Stress Assessment and Management while Medics Take Care of the VR Wounded

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Abstract:

"Stress Inoculation Training (SIT)" is designed to mitigate the potential negative effects of stressors in healthy individuals. As a cognitive-behavioral therapy technique, SIT is applied in a gradual, controlled, monitored, and repeated manner with the goal of desensitizing individuals to stressful stimuli. Prior simulated exposure can help prevent a fight/flight/freeze stress-response allowing individuals to accomplish tasks at hand. In our study, Soldiers (e.g., first responders or “medics”) navigate through virtual reality (VR) applied to SIT (“VR-SIT”) while performing tasks, such as putting a tourniquet on a casualty, in a stressful, but controlled, simulated combat casualty environment. Participants receive feedback on their psychological, physiological, and bio-chemical stress levels and practice coping strategies (i.e., combat breathing). We predict that this approach will not only improve Soldiers’ performance on real tasks, but also increase their stress resilience and hopefully prevent chronic psychological decompensation (e.g., post-traumatic stress disorder). Preliminary findings with a sample of 25 medics, suggest that those who learned coping techniques during the VR training, exhibited lower levels of stress than what was seen in the control group.
INTRODUCTION

Psychological Stress in the Battlefield.

Warfighters face a myriad of stressors when deployed to the battlefield. Some of these stressors are sleep deprivation, information overload, exposure to injuries/dead bodies, and anxiety for the welfare of fellow warfighters and family left behind (Lukey, Stetz, Romano, 2005). Hoge et al. (2004) have reported that approximately 18% of Warfighters returning from Iraq and 11% returning from Afghanistan (n = 6, 201) screened positive on stress-related measures (i.e., Post Traumatic Stress Disorder (PTSD)). He later added that 1 in 10 U.S. Iraq-War veterans suffer some type of stress disorder (Hoge, Auchterloni, Milliken, 2006). Interestingly, Stetz et al. (2006) have also found that, in 2003, about 7% (21 out of 282) of medical evacuations in Operation Enduring Freedom and 6% (365 out of 5,389) of those in Operation Iraqi Freedom were due to psychiatric illness. Stetz et al. (2007) also reported that 21% of those evacuated had prior psychiatric histories before deploying to the theater of operations. Most prior histories were either related to stress (i.e., PTSD, n = 33, 31%) or to depression, (n = 72, 66%).

Anxiety and depression are two of the most common types of mental disorders in the United States. The National Institute of Mental Health reports that 19 million Americans ages 18 to 54, or 13% of adults, are afflicted by these illnesses (Narrow et al., 1998). Stress reactions can be manifested in a range from Acute Stress Disorder (ASD) to Post Traumatic Stress Disorder (Bryant & Harvey, 2000). ASD symptoms are relatively short lived and generally dissipate in less than a month. On the other hand, PTSD symptoms must be present for more than one month (to rule out Acute Stress Disorder) and the disturbance must cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

Stress Inoculation via Training.

Stress Inoculation [exposure] Training (SIT) is a prevention strategy that aims to mitigate the negative effects of psychological stressors in healthy individuals. Its foundation dates back to Wolpe’s work on cognitive/behavioral stress-coping training in the early 1970’s. The cognitive-behavioral preventive approach, which is central to SIT, has been implemented in military, medical, and other settings. SIT attempts to immunize an individual from reacting negatively to stress exposure (Abramson, Metalsky, Alloy, 1989). The individual and the stressful condition must be identified a priori (Adams, 2005). Gradual and repeated stress exposure is thought to desensitize individuals to stimuli that may impede performance and produce psychological trauma (Wiederhold, Bullinger, Wiederhold, 2006), decreasing the probability of later negative responses (Driskell, Johnston, 1998). That is, through successive approximations, individuals build a sense of expectancy that is integrated into positive cognitive appraisal providing a greater sense of mastery and confidence or “self-efficacy.” The rationale for stress reduction is based on the premise that the availability of information or pre-exposure to the stress reduces the novelty of stressful tasks. This exposure then increases the sense of predictability and control and the likelihood that individuals will react more positively and exhibit fewer negative physiological and emotional responses to future stressful events.

