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14.ABSTRACT
This study tested and evaluated a group-based predeployment stress inoculation training (PreSTINT) program designed to help deploying personnel better cope with combat-related stressors and mitigate the negative behavioral effects of trauma exposure. Army personnel undergoing a regular predeployment combat training regimen were randomized into experimental and control groups by platoon. Experimental groups received battle breathing skills training and control groups received a stress management lecture. Phase 1 of the study included a pilot test of the acceptability and ability of the training materials to reduce physiological arousal, including heart rate variability, in response to the multisensory stressor environment (MSE). Phase 2 included a pre- and post-deployment survey of 800 soldiers to evaluate the ability of the PreSTINT training to reduce the risk of PTSD and other psychological distress symptoms. Multivariate analyses assessed differences between experimental and control groups controlling for potential covariates. Key findings showed that PRESTINT may help mitigate the risk for hyperarousal symptoms among mentally healthy military personnel who are not otherwise interested in learning stress control techniques. Further research is warranted into the effects of biofeedback in stress control for military personnel.

15. SUBJECT TERMS
Stress management, predeployment, intervention, stress inoculation, heart rate variability

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1. INTRODUCTION TO PRESTINT

Promising strategies for promoting resiliency and positive mental health outcomes in military members have included biofeedback, relaxation breathing, stress inoculation training, and virtual reality technologies (Hourani et al, 2011). We conducted this 3- year longitudinal study to test and evaluate a group-based Predeployment Stress Inoculation Training (PreSTINT) program designed to help deploying personnel better cope with combat-related stressors and to mitigate the negative behavioral effects of trauma exposure. The PreSTINT program included three main components: (1) an educational component in which general stress management literature was presented, (2) a skills-acquisition component in which personnel utilized biofeedback to learn two relaxation breathing techniques, and (3) a video-based component that involved exposure to a multisensory stressor environment (MSE) in which to practice the learned techniques. U.S. Army personnel undergoing a regular predeployment combat training regimen at Ft. Bragg in North Carolina were recruited and randomized into experimental and control groups by platoon. Experimental groups received the 20-minute battle breathing skills training, and control groups received a 20-minute stress management lecture. Phase 1 of the study included 60 predeploying soldiers to pilot test the materials and examine the acceptability and ability of the training materials to reduce physiological arousal (heart rate variability [HRV]) in response to the MSE. Phase 2 included more than 800 predeploying soldiers to evaluate the ability of the PreSTINT training to reduce the risk of post-traumatic stress disorder (PTSD) and other post-deployment psychological distress symptoms. Participants reported their stress levels and use of training materials in bimonthly e-mails. Multivariate analyses assessed differences between experimental and control groups on possible PTSD and other stress-related outcome variables while controlling for potential covariates.

Key Words: stress management, predeployment, intervention, stress inoculation, heart rate variability, relaxation breathing, posttraumatic stress disorder

2. BODY

2.1 Phase 1: Pilot Test

Task 1: System preparation accomplishments

a) After review and evaluation of most appropriate software approaches and hardware for this study, including planning for the purchase of MP3 players in preparation for the pilot test, we identified the specific MP3 players we would purchase, COBY 2.8" Touchscreen Video MP3 Player with Speaker, and ordered 60 of them for the pilot study.
b) Data collection software was configured and tested for reaction time (RT) assessments.
c) Data collection software was configured and tested for heart rate variability (HRV) assessments.
d) Multimedia stressor environments (MSE) were enhanced and extended with additional arousal stimuli and an Afghanistan themed MSE was developed and tested.
e) Software was designed to link the MSE computer with the data collection laptops through internal wireless router connections.
f) All experimentally engineered systems were tested and certified for their functionality for data collection.

Task 2: Pilot testing accomplishments

a) Study team briefed site POCs and finalized data collection room locations and facilities at Ft. Bragg.
b) Study team prepared human studies protocol documents for pilot testing and submitted to RTI IRB and USAMRMC HRPO for approval.
c) Study team revised and verified data collection instruments such as screening questionnaires.
d) Setup the PRESTINT learning environments anticipated to be at data collection locations.
e) Worked with military POC to recruit 60 active duty study participants.
f) Conducted testing of the PRESTINT protocol at baseline and 1 week.
g) Prepared data for statistical analysis, analyzed data, and reviewed results.
h) Made necessary corrective actions to methods and data collection systems.
i) Successfully piloted the PRESTINT system and questionnaire in 60 participants.

Specific accomplishments during the pilot testing task included the following:

After obtaining IRB approvals from RTI, and HRPO for the pilot test, a full demonstration of PreSTINT was conducted at Ft. Bragg on August 15, 2012 (See Appendix I). CPT Joseph Swanstrom and SPC Tubilleja coordinated the logistics of this demonstration with RTI. They attended as well as other personnel who helped socialize the study. The RTI team brought six laptop computers and the main computer to run the MSE and link the laptops and went through the entire PreSTINT protocol with the six attendees. At the conclusion of the demonstration, we engaged in an open-ended discussion with the soldiers present to get their feedback on areas where we may need to make some changes. Subsequent to this demonstration, we reviewed

the recommendations with the full RTI PreSTINT team and incorporated changes where needed and appropriate.

Changes to the draft baseline questionnaire were made based on suggestions from the IPR. Also, design changes included revising the randomization process to include platoon rather than squad and a revision of control group materials to include a generic stress management lecture and handouts.

We continued weekly meetings with our Ft. Bragg colleagues and CPT Swanstrom identified that the 3rd Brigade's Global Reaction Force (GRF) would participate in our Phase 1 Pilot study. The pilot study included 60 Soldiers and involved 2 sessions. The first session was a 1.5 hour session and the second, one week later, was a 45 minute refresher session.

Project staff prepared for the Pilot Study by testing all equipment and preparing all MP3 players for distribution to the soldiers.

We conducted the Phase 1 Pilot Study and trained 56 out of 60 selected participants in 3 sessions. One week later, we returned for the shorter refresher session and trained 31/56 participants. The data from this refresher session was combined with the baseline data collected on 2 October.

Subsequent to the Pilot, we prepared the completed questionnaires for our data entry subcontractor for keying. Upon receipt of the keyed data we began the preparation of the codebook, data dictionary, and analysis. In addition, we began the process of preparing the physiologic data for analysis.

Task 3: Prepare reports and conduct briefings of pilot accomplishments

a) Conducted preliminary analysis of pilot data.
b) Conducted multiple analyses of heart rate variability (HRV) and reaction time (RT) pilot data.
c) Prepared comprehensive report on pilot test findings. (See Appendix II.)

Heart rate data was collected from each soldier during the PRESTINT pilot testing. A pulse sensor was attached to the ear and recorded continuously throughout the sessions. Changes in the time between heart beats, called heart rate variability, contains information on the brains regulation of heart rate. The pattern of these changes were analyzed to measure the influence of the calming (i.e., parasympathetic) branch of the nervous system. Soldiers in the experimental group showed a trend towards greater influence of the calming parasympathetic nervous system on heart rate, particularly during the biofeedback training. However, the differences between the control and experimental group were not significantly different.

Prior to analysis, pulse intervals were analyzed to identify errors in pulse detection, which were corrected automatically by a computer program. Some errors in pulse detection could not be corrected by the computer program, so the data were manually inspected to identify the timing

of each pulse. Based on these findings, improvements were made to the editing program. This process also yielded a larger sample of pilot data for confirming a significant difference in heart rate variability between the control and experimental groups.

Preliminary results – Heart Period and RSA – PRESTINT pilot test

Takeaways: no significant group differences in HRV measures during any segment (Day A or Day B)

Effects are in the expected direction

Small sample (12 & 22)

Baseline difference between groups in HP/RSA

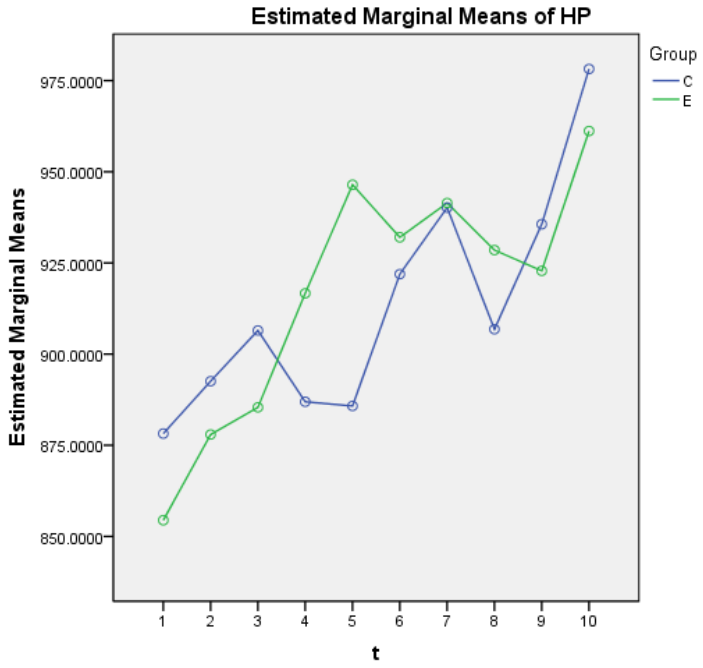
Automated editing needs to be validated by manual inspection

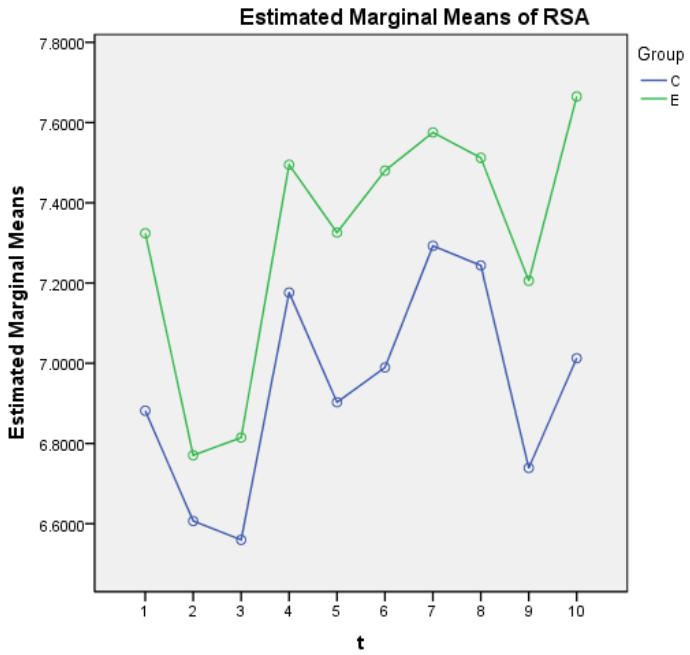
N = 12, Control

N = 22, Experimental

T-tests and for respiratory sinus arrhythmia/heart period (RSA/HP) values at each time point are all non-significant (also tested old SDNN measure, same result).Repeated Measures ANOVA indicated groups start different on RSA and maintain small separation throughout.

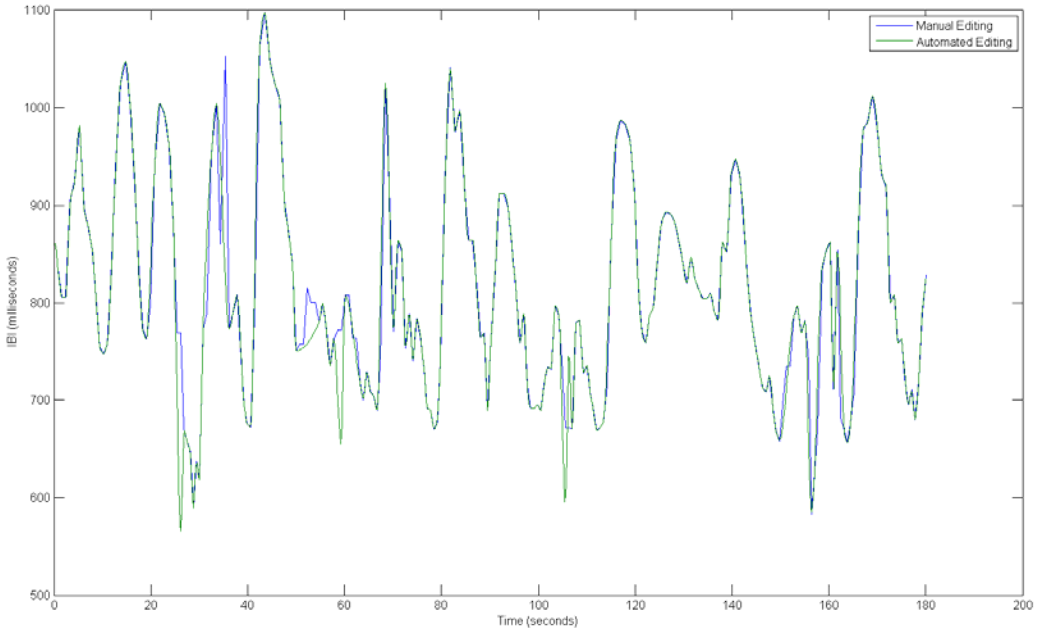
1	PRE_MSE
2	MSE_VID
3	MSE
4	Instruction
5	Focus_BF
6	Focus_EO
7	Relax_BF
8	Relax_EC
9	Post_MSE
10	Relax





Automated editing versus manual editing

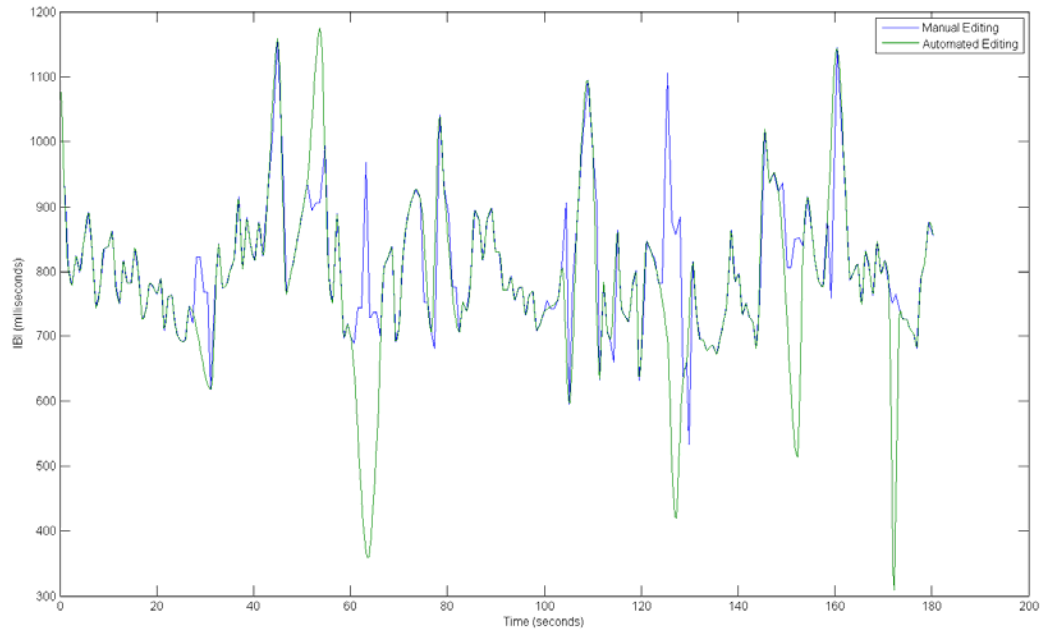
This file has < 15% edits, and the results are very similar with both methods.

