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Combat-Related Post-Traumatic Stress Disorder: A Case Report Using Virtual Reality Graded Exposure Therapy With Physiological Monitoring With a Female Seabee

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ABSTRACT In this report we describe virtual reality graded exposure therapy (VRGET) for the treatment of combat-related post-traumatic stress disorder (PTSD). In addition, we summarize the outcomes of a case study, from an Office Of Naval Research (ONR)-funded project of VRGET with an active duty female Seabee who completed three combat tours to Iraq. Details of the collaborative program involving this ONR-funded project at Naval Medical Center San Diego (NMCSD) and Naval Hospital Camp Pendleton (NHCP) are also discussed.

INTRODUCTION

The war in Iraq has been described as "an equal opportunity war" in which attacks come not only from enemy fighters, but also from roadside bombs and mortars.[1] Although women are barred from ground jobs in infantry, armor, and artillery units, and are technically confined to support roles,[1,2] it is exactly these "support roles" that include some of the most dangerous jobs. These support roles include: driving supply convoys, guarding checkpoints, and searching women as part of neighborhood patrols where they come under direct fire and may become casualties. Hoge et al.[2] reported that among a sample of 2,064 U.S. soldiers who completed a 1-year deployment to Iraq or Kuwait, 12% of female and 13% of male soldiers met the criteria for post-traumatic stress disorder (PTSD) or depression. Grieger et al.[3] has noted that 9% of male and female health care workers, deployed to Iraq and Afghanistan, met diagnostic criteria for PTSD. Further, as with male service members, female veterans are at risk for exposure to combat-related incidents and trauma, which have the potential to result in PTSD or other stress reactions at a higher incidence than previously thought.[4] It was also expected and documented that the rate of PTSD will be higher among troops who have been to Iraq more than once.[5–7] Mental health diagnoses, including PTSD, secondary to combat tours in Iraq, were recently rated as the second leading cause of combat injury.[8]

Approximately 15% (210,000) of the 1.4 million active duty service members deployed to Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) were female.[4] In 2006 nearly 3,800 women who had deployed to Iraq were diagnosed with PTSD and treated by the Department of Veterans Administration (VA).[1] These 3,800 women accounted for 14% of a total 27,000 recent veterans treated for PTSD in 2006. More than 100 female service members have died and nearly 570 have been wounded in Iraq and Afghanistan.[1] Of the OIF/OEF veterans who have sought VA care between 2002 and 2006, 12% were women, and the Disabled American Veterans has estimated that by 2010, 14% of all veterans seeking care will be women.[4]

Both the recent Report of the President's Commission on Care for America's Returning Wounded Warriors and the June 2007 Report of the Department of Defense (DOD) Task Force on Mental Health concluded that 11 to 25% of OIF and/or OEF veterans have been diagnosed with PTSD.[4,9] Both reports recommended that the VA and DOD should aggressively prevent, develop early intervention strategies, and treat PTSD. Early treatment intervention for PTSD has been endorsed in other reports as well.[7,10,11] Additionally, the Report of the Department of Defense Task Force on Mental Health recommended that the "Department of Defense should develop treatment programs specifically geared towards the psychological health needs of female service members" (4, p. 60).

Because the PTSD diagnosis comprises a complex of symptoms, a combination of treatments is recommended.[12] A meta-analysis of traditional therapy for PTSD (i.e., various forms of cognitive behavioral therapy, stress inoculation training, prolonged exposure, and eye movement desensitization and reprocessing [EMDR], etc.) reported only 44% of all

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those who entered treatment were classified as improved at the end of the treatment.[13] Milliken et al.[14] reported that soldiers, who were diagnosed with PTSD, and who received three or more sessions of mental health treatment enjoyed a 37% improvement rate; this 37% positive treatment response was not inconsistent with the response rate documented in other PTSD treatment studies.[15,16] Milliken et al.[14] concluded that, "in the context of the recent DOD Task Force finding, the 37% treatment response rate for PTSD is not optimal in military health clinics because soldiers are either not receiving a sufficient number of sessions or the treatment provided is ineffective." PTSD treatment with antidepressant medications, such as selective serotonin reuptake inhibitors, rarely yields rates better than a 40% reduction in Clinician Administered PTSD Scale (CAPS) scores, and most patients will still meet criteria for PTSD at the end of an adequate treatment trial.[17]