Saunders et al. (1996) offer the following findings regarding the effectiveness of SIT: 1) the greater the number of training sessions the better; 2) results from both field and laboratory studies seem to be somewhat comparable; 3) SIT is more effective for state anxiety if used with small groups; and finally 4) SIT programs using imagery components are more effective at
reducing performance anxiety than those that do not use imagery unless the latter uses behavioral practice in coping. They also state that SIT’s success depends upon employing stress-coping training-features, and instructional design. Adaptive coping strategies and their associated appraisals could act as a moderating buffer against stress-induced impairment.

Coping skills, such as combat breathing, can first be taught in a safe environment. After the basic skill is taught, the individual can be asked to perform the skill in a more vivid environment. Vividness is an important component of the SIT approach and it must be controlled, allowing individuals to gradually adapt to stressors and learn how to cope. With recent advances in virtual reality (VR), VR lends itself quite well to SIT. That is, in a virtual world, stressors can be systematically added to scenarios until the individual habituates to these stressors. Military personnel can train in virtual environments (i.e., Iraqi village, a shoot house, or a ship) where simulations can be viewed on desktops, laptops, through a head-mounted display, or as a 1 or 3-wall CAVE projection system. The training can then transferred to real-world exercises in structures designed specifically for tactical training. Here, VR-SIT is particularly useful as it can be easily integrated and embedded in training in warfighters’ systems.

To address problems related to the potential for combat power loss which can result from psychological decompensation, the United States Army Aeromedical Research Laboratory (USAARL) is currently conducting a study with the goal to harden Soldiers against stress. Specifically, the objective of this study is to evaluate the utility of Virtual Reality Stress Inoculation Training (VR-SIT) to inoculate (e.g., habituate, harden, protect) against harmful stress and help maintain or increase the performance of Soldiers undergoing rigorous field-relevant medical training. We believe that those medics training with VR scenarios and receiving coping training will show lower stress levels, with time, than those that do not get this opportunity.

METHODS
Participants and Research Design.

For the present paper, we are reporting part of the obtained sample-to-date (n = 25) attending the Flight Medic Course in Fort Rucker, Alabama (Sub-sample #1) and medics working at the medical clinic at Fort Rucker (Sub-sample #2).

Our present study started in January, 2007 and will end in June (2007). Therefore, we use present tense to describe our research design. We are using a criterion for significance (alpha) set at .05 and an effect size (f) of .40 to yield a power of .80. After the USAARL research team coordinates with the participants’ units/schools, they visit with and brief Soldiers on the purpose of the study. Once volunteers sign informed consents and undergo screening procedures (e.g., vitals and “PTSD Checklist- Military Version,” Weathers, Huska, & Keane, 1991), the Principal Investigator (PI) assigns qualified volunteers to the experimental phase. We also post-screen participants before they leave our laboratory by checking for potential “cybersickness” via the “Simulator Sickness Questionnaire” (Kennedy et al., 1993).

Participants (n = 63-75) are matched as closely as possible based on factors thought to affect VR-SIT efficacy such as gender, age, prior gaming experience, and deployment history. Previous work conducted by Wiederhold at the Virtual Reality Medical Center, suggests that to assess the efficacy of a virtual reality exposure, more than one session is required. Each participant is assigned to one of the groups as defined below:
• “Control Group” does not do undergo any VR or coping training (CT), only vital signs are measured.
• “Group 1” gets 2 (or 4) VR game play sessions, but no CT.
• “Group 2” gets 2 (or 4) CT sessions, but no VR sessions.
• “Group 3” gets VR + CT training during 2 (or 4) sessions of game play.

Assessment Tools and Technology.

We do not only measure the experience of the participant in our VR world but also measure some of their stress levels.

Presence has been defined as the subjective experience of being in one place or environment, even when one is physically situated in another place or environment (Witmer & Singer, 1994). As applied to a virtual environment, presence refers to experiencing the computer-generated environment rather than the actual physical locale. The Presence Questionnaire (PQ) is administered after each VR session. There is no weighting of items or subscales. Administration time for the PQ is about 3 minutes.

