- K Kroenke & R L Spitzer (2002), The PHQ-9: A new depression and diagnostic severity measure. *Psychiatric Annals* **32**, pp. 509-521.
- P B Lester, P D Harms, M N Herian, D V Krasikova and S J Beal (2011), The Comprehensive Soldier Fitness Program Evaluation Report #3: Longitudinal Analysis of the Impact of Master Resilience
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- B Lok, R E Ferdig, A Raij, K Johnson, R Dickerson, J Coutts and D S Lind (2007), Applying Virtual Reality in Medical Communication Education: Current Findings and Potential Teaching and Learning Benefits of Immersive Virtual Patients, *Jour. of Virtual Reality*, **10**, 3-4, pp. 185-195.
- R E Lubow and A U Moore (1959), Latent inhibition: The effect of non-reinforced exposure to the conditioned stimulus, *J Comp Physiol Psychol*, **52**, pp. 415-419.
- S S Luthar, D Cicchetti and B Becker (2000). The construct of resilience: A critical evaluation and guidelines for future work, *Child Development*, **71**, pp. 543-562.
- B S McEwen and E Stellar (1993), Stress and the individual: Mechanism leading to disease, *Archives of Internal Medicine*, **153**, pp. 2093-2101.
- B S McEwen (2000), Allostasis and allostatic load: Implications for neuropsychopharmacology, *Neuropsychopharmacology*, **22**, pp. 108-124. doi:10.1016/S0893-133X(99)00129-3
- B S McEwen (2002), Sex, stress and the hippocampus: Allostasis, allostatic load and the aging process, *Neurology of Aging*, **23**, pp. 921-939.
- A Ortony, G Clore and A Collins (1988), *The cognitive structure of emotions*. Cambridge University.
- T Parsons and Rizzo, A A (2008), Affective Outcomes of Virtual Reality Exposure Therapy for Anxiety and Specific Phobias: A Meta-Analysis, *Journal of Behavior Therapy & Experimental Psychiatry*, **39**, pp. 250-261.
- PBS (2012, January 2). Health Experts Question Army Report on Psychological Training: http://www.pbs.org/newshour/updates/military/jan-june12/csf_training_01-02.html
- G Reger and G Gahm (2008), Virtual Reality Exposure Therapy for Active Duty Soldiers, *Journal of Clinical Psychology*, **64**, pp. 940-946.
- G Reger and G Gahm (2010), Comparing Virtual Reality Exposure Therapy to Prolonged Exposure. Randomized Controlled Trial: <http://clinicaltrials.gov/ct2/show/NCT01193725?term=Reger&rank=2>
- G M Reger, K M Holloway, B O Rothbaum, J Difede, A A Rizzo and G A Gahm (2011a), Effectiveness of virtual reality exposure therapy for active duty soldiers in a military mental health clinic, *Journal of Traumatic Stress*, **24**, 1, pp, 93-96.
- G Reger and G Gahm (2011b), Comparing Virtual Reality Exposure Therapy to Prolonged Exposure (VRPE Extension). Randomized Controlled Trial: <http://clinicaltrials.gov/ct2/show/NCT01352637>
- K J Ressler, B O Rothbaum, L Tannenbaum, P Anderson, E Zimand, L Hodges and M. Davis (2004), Facilitation of Psychotherapy with D-Cycloserine, a Putative Cognitive Enhancer, *Archives of General Psychiatry*, **61**, pp. 1136-1144.
- A Rizzo, T D Parsons, B Lange, P Kenny, J G Buckwalter, B O Rothbaum, J Difede, J Frazier, B Newman, J Williams and G Reger (2011a), Virtual Reality Goes to War: A Brief Review of the Future of Military Behavioral Healthcare, *Journal of Clinical Psychology in Medical Settings*, **18**, pp. 176-187.
- A Rizzo, B Lange, J G Buckwalter, E Forbell, J Kim, K Sagae, J Williams, B O Rothbaum, J Difede, G Reger, T Parsons and P Kenny (2011b), An Intelligent Virtual Human System for Providing Healthcare Information and Support, In *Technology and Informatics*, (J D Westwood et al., Eds), IOS Press, Amsterdam, NL, pp. 503-509.
- A A Rizzo, T Parsons, J G Buckwalter and P Kenny (in press), The birth of intelligent virtual patients in clinical training, *American Behavioral Scientist*.
- G Riva (2011), The Key to Unlocking the Virtual Body: Virtual Reality in the Treatment of Obesity and Eating Disorders. *Journal of Diabetes Science and Technology*, **5**, 2, pp. 283-292.
- B O Rothbaum, E A Meadows, P Resick et al. (2000), Cognitive-behavioral therapy. In *Effective treatments for PTSD* (E B Foa, M Keane, M J Friedman, Eds), Guilford, New York, pp. 60-83.
- B O Rothbaum, L Hodges, D Ready, K Graap & R Alarcon (2001), Virtual reality exposure therapy for Vietnam veterans with posttraumatic stress disorder. *Journal of Clinical Psychiatry*, **62**, pp. 617-622.
- B O Rothbaum & A C Schwartz (2002), Exposure therapy for posttraumatic stress disorder. *American Journal of Psychotherapy*, **56**, pp. 59-75.
- B O Rothbaum, J Difede and A A Rizzo (2008), *Therapist treatment manual for virtual reality exposure therapy: Posttraumatic stress disorder in Iraq combat veterans*. Atlanta: Virtually Better Inc.
- F D Rose, B M Brooks and A A Rizzo (2005), Virtual Reality in Brain Damage Rehabilitation: Review. *CyberPsych. and Behavior*, **8**, 3, pp. 241-262.

- K H Seal, D Bertenthal, C R Nuber, S Sen, & C Marmar (2007), Bringing the War Back Home: Mental Health Disorders Among 103,788 US Veterans Returning From Iraq and Afghanistan Seen at Department of Veterans Affairs Facilities. *Arch Intern Med* **167**, pp. 476-482.
- H M Sones, S R Thorp and M Raskind (2011), Prevention of Posttraumatic Stress Disorder. *Psychiatric Clinics of N. America*, **34**, pp. 79-94.
- P Sterling and J Eyer (1988), Allostasis: A new paradigm to explain arousal pathology. In *Handbook of life stress, cognition and health* (S Fisher & J Reason, Eds), Wiley, New York, NY, pp. 629-639.
- T Tanielian, L H Jaycox, T L Schell, G N Marshall, M A Burnam, C Eibner, B R Karney, L S Meredith, J S Ringel, 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/>
- D L Walker, K J Ressler, K T Lu and M Davis (2002), Facilitation of conditioned fear extinction by systemic administration or intra-amygdala infusions of D-Cycloserine as assessed with fear-potentiated startle in rats, *Journal of Neuroscience*, **22**, pp. 2343-2351.