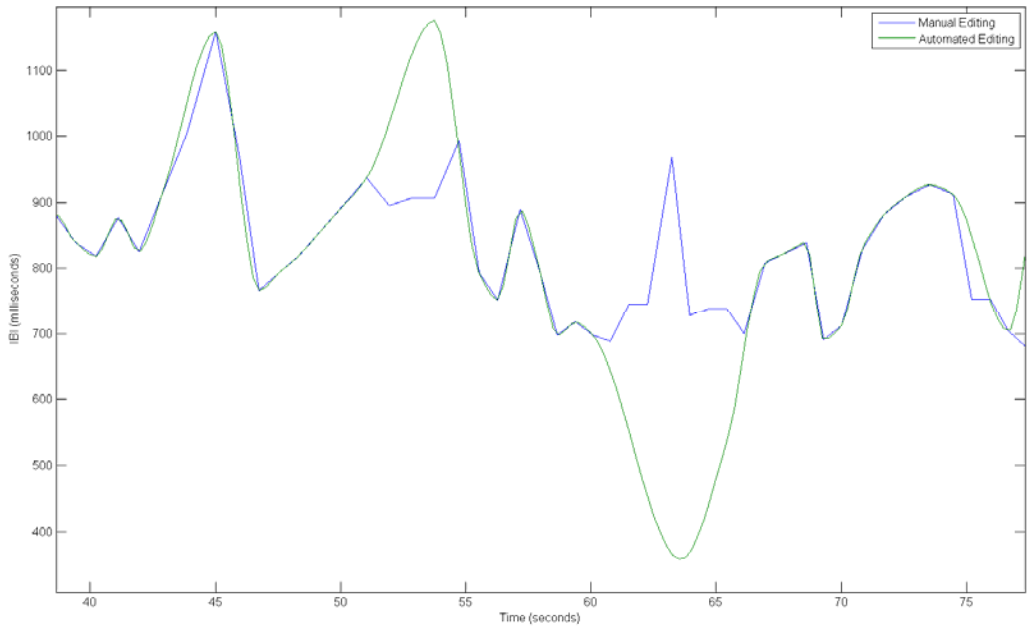


The data below (same data, last figure is zoomed in), shows the weakness of the automated editing. This file had >15% of the data replaced by auto-editing and was thus excluded from the results. However, the manual approach yields a usable data set for HRV analysis.

Manual editing is time and labor intensive, but it is the gold standard in the field. In addition, the devices being used need to be benchmarked against ECG, which is the gold standard for HRV analysis.

Finally, the existing signal was improved with re-analysis of the pulse wave signal. This signal was used to determine whether the pulse-interval extraction could be improved.





Analysis of Full Pilot Data. Heart rate variability measures were first extracted from physiological data collected during the pilot study. A significant amount of noise was observed in some of the pulse-interval data provided by the physiological monitoring system. A new method was developed to extract the raw pulse signal from the system. Software was created to pre-process the pulse signals, extract the pulse intervals from the processed signal, and divide the data into segments of time based upon experiment events. Re-analysis of the pulse interval data indicated that the pre-processing reduced noise and increased the amount of usable data. A slight variation in analyzing the heart rate variability was proposed to account for the slow breathing of the participants in the Battle Breathing group. Statistical analysis of the new heart

rate measures indicated that Battle Breathing significantly decreased autonomic arousal in the experimental group during the biofeedback.

Baseline pilot survey data were examined for pre-existing group differences that could impact post-deployment inference. We also examined distributions of responses as a check of instrumentation in preparation for the full study. Several minor modifications were made to the instrument to ensure that the survey would measure the constructs as intended. Analyses of the pilot data included the creation of computer code were reusable with the full study data, facilitating future tasks of data cleaning and secondary variable derivation.

Results: There were no significant differences in heart rate between the two groups at any point in the protocol. However, the biofeedback had the expected effect of reducing physiologic arousal as measured by an increase in the RSA level of the experimental group. During the Focus-Eyes Open segment of the training, experimental subjects exhibited significantly greater RSA, $t(51) = 10.38$, $p = 0.002$. This effect was not significant again until the final resting baseline segment, $t(50) = 4.19$, $p = 0.046$. Differences in the sample size were due to data being excluded for having too many artifacts.

Key changes for the main study: After reviewing the pilot study procedures and results, we identified the following key enhancements for the main study: eliminate refresher day, check user identity for conflict, improve reaction time measure, and enhance the mse's visual presentation. The main study will be limited to the training days only. The refresher day was removed from the protocol as it provided no significant findings during analysis of collected data.

Each participant was given a user identity number to uniquely identify his or her data during post-study data analysis. User identity conflict checking was implemented to prevent two participants from entering the same user identity number. If a participant entered an existing user identity number, he or she was alerted with a noticeable window and requested to enter a correct number. Participants were required to enter a unique user identity number before any data were collected.

An additional Reaction Time Application (RTApp) was added to improve the measurement of each participant's reaction time. At the conclusion of the virtual simulation, the RTApp executes on each participant's workstation computer. The RTApp has the same visual characteristics and response stimuli as the group virtual reality simulation. Due to the increased sampling rate when collecting game controller responses to RTApp stimuli and the greater precision in stimuli presentation, we were able to collect more precise measurements of individual reaction times in the millisecond range, which is consistent with the scale of reported findings in other reaction time studies.

The virtual simulation visuals were enhanced using newly available video capture tools to improve the quality of the virtual simulation. Video enhancements produced a higher-quality

visual experience and enable more precise control of color-coded stimulus objects and feedback response to game controllers.

2.2 Phase 2: Full Study

Task 1 Main study preparation accomplishments

▪ Obtained RTI IRB and HRPO approvals.
▪ Obtained Ft. Bragg approval and identified 3 data collection sites on base.
▪ Technical and Procedural Manuals were prepared to ensure consistency in procedures.
▪ Technical systems (software and hardware) were updated and tested.
▪ Questionnaires, information pamphlets, posters and consent forms were finalized and printed.
▪ Control condition stress management narrative and slides were finalized.
▪ 90 Laptops, game controllers, ear clips, MP3 players were purchased, configured, and tested.

Specifically, main study preparation included the following:

IRB. On January 16, 2013, RTI received approval (continuing review) from its IRB for the PRESTINT study. This submission included some revisions that we made to the study subsequent to the findings from the Pilot, Phase 1. We also obtained approval from HRPO.

Gift Cards. After corresponding with the client and the IRB personnel from USARMRMC regarding the issuance of Amazon gift cards to participating Soldiers, RTI prepared and submitted the request to include this officially in our protocol. The participants were informed (as part of their session) that they'll be asked to complete a short questionnaire upon their return from deployment and to give contact information where they may be reached for a 20-minute follow-up web survey after their return. They were informed that if they participate, they'll receive a $10 Amazon gift card as a means by which they can download additional relaxation music or other audio recordings.

Sample Size. Based on the response rates from the pilot study, the expected follow-up rate was around 20%. To compensate for a lower than anticipated response rate, the estimated sample size was increased from 800 to 1000 participants to ensure enough statistical power to detect post-deployment experimental effects.

Laptop HRV Monitoring. In order to complete data collection in one week as requested by our Ft. Bragg POC, we obtained 90 laptops, configured them all with Windows and HRV software and linked them to the main MSE computer.

MP3 Players. We ordered 1,000 MP3 players and programmed ½ of them for either the full PRESTINT training or the stress management training depending on participants' experimental or control group membership.

Study-Related Materials. We finalized the development of the visual aid presentation to appear on the screen in the front of the room during the time in which participants are listening to the control condition stress management recording. This slide show was an automated presentation with rolling images that are pertinent to the stress management materials. We have used both Army and civilian images.

We also developed a pamphlet providing general stress management materials for both control and experimental group participants and a poster regarding the study designed to increase awareness, participation, and motivation to participate by emphasizing the MP3 player incentives. Draft questionnaires were reviewed by our partners at Ft. Bragg, and slight changes were made to improved readability (**see Final questionnaire in Appendix III**).

We completed updates and enhancements to the PreSTINT program and protocol and prepared all 90 machines for testing in a mock sessions. Our POC identified the Global Response Force Platoons for the full study data collection and requested that all data be collected within the March through April 2013 timeframe. She also sent out the tasking request and efficiently scheduled more than 1,000 Soldiers for participation in 90-minute sessions.

Development of Reaction Time Measure. A new reaction time (RT) task was developed that provided a more accurate measure and improved analysis of RT.

Task 2: PRESTINT main study data collection accomplishments

a) Setup the PRESTINT learning environment
b) Participants were recruited and scheduled, and randomized to stress inoculation training (SIT) or stress management (SM) training
c) SIT and SM training was conducted
d) All participants were provided .mp3 players for SIT sustainment

Participants: Participants were members of the United States Army who volunteered to participate in a stress management study from a convenience sample of companies expected to deploy from a large east coast Army installation. Within those companies, platoons were randomly assigned to either experimental (SIT) or control groups. Following on-site baseline data collection (see Lewis et al., 2015 for details), interim emails were sent bimonthly to those who provided a valid address, requesting an assessment of the use of the techniques they learned at baseline (n=891). Between 1 and 2 years post-baseline (*M* = 69.87 weeks, range = 59.14 - 97.29 weeks), a final follow-up survey was administered onsite to 149 participants and via email to 118 participants who completed the survey online. The study was approved by the institutional review boards of the U.S. Army Human Research Protection Office and RTI International. All participants provided voluntary written informed consent.

Questionnaire Measures: Perceived stress was measured using the Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983), a 10-item scale to assess a person's perception of stress and control. An example item is "In the last month, how often have you felt nervous and stressed?" The scale provides a total perceived stress score ranging from 0 to 35, with higher scores indicating more perceived stress. The mean in this sample was 14.22 (*SD* = 7.08) and scores showed good internal consistency (Cronbach's α = 0.86).

PTSD Symptoms were measured at baseline using the PTSD Checklist-Civilian Version (PCL-C; Weathers, Litz, Herman, Huska, & Keane, 1993), a 17-item screening instrument. The civilian version, chosen to capture PTSD symptomatology prior to military service, has been used frequently with military populations (Hoge et al., 2004; Wilkins, Lang, & Norman, 2011). A cutoff point of 43 was used on PCL-C to indicate possible PTSD, a midpoint cutoff between recommended highest and lowest cut points (Bliese et al., 2008; National Center for PTSD, 2012). PCL-C scores showed excellent internal reliability in this sample (Cronbach's α = .94). At follow-up, the PCL-Military Version (PCL-M; Weathers, Huska, & Keane, 1991) was used. It included the same 17 items and scoring as the civilian version, but it referred to "military experiences" instead of "experiences" and was used since all participants were expected to be deployed post-baseline data collection (Weathers et al., 1991). PCL-M scores also showed excellent internal reliability (Cronbach's α = .96). Four latent variables were computed from the PCL representing the four key diagnostic criteria subscales for PTSD: avoidance, re-experiencing, hyperarousal, and emotional numbing (Mansfield, Williams, Hourani, & Babeu, 2010).

To screen for GAD symptoms, seven items adapted from the Patient Health Questionnaire (Spitzer, Kroenke, & Williams, 1999) were used. Responses were scored on a 5-point scale from 0 (none of the time) to 4 (all of the time). If respondents indicated that they had been feeling nervous, anxious, or on edge, or had been worrying about different things (the first questions in the set) for several days or more in the past 30 days, the analysis examined whether they reported any of the other symptoms. Using the standardized scoring algorithm, we used a cutoff of 10 to indicate GAD. *Loss of control or aggression* was measured with the item, "During the past year, have you had thoughts or concerns that you might lose control or hurt someone?" Response options were yes, no, and unsure. *Taking mental health medication* was measured using the yes-no item, "Are you currently taking medication prescribed by a doctor or other health professional for depression, anxiety, or sleeping problems?"

Potential covariates and control variables included sociodemographics (age, gender, education, marital status) and military-related variables such as paygrade and time since returning from deployment. HRV was measured with a pulse signal obtained from a photoplethysmograph sensor attached to the earlobe and monitored continually from 3 minutes before the pre-training MSE began to 3 minutes after the post-training MSE was administered. A measure of the delta (or change) between pre-training RSA and post-training RSA was calculated from the pulse interval data and used as an indicator of SIT effectiveness. Additional information about HRV

measurements used in this study have been published elsewhere (Hourani et al., 2016 in press; Lewis et al., 2015). Combat exposure was assessed with the Combat Experiences Scale from the Deployment Risk and Resilience Inventory to capture the various dimensions of stress experienced during combat situations and was measured at baseline only since the units did not deploy as expected. Mean scores were calculated from the frequency that each type of event was experienced during deployments.

At baseline, use of relaxation techniques ("What relaxation techniques do you practice?") and interest in learning about stress reduction ("How interested are you in learning techniques that may reduce stress?") were examined. Use of the SIT techniques was measured at follow-up through multiple items. First, participants were asked "Were you taught the breathing technique called Battle Breathing?" Brief descriptions of the two techniques were included for reference. Through single yes/no items, participants were asked if they "used the Battle Breathing focused breathing technique with [their] eyes open to help [them] focus or manage stress" and if they "used the Battle Breathing relaxation breathing technique with [their] eyes closed to help [them] sleep or relax." Perceived usefulness of SIT was assessed by asking participants to rate, on a scale from a lot to none at all, how much each technique (focused breathing and relaxation) helped them focus or manage their stress and helped them sleep or relax. Participants were asked "Do you think the Battle Breathing technique would be helpful to others?" Participants were also asked to indicate if they used the MP3 player they received to "listen to the Battle Breathing technique during the last 6 months," if they had "downloaded and listened to any additional relaxation or breathing music or videos (on [their] MP3 player or other device) in the past year," and if they had "used relaxation techniques other than Battle Breathing to help [them] sleep or to help manage stress since the training" and how often and how much the other techniques helped. Finally, differences in the control and experimental groups were examined by mode of follow-up survey completion (i.e., in-person, paper-pencil survey versus Web-based survey).

Baseline Data Collection Onsite. RTI conducted 65 sessions in total: 28 control and 27 experimental. Overall, we collected data from over 875 Soldiers. Soldiers attended 90 minute sessions in a classroom with 20–26 Soldiers per session. Sessions were randomly assigned to receive the control or experimental (SIT) training. Following a brief orientation, participants completed a 25-minute confidential questionnaire regarding their mental health and health behaviors. Both groups received a stress management information pamphlet to serve as the educational component of the SIT program. The control groups received SM, which included a 20-minute taped narrative and slideshow presentation on Stress Management. SIT was provided during a 20-minute group presentation on two separate relaxation breathing techniques, abdominal or relaxation breathing with eyes closed and attentional retraining or focused breathing with eyes open (see Hourani et al., 2011b for details). HRV data were gathered from both SIT and SM groups. Pre- and post-training presentations of an MSE, a video in which participants had to respond to triggers in an operational scenario using a game

controller, were presented to both groups. The scenario, a 3-D virtual simulation with enemy combatants, hazards, explosions, etc., had been shown to increase arousal as measured by heart rate in previous studies (Hourani et al., 2011b) and was used to allow participants to practice the breathing skills learned in training (controls were asked to think about the stress management skills presented in the slideshow), and to test physiological reactivity (Hourani et al., 2011b). Following the training, participants in both groups received MP3 players that contained the group-specific stress reduction training they received. SIT participants were encouraged to use the MP3 recording to practice the SIT technique or recall stress management practices, respectively.

Task 3: Monitored PRESTINT and CBP activity during deployment accomplishments

▪ Developed interim emails.
▪ Developed brief web survey.
▪ Obtained IRB approval for incentives.
▪ Monitored response rate.