Psychological Stress. We use the “Multiple Affect Adjective Check List-Revised” (MAACL-R, Zuckerman & Lubin, 1985) to measure five components of subjective trait characteristics that affect changes in response to stressful situations. Specifically, this instrument measures anxiety, depression, and hostility. Participants must choose (i.e., by checking a box) which adjectives (out of 132 potential descriptors) best describes how they feel before and after each session. This questionnaire is presented to the participant before and after each session. It is scored using a scoring guidance developed by the Army Research Laboratory (ARL)-Engineering Directorate. Administration time for the MAACL-R is about 2 minutes long.

Bio-chemical Stress. We utilize a salivary amylase test as a measure of biochemical stress. Amylase is an enzyme that hydrolyzes starch to oligosaccharides and then slowly to maltose and glucose. Salivary amylase concentrations are predictive of plasma catecholamine levels and can be used as a measure of stress. Studies conducted by ARL in collaboration with the Northwestern University report a positive correlation between cortisol and amylase (Chatterton et al., 1996). The “Salivary Amylase Kit” is self-contained and in this study, salivary amylase is collected before and after each exposure. Amylase levels are quantified using tabled values of time for color change and ambient temperature recording. Measurement of amylase concentration in saliva involves simple observation of chemical color changes according to standard photometric procedures. Saliva samples for amylase assay are obtained from participants by asking them to “spit in a cup.” A 50ul of that dilution is then added to a pre-measured reagent, and the time for color change is recorded. We use the recorded time of this transformation as an additional measure of stress.

Physiological Stress. We also monitor objective physiological stress indices from participants in this study using a “PhysioLab.” The Physiolab is a device that captures (among other parameters), peripheral body temperature, breathing rate, and pulse rate. Some sensors are placed on the participant’s wrists to capture heart rate, on fingers to capture peripheral body temperature, and around the chest to capture breathing rate. The research team visually monitors graphical displays of these markers from a remote location using the PhysioLab software and note when levels fluctuate in response to stressors presented and/or in response to employment of the participants’ stress coping strategies.
Virtual reality scenarios and rest of the equipment used. The scenarios used for the VR testing portion of this study have been developed by the Virtual Reality Medical Center (VRMC). Our participants are able to navigate (e.g., “walk” or “fly”) through Iraqi or Afghan VR combat scenarios. The “Combat Medic” and the “Flight Medic” scenarios we utilize are displayed using a laptop computer with imagery presented via a Z800 3D Visor head mounted display (HMD). In the Combat Medic Scenario, participants are able to perform the following tasks: 1. Move casualty to cover; 2. Assess and stop life threatening bleeding (applies tourniquet); 3. Request additional help/employs all personnel available if necessary; 4. Assess airway; 5. Breathing (Asherman chest seal/Needle decompression); 6. Check for additional wounds; and 7. Administer pain medication. In the Flight Medic module, participants can: 1. Assess and stop life threatening bleeding (applies tourniquet); 2. Request additional help/employs all personnel available if necessary; 3. Assess airway; 4. Breathing (Asherman chest seal/Needle decompression); 5. Check for additional wounds; and 6. Administer pain medication.

Our visor system combines two OLED microdisplays with stereovision 3D capabilities, stereo audio, a noise-canceling microphone, and an integrated head tracker. Its high-speed head tracker enables full 360-degree virtual-surround viewing. This HMD also helps participants “walk/drive/fly” inside the VR scenarios with additional help from a dual action Logitech joystick. To enhance the experience while navigating these scenarios, we also add display synched vibrations using a low frequency effects (LFE) speaker. The “ButtKicker” LFE is a type of “noiseless speaker” that accurately reproduces the "feeling" range of many natural and man-made low frequency sounds such as earthquakes, thunderstorms, rocket launches, waves, explosions, tornadoes, volcanoes, etc. Another device used to enhance the realism of the experience is the “ScentPalette™”. This is a computer-controlled, 8-cartridge scent machine that uses puffs of air to project different scents (gunpowder, body odor, blood, vomit, burning trash, etc…) on cue for a predetermined time. When it is connected to a computer, it can provide up to 64 scents on cue precisely synched to the computer’s visuals to present associated odors. Odors are interspersed with bursts of unscented air in between smells to clear for the next scent, thus eliminating cross bleed/mixing problems. Additionally, we have cameras in the VR booth to capture participants’ facial expressions and gestures (i.e., fidgeting) while navigating the scenarios. See Figure 1 for a photo of the quad-splitter used to capture all images.