Recently, the Institutes of Medicine concluded that only exposure therapy had sufficient evidence for the treatment for PTSD.[18] Before the availability of virtual reality (VR) therapy applications, the existing standard of care for PTSD was imaginal exposure therapy, in which patients "relive" the traumatic event in a graded and repeated process.[19] Exposure therapy is based on emotional processing theory (EPT). Applying EPT to PTSD, fear and memories have been stored as a "fear structure" and include psychological and physiological information about stimuli, meaning, and responses.[20] Once accessed and emotionally engaged, the "fear structure" is open to modification through cognitive behavioral therapy and, over time, will result in extinction of the fear response.[12]

Although exposure therapy has been shown to be effective for the treatment of patients diagnosed with PTSD, there is room for improvement.[21,22] One hallmark of PTSD is avoiding reminders of the trauma[19] and because of this avoidance, many patients are unwilling or unable to effectively visualize the traumatic event(s) during imaginal therapy.[12] This is where the immersive, interactive, and realistic nature of VR treatment represents a promising early intervention that has been documented as an exceptional treatment for anxiety disorders and specifically for PTSD.[23–30] VR overcomes many of the shortcomings of imaginal exposure by providing external visual and auditory stimuli for the patient, thus eliminating the need for intense imaginal skills. Also, VR permits the patients, diagnosed with combat-related PTSD, to interact with anxiety-inducing scenarios (i.e., combat, patrolling in a combat zone, driving in a Humvee, providing medical care to a wounded Marine, etc.) in the safety and confidentiality of the therapy room.[12]

Citing data from the treatment of patients with PTSD, Wiederhold et al. concluded that, "VR has been shown to improve treatment efficacy for PTSD in survivors of motor vehicle accidents, war veterans, and those involved in the 9/11 World Trade Center attacks."[23] Wiederhold and Wiederhold[24] also reviewed the results of several studies that demonstrated the efficacy of combined physiological (i.e., heart rate, breath rate, skin conductance, and peripheral temperature) and psychological VR treatment for a number of phobias and PTSD. This form of VR treatment has been named virtual reality graded exposure therapy with physiological monitoring (VRGET). Wiederhold and Wiederhold[12] concluded that VR techniques, with physiological monitoring, provide many novel and beneficial avenues for the evaluation and treatment of psychological conditions (i.e., up to an 80% effectiveness for treating various anxiety disorders), including PTSD. Of note, the physiological monitoring not only provides the patient with an increased opportunity to practice experiential methods of self-regulation, facilitating the patient's gaining a sense of mastery over arousal, but the physiological monitoring allows the therapist to monitor the patient's level of arousal/relaxation and to adjust or grade the intensity of the VR exposure to gain the most effective therapeutic outcome.[26,29]

To assess the effectiveness of VRGET with Navy and Marine Corps personnel diagnosed with combat-related PTSD, ONR funded trials to develop VR-based treatments and to test their effectiveness versus usual treatments. The full results of these studies have not yet been reported, but early cases during treatment development indicated that VR-based treatments are safe and effective.[27–30] The VRGET cases thus far presented, however, have been mostly male.

Recently, a female Seabee, diagnosed with comorbid PTSD and mild traumatic brain injury (mTBI), completed VRGET as part of the randomized phase of this study. Of note, this female Seabee completed three tours to Iraq between February 2003 and October 2006. Following is the report of the VRGET, with physiological monitoring, with this female Seabee.