After baseline data collection, we were informed that our baseline participants would not deploy as planned. We feared that this change could result in significantly less traumatic exposures and lower than anticipated PTSD rates. By monitoring for non-combat related trauma and stressful experiences, we hoped the SIT training would mitigate some of the reduction in expected outcomes.

Follow-Up Web Survey. To keep participants engaged in the study between baseline and follow-up surveys and to examine practice and stress levels post-baseline, email reminders with brief questions were sent to baseline participants who had provided useable email addresses at baseline. Approximately every 2 months, participants were asked to complete a short 5-question survey. The five items were completed online and gathered information on use of the MP3 players, stress management information, and a review of the group-specific relaxation technique training. In addition, participants were asked to rate their stress. The survey was administered through Survey Monkey and it was sent via email to both military and personal email addresses. It included the respondent ID and link to the Survey Monkey site so respondents could log in. The emails were prepared using Microsoft Word's mail merge wizard. Emails that bounced back were examined and fixed if possible. We continued this follow-up process every other month throughout year 3. Due to a low response rate, we requested and obtained IRB approval to send participants a $10 Amazon gift card to encourage participation. After a brief increase in responses, this incentive failed to garner a much-improved response rate. A total of 145 participants completed at least one of the bimonthly surveys. Upon completion of a bi-monthly survey, participants were sent gift code via email. The final response rate for that part of the study remained low at 29.82%.

EMAIL TEXT

Dear Stress Management Training Participant,

Here's your $10 Amazon Gift Card! (Code) Just type the code in when you are asked if you have a gift card and the credit will be applied to your purchase. The code can only be used once.

We hope you enjoy it. Now we need your help.

As a participant in the Stress Management Study training (with MP3 player) that you received from RTI International in March and April of 2013, we are asking you to complete a FINAL FOLLOW-UP QUESTIONNAIRE to let us know how you are doing now, nearly two years after your initial stress training. As of today, we have not yet received your completed questionnaire.

Even if you have PCS'd or moved or been discharged in the last 24 months, we still need your help!

Recall that your answers will not be shared with the Army and all answers will be analyzed in group form to ensure the confidentiality of your responses. It should take about 20 minutes to complete the survey.

Please complete the final follow-up questionnaire by February 14, 2015.

To complete the final follow-up questionnaire online, click on this web link: https://www.surveymonkey.com/s/PSM-FollowUp

Note: If clicking on the link does not open the web page, you can copy and paste the link into your browser.

Log into the survey using following log-in information:

Password: stress
Participant ID:

If you prefer to complete the survey by telephone, please respond to this email and request someone from the study team to contact you by phone to conduct the interview. Be sure to provide a telephone number and the best days and times for someone to contact you.

If you have any questions about the Stress Management Study you participated in (including problems with the MP3 player) or questions about this follow-up survey, please contact Jessica Nelson by phone at 800-334-8571 (extension 2- 7447), or by email at jnelson@rti.org

Thank you for your help!

NOTE: THIS EMAIL AND THE SAME GIFT CARD CODE ABOVE WAS SENT TO BOTH YOUR MILITARY AND PERSONAL EMAIL ADDRESSES IF YOU PROVIDED BOTH DURING THE TRAINING.

Task 4: Follow-up questionnaire accomplishments

- Developed follow-up questionnaire and amended IRB protocols.
- Conducted onsite data collection.
- Developed website for follow-up data collection.
- Conducted email follow-up data collection.

Follow-Up Questionnaire. The main follow-up questionnaire was developed and revised based on item analysis of similar questions on the baseline survey (see **Appendix IV**). Items on the follow-up questionnaire included the baseline survey measures as well as items to assess the

use and helpfulness of the MP3-recorded SIT instructions. An IRB amendment for the finalized questionnaire was submitted and approved by RTI IRB and HRPO.

Onsite Data collection. Although originally proposed as a web survey, due to the low response rate to the interim surveys, our project team identified an alternative approach for the main follow-up survey that could increase the follow-up response rate. After some delay regarding the transition of our previous base POC to a newly assigned base POC, we were able to identify and work with CPT Mark Wesseler to conduct the Phase 2 full follow-up study on-site at Ft. Bragg. CPT Wesseler scheduled the planned in- person follow up for a 2-hour period in the base auditorium for baseline participants who were still on the installation. We provided encrypted lists of the baseline survey respondent names and emails to CPT Wesseler who requested their participation in the follow-up data collection. Of approximately 800 baseline participants, 149 came to the 30-minute session and completed the follow-up survey.

Web-based data collection. Participants who did not complete the follow-up onsite, including those who possibly transferred to other units and for whom we had email addresses, were invited to complete the questionnaire online. These participants, contacted via email, were provided a secure login and password to access the survey. At this follow-up, participants were offered $20 in Amazon gift cards, provided through an online code, upon completion of the survey. After several months of a continued poor response, a code for an additional $10 gift card was provided prior to survey completion. These efforts, combined with email reminders sent approximately every 2 weeks, resulted in 146 participants who completed the online version of the survey.

Task 5: Follow-up data preparation, analysis, and literature review accomplishments

▪ Completed data preparation/cleaning and generated final codebook.
▪ Conducted response rate and missing data analyses.
▪ Conducted descriptive analyses.
▪ Conducted multivariate analyses.
▪ Conducted literature search and updated literature reviews.

Data Preparation. Data processing analysts updated the data sets with the naming changes and implemented several minor corrections to labels and formats, collapsing variables with low values. Algorithms for scoring the mental health scales were also coded. A preliminary codebook was generated and descriptive analyses were conducted to examine distributions by experimental vs controls groups to check randomization effect. The HRV database was also updated with a single time point for the intervention and a set of separate databases was created with the continuous HRV measures that were taken during the MSEs and the Intervention. Preliminary analyses checked for outliers, and examined patterns of missing data.

All analyses controlled for clustering at the session (two platoon) level using the SAS survey procedures.

Response Rate. Of the 891 baseline participants, (469 treatment, 422 controls), 267 participants (149 treatment, 118 controls) had sufficient baseline and follow-up data for analyses (see Figure 1). Preliminary to testing primary hypotheses, a dummy code was created to indicate whether or not participants had completed the follow-up survey and logistic regression models were run with each baseline variable as the independent variable. In nonresponse analyses we assessed whether missingness (i.e., failure to participate in the follow-up survey) was likely to bias estimates of the treatment effect. This was done by assessing whether those who did versus those who did not complete the follow-up survey were different on any baseline characteristics. This translated into tests of whether the baseline variables were predictive of dropping out of the study. We used a Bonferroni correction to control for multiple comparisons. All baseline survey items, HRV measures, and response time measures were tested for being predictive of dropout. We found that none of the variables were predictive of dropout, thus making the missing data assumptions for the multiple regression models used to estimate the treatment effects tenable.

Descriptive Analyses. The data were evaluated for baseline group differences on all survey and physiologic variables in the data set. The majority of variables showed no differences between experimental and control groups, however the few variables that showed group differences were controlled for in subsequent analyses. We examined potential contamination between experimental and control groups (ie., experimental group sharing Battle Breathing training with controls and/or controls receiving relaxation breathing techniques from other sources) and assessed the need for modification to our analysis plan. Descriptive statistics were analyzed to examine differences in mental health outcomes by breathing technique users versus non-users. Univariate relationships between PTSD measures, using DSM cutoffs of 43 and 50, were examined between the covariates and HRV measures. Descriptive analyses were also performed looking at the demographic differences between the battle breathing and control groups for baseline and follow-up PRESTINT populations. T-tests and chi-squared tests were performed to compare the demographic variables.

Multivariate Analyses. We performed an analysis examining the relationship between HRV and posttraumatic stress for a manuscript on the baseline HRV findings. Multivariate analyses were conducted on additional baseline findings for papers on help-seeking, coping behaviors, and suicidal ideation. In addition, an analysis examining the relationship between HRV and posttraumatic stress was performed. Baseline (Pre-MSE) values, MSE values, and the Pre-MSE to MSE change were examined by heart period (HP) and respiratory sinus arrhythmia (RSA). Relationships between the HRV variables and possible covariates was explored first using t-tests, correlations, and ANOVA adjusted for the cluster effect. Multivariate analysis using clustered logistic regression was preliminarily examined.

Task 6: Reports, briefings, and publication accomplishments

▪ Published paper on HRV findings (Lewis et al) in Psychophysiology
▪ Presented HRV findings at MHSRS and ISTSS
▪ Published paper on Health-seeking finding

We completed a peer-reviewed manuscript which was published in *Psychophysiology* (see Appendix V). Our results were presented at the MHSRS in August 2015 and at the International Society for Traumatic Stress Studies (ISTSS) meeting in November 2015 (see Appendix VI). The paper (Lewis et al.) entitled "Relaxation training assisted by heart rate variability biofeedback: Implication for a military predeployment stress inoculation protocol" in *Psychophysiology,* 52(2015), 1167–1174, described the heart rate variability and PTSD findings at study baseline. Findings showed that PRESTINT altered the parasympathetic regulation of cardiac activity, with experimental subjects exhibiting greater HRV, that is, less arousal, using the post-training MSE designed to heighten arousal.

We completed analyses and published a second manuscript entitled, "Help-seeking behaviors among active-duty military personnel: utilization of chaplains and other mental health service providers." This was published in The *Journal of Health Care Chaplaincy, 2016 May 18:1-18 [Epub ahead of print]* (See Appendix VII). Using logistic regressions, we described the issues for which soldiers reported seeking help, then outlined the characteristic of those who were most likely to seek help from a chaplain. Of the soldiers who sought help from a chaplain within the previous year, almost 30% reported high levels of combat exposure, 51% screening positive for depression, 39% had probable PTSD, and 27% screened positive for generalized anxiety disorder. The participant's unit firing on the enemy, personally firing on the enemy, and seeing dead bodies or human remains predicted seeing a chaplain.

We completed a third manuscript entitled "Health-related coping behaviors and mental health in military personnel" and submitted it for publication (See Appendix VIII). This study examined the predictive validity of individual health-related coping behaviors and mental health longitudinally after controlling for cross-sectional relationships and stability across time. Soldiers (N = 263) were assessed on measures of mental health and coping behaviors at baseline (Time 1) and follow-up (Time 2; M = 69.87 weeks). We used a two-wave, cross-lagged regression design using structural equation modeling. Findings showed that talking, exercising, engaging in a hobby, and planning how to solve the problem were associated with fewer anxiety, stress, and depressive symptoms. Smoking, drinking, and thinking about hurting oneself were associated with more symptoms. Drug use was associated with more depressive symptoms. Praying was not related to mental health. Depressive symptoms at baseline predicted talking to friends and exercising less at follow-up. Stress at baseline predicted engaging in a hobby less at follow-up. Exercising at baseline predicted less stress at follow-up. All other cross-lagged effects were nonsignificant. We concluded that it is possible that the cross-sectional relationships are

interdependent and reinforcing and that engaging in more positive coping behaviors may help to reduce mental health symptoms. Clinically, this knowledge is critical to more efficiently target behaviors with the greatest associations to mental health in military personnel.

We completed a fourth manuscript entitled: Effects of Sleep Disturbances on Suicidal and Violent Ideation in a Military Sample: The Mediating Role of Mental Health and submitted it for publication (See Appendix IX). The goal of this study was to examine the relationship between sleep disturbances, mental health (perceived stress, posttraumatic stress disorder [PTSD] symptoms, and depressive symptoms), and suicidal ideation (SI) or violent ideation (VI) in a sample of military service members. Mediation analyses were performed using the Hayes PROCESS macro for mediation, moderation, and conditional process analyses. Bias-corrected 95% bootstrap confidence interval estimates of the indirect effects using 10,000 bootstrap samples were obtained, and normal theory (Sobel) tests for indirect effects were also calculated. Results showed that sleep disturbances were significantly related to SI and VI. Sleep issues were also significantly related to stress, PTSD, and depression. PTSD, perceived stress, and depression significantly mediated the relationship between sleep disturbances and SI; after accounting for mental health symptoms, sleep no longer had a significant direct effect on SI. Although PTSD, perceived stress, and depression also significantly mediated the relationship between sleep and VI, sleep continued to have a significant direct effect on VI in simple mediation models of stress and depression. We concluded that our results did not support the multiplicative or synergistic effects of sleep and mental health. Instead, our findings suggested that sleep disturbances may operate as a risk factor or symptom of mental health issues and SI, and that they may be a

The main study paper entitled “Effects of Stress Inoculation Training with Relaxation Breathing on Mental Health Outcomes in the Military: A Longitudinal Study”, addressed the PRESTINT study’s primary research questions concerned with estimating the effects of the battle breathing training on mental health and PTSD outcomes (See Appendix X). We evaluated several potential moderators. We focused on ensuring that the baseline and medication variables were accurate and consistent. In addition, we ran analyses examining primary and secondary outcomes at baseline versus follow-up, thus comparing the battle breathing group to the control group. There were several group differences between our experimental (battle breathing) and control groups. We also

- derived baseline variables to indicate whether participants had serious mental health issues (depression, anxiety, or PTSD); were seeing a counselor; had sleep problems; or were taking a prescription medication for anxiety, depression, or sleep problems.
- created a table examining descriptive and demographic terms comparing control and battle breathing groups within the baseline and follow-up populations. We added terms to this table as determined by the group and looked for significant differences using chi-squared tests adjusting for clustering.

- created a table that focused on examining the relationships between primary and secondary outcomes and control versus battle breathing groups. We examined these outcomes at baseline, follow-up, and individuals who move from low values to high values at follow-up (incidence).
- fit regression models to estimate the intervention effect on primary and secondary outcomes, including covariates and moderation (interaction) effects to estimate whether the intervention had differential efficacy for subgroups that were more interested in stress control techniques, were on medications, or had baseline mental health problems.
- explored potential mediation models.
- updated the literature search and modified the terminology of the report (SIT vs PRESTINT) since subjects had not deployed as expected.

Findings showed that SIT did not have an overall effect on perceived stress scores or possible posttraumatic stress disorder (PTSD) symptoms when controlling for covariates. Consistent with previous findings in which SIT mitigated the risk of PTSD in those without baseline mental health problems, the current study showed that SIT may prevent reduce the risk of hyperarousal symptoms among mentally healthy military personnel who are not otherwise interested in learning stress-control techniques but was not supported as a general predeployment mental health prevention strategy. An HRV increase in response with relaxation breathing training suggests future research is warranted into mental health effects of self-regulation techniques.

Analyses of Subthreshold PTSD. An additional analysis was initiated when we noticed a number of the participants reported partial or sub-threshold PTSD. These participants did not meet the full definition of PTSD (PCL > 43 or > 50) but still had symptoms (as identified in the PCL). Multivariate analyses were conducted to examine the differential correlates of no PTSD symptoms versus subthreshold PTSD and subthreshold versus threshold PTSD. These analyses were discontinued as a result of a declined no cost extension request.

Preparing for Transition. During Year 4, RTI continued to refine our PreSTINT protocol and software for preparation to transition to the Army. We further fine-tuned the results screen that the participant sees and developed a project-specific smartphone application (for use on Android or Apple devices). In addition, we refined the instructor guide used by military program instructors. A training officer at Ft. Bragg expressed interest about transitioning the program to the military base; unfortunately, after extensive outreach and communication with the client, we were unable to identify a viable Army office that was able to support the implementation of the program at Ft. Bragg. On the other hand, our successful testing of the HRV methodology and resulting reduction of physiological arousal led to the development of a proposed HRV biofeedback intervention to increase resilience in the Reserve Component.