RESULTS

Preliminary data. Table 1 presents the specific demographic breakdown of our present sample. In general, it was composed of largely Caucasian males, between the ages of 21 to 42 years old. They hold high school diplomas and enlisted (e.g., E-4) military ranks. The tenure in the Army of a majority of participants with less than 5 years, and most planned to remain in the service. The great majority reported having at least some VR or video-game experience.

As mentioned earlier, at the beginning of our study, we screened participants for Post Traumatic Stress Disorder using the PTSD Checklist (Weathers, Huska, and Keane, 1991). Our participants obtained an overall composite, PTSD checklist mean score of 15 (s.d., 11; Range: 0 to 37). This is well below the threshold of 50 which generally indicates the presence of PTSD (Weathers, et al., 1994). In addition, participants scored well below a 4 on our 5 point scale providing further evidence that PTSD was not present. Hence, we are confident that none of our participants were suffering from PTSD.
We also examined the perceived realism of our VR environment using several scales developed from the Presence Questionnaire (Witmer and Singer, 1998). The presence questionnaire is designed to measure the amount of involvement and immersion that an individual experiences in a VR environment. The questionnaire measures several dimensions of an individual’s immersion in the VR environment including: the amount of perceived control they possess in the environment (i.e., involvement/control dimension), their perception that their interaction with and within the environment is “natural” (i.e., natural level of interaction dimension), and the overall quality of the VR interface (interface quality dimension). The results we obtained indicate that participants maintained a moderate level of immersion in our VR environment. Specifically, on our 7-point scale, participants rated our VR environment 3.7 (s.d., .78) on the “involvement/control” dimension, 3.2 (s.d., 1.3) on the “natural level of interaction” dimension, and 3.3 (s.d., 0.9) on the “interface quality” dimension.

In Figures 2-3, we present results of our inferential analyses. Specifically, we performed a two-way multivariate analysis of variance (condition x inoculation) to determine if there were differences between the experimental group and inoculation conditions across measures of anxiety, depression, hostility, and “dysphoria” (a composite measure of anxiety, depression and hostility), and amount of time required for salivary amylase transformation. Tests of the overall model indicated that results obtained across conditions were trending in the hypothesized direction and approaching significance (Wilk’s Lambda = F(35, 2) = .492; p < .08). Tests of Between Subjects Effects indicates that condition affects levels of post-treatment anxiety (F (35, 2) = 4.16, p < .05) and post-treatment dysphoria (F (35, 2) = 3.53, p < .05). The results of post hoc comparisons using t-test procedures indicate that participants in the VR-Only (Mean = 60, s.d. = 20; p <.05) condition experienced a greater level of post-treatment anxiety than participants in both the combined CT + VR (Mean = 48, s.d. = 5.5) and the CT –only conditions (Mean = 45, s.d., 0). Results of post hoc comparisons also indicate that participants in the VR-Only (Mean = 64, s.d. = 28.4, p<.10) condition exhibited a greater level of post-treatment anxiety than participants in both the combined CT + VR (Mean = 50, s.d. = 9.1) and the CT – only conditions (Mean = 45, s.d. = 4.4). However, our conclusions on dysphoria are preliminary based on the fact that they were trending in the hypothesized direction and were approaching significance (p<.10).

Our results also indicate that the recorded time of salivary amylase transformation increases with the inoculations participants experience (F (18, 2) = 4.78, p < .05). Results of post-hoc comparisons using t-test procedures indicate that participants exhibited more stress in the second inoculation (Mean = 362, s.d., 185) than the first inoculation (Mean = 250, s.d., 106). Finally, analysis of the breathing pattern (diaphragm expansion) of our participants (see Figure 4) suggests a slight increase for both of the groups receiving CT. However, firm conclusions can not be drawn from this preliminary data.