METHOD

Participant

A female volunteer, Second Class Petty Officer Seabee met the study criteria for participation and began VRGET treatment. This participant met the DSM-IV-R[31] criteria for chronic PTSD. This participant's comorbid diagnoses included: attention-deficit/hyperactivity disorder (ADHD), postconcussion syndrome, generalized anxiety disorder, cervicalgia, bulging intervertebral disc lumbar, myalgia, and myositis. The participant's age was 26 years; she had served 6 years of continuous active duty. She had completed three tours of combat duty in Iraq starting with deployment during and following the opening days of Operation Iraqi Freedom (OIF) (February 2003–September 2003). Her second and third combat tours of duty in Iraq were during August 2004–March 2005 and April 2006–October 2006, respectively. Following her first combat deployment, she was diagnosed with PTSD and prescribed paroxetine by a Navy psychiatrist; this participant then took paroxetine intermittently during the next 3 years. She had no previous mental health treatment other than her psychotropic medication. Following a re-evaluation with a Navy psychiatrist, this participant had been stable on paroxetine for 6 months before starting VRGET treatment.

The participant served in combat operations in Iraq as a Humvee 50 caliber gunner protecting convoys. She was exposed to heavy combat as measured by the Combat Exposure Scale.[32] She was exposed to 5 blasts, including exposure to an improvised explosive device (IED), a rocket propelled grenade (RPG), and a land mine, which occurred from between 15 and 60 meters away from where she was located at the time of the blasts. As a result of these blasts, the participant reported that she never lost consciousness but was dazed and confused and experienced brief amnesia from several of the blasts. The participant's blast exposure information was gathered utilizing the Blast Exposure Scale,[33] which is a screening questionnaire adapted from the blast exposure questions on the Post Deployment Health Assessment (PDHA). The screening questionnaire includes three items, assessing if an individual was exposed to a blast, and if so, what type of blast and the symptoms associated with the blast (loss of consciousness, amnesia).[33] Additionally, the participant was injured in July 2006 when a Humvee hatch was jarred loose, causing the Humvee hatch to strike her in her upper back/neck area. During the participant's early VRGET, she was referred to the Naval Medical Center San Diego (NMCSD) TBI clinic for evaluation of her blast exposure and her report of continued difficulties with upper back/neck area pain and restricted range of motion. The evaluating neurologist found no evidence of current neurocortical or physical difficulties secondary to her mTBI. However, he found her diffuse neck and muscle pain/inflammation problematic and he prescribed Lyrcia and physical therapy and the participant was continued in a full duty status. Likewise, I did not observe that the participant experienced any difficulties secondary to her diagnoses of mTBI and "diffuse neck and muscles pain/inflammation" during her VRGET.

This participant had not been prescribed any medications for ADHD since she joined the Navy. This participant did not report, nor was she observed while involved in VRGET, that sitting and moving on a swivel office chair was impaired by her difficulties with upper back/neck area pain and range of motion difficulties. This participant completed a total of 20 VRGET sessions.

Procedure

This volunteer participant was referred to the VRGET treatment at NMCSD by a Navy psychiatrist and was interviewed by a research assistant. Once the participant was deemed eligible, she was provided additional information about the treatment study and was asked to provide informed consent.

After consent was obtained, a pretreatment evaluation was conducted by the research assistant and a psychiatrist reviewed this evaluation as well as the inclusion (currently meeting PTSD diagnostic criteria, deployed to OIF/OEF) and exclusion criteria (i.e., current suicidal or homicidal ideation, current substance abuse, and unstable response to psychotropic medication). The psychiatrist also reviewed the procedures of the project in detail with the participant. The research assistant scheduled the initial treatment session with the clinical psychologist (D.P.W.). The participant's initial evaluation and her two subsequent evaluatons (i.e., post 10 sessions of VRGET and post 20 session of VRGET) were completed utilizing the instruments listed below.