3. KEY RESEARCH ACCOMPLISHMENTS

Year 1 Research Accomplishments

- Obtained preliminary RTI IRB and HRPO approvals.
- Conducted Phase 1 pilot test and evaluated results.
- Successfully recruited more than 800 participants for our Phase 2 intervention.

Year 2 Research Accomplishments

- Obtained all necessary IRB approvals for amended protocols.
- Conducted baseline survey data preparation and analysis.
- Conducted baseline physiologic data preparation and analysis.
- Began draft of paper on baseline physiologic data results.
- Conducted 3 waves of interim Web-based e-mail follow-ups.
- Identified a new point of contact at Ft. Bragg and scheduled main follow-up survey.
- Finalized the full follow-up questionnaire.
- Drafted analysis plan of follow-up survey.

Year 3 Research Accomplishments

- Obtained all necessary IRB approvals for amended protocols.
- Finalized and submitted paper on baseline physiologic data results.
- Submitted revised paper on baseline physiologic date results that was accepted for publication in *Psychophysiology*.
- Conducted bimonthly interim e-mail surveys.
- Conducted on-site and Web-based follow-up data collection.
- Prepared and submitted baseline coping paper.
- Revised software, training materials, and protocols to permit transitioning to non-research training environment.

Year 4 Research Accomplishments

- Obtained necessary IRB continuing approvals.
- Presented a poster of results to date at MHSRS and ISTSS.
- Worked on complex analyses for three additional manuscripts, which were subsequently submitted as follows:

- Morgan, J., Hourani, L., & Tueller, S. (2016). Relationships between active and avoidant coping behaviors and mental health outcomes in military personnel. See Appendix VIII.
- Hourani, L., Tueller, S., Kizakevich, P., Strange, L., Lewis, G., Weimer, B., Morgan, J., Cooney, D., and Nelson, J. (2016). Effects of predeployment stress inoculation training with relaxation breathing on mental health outcomes in the military: A longitudinal study. See Appendix X.
- Morgan, J., Hourani, L., Tueller, S., Strange, L., Lane, M., Lewis, G. (2016). Effects of sleep disturbances on suicidal and violent ideation in a military sample: The mediating role of mental health. Submitted to *Sleep*, April 2016. See Appendix IX.

4. REPORTABLE OUTCOMES

4.1 Manuscripts

Lewis, G., Hourani, L., Tueller, S., Kizakevich, P., Bryant, S., Weimer, B., & Strange, L. (2015). Relaxation training assisted by heart rate variability biofeedback: implication for a military predeployment stress inoculation protocol. *Psychophysiology*, 52:1167–1174. See Appendix V.

Morgan, J., Hourani, L., Lane, M., & Tueller, S. (2016). Help-seeking behaviors among active-duty military personnel: Utilization of chaplains and other mental health service providers. *Journal of Health Care Chaplaincy,* DOI:10.1080/08854726.2016.1171598. See Appendix VII.

4.2 Presentations

Relaxation Training Assisted by Heart Rate Variability Biofeedback: Implication for a Military Predeployment Stress Inoculation Protocol. Poster presented at the Military Health System Research Society, August 2015; International Society for Traumatic Stress Studies, New Orleans, LA, November 2015. See Appendix VI.

Morgan, J., Hourani, L., & Tueller, S. (2016). Relationships between active and avoidant coping behaviors and mental health outcomes in military personnel. Poster presented to MHSRS 2016, See Appendix VIII.

Hourani, L., Tueller, S., Kizakevich, P., Strange, L., Lewis, G., Weimer, B., Morgan, J., Cooney, D., and Nelson, J. (2016). Effects of predeployment stress inoculation training with relaxation breathing on mental health outcomes in the military: A longitudinal study. Poster presented to MHSRS, 2016. See Appendix X.

Morgan, J., Hourani, L., Tueller, S., Strange, L., Lane, M., Lewis, G. (2016). Effects of sleep disturbances on suicidal and violent ideation in a military sample: The mediating role of mental health. Poster presented to MHSRS, 2016. See Appendix IX.

4.3 Employment or Research Opportunities

Jessica Kelley Morgan, MS, a doctoral student in psychology, worked as an intern on this grant. During the last 16 months of the grant, she gained extensive experience in reviewing literature, developing research questions, analyzing data, interpreting results, and writing scientific reports. Because of the experience afforded by this grant, she has applied for a permanent position with RTI International.

As a result of our encouraging findings with the heart rate variability data at baseline, we applied for and were awarded funding for a study to evaluate HRV biofeedback as a resilience-building intervention in the Reserve Component.

5. CONCLUSION

RTI successfully piloted the Phase 1 PreSTINT training protocol—showing that our randomization process was effective in ensuring comparability between the experimental and control groups, and that the PreSTINT mindful breathing and biofeedback training was effective in reducing physiological arousal.

From our analyses of the Phase 2 baseline physiologic data, we found that PreSTINT altered the parasympathetic regulation of cardiac activity. Following the baseline PreSTINT training, soldiers exhibited greater heart rate variability (i.e., less arousal during a post-training combat simulation designed to heighten arousal), suggesting that the brief relaxation breathing reduced their physiologic arousal response to stress. Autonomic reactivity was also found to be related to PTSD and self-reported use of mental health services at baseline. In addition, structural equation modeling that assessed the relationship between active and avoidant coping behaviors and mental health outcomes verified many strong cross-sectional relationships. For example, active coping activities were associated with fewer PTSD, anxiety, perceived stress, and depression symptoms at baseline, whereas avoidant behaviors (e.g., smoking, drinking, suicidal ideation) were associated with more symptoms. These preliminary study findings reinforced and enhanced the scientific literature pointing to stress inoculation training as a potential preventive approach to PTSD in the military.

From our multivariate analyses of the follow-up data, this study showed that PreSTINT did not have an overall effect on PTSD or perceived stress scores when controlling for other variables. Consistent with previous findings in which PreSTINT was important in mitigating the risk of PTSD in people without baseline mental health problems, the current study showed that PreSTINT may prevent possible hyperarousal among mentally healthy military personnel who are not otherwise interested in learning stress control techniques. Due to this limitation, PreSTINT could not be supported as a general predeployment mental health prevention strategy. An HRV increase in response with relaxation breathing training suggests future research is warranted into mental health effects of self-regulation techniques. From supplementary and complementary analyses, we concluded that the impact of experience with previous relaxation techniques on the change in heart rate was partially mediated by interest in learning such techniques. This experience appears to have primed the physiological response to the PreSTINT intervention. Further, our results did not support the multiplicative or synergistic effects of sleep and mental health. Instead, our findings suggested that sleep disturbances may operate as a risk factor or symptom of mental health issues and suicidal ideation, and that sleep disturbances may be a unique predictor of perceived loss of control above and beyond stress and depression.

Please see below for complete list of personnel supported during the course of this award. An updated Quad Chart is available in Appendix XI.

Personnel Supported by Award

Person	CTD Hours	Person	CTD Hours
Anderson, Brett P	75.4	Nguyen, Mai T	9.5
Bakalov, Vesselina D	57.0	Nguyen, Patricia M	52.0
Beck, Susan M	1.3	Njoku, Renee J	0.5
Bishop, Ellen	82.5	O'Hara, Robert M	25.6
Bogus, Michelle J	5.8	Olszewski, Jonathan C	0.4
Bohn, Loretta J	3.1	Parker, Robyn S	28.9
Bond, Debbie F	2.8	Parrish, Brittany L	3.1
Boykin, Catherine A	16.7	Preasha, Henrietta M	4.1
Braxton, Nancy C	26.5	Ramirez, Derek D	11.5
Bryant, Stephanie P	961.5	Ridenour, Ty A	6.0
Callot, Emily A	9.3	Sadler-Redmond, Susan L	3.6
Cannada, Judith	1.3	Shogren, Julie L	3.2
Cooney, Darryl A	558.5	Snaauw, Roxanne	2.3
Cox, Deborah A	0.5	Strange, Laura B	248.8
Craig, Mikayla J	9.1	Theilgard, John H	4.8
Eckhoff, Randall P	147.7	Tueller, Stephen J	682.1
Faerber, Matthew J	42.0	Walker, Thomas S	2.5
Farr, Heather M	1.2	Weimer, Belinda J	859.1
Garner, Valerie L	27.2	Whitmire, Behnaz R	77.7
Geercken, Gina M	20.2	Yates, Nathan S	22.7
Golla, Bharathi J	71.8	**Total Regular SSES Labor**	**9,713.2**
Haac, Cliff O	1.5	**Reg Lab Labor**	
Hall, Terry L	3.5	Lewis, Gregory F	485.2
Hodgin, Kyle E	72.5	**Total Lab Labor**	**485.2**
Holloway, John W	23.0	**Srvcs-ODC Labor (Non-T&M)**	
Hourani, Laurel L	2,483.6	HR Directions	249.3
Hubal, Robert C	112.0	**Total Srvcs-ODC Labor (Non-T&M)**	**249.3**
James, Laura M	3.2	**Total All Project**	**10,447.7**
Keim, Emma L	1.3		
Kendrick, Douglas E	390.8		
Kizakevich, Paul	748.5		
Lambert, Shari B	33.7		
Lane, Marian E	146.8		
Lee, William M	25.0		
Monroe, Dorothy G	10.2		
Nelson, Jessica P	1,487.8		

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APPENDIX 1. TECHNICAL REPORT ON PREDEPLOYMENT STRESS INOCULATION TRAINING PROGRAM (PRESTINT): FT. BRAGG PILOT TEST FINDINGS

Testing and Evaluation of an Army Predeployment Stress Inoculation Training Program (PRESTINT)

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Award Date: 1 May 2012 to 30 April 2015
Sponsor: US Army Medical Research and Materiel Command (USAMRMC)

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Ft. Bragg

- COL Jay Earles
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- PFC Kyle Patterson
- SPC Kenneth Tubilleja

Study Rationale

- Research gap: Little is known about current predeployment efforts to mitigate combat and operational stress injuries
- Programs applied inconsistently and often without evaluation
- Need to shift from medical to preventive model but data to help develop and optimize mental health prevention programs is lacking
- Literature suggests that reduction of physiological arousal shortly after trauma exposure may reduce risk of PTSD symptoms and that methods of relaxation training and stress management techniques may be effective for reducing risk of combat stress casualties

Study Background

- Stress inoculation training shows most promise for applicability to military population
  - Education
  - Skills Acquisition
  - Practice and test in situation that emulate the stressful environment
- Leveraging prior work in multisensory/virtual environments to aid program development and prior work with Marines
- Concept Award by Congressionally Directed Medical Research Program but no data collection allowed

Objective

The objective of this program is to help deploying soldiers better cope with combat-related stressors and reduce the risk of PTSD and other stress-related symptoms.

Hypotheses

- H1: In the predeployment training phase, the PRESTINT group will have improved physiological control (as measured by heart rate variability) (HRV) and speed/accuracy (as measured by reaction time) (RT) performance compared to a group receiving current best practices (CBP) (e.g., Battlemind/resilience training)

- H2: The PRESTINT group will have fewer stress-related symptoms following deployment than the CBP group in terms of PTSD symptoms and related symptoms, including sleep and mood problems

- H3: The more that PRESTINT is used in conjunction with a stressful or traumatic event exposure during deployment (higher compliance), the fewer stress-related symptoms will be reported

Study Design

- Pre- and postdeployment randomized intervention study
- Controls receive CBP, informational materials such as Battlemind or resilience building; experimental group receives both CBP and PRESTINT, which contains two training techniques:
  - (1) Biofeedback-facilitated breathing retraining for control of autonomic reactivity
  - (2) Attentional control for staying fully engaged in the moment at hand while maintaining optimal attention levels
- Techniques practiced during multimedia stressor environment (MSE) with biofeedback and physiologic monitoring (HRV and RT). MSE is administered during initial training and 1 week later
- MP3 players provided during deployment to practice training (also capable of storing music, videos, etc.)
- Bimonthly website data collection of stressful experiences and training reminders
- Postdeployment survey

Measures and Analyses

Self-Report Outcome and Covariate Measures

- PTSD Checklist—Military Version (PCL-M)
- Patient Health Questionnaire—Depression Subscale (PHQ-9)
- Beck Anxiety Inventory (BAI)
- Pittsburgh Sleep Quality Index (PSQI)
- Two-Item Conjoint Screening (TICS)
- Combat Exposure Scale (CES)

Psychophysical Reactivity and Cognitive Performance Measures

- Heart Rate Variability (Stress Sweeper Pro software)
- Reaction time (via game controller to MSE triggers)

Analyses

- Multiple Regression to compare HRV and RT means and adjust for potential covariates
- General linear models to compare adjusted mean of PCL symptom scores

Methods (Predeployment)

Session A : PRESTINT training

Enter	Consent	Questionnaire	Start HRV	Pre-MSE	MSE	Post-MSE Intervention	Discuss

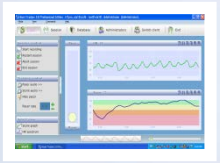
HRV data collection (Session A)

Regular duty (about 1 week)

Session B: Post 1 week duty

Re-seat	Start HRV	Debrief	Pre-MSE	MSE	Post-MSE	Debrief

HRV data collection (Session B)



MSE projection & reaction time targets

HR & HRV Biofeedback

MSE Computer → **802.11b Wireless Hub** → **PRESTINT Workstations**

Time Sync

Reaction Time Game Controller

Study Progress

- All IRB approvals for pilot study obtained
- Resilience best practice materials identified
- Predeployment survey instrument drafted
- Multimedia stressor environment development
  - 10-minute path through widescreen background scene
  - Arousal and reaction time triggers input
  - Surround sound engineered
- Physiological measurement equipment obtained and tested for pilot study
  - Earclips and Stress Sweeper Pro to measure heart rate variability
  - Game controllers for reaction time recording
  - Laptops and software for practicing stress control breathing exercises and converting HRV data to statistical database
- PRESTINT training protocol/manual drafted

Timeline

Phase 1: Pilot test of 60 deploying soldiers at Ft. Bragg (Year 1)

- System preparation: 5/18/12–11/18/12
  - Configure and test data collection software
  - Load software for MP3 players
- Pilot testing: 11/18/12–4/18/13
- Prepare reports and conduct briefings of results: 4/18/13–5/18/13

Phase 2: Full study of 800 deploying soldiers (Years 2-3)

- System Preparation: 2/18/13–5/18/15
- Conduct baseline predeployment data collection: 5/18/13–10/18/13
- Conduct web-based deployment data collection: 6/18/13–4/18/14
- Conduct postdeployment data collection: 4/18/14–10/18/14
- Statistical analysis: 8/18/14–12/18/14
- Reporting: 12/18/14–4/18/15

Significance/Transition Plan

- Findings from this study will provide the necessary next step in the development and evaluation of effective predeployment stress inoculation training programs for force health protection and combat stress casualty prevention

- If shown to be effective in mitigating psychological casualties and improving sleep, evidence-based training modules can then be developed for throughout the Services to supplement and strengthen current combat and operational stress programs

APPENDIX II. TESTING AND EVALUATION OF AN ARMY PREDEPLOYMENT STRESS INOCULATION TRAINING PROGRAM (PRESTINT) (FT. BRAGG DEMO, AUGUST 2015)

February 2013

Technical Report on Predeployment Stress Inoculation Training Program (PRESTINT): Ft. Bragg Pilot Test Findings

Prepared for

USAMRAA
Attn: MCMR – AAA-S
Award No. W81XWH-12-2-0039

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Background

Although there is much ongoing research to determine the most effective *treatments* for PTSD, much less is known about *preventive* efforts designed to psychologically prepare personnel for potential deployment and combat-related stressors. There is some evidence however that a reduction in physiological arousal shortly after exposure to a stressful or traumatic experience may reduce the risk of PTSD symptoms. This project tests and evaluates a group pre-deployment stress inoculation training (PreSTINT) program designed to help deploying personnel better cope with combat-related stressors and mitigate negative behavioral effects of trauma exposure by providing relaxation training breathing skills. The PreSTINT program includes an educational component in which personnel are introduced to didactic stress management materials, a skills acquisition component in which two arousal reduction breathing techniques (Battle Breathing) are presented and biofeedback is used to help learn the techniques, and a practice component which involves exposure to a multisensory stressor environment (MSE) to practice the techniques during a combat-simulated video scenario. Self-report questionnaires are administered to assess psychological symptoms and independent variables and heart rate variability (HRV) and reaction time (RT) are measured to assess physiological arousal and performance. MP3 players are provided to all participants with the training materials loaded and are encouraged to review and use as needed, especially during deployment. The overall goal of this project is to develop an evidence-based, cost-effective pre-deployment stress inoculation training program to reduce the risk of post-deployment psychological problems.