CONCLUSION

Many warfighters are coming back home from deployments with stress-related problems. USAARL is trying to help the cause by hardening medics, who must treat the wounded while pulling security, against stress. Preliminary findings from our ongoing study show that most of the medics in our sample were single Caucasian enlisted young males with some VR/ video-game experience. During the screening process, we did not lose any participants due to having pre-existing PTSD symptoms.
Our preliminary analyses suggest that the VR environment (e.g., presence) was very natural, that they generally enjoyed the environment, and experience minor to no discomfort while navigating within the environment. Preliminary comparative analyses also indicated that we have identified a tool and set of techniques that induce a level of stress high enough to potentially produce an “inoculation” effect. Specifically, our results indicate that our VR environment did increase levels of post-treatment anxiety and dysphoria. These measures were higher than the levels of anxiety and dysphoria experienced by participants in the CT and VR and the CT-only conditions.

It seems to be that the VR technology holds the potential to benefit our capacity to inoculate soldiers against combat stress. If this is true, this should be a powerful tool to incorporate while preparing soldiers for deployment (e.g., as marksmanship practice). However, again, these are encouraging yet preliminary findings from a study that should end around Summer of 2007.
Table 1. Descriptive demographical analysis of our present sample.

<table>
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<tr>
<th>Sub-sample Number</th>
<th>Sub-sample #1</th>
<th>Sub-sample #2</th>
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</thead>
<tbody>
<tr>
<td>Sample Size</td>
<td>13</td>
<td>12</td>
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<tr>
<td>Race</td>
<td>Caucasian (10, 77%)</td>
<td>Caucasian (7, 58%)</td>
</tr>
<tr>
<td>Years in the Army</td>
<td>Less than 5 (7, 54%)</td>
<td>Less than 5 (7, 58%)</td>
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<td>Marital Status</td>
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<td>Married (10, 83%)</td>
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<tr>
<td>Gender</td>
<td>Male (13, 100%)</td>
<td>Male (9, 82%)</td>
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<tr>
<td>Rank</td>
<td>E-4 (6, 46%)</td>
<td>E-4 (6, 55%)</td>
</tr>
<tr>
<td>Age Range</td>
<td>21-39 years old</td>
<td>21-42 years old</td>
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<tr>
<td>Kids</td>
<td>None (11, 85%)</td>
<td>0-1 (6, 60%)</td>
</tr>
<tr>
<td>Level Education</td>
<td>High School (12, 92%)</td>
<td>High School (8, 67%)</td>
</tr>
<tr>
<td>Military Component</td>
<td>Reserve (10, 77%)</td>
<td>Active (12, 100%)</td>
</tr>
<tr>
<td>Previous Deployment</td>
<td>Yes (10, 77%)</td>
<td>No (7, 58%)</td>
</tr>
<tr>
<td>Deploying Soon</td>
<td>Yes (8, 73%)</td>
<td>No (8, 67%)</td>
</tr>
<tr>
<td>Staying in the Army</td>
<td>Yes (12, 92%)</td>
<td>Yes (10, 91%)</td>
</tr>
<tr>
<td>VR/Video Experience</td>
<td>Yes (12, 92%)</td>
<td>Yes (8, 67%)</td>
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Figure 1. Photo of simultaneous images taken to monitor each participant during the data collection at USAARL.
Figure 2. Graph of the Effects of Condition on Post-Anxiety.

Estimated Marginal Means of Anxiety

MAACL-R Score

Inoc. 1  Inoc. 2
Figure 3. Graph of the Effects of Condition on Post-Dysphoria (Dys).

Estimated Marginal Means of Dysphoria

MAACL-R Score

CT Only
VR Only
CTVR

Inoc. 1  Inoc. 2
Figure 4. Inferential analysis of respiration rate.

Sub-samples #1 & 2

Respiratory Effort

CT  VR  CT + (VR)

Pre-Respiration  Post-Respiration
REFERENCES


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