Clinical Measurement Instruments

The following clinician-rated and self-report measures were utilized in the assessments of this participant (i.e., pre-VRGET treatment after 10 weeks/10 sessions of VRGET and 3 months later, following 10 more VRGET sessions): PTSD Checklist Military Version (PCL-M),[34] the Patient Health Questionniare-9 (PHQ-9) for depression severity,[35] the Beck Anxiety Inventory (BAI),[36] the Combat Exposure Scale,[32,37] the Blast Exposure Assessment,[33] and the CAPS.[38] The PCL-M is a 17-item questionnaire that measures the severity of re-experiencing, avoidance, and arousal PTSD symptoms over the previous month on a 5-point scale, with answer options ranging from: not at all, a little bit, moderately, quite a bit, to extremely. The PCL-M also identifies whether an individual meets criteria for PTSD, on the basis of the DSM-IV-TR criteria. The PHQ-9 is a 10-item measure that assesses the frequency of depression symptoms over the previous 2 weeks as well as how difficult the symptoms have made functioning. Frequency responses range from: not at all, several days, more than half the days, to nearly every day. The BAI is a self-report questionnaire with 21 items measuring the somatic and cognitive components of anxiety. The BAI measures the symptoms of anxiety that minimally overlap with depression; specifically, physiological and panic-related symptoms of anxiety. The BAI assesses the frequency of symptoms over the past week on a 4-point scale ranging from 0 to 3. The CAPS is a clinician-administered structured interview to assess whether an individual meets DSM-IV criteria for PTSD and to rate in detail the frequency and severity of PTSD symptoms over the previous week and/or month. A time interval of the previous week was used for this study.

Additionally, psychophysiological measures of skin conductance and peripheral finger temperature were obtained at each assessment interval. Both skin conductance and peripheral skin temperature were included because they are measures of autonomic functioning,[39] which has been shown to be disrupted in persons with PTSD.[40,41] Skin conductance was measured, in micromhos, by placing electrodes on the dorsal side of the participant's middle finger and index finger. The skin conductance measurement is an indirect measure of sweat gland activity because as sweat glands are activated there is a conductive pathway to the skin. This process is mediated by the sympathetic nervous system.[39] Peripheral finger temperature was measured in Fahrenheit by placing a temperature sensor inside the Velcro strap that secures the SC electrode on the dorsal side of the ring or fourth finger. Finger temperature is strongly related to vasoconstriction, a process mediated by the autonomic nervous system.[39]

These psychophysiological measures were recorded in real-time, during a 5-minute baseline, 5-minute recall stressor,

and 5-minute recovery period. During the recall stressor, the participant was asked to describe, "The most disturbing memory from her recent deployment." The participant recalled the memory aloud for the first minute and then was instructed to think about the memory for the next 4 minutes, being prompted every minute to continue thinking about the traumatic memory.

Equipment

The VRGET system relied on visual and auditory presentations. VRGET runs on three computers. One computer displays the visual and auditory stimuli on a standard computer screen, as well as to the participant through VR goggles with built-in headphones. The second computer displays the control panel and menu, which the clinical psychologist (D.P.W.) uses to add arousal elements into the VRGET environment with single button clicks without disturbing the participant's exploration or viewing. A third computer runs the J & J Engineering physiological monitoring (skin conductance, peripheral skin temperature, respiration rate, heart rate, and heart rate variability) and feedback system (J & J Engineering, Inc., Poulsbo, WA). Importantly, computer graphic images and spatial audio, consistent with the orientation and position of the participant's head, are computed in real time as the participant experiences and explores each environment. All environments are immersive (i.e., the participant experiencing only the computer-generated audio and visual stimuli while "real-world" stimuli are shut out). The clinical psychologist communicates with the participant via a microphone linked to headphones.

The participant sat on a chair that could rotate 360 degrees in order for her to be able to move where she chose to go. The participant "walked" in the environment or "drove" a Humvee in the environment by pushing a button on the handheld joystick. The participant "fired" the M-16 rifle or "fired" the 50 caliber machine gun by depressing another button on the joystick. Audio, headtracking, and real-time graphics were computed on two PCs. The physiological measures were computed, recorded, and stored on a portable PC. The Virtual Baghdad, PTSD Convoy and PTSD Village software and environment models were custom-built (to run on a PC) by the Virtual Reality Medical Center (San Diego, CA) using 3-D game technology incorporating information from focus groups and suggestions from 18 Navy and Marine Corps combat veterans who were deployed to Iraq or Afghanistan.[29] Additionally, the software and the combat scenarios were reviewed by and approved by the ONR.

Treatment

In this ONR-directed research protocol, the 20 individual treatment sessions each lasted 90 minutes and were conducted weekly by one of the authors (D.P.W.). Sessions 1 and 2 focused on orienting and introducing the participant to the process and method of meditation as an intervention that could facilitate emotional, cognitive, and physical relaxation. To maintain consistent meditation training and practice, a two-computer disc meditation training program (Jon Cabot Zinn and Andrew Weil, Meditation for Optimum Health, Sounds True, Boulder, CO) was played for and given to the participant.