For this study, we will recruit Army personnel undergoing a regular pre-deployment combat training regimen at Ft Bragg and randomize them into experimental and control groups by platoon. Experimental groups will receive the 20 minute Battle Breathing skills training while control groups receive a 20 minute stress management lecture. Phase 1 of the study includes 60 pre-deploying soldiers to pilot test the materials and examine the acceptability and ability of the training materials to reduce physiological arousal (HRV) in response to the MSE. Phase 2 includes 800 pre-deploying soldiers to evaluate the ability of the PreSTINT training to reduce the risk of PTSD and other psychological distress symptoms post deployment. This document describes the methods, analyses, and findings of the pilot test designed for the study entitled Testing and Evaluation of a Predeployment Stress Inoculation Training Program (PRESTINT) and conducted for the U.S. Army by RTI International.

Methods

Pilot data were obtained from Army personnel at Ft. Bragg, NC. Three randomly selected groups of soldiers participated, for a total of 56 (35 experimental and 21 control) personnel. All participants were on active duty undergoing predeployment preparations with projected deployment to Afghanistan. Data were obtained for participants in each group over 2 separate sessions on 2 different days. During the first session, a team of 3 to 4 trained individuals administered the survey, conducted PRESTINT training or current best practice (CBP) training, and ensured proper collection of physiologic measurements for each group. The second session was conducted 1 week later and served as a refresher for the training received during the first session. Of the 56 participants at the first session, 31 returned for the refresher session.

In this study, we used stress inoculation training (SIT) to train combatants to control their cognitive and somatic arousal and then allowed them to practice with a video stressor environment. The combination of the three SIT components constituted the predeployment SIT program tested by this study. As described in detail in the following sections, the first stage of SIT involved the provision of current combat and operational stress control (COSC) educational materials, and the second stage involved learning simple relaxation breathing techniques proven to reduce physiological arousal . We tailored our skills training to those that could be utilized during combat situations as well as during post-combat recuperation. The CBP or control group received a didactic stress management lecture. Both training periods were recorded and took 20 minutes to complete. The third stage involved practicing the breathing techniques (or recalling the stress management information) during a multisensory stressor environment (MSE) with physiological state measured by respiratory sinus arrhythmia (RSA), a specific component of heart rate variability (HRV), and by reaction time (RT). The MSE was presented prior to and after the SIT and CBP trainings. Participants were instructed to act as if on patrol and to respond to different situations in the MSE environment using a video game controller.

The PRESTINT pilot study was conducted as a randomized trial with both control and experimental groups. Participants were randomly assigned to either a control or experimental group. The pilot study consisted of 2 days: a training day and a refresher day. On the training day, the control group received the CBP stress management audio presentationdescribing identification of stress characteristics and coping strategies for stressful situations. The experimental group received the PRESTINT Battle Breathing training. Battle Breathing training consisted of an audio presentation guiding participants through 2 deep breathing techniques. The Focus Eyes-Open training was directed toward use in combat situations to maintain calm yet focused attention. Participants were guided through a deep breathing exercise while maintaining focus on a neutral object in the environment. The Eyes-Closed training was directed toward use during rest periods to increase the quality of relaxation and sleep. Participants were

guided through an exercise that involved closing their eyes and focusing on deep breathing and relaxing all parts of the body. Both groups were given copies of the briefing information contained in the PowerPoint lecture and MP3 players containing audio recordings of the Battle Breathing training. On the refresher day, participants received a brief review or shortened training lesson.

The study used paper-based and electronic data collection strategies to gather quantitative measures of mental state, arousal level, reaction time, and training practice. Data were collected at key points throughout each instruction period. A 20-minute self-assessment questionnaire, based on existing psychometric instruments used by the military, was administered to establish a baseline measure of mental condition. Commercial biofeedback software, Biocom Stressweeper Pro, was used to provide guided breathing practice, to collect heart rate information from an earlobe photoplethysmograph (PPG) pulse monitor connected to the workstation computer's USB port, and to display graphs representing heart rate and arousal state. Heart rate data were collected throughout the training and MSE. The data collected by the commercial software were examined further in 3-minute segments using a novel HRV and RSA analysis algorithm adapted from the Porges-Bohrer methodology (Porges, 2007; Lewis et al., 2012) to determine a measure of HRV and RSA for each period of the protocol (i.e., before, during, and after instruction or training). Reaction time was measured by time-stamped responses collected from game controller devices in response to viewings of a stimulating virtual reality simulation containing a variety of color-coded response stimuli. On the refresher day, electronic surveys were used to determine the extent to which participants were able to use the lecture or breathing techniques.

The MSE was used to increase participants' arousal state by using an interactive virtual simulation environment. The environment includes combat intensive movie clips along with a virtual simulation containing combat-related elements, including explosions and sounds of gunfire, and aircraft, and response stimulus objects. The immersive characteristic of simulation was enhanced by using high-definition video and surround-sound audio presentation.

The PRESTINT data collection system consisted of a set of laptop computers communicating over a stand-alone wireless network. The MSE computer ran a control application that guided the training facilitator through the various protocol segments for control or experimental groups and displayed the MSE virtual simulation. The participant workstation computers received cues from the master MSE machine that coordinated their displays with facilitator training. The participant workstations displayed the commercial biofeedback application, collected the game controller responses, and automatically transferred collected data to the master MSE machine at the conclusion of each training session. The

game controllers provided a vibration feedback in response to visual cues in the virtual simulation in order to keep participants engaged in the virtual simulation.

Survey Data and Results

The pilot survey consisted of approximately 42 items, including the following scales: Post Deployment Clinical Assessment Tool (PDCAT), Patient Health Questionnaire (PHQ), Post Deployment Health Reassessment (PDHRA), PTSD Checklist (PCL), Perceived Stress Scale, and Center for Epidemiologic Studies Depression Scale (CES-D). In addition, items from the Survey of Health Related Behaviors among Active Duty Military Personnel were included that measured family, work, and deployment stress; receipt and type of mental health treatment; and number, length, and locations of deployments. Based on findings and feedback on the pilot survey, the baseline instrument was revised for full-scale implementation. Stress management and deployment questions were moved to the front of the survey, and items related to health behaviors and stress were moved later in the survey. Changes to the order of the items were made so that the questions that soldiers are not frequently asked come sooner in the survey and thus keep their interest. Questions that soldiers are asked frequently are asked later. In addition, two new questions were added regarding the frequency of participating in high-performance or extreme workouts and ways of coping with stressful situations. A question measuring the amount of stress experienced in the past 12 months due to various situations was removed and will be included at follow-up only.

Data Cleaning. Variables were recoded and reviewed for quality assurance as needed for analysis. For example, many questionnaire variables were recoded to binary versions. For example, the question "How often have you found that you could not cope with all the things that you had to do?" was recorded from five response options (Never, Almost Never, Sometimes, Fairly Often, or Very Often) to two response options of (Never, Almost Never, or Sometimes vs. Fairly Often or Very Often).

Combat exposure was measured for the last deployment using a scale adapted from the Marine Corps and used in previous military surveys. These items concern exposure to incoming fire, mines, improvised explosive devices (IEDs), firing on the enemy, viewing dead bodies or human remains, interacting with enemy prisoners of war, and similar circumstances that may be relevant. From these 17 items, a sum score was created using each individual item where a response of "51+" was assigned a value of 4, "13 to 50" was assigned a value of 3, "4 to 12" was assigned a value of 2, "1 to 3" was assigned a value of 1, and "0" was assigned a value of 0. A sum of zero was considered "Deployed but not exposed to combat," a sum of 1 to 9 was considered "Moderate combat exposure," and a sum of 10 or greater was considered "High combat exposure."

The questionnaire also allowed for the creation of some standard assessment scales or scores for stress, PTSD, depression, and anxiety. Specifically, we created scales for stress, generalized anxiety disorder (GAD), Perceived Stress Scale (PSS), Center for Epidemiologic Studies Depression Scale (CESD), and PTSD.

Codebooks. A codebook was created that includes frequencies for all variables with categorical questionnaire responses or mean and range for all variables with continuous responses (e.g., age). There is a section for questionnaire responses, roster data, response time data, HRV data, and all recoded and derived variables.

Analyses. Analysis of survey data were conducted to examine whether there were baseline group differences that may need to be controlled for in follow-up analyses. After computing descriptive statistics, independent samples t-tests were used for continuous variables, while a chi-squared test of independence was used for categorical variables.

Results. Descriptive statistics are shown in Table 1.

Table 1. Descriptive Results for the Survey Data

Variable	Control N = 21 mean 25.1		Experimental N = 35 mean 24.9		Total N = 56 mean 25	
Age (mean)	**n**	**percent**	**n**	**percent**	**n**	**percent**
Gender						
Male	20	95.2	31	88.6	51	91.1
Female	1	4.8	4	11.4	5	8.9
Education						
High school or less	12	57.1	16	45.7	28	50
Some college or trade school	9	42.9	19	54.3	28	50
Paygrade						
E1–E3	5	23.8	17	48.6	22	39.3
E4–E6	16	76.2	18	51.4	34	60.7
Marital status						
Married/living as married	15	71.4	17	48.6	32	57.1
Single, never married	4	19	16	45.7	20	35.7
Separated/widowed/divorced	2	9.5	2	5.7	4	7.1
Ever deployed (Yes)	11	55	10	30.3	21	39.6
Number times deployed in Iraq and/or Afghanistan						
Once	4	36.4	5	45.5	9	40.9

2 or more times	7	63.6	5	45.5	12	54.5
Deployed elsewhere	0	0	1	9.1	1	4.5
Stress in work or family (a lot)	10	47.6	10	28.6	20	35.7
Received counseling	7	33.3	9	25.7	16	28.6
Received combat stress management	0	0	1	2.9	1	1.8
Practices relaxation techniques	9	42.9	17	51.5	26	48.1
Regularly practice martial arts (1–3 times per month or more)	3	15	5	15.2	8	15.1
Interested in learning stress reduction	19	90.5	31	93.9	50	92.6
Amount of stress due to upcoming deployment						
A lot	0	0	1	3.3	1	2.1
Some	4	22.2	5	16.7	9	18.8
A little/None at all	12	66.7	20	66.7	32	66.7
Not deploying	2	11.1	4	13.3	6	12.5

(continued)

Table 1. Descriptive Results for the Survey Data (continued)

Variable Age (mean)	Control N = 21 mean 25.1		Experimental N = 35 mean 24.9		Total N = 56 mean 25	
	n	**percent**	**n**	**percent**	**n**	**percent**
Ever experience a serious or life threatening event (Yes)	14	70	23	69.7	37	69.8
Combat experience scale						
Low/medium level	8	40	20	60.6	28	52.8
High level	12	60	13	39.4	25	47.2
Frequency of video games prior to military						
Less than 4 hours per week	6	28.6	13	40.6	19	35.8
4 or more hours per week	15	71.4	19	59.4	34	64.2
Amount of caffeinated beverages today (more than 1)	13	61.9	17	53.1	30	56.6
Amount of energy drinks today (more than 1)	4	19	6	18.8	10	18.9
Tobacco use today (Yes)	7	33.3	19	59.4	26	49.1
Harmful or suicidal thoughts in past month (Yes)	1	5	1	2.9	2	3.7
Prescribed medication for depression, etc. in past year (Yes)	1	4.8	3	8.8	4	7.3
Depression (CES-D > 16)	3	14.3	11	31.4	14	25
PTSD Checklist (PCL > 50)	2	9.5	5	14.3	7	12.5
	mean		**mean**		**mean**	
Generalized anxiety (PHQ mean)	5		4.7		4.8	
Perceived Stress Scale (mean)	13.6		12.8		13.1	

Only 2 out of over 350 items had significant group differences, which is far less than the type I error rate. The following items were the ones for which there were group differences:

1. Q12s_MONEY_STRESS “Problems with money”: Control cases had less money stress, but this effect goes away when collapsing the categories “quite a lot” with “some” and “a little” with “none at all.”. The effect was caused by experimental cases using the “a little” category more while control cases used the “none at all” categories.

2. Q37j_CAUSALTU “My unit suffered causalities”: A total of 75% of control cases had seen 1 or more casualties in prior deployments, while 69% of experimental cases had seen no casualties in prior deployments. Follow-up analyses will control for this experiential difference.

Reaction Time Data and Results

During the MSE, participants were asked to respond to potentially threatening situations by pressing the red square button on their controllers. The proportion of correct responses was computed and called the hit rate. The false alarm rate was computed as the number of presses of the red button in the absence of a potentially threatening situation divided by the number of potentially threatening situations. From these two measures, the sensitivity index (also called *d*-prime) was computed. To simulate a complex task, participants were also asked to watch for other types of events, leading to a total of 20 reaction time measures across the two MSEs.

Analyses. Analysis of reaction time data were conducted using *t*-tests to examine whether there were group effects during the MSEs.

Results. There were group effects only for the false alarm rate where experimental cases had greater false alarm rates than control cases. This occurred for only 1 out of 20 comparisons, which is equal to the type I error rate of .05.

Heart Rate Data and Results

Heart rate HRV were assessed using custom-designed software. Raw pulse signals were extracted from the Biocom records of each participant. The Biocom system continuously recorded earlobe PPG (i.e., pulse wave) data at 240 samples per second. Precise timing information was stored for each session to facilitate extraction of event-related physiological signals.

Raw pulse signals were first preprocessed to improve the detection of individual pulses. The pulse signal was first smoothed by convolving the signal with a 64-point “Flat Top” window, with a cut-off frequency of 7.5Hz. The first-derivative of the filtered pulse signal was then calculated and the peak of the rising slope (i.e., the local maxima of the first-derivative) used for pulse wave detection. Based on the start times for each segment of the protocol, raw pulse data were parsed into equal length segments for each segment of the protocol. Parsed, preprocessed pulse signals were then analyzed by an adaptive pulse detector, which searches for local maxima within a time window with a start time and duration defined by the difference between the two prior pulse times. Testing showed that the adaptive algorithm missed fewer pulse waves than the Biocom signal analysis.

For subjects with faster heart rates, the program looked at a shorter window closer to the previous pulse, while for slower heart rates the window began later and lasted longer. Adaptation began after the third detected pulse interval. Ceiling and floor conditions were imposed to prevent the adaptation from forcing the expected range outside the physiologically relevant range, for example as a result of periodic signal loss. If multiple peaks existed within the window, the first observed peak was used. An example is provided in Table 2.