Additionally, during the first two sessions, the participant was asked to discuss her PTSD symptoms. She was asked to, "tell her stories about her sentinel (i.e., most traumatic) events during her combat tours." The clinical psychologist discussed PTSD as a normal response to an abnormal situation. The clinical psychologist also explained that the goal of VRGET treatment was to help the participant gain control over her intrusive thoughts and feelings and for her to learn to tolerate events or stimuli that currently bothered her. Lastly, during the first two sessions, the participant was taught the principles of attentional retraining (i.e., whatever the participant pays attention to, she will enhance; if the participant pays attention to thoughts and feelings that are uncomfortable, these thoughts and feelings will be enhanced; if the participant pays attention to comfortable sensations in the moment or to the work in front of her, including while in the VRGET combat environment, she will enhance those thoughts and feelings). During 20 minutes of the VRGET session, the participant's physiological status was monitored to discover what type of combat exposure or positive mental images helped to increase or decrease her physiological arousal. For instance, heart rate, skin conductance, respiration rate, and peripheral skin temperature were evaluated during different VR combat scenarios with the expectation that three of these physiological measures (i.e., heart rate, skin conductance, respiration rate) would "increase" and peripheral temperature would "decrease" concordantly with the participant's increased arousal. Conversely, when the participant reached maximum arousal, she was instructed to "hold fire" and switch from the combat environment to a noncombat environment using her skills with meditation and progressive relaxation and it was expected that her physiological arousal would decrease to levels indicating increased control and relaxation, according to the VRGET protocol.[26]

During sessions 3 to 20, the participant applied her skill with meditation, increased physiological control, and attentional refocusing within the VR environment. The 90-minute treatment sessions were divided as follows: 20–25 minutes of review of treatment progress during the previous week, success with meditation, and attentional refocusing; 20 minutes of additional training with meditation and attentional refocusing; 20 minutes of VRGET; and 20–25 minutes of debriefing following VRGET. The 20 minutes of VRGET included time to allow the participant to get used to a safe area in the VR, movement to the various areas in the VR combat environment during which arousal elements were increased with the participant being instructed to utilize her meditation skills, and attentional refocusing to calm her mind and body. The debriefing period was utilized to ask the participant about her experience in the VR, feedback was given to the participant about what was observed on the physiological monitoring, and the participant was encouraged to use her skills in the context of

her everyday life. Finally, plans for the subsequent VRGET session were discussed. The participant was encouraged to practice meditation and attentional refocusing daily and to apply these skills whenever arousing stimuli intruded into her thoughts, feelings, and activities. Additional details concerning the VRGET protocol, including the rationale for 20 minutes of VRGET per treatment session, are described in the VRGET Training Manual.[26]

RESULTS

The participant's symptom severity decreased from diagnostic levels to nondiagnostic levels on all paper-and-pencil measures from her pretreatment to post-10-week assessment. These treatment gains were maintained throughout the final assessment, conducted 3 months later, after the participant completed 10 additional VRGET sessions. (See Figures 1–4). Between pretreatment and post-10-week assessments, the participant's scores reduced from 14 to 2 on the PHQ-9, from 28 to 3 on the BAI, from 65 to 27 on the PCL-M, and from 83 to 11 on the CAPS. These reductions were maintained at the post-20-VRGET-session assessment: PHQ-9 = 2; BAI = 6; PCL-M = 24; and CAPS = 12. Of note, the female participant's symptom severity scores on the PCL-M and BAI scores