Table 2. Adaptive Pulse Detection Windows, Times Given in Seconds from Previous Pulse Wave Detection

Condition	Start Time	Window Size	End Time
Rapid heart rate (mean interval = 0.650 s)	(0.650)/2 = 0.325 s	0.2 + 0.9*(0.650) = 0.785 s	0.325 + 0.785 = 1.100 s
Slow heart rate (mean interval = 1.000 s)	(1.00)/2 = 0.500 s	0.2 + 0.9*(1.00) = 1.100 s	0.500 + 1.100 = 1.600 s

Data Cleaning. Extracted pulse intervals were edited for artifacts prior to calculating measure of heart rate (i.e., mean pulse interval) and heart rate variability. Sequential pulse interval differences were used to identify outlier intervals, based on the parameters suggested by Berntson et al. (1990). Briefly, the distribution of valid pulse interval differences was modeled by the median and the Quartile Deviation of the observed differences. Pulse intervals outside this range were flagged for replacement, and piece-wise cubic interpolation was applied to the "valid" pulse interval time-series to generate an evenly sampled time-series of heart period at four samples per second (i.e., 4Hz). If more than 15% of the total time-series was based on interpolated pulse intervals, the file was removed from further analysis in order to limit the influence of the interpolation on measures of variability. The median amount of data estimated by interpolation was 4.06% for the pilot dataset.

Analyses. Two measures of heart rate variability were calculated from the interpolated time-series in addition to the mean heart period for the segment. First, respiratory sinus arrhythmia (RSA) was calculated according to the Porges-Bohrer method (see Lewis et al., 2012 for a review). However, the biofeedback manipulation forces subjects to breath at a rate (6 breaths per minute = 0.10Hz) slightly slower than the slowest spontaneous respiration (8.33 breaths per minute = 0.12 Hz) expected by the Porges-Bohrer algorithm. To account for this group difference in respiratory patterns, a broader range of respiration rates was incorporated into a modified Porges-Bohrer analysis strategy. This new measure of heart rate variability maintains many of the advantages of the existing methodology (see again, Lewis et al., 2012) but lacks the neuroanatomical specificity inherent in measuring spontaneous RSA. This is an unavoidable trade-off, considering that the mechanism of action for the biofeedback likely relies on this manipulation of respiratory activity that brings it into the range of blood-pressure and other slower physiologic oscillations.

Results. There were no significant differences in heart rate between the two groups at any point in the protocol. However, the biofeedback had the expected effect of reducing physiologic arousal, as measured by an increase in the RSA level of the experimental group. During the Focus-Eyes Open segment of the training, experimental subjects exhibited significantly greater RSA, $t(51) = 10.38$, $p = 0.002$. This effect was not significant again until the final resting baseline segment, $t(50) = 4.19$, $p = 0.046$. Differences in the sample size are due to data being excluded for having too many artifacts.

Key Changes for the Main Study

After reviewing the pilot study procedures and results, we identified the following key enhancements for the main study: eliminate refresher day, check user identity for conflict, improve reaction time measure, and enhance the MSE's visual presentation. The main study will be limited to the

training days only. The refresher day was removed from the protocol as it provided no significant findings during analysis of collected data.

Each participant was given a user identity number to uniquely identify his or her data during post-study data analysis. User identity conflict checking was implemented to prevent two participants from entering the same user identity number. If a participant enters an existing user identity number, he or she is alerted with a noticeable window and requested to enter a correct number. Participants are required to enter a unique user identity number before any data are collected.

An additional Reaction Time Application (RTApp) was added to improve the measurement of each participant's reaction time. At the conclusion of the virtual simulation, the RTApp executes on each participant's workstation computer. The RTApp has the same visual characteristics and response stimuli as the group virtual reality simulation. Due to the increased sampling rate when collecting game controller responses to RTApp stimuli and the greater precision in stimuli presentation, we were are able to collect more precise measurements of individual reaction times in the millisecond range, which is consistent with the scale of reported findings in other reaction time studies.

The virtual simulation visuals were enhanced using newly available video capture tools to improve the quality of the virtual simulation. Video enhancements produce a higher-quality visual experience and enable more precise control of color-coded stimulus objects and feedback response to game controllers.

References

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Lewis, G. F., Furman, S. A., McCool, M. F., & Porges, S. W. (2012). Statistical strategies to quantify respiratory sinus arrhythmia: are commonly used metrics equivalent? *Biological Psychology*, *89*(2), 349.

Porges, S. W. (2007). The polyvagal perspective. *Biological Psychology, 74*(2), 116-143.

APPENDIX III. PREDEPLOYMENT STRESS MANGEMENT QUESTIONNAIRE (BASELINE QUESTIONNAIRE)

PREDEPLOYMENT STRESS MANAGEMENT QUESTIONNAIRE

INSTRUCTIONS FOR COMPLETING THE QUESTIONNAIRE

All questions on this survey provide a set of possible answers. Please read all the answers before marking your choice. If none of the printed answers exactly applies to you, place an "X" on the square for the one answer that best fits your situation.

- **Use only the pencil you were given. Erase cleanly any answer you wish to change.**
- **Put an "X" on the center of the square to indicate your answer. Do not use other marks.**

CORRECT MARK ☒ ☐ ☐ ☐

INCORRECT MARKS ☑ ☒ ⬬ ⊙

- **If you are asked to give numbers or write letters in boxes, please enter your responses as shown below. Please enter one number or letter to a box.**

Telephone number

5	*5*	*5*	—	*5*	*5*	*5*	—	*5*	*5*	*5*	*5*

- **For many questions, you should put an "X" in only one square for your answer in the column below the question. However, some questions ask you to mark all the choices that apply. When asked to "mark all that apply," please do so as shown here:**

EXAMPLE: Have you ever had any of the following conditions? (Mark all that apply.)

- ☐ Back pain
- ☐ Ringing in the ears
- ☒ Difficulty remembering
- ☐ Trouble sleeping
- ☐ Chronic headaches
- ☐ Skin rashes
- ☒ Difficulty breathing

PRIVACY ACT STATEMENT

Authority. 5 U.S.C. 301

Purpose. Medical research information will be collected in an experimental research project #0213380, titled Testing and Evaluation of a Predeployment Stress Inoculation Training Program (PRESTINT), to enhance basic medical knowledge, or to develop tests, procedures, and equipment to improve the diagnosis, treatment, or prevention of illness, injury, or performance impairment.

Routine Uses. Medical research information will be used for analysis and reports by the US Army Medical Research and Materiel Command, Department of Defense, and other U.S. Government agencies, provided this use is compatible with the purpose for which the information was collected. Use of the information may be granted to non-Government agencies or individuals by the Army Surgeon General following the provisions of the Freedom of Information Act or as may be indicated in the accompanying Informed Consent Form.

Disclosure. Provision of information is voluntary. There are no penalties for not providing the requested information but failure to provide the requested information may result in failure to be accepted as a research volunteer.

PLEASE GO TO PAGE 2. ➔

Insert Lithocode Here

Please provide the following personal and contact information. Again, please be assured that your confidentiality will be maintained. This information will be used to contact you for <u>one</u> follow-up survey.

What is your date of birth?

		/			/				
D	**D**		**M**	**M**		**Y**	**Y**	**Y**	**Y**

Please use the boxes below to spell your last and first names and middle initial. Please write clearly and neatly.

Last Name

First Name **MI**

Please provide BOTH your MILITARY and your PERSONAL email addresses. Please write clearly and neatly.

Military E-mail

Personal E-mail

PLEASE NOTE:
THIS PAGE WILL BE SEPARATED FROM THE REST OF THE QUESTIONNAIRE TO PROTECT THE CONFIDENTIALITY OF YOUR RESPONSES!

These first few questions ask about your background.

1. Are you male or female?

- ☐1 Male
- ☐2 Female

2. What is your marital status?

- ☐1 Married
- ☐2 Living as married (living with fiancé, boyfriend, or girlfriend but not married)
- ☐3 Separated and not living as married
- ☐4 Divorced and not living as married
- ☐5 Widowed and not living as married
- ☐6 Single, never married, and not living as married

3. Are you a single parent? That is, are you a parent who is separated, widowed, or divorced and not remarried, or a parent who has never married and has children under age 18?

- ☐1 Yes
- ☐2 No

4. What is your highest level of education?

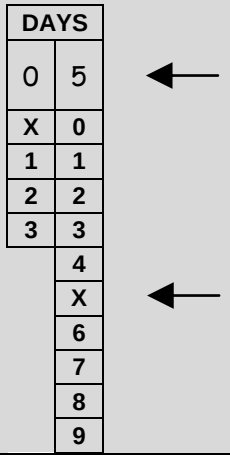
- ☐1 I did not graduate from high school
- ☐2 GED or ABE certificate
- ☐3 High school diploma
- ☐4 Trade or technical school graduate
- ☐5 Some college but not a 2- or 4-year degree
- ☐6 2-year college degree (AA or equivalent)
- ☐7 4-year college degree (BA, BS, or equivalent)
- ☐8 Graduate or professional study but no graduate degree
- ☐9 Graduate or professional degree

5. What is your current pay grade?

- ☐1 E1–E3
- ☐2 E4–E6
- ☐3 E7–E9
- ☐4 W1–W5
- ☐5 O1–O3
- ☐6 O4–O6

If you are asked to give numbers for your answer, please enter your response as shown below:

EXAMPLE: During the past 30 days, how many full 24-hour days were you deployed at sea or in the field?



6. How old are you?

YEARS	
0	0
1	1
2	2
3	3
4	4
5	5
6	6
	7
	8
	9

Insert Lithocode Here

The next set of questions asks about your stress level and stress management techniques.

7. During the <u>past 12 months</u>, how much stress did you experience <u>at work</u> or while carrying out your military duties?

- ☐1 A lot
- ☐2 Some
- ☐3 A little
- ☐4 None at all

8. During the <u>past 12 months</u>, how much stress did you experience <u>in your family life</u>? "Family life" refers to your relationship(s) with your spouse and children; with your live-in fiancé, boyfriend, or girlfriend; or with the person you date seriously.

- ☐1 A lot
- ☐2 Some
- ☐3 A little
- ☐4 None at all

9. How much stress are you experiencing due to an upcoming deployment?

- ☐1 A lot
- ☐2 Some
- ☐3 A little
- ☐4 None at all
- ☐5 I am not deploying

10. Have you received previous training in managing the stress of deployment and/or combat?

- ☐1 Yes
- ☐2 No

If yes, what training have you received? (*MARK ALL THAT APPLY.*)

- ☐1 Comprehensive Soldier Fitness (CFS)
- ☐2 Battlemind Training
- ☐3 Master Resilience Training (MRT)
- ☐4 Mindfulness training
- ☐5 Mental skills training
- ☐6 Breathing techniques/training
- ☐7 Other (specify): _____

11. Do you agree that your military training in managing the stress of deployment and/or combat has been adequate?

- ☐1 Strongly agree
- ☐2 Agree
- ☐3 Disagree
- ☐4 Strongly Disagree

12. How often do you practice relaxation techniques?

- ☐1 Frequently
- ☐2 Sometimes
- ☐3 Rarely
- ☐4 Never → **(GO TO QUESTION 14)**

13. What relaxation techniques do you practice?

_____

14. How often on average do you practice martial arts?

- ☐1 Everyday
- ☐2 Several times per week
- ☐3 Once a week
- ☐4 1 to 3 times per month
- ☐5 A few times per year
- ☐6 Never

15. When was the <u>last</u> time you practiced martial arts?

- ☐1 Today
- ☐2 In the past week
- ☐3 In the last month
- ☐4 Over a month ago
- ☐5 Never → **(GO TO QUESTION 17)**

16. What kind of martial arts do you practice?

_____

17. How often on average do you practice or participate in extreme or high performance workouts, such as Insanity, 30 Minute Abs, and P90X?

- ☐1 Everyday
- ☐2 Several times per week
- ☐3 Once a week
- ☐4 1 to 3 times per month
- ☐5 A few times per year
- ☐6 Never

18. How interested are you in learning techniques that may reduce stress?

- ☐1 Extremely
- ☐2 Quite a bit
- ☐3 Moderately
- ☐4 A little bit
- ☐5 Not at all

Now we would like to know about your deployments, your experiences while deployed, and things that may have happened to you since returning from deployment. If you have never been deployed, please skip to Question 28.

19. Have you ever been deployed in your lifetime?

- ☐1 Yes
- ☐2 No → **(GO TO QUESTION 28)**

20. When did you leave on your last deployment?

MONTH		/	YEAR			
0	0		0	0	0	0
1	1		1	1	1	1
	2		2	2	2	2
	3			3	3	3
	4			4	4	4
	5			5	5	5
	6			6	6	6
	7			7	7	7
	8			8	8	8
	9			9	9	9

21. Number of times you have deployed to Iraq and/or Afghanistan?

- ☐0 Have never been deployed
- ☐1 Once only
- ☐2 2 or 3 times
- ☐3 4 or more times
- ☐4 I have not deployed to Iraq or Afghanistan but have deployed elsewhere (e.g., Bosnia, Gulf, Haiti, etc.)

22. How many months have you been stateside since your last overseas (OCONUS) deployment?

- ☐1 Less than 6 months
- ☐2 6-12 months
- ☐3 13-18 months
- ☐4 19-24 months
- ☐5 25-36 months
- ☐6 More than 36 months

23. How many months did your last OCONUS deployment last?

- ☐1 Less than 6 months
- ☐2 6-12 months
- ☐3 13-18 months
- ☐4 19-24 months
- ☐5 25-36 months
- ☐6 More than 36 months

24. During your last deployment did you receive combat/special pay?

- ☐1 Yes
- ☐2 No

25. On how many deployments since 2002 have you received combat/special pay?

- ☐0 0
- ☐1 1
- ☐2 2
- ☐3 3
- ☐4 4
- ☐5 5
- ☐6 6
- ☐7 7
- ☐8 8
- ☐9 9 or more

26. Since your return from your last deployment, have you had thoughts or concerns that you might lose control or hurt someone?

- ☐1 Yes
- ☐2 No
- ☐3 Unsure

27. Thinking about your last deployment, how many times did you have each of the following experiences?

(Mark a response for each statement below. Indicate your answer by putting an "X" in the box for your response.)	Number of Times				
	0	1–3	4–12	13–50	51 or More
a. I was sent outside the wire on combat patrols, convoys, or sorties.	☐1	☐2	☐3	☐4	☐5
b. I, or members of my unit, received incoming fire from small arms, artillery, rockets, or mortars.	☐1	☐2	☐3	☐4	☐5
c. I, or members of my unit, encountered mines, booby traps, or improvised explosive devices (IEDs).	☐1	☐2	☐3	☐4	☐5
d. I worked with landmines or other unexploded ordnances.	☐1	☐2	☐3	☐4	☐5
e. My unit fired on the enemy.	☐1	☐2	☐3	☐4	☐5
f. I personally fired my weapon at the enemy.	☐1	☐2	☐3	☐4	☐5
g. I engaged in hand-to-hand combat.	☐1	☐2	☐3	☐4	☐5
h. I was responsible for the death or serious injury of an enemy.	☐1	☐2	☐3	☐4	☐5
i. I witnessed members of my unit or an ally unit being seriously wounded or killed.	☐1	☐2	☐3	☐4	☐5
j. My unit suffered causalities.	☐1	☐2	☐3	☐4	☐5
k. I saw dead bodies or human remains.	☐1	☐2	☐3	☐4	☐5
l. I handled, uncovered, or removed dead bodies or human remains.	☐1	☐2	☐3	☐4	☐5
m. Someone I knew well was killed in combat.	☐1	☐2	☐3	☐4	☐5
n. I took care of injured or dying people.	☐1	☐2	☐3	☐4	☐5
o. I interacted with enemy prisoners of war.	☐1	☐2	☐3	☐4	☐5
p. I was wounded in combat.	☐1	☐2	☐3	☐4	☐5
q. I questioned detainees or prisoners.	☐1	☐2	☐3	☐4	☐5

The next set of questions asks about your health, recent behaviors, and other things that affect people in their work and family lives.