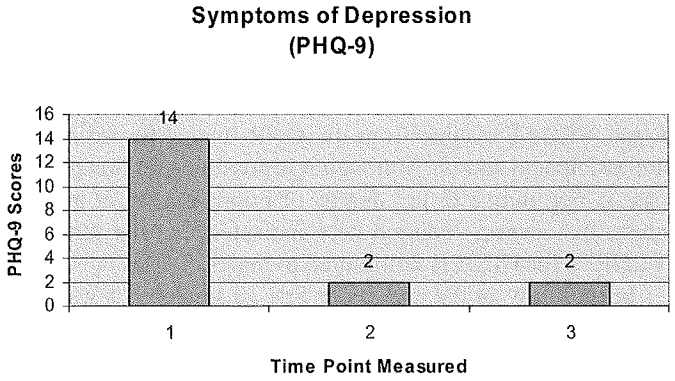

FIGURE 1. Results of PHQ-9 at pretreatment, post-10-week, and post-3-month assessments. PHQ-9 scoring guidelines: PHQ-9: 20–27 = severe depression; 15–19 = moderately severe depression; 10–14 = moderate depression; 5–9 = mild depression; and 0–4 = minimal depression.

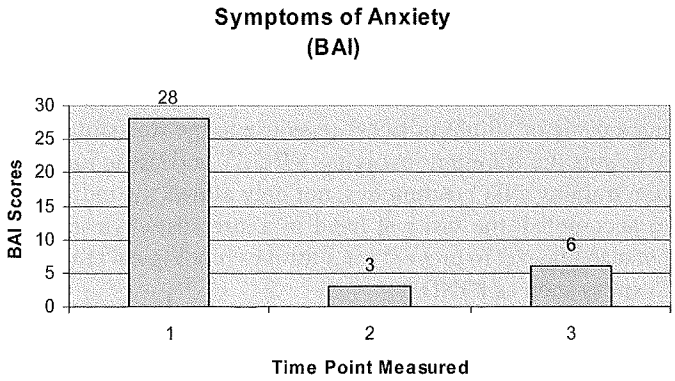

FIGURE 2. Results of the BAI at pretreatment, post-10-week, and post-3-month assessments. BAI scoring guidelines: BAI: 26–63 = severe anxiety; 16–25 = moderate anxiety; 8–15 = mild anxiety; and 0–7 = minimal anxiety.

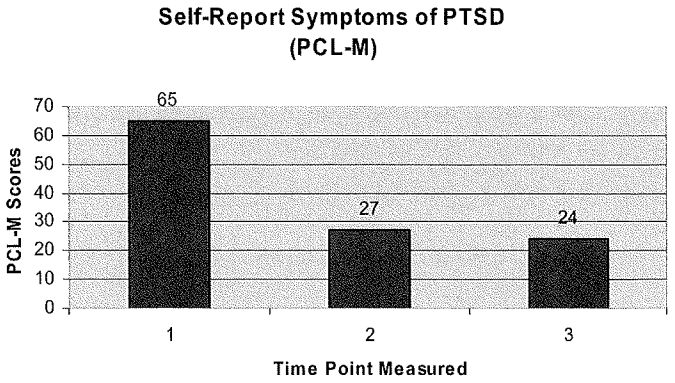

FIGURE 3. Results of PCL-M at pretreatment, post-10-week, and post-3-month assessments. PCL-M scoring guidelines: PCL-M: <30 = no PTSD; ≥50 = PTSD.

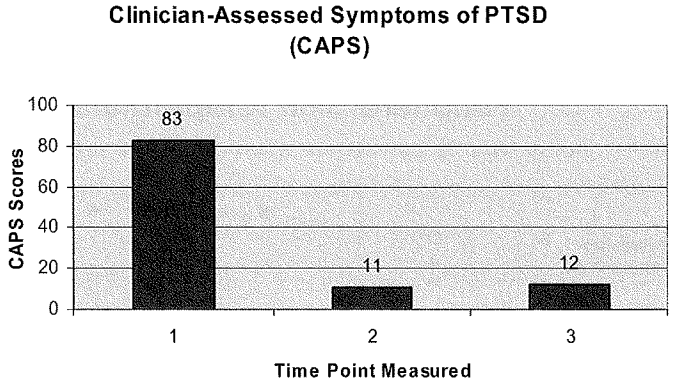

FIGURE 4. CAPS T at pretreatment,[1] post-10-week,[2] and post-3-month[3] assessments. CAPS scoring guidelines: >80 = extreme PTSD symptomatology; 60–79 = severe PTSD symptomatology; 40–59 = moderate PTSD symptomatology; 20–39 = mild PTSD symptomatology; and 0–19 = asymptomatic/symptoms.