28. During the past month, how often have you been bothered by each of the following?

(Mark an answer for each item below. Indicate your answer by putting an "X" in the box for your response.)	More than Half of the Days	Several Days	Not at All
a. Feeling nervous, anxious, on edge, or worrying a lot about different things	☐1	☐2	☐3
b. Getting tired very easily	☐1	☐2	☐3
c. Muscle tension, aches, or soreness	☐1	☐2	☐3
d. Trouble falling asleep or staying asleep	☐1	☐2	☐3
e. Trouble concentrating on things, such as reading a book or watching TV	☐1	☐2	☐3
f. Becoming easily annoyed or irritable	☐1	☐2	☐3
g. Feeling restless so that it is hard to sit still	☐1	☐2	☐3

29. Over the past month, have you been bothered by thoughts that you would be better off dead or of hurting yourself in some way?

☐1 Yes
☐2 No

If you are having any suicidal thoughts or other psychological distress, please seek help immediately. We encourage you to contact your unit's chaplain or a mental health professional. If you are in the United States, you also could contact the counseling hotline at 1-800-784-2433 or 1-800-SUICIDE. This is an anonymous, civilian hotline.

30. Instructions: The questions in this scale ask you about your feelings and thoughts during the past month. In each case, please indicate how often you felt or thought a certain way by putting an "X" in the box for your response.

(Mark an answer for each item below. Indicate your answer by putting an "X" in the box for your response.)	Never	Almost Never	Some-times	Fairly Often	Very Often
a. In the past month, how often have you been upset because of something that happened unexpectedly?	☐1	☐2	☐3	☐4	☐5
b. In the past month, how often have you felt that you were unable to control the important things in your life?	☐1	☐2	☐3	☐4	☐5
c. In the last month, how often have you felt nervous and stressed?	☐1	☐2	☐3	☐4	☐5
d. In the past month, how often have you felt confident about your ability to handle your personal problems?	☐1	☐2	☐3	☐4	☐5
e. In the past month, how often have you felt that things were going your way?	☐1	☐2	☐3	☐4	☐5
f. In the past month, how often have you found that you could not cope with all the things that you had to do?	☐1	☐2	☐3	☐4	☐5
g. In the past month, how often have you been able to control irritations in your life?	☐1	☐2	☐3	☐4	☐5
h. In the past month, how often have you felt that you were on top of things?	☐1	☐2	☐3	☐4	☐5
i. In the past month, how often have you been angered because of things that were outside of your control?	☐1	☐2	☐3	☐4	☐5
j. In the past month, how often have you felt difficulties were piling up so high that you could not overcome them?	☐1	☐2	☐3	☐4	☐5

31. Below is a list of problems and complaints that people sometimes have in response to stressful experiences. Please indicate how much you have been bothered by each problem in the past month.

(Mark an answer for each item below. Indicate your answer by putting an "X" in the box for your response.)	Extremely	Quite a Bit	Moderately	A Little Bit	Not at All
a. Having repeated, disturbing memories, thoughts, or images of a stressful experience	☐1	☐2	☐3	☐4	☐5
b. Having repeated, disturbing dreams of a stressful experiences	☐1	☐2	☐3	☐4	☐5
c. Suddenly acting or feeling as if a stressful experience were happening again (as if you were reliving it)	☐1	☐2	☐3	☐4	☐5
d. Feeling very upset when something reminded you of a stressful experience	☐1	☐2	☐3	☐4	☐5
e. Having physical reactions (e.g., heart pounding, trouble breathing, sweating) when something reminded you of a stressful experience	☐1	☐2	☐3	☐4	☐5
f. Avoiding thinking or talking about a stressful experience or avoiding having feelings related to it	☐1	☐2	☐3	☐4	☐5
g. Avoiding activities or situations because they reminded you of a stressful experience	☐1	☐2	☐3	☐4	☐5
h. Having trouble remembering important parts of a stressful experience	☐1	☐2	☐3	☐4	☐5
i. Losing interest in activities you used to enjoy	☐1	☐2	☐3	☐4	☐5
j. Feeling distant or cut off from other people	☐1	☐2	☐3	☐4	☐5
k. Feeling emotionally numb or being unable to have loving feelings toward those close to you	☐1	☐2	☐3	☐4	☐5
l. Feeling as if your future will be cut short somehow	☐1	☐2	☐3	☐4	☐5
m. Trouble falling or staying asleep	☐1	☐2	☐3	☐4	☐5
n. Feeling irritable or having angry outbursts	☐1	☐2	☐3	☐4	☐5
o. Having difficulty concentrating	☐1	☐2	☐3	☐4	☐5
p. Being "super alert," watchful, or on guard	☐1	☐2	☐3	☐4	☐5
q. Feeling jumpy or easily startled	☐1	☐2	☐3	☐4	☐5

32. In general, how long have you experienced the problems listed in Question 31?

- ☐1 I have never had any of these problems
- ☐2 Less than 1 month
- ☐3 1 month
- ☐4 2 to 3 months
- ☐5 4 to 6 months
- ☐6 7 months or longer

33. Below is a list of ways you might have felt or behaved. Please indicate how often you felt this way during the <u>past week</u>:

(Mark an answer for <u>each</u> statement below. Indicate your answer by putting an "X" in the box for your response.)	**Most or All of the Time (5–7 Days)**	**Occasionally or a Moderate Amount of the Time (3–4 Days)**	**Some or a Little of the Time (1–2 Days)**	**Rarely or None of the Time (Less Than 1 Day)**
a. I was bothered by things that usually do not bother me	☐1	☐2	☐3	☐4
b. I did not feel like eating; my appetite was poor	☐1	☐2	☐3	☐4
c. I felt that I could not shake off the blues even with help from my family and friends	☐1	☐2	☐3	☐4
d. I felt that I was just as good as other people	☐1	☐2	☐3	☐4
e. I had trouble keeping my mind on what I was doing	☐1	☐2	☐3	☐4
f. I felt depressed	☐1	☐2	☐3	☐4
g. I felt like everything I did was an effort	☐1	☐2	☐3	☐4
h. I felt hopeful about the future	☐1	☐2	☐3	☐4
i. I thought my life had been a failure	☐1	☐2	☐3	☐4
j. I felt fearful	☐1	☐2	☐3	☐4
k. My sleep was restless	☐1	☐2	☐3	☐4
l. I was happy	☐1	☐2	☐3	☐4
m. I talked less than usual	☐1	☐2	☐3	☐4
n. I felt lonely	☐1	☐2	☐3	☐4
o. I felt that people were unfriendly	☐1	☐2	☐3	☐4
p. I enjoyed life	☐1	☐2	☐3	☐4
q. I had crying spells	☐1	☐2	☐3	☐4
r. I felt sad	☐1	☐2	☐3	☐4
s. I felt that people disliked me	☐1	☐2	☐3	☐4
t. I could not "get going"	☐1	☐2	☐3	☐4

34. Did you ever in your lifetime have an experience that caused you to think that you would be injured or killed (e.g., witnessing or experiencing a serious accident, illness, or natural disaster, or being assaulted or threatened with a weapon)? (*MARK ALL THAT APPLY*.)

- ☐1 Yes, as a child
- ☐2 Yes, as an adult
- ☐3 Yes, during deployment
- ☐4 Yes, during combat
- ☐5 Yes, during postdeployment
- ☐6 No

35. When you feel pressured, stressed, depressed, or anxious, how often do you engage in each of the following activities?

(Mark an answer for each item below. Indicate your answer by putting an "X" in the box for your response.)	A Lot	Some	A Little	None at All
a. Talk to a friend or family member	☐1	☐2	☐3	☐4
b. Light up a cigarette	☐1	☐2	☐3	☐4
c. Have a drink	☐1	☐2	☐3	☐4
d. Say a prayer	☐1	☐2	☐3	☐4
e. Exercise or play sports	☐1	☐2	☐3	☐4
f. Engage in a hobby	☐1	☐2	☐3	☐4
g. Get something to eat	☐1	☐2	☐3	☐4
h. Smoke marijuana or use other illegal drugs	☐1	☐2	☐3	☐4
i. Think of a plan to solve the problem	☐1	☐2	☐3	☐4
j. Think about hurting myself or killing myself	☐1	☐2	☐3	☐4

In the next few questions, "mental health professional" refers to a psychologist, psychiatrist, clinical social worker, or other mental health counselor.

36. In the past 12 months, did you receive counseling or therapy for mental health or substance abuse from the following?

(Mark an answer for each item below. Indicate your answer by putting an "X" in the box for your response.)	Yes	No
a. Mental health professional at a military facility (e.g., psychologist, psychiatrist, clinical social worker, or other mental health counselor)	☐1	☐2
b. General medical doctor at a military facility	☐1	☐2
c. Military chaplain	☐1	☐2
d. Civilian mental health professional (e.g., psychologist, psychiatrist, clinical social worker, or other mental health counselor)	☐1	☐2
e. General medical doctor at a civilian facility	☐1	☐2
f. Civilian pastor, rabbi, or other pastoral counselor	☐1	☐2
g. Self-help group (e.g., AA, NA)	☐1	☐2

37. For what concerns did you seek counseling or therapy in the past 12 months? (*MARK ALL THAT APPLY.*)

☐1 Depression
☐2 Anxiety
☐3 Family problems
☐4 Substance use problems
☐5 Anger management
☐6 Stress management
☐7 Combat/operational stress
☐8 Other (specify): _____
☐9 I did not seek help from a mental health professional in the past 12 months

38. Have you been prescribed medication for depression, anxiety, or sleeping problems by a doctor or other health professional?

☐1 Yes, in the past month
☐2 Yes, more than a month ago but within the past 12 months
☐3 No, or not in the past 12 months

The next questions ask about your general preferences.

39. Do you enjoy playing video games?

- ☐1 Yes
- ☐2 No
- ☐3 Unsure

40. How frequently did you play video or computer games . . .?

(Mark a response for each statement below. Indicate your answer by putting an "X" in the box for your response.)	Hours per Week				
	0	1–3	4–6	7–8	9 or more
a. prior to joining the military	☐1	☐2	☐3	☐4	☐5
b. since joining the military	☐1	☐2	☐3	☐4	☐5

41. How many cups of any caffeinated beverage have you had today?

- ☐1 None
- ☐2 1–2 cups
- ☐3 3–4 cups
- ☐4 5 or more cups

42. How many energy drinks (e.g., Red Bull) have you had today?

- ☐1 None
- ☐2 1–2 drinks
- ☐3 3–4 drinks
- ☐4 5 or more drinks

43. When was the last time you . . .?

(Mark a response for each statement below. Indicate your answer by putting an "X" in the box for your response.)	Today	During the Past 30 Days	1-3 Months Ago	4-6 Months Ago	7-12 Months Ago	More than 1 Year Ago	I Have Never Smoked/ Used
a. smoked a cigarette?	☐1	☐2	☐3	☐4	☐5	☐6	☐7
b. used chewing tobacco, snuff, or other smokeless tobacco?	☐1	☐2	☐3	☐4	☐5	☐6	☐7

Please feel free to share any comments you may have about this survey: _____

_____

_____

_____

THANK YOU VERY MUCH FOR YOUR TIME, EFFORT, AND COOPERATION IN COMPLETING THIS QUESTIONNAIRE.

IF YOU WOULD LIKE ADDITIONAL COMBAT AND OPERATIONAL STRESS (COSC) INFORMATION OR TO SPEAK TO SOMEONE ABOUT COSC, BROCHURES AND CONTACT INFORMATION REGARDING PROFESSIONAL SERVICES ARE AVAILABLE FROM THE INVESTIGATORS.

THIS BLOCK FOR OFFICE USE ONLY

SURVEY TYPE	SESSION TYPE

DATE

APPENDIX IV. PREDEPLOYMENT STRESS MANAGEMENT FOLLOW-UP QUESTIONNAIRE

PREDEPLOYMENT STRESS MANAGEMENT
FOLLOW-UP QUESTIONNAIRE

INSTRUCTIONS FOR COMPLETING THE QUESTIONNAIRE

All questions on this survey provide a set of possible answers. Please read all the answers before marking your choice. If none of the printed answers exactly applies to you, place an "X" on the square for the one answer that best fits your situation.

- **Use only the pencil you were given. Erase cleanly any answer you wish to change.**
- **Please note all instructions, such as Skips. For some items, your response will result in skipping questions that are not applicable to your situation.**
- **Put an "X" on the center of the square to indicate your answer. Do not use other marks.**

CORRECT MARK ☒ ☐ ☐ ☐

INCORRECT MARKS ☑ ☒ ⬬ ⦿

- **For many questions, you should put an "X" in only one square for your answer in the column below the question. However, some questions ask you to mark all the choices that apply. When asked to "mark all that apply," please do so as shown here:**

EXAMPLE: Have you ever had any of the following conditions? (Mark all that apply.)

- ☐ Back pain
- ☐ Ringing in the ears
- ☒ Difficulty remembering
- ☐ Trouble sleeping
- ☐ Chronic headaches
- ☐ Skin rashes
- ☒ Difficulty breathing

PRIVACY ACT STATEMENT

Authority. 5 U.S.C. 301

Purpose. Medical research information will be collected in an experimental research project #0213380, titled Predeployment Stress Inoculation Training Program (i.e., stress management study), to enhance basic medical knowledge, or to develop tests, procedures, and equipment to improve the diagnosis, treatment, or prevention of illness, injury, or performance impairment.

Routine Uses. Medical research information will be used for analysis and reports by the Departments of the Army and Defense, and other U.S. Government agencies, provided this use is compatible with the purpose for which the information was collected. Use of the information may be granted to non-Government agencies or individuals by the Army Surgeon General following the provisions of the Freedom of Information Act or as may be indicated in the accompanying Informed Consent Form.

Disclosure. Provision of information is voluntary. There are no penalties for not providing the requested information but failure to provide the requested information may result in failure to be accepted as a research volunteer.

PLEASE GO TO PAGE 2. ➔

Insert Lithocode Here

These first few questions ask about your background.

1. What is your marital status?

- ☐1 Married
- ☐2 Living as married (living with fiancé, boyfriend, or girlfriend but not married)
- ☐3 Separated and not living as married
- ☐4 Divorced and not living as married
- ☐5 Widowed and not living as married
- ☐6 Single, never married, and not living as married

2. What is your <u>current</u> pay grade?

- ☐1 E1–E3
- ☐2 E4–E6
- ☐3 E7–E9
- ☐4 W1–W5
- ☐5 O1–O3
- ☐6 O4–O6

3. When did you return from your <u>last</u> deployment?

- ☐1 Less than 2 months ago
- ☐2 2–3 months ago
- ☐3 4-5 months ago
- ☐4 6-12 months ago
- ☐5 More than 1 year ago
- ☐6 I have never been deployed → **(GO TO QUESTION 5)**

4. Where were you deployed during your <u>last</u> deployment?

- ☐1 Afghanistan/Iraq
- ☐2 Other (Specify): _____

The next few questions address stress management techniques.