started at a higher level and ended at a lower than those similar scores from male participants previously reported that have completed the VRGET protocol.[27,28,30]

Skin conductance changed over time and indicated decreased arousal (i.e., lower micromhos per second) as VRGET progressed (see Figure 5). Specifically, skin conductance dropped from 9.61 micromhos per second during the recovery phase of the pretreatment assessment to 4.98 and 4.39 micromhos per second during the recovery phases of the post-10-week and the post-3-month (post-20-VRGET sessions) assessment, respectively. In addition, the participant's skin conductance, during the baseline and stressor phases, also reduced from the pretreatment assessment to the post-10-week and post-3-month assessments.

Although peripheral skin temperature increased during the progress of VRGET, from the pretreatment assessment (temp T1) through the post-3-month assessment, suggesting that the participant was experiencing decreased arousal as VRGET progressed, there was no indication of increased arousal during the elicitation of the stressor (i.e., time point 2 with decreased peripheral skin temperature) (see Figure 6). Of note, our participant was able to achieve, "autonomic balance, or

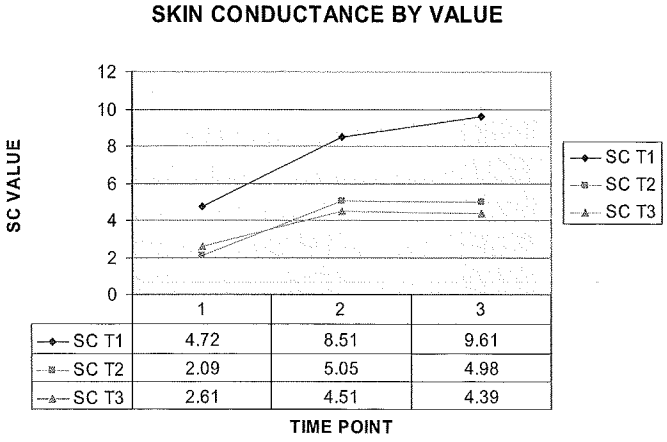

FIGURE 5. Physiological Assessment of Skin Conductance (micromhos per second) at pretreatment (SC T1), post-10-week (SC T2), and post-3-month assessments (SC T3). Time point 1, baseline; time point 2, stressor; time point 3, recovery.

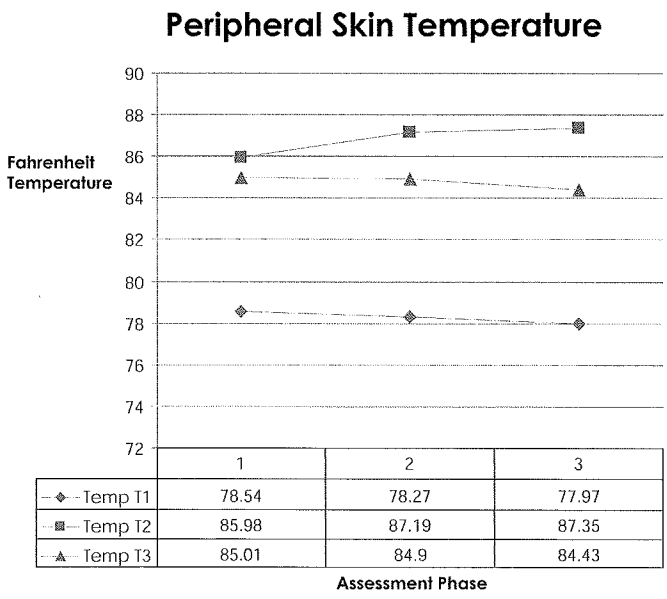

FIGURE 6. Physiological Assessment of Peripheral Skin Temperature (degrees Fahrenheit) at pretreatment (temp T1), post-10-week (temp T2), and post-3-month assessments (temp T3). Time point 1, baseline; time point 2, stressor; time point 3, recovery.

parasympathetic predominance, with her peripheral skin temperatures between 85 and 90 degrees" Fahrenheit at VRGET post-treatment assessment and 3-month-follow-up assessment.

After VRGET, the participant has remained on full active duty status and has continued to work in her Seabee rating. She plans to remain in the Navy and obtain a college degree with the goal of becoming an officer.

DISCUSSION

Virtual reality graded exposure therapy (VRGET) led to measurable reductions in PTSD, depression and anxiety and was well tolerated by the female participant. During the VRGET sessions, our participant described becoming engaged in the graded exposures of the VR simulations, as has been previously documented with VRGET.[12,23–30] Specifically, she spontaneously and frequently verbalized instructions to the Humvee driver about road conditions and insurgent position while in the VR. She also expressed that the VRGET "assisted me in improving my skills with being in the moment and having better control over my combat thoughts, feelings, and being startled." On the basis of the results of her reduced skin conductance and peripheral skin temperature assessments from the pretreatment to the post-10-week assessment and through the post- 3-month assessment, our participant demonstrated physiological habituation to her combat experiences. Her reductions to nondiagnostic levels on the PHQ-9, BAI, PCL-M, and CAPS further documented habituation. This suggested that VRGET taught our participant how to better control her physiology, which contributed to her PTSD symptom management.

Although the full results of VRGET treatment are still pending, and no gender-based analysis has previously been reported, this female participant appeared to have impressive improvements when compared to her male participants. Initially, this participant had higher anxiety and PTSD symptom severity scores than previously reported for male participants in VRGET.[30] After 10 VRGET sessions, however, her PCL-M, PHQ-9, and BAI scores were not only all measurably lower from baseline, but also lower than the participants who have been reported to have completed VRGET.[27,28,30] Additional VRGET results, from the ONR-funded research trial, are anticipated soon.[42] Although it is possible that this participant is not unique in her degree of improvement, at a minimum, the success reported here indicated that the utility of VRGETv for PTSD is not limited to males.

Intriguingly, at the end of her first 10 sessions of VRGET, the participant mentioned, "I wished I had this training (i.e., meditation and exposure components) prior to my first combat deployment or between my combat deployments!" Moreover, she elaborated, "I don't think that my PTSD difficulties would have been as bad if I would have had this treatment before or between my combat deployments." Wiederhold and Wiederhold[12] have noted that specific training (stress exposure training or stress inoculation training), before exposure to a stressor (i.e., combat), can help desensitize the individual to the stressful situation, thereby avoiding a panic or "flight or fight" response to the stressful event. This specific training, involving VRGET and stress inoculation training (SIT) techniques, not only allows the individual to accomplish the tasks at hand in a stressful environment, but also may act to prevent long-term psychological reactions to stress such as PTSD.

We must caution that there are obvious limitations to the generalizability of these results to other PTSD treatment populations at other medical centers, military or civilian. Our case study focused on selective psychological questionnaires and physiological assessment, utilized one VRGET program, and

also utilized a single meditation training stimulus. Although the participant's neurologic treatment was held stable during her VRGET, the participant's improvements may have been because of factors other than VR. Future research is needed to understand the active ingredients associated with habituation. The positive effect of the individual therapist, the participant's motivation, and the treatment itself cannot be separated on the basis of a single case. Clearly the novelty of the treatment inspired zeal in both the therapist and the participant. We hope that such positive therapeutic zeal remains a constant, not only in our VRGET programs at Naval Medical Center San Diego and Naval Hospital Camp Pendleton, but also among staff of other programs providing treatment and consultation to sailors, marines, and soldiers who have been diagnosed with combat-related PTSD.

In summary, this case demonstrates that VRGET treatment, delivered according to the standard protocol previously described,[29] can also be effective with a female participant diagnosed with PTSD. The protocol did not need to be modified on the basis of the participant's sex, and results were as good or better than those reported in males that were treated using the same method.[27,28,30] Detailed analysis of larger groups will be needed to determine whether gender is a significant predictor of treatment response overall. Given that combat duty, including the "support roles" for those deployed to OIF/OEF combat zones, "confers a similar risk for PTSD and depression by gender,"[2] it is anticipated that combat PTSD will not be a problem only of males. It is hoped that by adding VRGET to the psychotherapeutic treatment options available for warriors, the success rate for the treatment of PTSD will increase for both men and women.

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