5. Do you agree that your military training in managing the stress of deployment and/or combat has been adequate?

- ☐1 Strongly agree
- ☐2 Agree
- ☐3 Disagree
- ☐4 Strongly Disagree

6. Were you taught the breathing technique called Battle Breathing when you received an MP3 player? This technique includes 2 different methods that help you (1) focus and be calm during specific tasks or mission with your eyes open, and (2) to relax after completing tasks or missions by breathing deeply with your eyes closed.

- ☐1 Yes
- ☐2 No
- ☐3 Don't know

7. **Since the training when you received your MP3 player, did you use the Battle Breathing focused breathing technique with your eyes open to help you manage stress?**

- ☐1 Yes
- ☐2 No

8. **How often did you use the Battle Breathing focused breathing technique with your eyes open?**

- ☐1 Frequently
- ☐2 Sometimes
- ☐3 Rarely
- ☐4 I did not use the Battle Breathing focused breathing technique with my eyes open

9. **How much did the Battle Breathing focused breathing technique with your eyes open help you focus or manage your stress?**

- ☐1 A lot
- ☐2 Some
- ☐3 A little
- ☐4 None at all
- ☐5 I did not use the Battle Breathing focused breathing technique with my eyes open

10. **Since the training when you received your MP3 player, did you use the Battle Breathing relaxation breathing technique with your eyes closed to help you sleep or relax?**

- ☐1 Yes
- ☐2 No

11. **How often did you use the Battle Breathing relaxation technique with your eyes closed?**

- ☐1 Frequently
- ☐2 Sometimes
- ☐3 Rarely
- ☐4 I did not use the Battle Breathing relaxation breathing technique with my eyes closed

12. **How much did the Battle Breathing relaxation technique with your eyes closed help you sleep or relax?**

- ☐1 A lot
- ☐2 Some
- ☐3 A little
- ☐4 None at all
- ☐5 I did not use the Battle Breathing relaxation breathing technique with my eyes closed

PLEASE GO TO PAGE 4. ➔

13. After you received an MP3 player with the Battle Breathing technique loaded on it, did you:

(Mark an answer for <u>each</u> item below. Indicate your answer by putting an "X" in the box for your response.)	Yes	No
a. use your MP3 player to listen to the Battle Breathing technique during the last year?	☐1	☐2
b. share your MP3 player with others during the last year?	☐1	☐2

14. Have you downloaded and listened to any additional relaxation or breathing music or videos (on your MP3 player or other device) in the past year?

☐1 Yes
☐2 No

15. Were you taught the Battle Breathing techniques (deep breathing with eyes open and eyes closed) <u>outside of formal classroom training by another person</u>?

☐1 Yes
☐2 No

16. Do you think the Battle Breathing technique would be helpful to others?

☐1 Yes
☐2 No
☐3 I don't know

17. Were you interested in stress control techniques prior to receiving Battle Breathing training and the MP3 player?

☐1 Yes
☐2 No

18. Have you developed an interested in stress control techniques since receiving Battle Breathing training and the MP3 player?

☐1 Yes
☐2 No

19. <u>Since the training when you received your MP3 player</u>, did you use relaxation techniques <u>other than Battle Breathing</u> to help you sleep or to help manage stress?

☐1 Yes (If yes, specify the relaxation techniques you used.) _____
☐2 No → **(GO TO QUESTION 21)**

20. How often did you use techniques other than Battle Breathing?

☐1 Frequently
☐2 Sometimes
☐3 Rarely
☐4 Never

21. How much did techniques other than Battle Breathing help you sleep or manage your stress?

☐1 A lot
☐2 Some
☐3 A little
☐4 None at all

22. When you feel pressured, stressed, depressed, or anxious, how often do you engage in each of the following activities?

(Mark an answer for <u>each</u> item below. Indicate your answer by putting an "X" in the box for your response.)	Frequently	Sometimes	Rarely	Never
a. Talk to a friend or family member	☐1	☐2	☐3	☐4
b. Light up a cigarette	☐1	☐2	☐3	☐4
c. Have a drink	☐1	☐2	☐3	☐4
d. Say a prayer	☐1	☐2	☐3	☐4
e. Exercise or play sports	☐1	☐2	☐3	☐4
f. Engage in a hobby	☐1	☐2	☐3	☐4
g. Get something to eat	☐1	☐2	☐3	☐4
h. Smoke marijuana or use other illegal drugs	☐1	☐2	☐3	☐4
i. Think of a plan to solve the problem	☐1	☐2	☐3	☐4
j. Think about hurting myself or killing myself	☐1	☐2	☐3	☐4

23. Do you regularly practice martial arts?

☐1 Yes
☐2 No → **(GO TO QUESTION 25)**

24. What kind of martial arts do you practice? (MARK ALL THAT APPLY.)

☐1 Karate
☐2 Tae Kwon Do
☐3 Judo
☐4 Jiu-Jitsu
☐5 Mixed Martial Arts
☐6 Other (specify): _____

The next set of questions asks about your mental or emotional health, stress, and some other things that affect people in their work and family lives.

25. <u>Since the training when you received your MP3 player</u>, how much stress have you experienced <u>at work</u> or while carrying out your military duties?

☐1 A lot
☐2 Some
☐3 A little
☐4 None at all

26. <u>Since the training when you received your MP3 player</u>, how much stress have you experienced <u>in your family life</u>? "Family life" refers to your relationship(s) with your spouse and children; with your live-in fiancé, boyfriend, or girlfriend; or with the person you date seriously.

☐1 A lot
☐2 Some
☐3 A little
☐4 None at all

PLEASE GO TO PAGE 6. ➔

27. Since the training when you received your MP3 player, have you had thoughts or concerns that you might lose control or hurt someone?

☐1 Yes
☐2 No
☐3 Unsure

28. Since the training when you received your MP3 player, have you been bothered by thoughts that you would be better off dead or of hurting yourself in some way?

☐1 Yes
☐2 No

If you are having any suicidal thoughts or other psychological distress, please seek help immediately. We encourage you to contact your unit's chaplain or a mental health professional. If you are in the United States, you also could contact the counseling hotline at 1-800-784-2433 or 1-800-SUICIDE. This is an anonymous, civilian hotline.

29. During the past month, how often have you been bothered by each of the following?

(Mark an answer for each item below. Indicate your answer by putting an "X" in the box for your response.)	More than Half of the Days	Several Days	Not at All
a. Feeling nervous, anxious, on edge, or worrying a lot about different things	☐1	☐2	☐3
b. Getting tired very easily	☐1	☐2	☐3
c. Muscle tension, aches, or soreness	☐1	☐2	☐3
d. Trouble falling asleep or staying asleep	☐1	☐2	☐3
e. Trouble concentrating on things, such as reading a book or watching TV	☐1	☐2	☐3
f. Becoming easily annoyed or irritable	☐1	☐2	☐3
g. Feeling restless so that it is hard to sit still	☐1	☐2	☐3

30. Instructions: The questions in this scale ask you about your feelings and thoughts during the <u>past month</u>. *In each case, please indicate how often you felt or thought a certain way by putting an "X" in the box for your response.*

	Never	Almost Never	Sometimes	Fairly Often	Very Often
a. During the past month, how often have you been upset because of something that happened unexpectedly?	☐1	☐2	☐3	☐4	☐5
b. During the past month, how often have you felt that you were unable to control the important things in your life?	☐1	☐2	☐3	☐4	☐5
c. During the past month, how often have you felt nervous and stressed?	☐1	☐2	☐3	☐4	☐5
d. During the past month, how often have you felt confident about your ability to handle your personal problems?	☐1	☐2	☐3	☐4	☐5
e. During the past month, how often have you felt that things were going your way?	☐1	☐2	☐3	☐4	☐5
f. During the past month, how often have you found that you could not cope with all the things that you had to do?	☐1	☐2	☐3	☐4	☐5
g. During the past month, how often have you been able to control irritations in your life?	☐1	☐2	☐3	☐4	☐5
h. During the past month, how often have you felt that you were on top of things?	☐1	☐2	☐3	☐4	☐5
i. During the past month, how often have you been angered because of things that were outside of your control?	☐1	☐2	☐3	☐4	☐5
j. During the past month, how often have you felt difficulties were piling up so high that you could not overcome them?	☐1	☐2	☐3	☐4	☐5

PLEASE GO TO PAGE 8. ➔

31. Below is a list of problems and complaints that veterans sometimes have in response to a stressful military experience.

(Mark an answer for <u>each</u> item below. Indicate your answer by putting an "X" in the box for your response.)	Extremely	Quite a Bit	Moderately	A Little Bit	Not at All
a. Repeated, disturbing memories, thoughts, or images of a stressful military experience	☐1	☐2	☐3	☐4	☐5
b. Repeated, disturbing dreams of a stressful military experiences	☐1	☐2	☐3	☐4	☐5
c. Suddenly acting or feeling as if a stressful military experience were happening again (as if you were reliving it)	☐1	☐2	☐3	☐4	☐5
d. Feeling very upset when something reminded you of a stressful military experience	☐1	☐2	☐3	☐4	☐5
e. Having physical reactions (e.g., heart pounding, trouble breathing, sweating) when something reminded you of a stressful military experience	☐1	☐2	☐3	☐4	☐5
f. Avoid thinking about or talking about a stressful military experience or avoid having feelings related to it	☐1	☐2	☐3	☐4	☐5
g. Avoid activities or situations because they reminded you of a stressful military experience	☐1	☐2	☐3	☐4	☐5
h. Trouble remembering important parts of a stressful military experience	☐1	☐2	☐3	☐4	☐5
i. Loss of interest in activities you used to enjoy	☐1	☐2	☐3	☐4	☐5
j. Feeling distant or cut off from other people	☐1	☐2	☐3	☐4	☐5
k. Feeling emotionally numb or being unable to have loving feelings for those close to you	☐1	☐2	☐3	☐4	☐5
l. Feeling as if your future will be cut short somehow	☐1	☐2	☐3	☐4	☐5
m. Trouble falling or staying asleep	☐1	☐2	☐3	☐4	☐5
n. Feeling irritable or having angry outbursts	☐1	☐2	☐3	☐4	☐5
o. Having difficulty concentrating	☐1	☐2	☐3	☐4	☐5
p. Being "super alert" or watchful on guard	☐1	☐2	☐3	☐4	☐5
q. Feeling jumpy or easily startled	☐1	☐2	☐3	☐4	☐5

32. In general, how long have you experienced the problems listed in Question 31?

☐1 I have never had any of these problems
☐2 Less than 1 month
☐3 1 month
☐4 2 to 3 months
☐5 4 to 6 months
☐6 7 months or longer

33. Below is a list of ways you might have felt or behaved. Please indicate how often you felt this way during the past week:

(Mark an answer for each statement below. Indicate your answer by putting an "X" in the box for your response.)	Most or All of the Time (5–7 Days)	Occasionally or a Moderate Amount of the Time (3–4 Days)	Some or a Little of the Time (1–2 Days)	Rarely or None of the Time (Less Than 1 Day)
a. I was bothered by things that usually do not bother me	☐1	☐2	☐3	☐4
b. I did not feel like eating; my appetite was poor	☐1	☐2	☐3	☐4
c. I felt that I could not shake off the blues even with help from my family and friends	☐1	☐2	☐3	☐4
d. I felt that I was just as good as other people	☐1	☐2	☐3	☐4
e. I had trouble keeping my mind on what I was doing	☐1	☐2	☐3	☐4
f. I felt depressed	☐1	☐2	☐3	☐4
g. I felt like everything I did was an effort	☐1	☐2	☐3	☐4
h. I felt hopeful about the future	☐1	☐2	☐3	☐4
i. I thought my life had been a failure	☐1	☐2	☐3	☐4
j. I felt fearful	☐1	☐2	☐3	☐4
k. My sleep was restless	☐1	☐2	☐3	☐4
l. I was happy	☐1	☐2	☐3	☐4
m. I talked less than usual	☐1	☐2	☐3	☐4
n. I felt lonely	☐1	☐2	☐3	☐4
o. I felt that people were unfriendly	☐1	☐2	☐3	☐4
p. I enjoyed life	☐1	☐2	☐3	☐4
q. I had crying spells	☐1	☐2	☐3	☐4
r. I felt sad	☐1	☐2	☐3	☐4
s. I felt that people disliked me	☐1	☐2	☐3	☐4
t. I could not "get going"	☐1	☐2	☐3	☐4

34. Since the training when you received your MP3 player, have you had an experience that caused you to think that you would be injured or killed (e.g., witnessing or experiencing a serious accident, illness, or natural disaster, or being assaulted or threatened with a weapon)?

☐1 Yes,
☐2 No

PLEASE GO TO PAGE 10. ➔

In the next few questions, "mental health professional" refers to a psychologist, psychiatrist, clinical social worker, or other mental health counselor.

35. Since the training when you received your MP3 player, have you received counseling or therapy for mental health or substance abuse from the following?

(Mark an answer for each item below. Indicate your answer by putting an "X" in the box for your response.)	Yes	No
a. Mental health professional at a military facility (e.g., psychologist, psychiatrist, clinical social worker, or other mental health counselor)	☐1	☐2
b. General medical doctor at a military facility	☐1	☐2
c. Military chaplain	☐1	☐2
d. Civilian mental health professional (e.g., psychologist, psychiatrist, clinical social worker, or other mental health counselor)	☐1	☐2
e. General medical doctor at a civilian facility	☐1	☐2
f. Civilian pastor, rabbi, or other pastoral counselor	☐1	☐2
g. Self-help group (e.g., AA, NA)	☐1	☐2

36. For what concerns did you seek counseling or therapy since you received your MP3 player? (MARK ALL THAT APPLY.)

☐1 I did not seek help from a mental health professional in the past month or since returning from my LAST deployment
☐2 Depression
☐3 Anxiety
☐4 Family problems
☐5 Substance use problems
☐6 Anger management
☐7 Stress management
☐8 Combat/operational stress
☐9 Other (specify): _____

37. Since the training when you received your MP3 player, have you ever drunk or used drugs more than you meant to?

☐1 Yes
☐2 No

38. Have you felt you wanted or needed to cut down on your drinking or drug use since the training when you received your MP3 player?

☐1 Yes
☐2 No

39. Are you currently taking medication for depression, anxiety, or sleeping problems prescribed by a doctor or other health professional?

☐1 Yes
☐2 No

The next few questions ask about your sleep and quality of sleep.

40. In the past 7 days. . . . .

(Mark an answer for each statement below. Indicate your answer by putting an "X" in the box for your response.)	Not at all	A little bit	Somewhat	Quite a bit	Very much
a. My sleep was restless	☐1	☐2	☐3	☐4	☐5
b. I was satisfied with my sleep	☐1	☐2	☐3	☐4	☐5
c. My sleep was refreshing	☐1	☐2	☐3	☐4	☐5
d. I had difficulty falling asleep	☐1	☐2	☐3	☐4	☐5
e. I had trouble staying asleep	☐1	☐2	☐3	☐4	☐5
f. I had trouble sleeping	☐1	☐2	☐3	☐4	☐5
g. I got enough sleep	☐1	☐2	☐3	☐4	☐5

41. In the past 7 days, my sleep was. . .

☐1 Very poor
☐2 Poor
☐3 Fair
☐4 Good
☐5 Very good

Please feel free to share any comments you may have about this survey or how the Battle Breathing training could be improved:

_____

_____

_____

_____

THANK YOU VERY MUCH FOR YOUR TIME, EFFORT, AND COOPERATION IN COMPLETING THIS QUESTIONNAIRE.

IF YOU WOULD LIKE ADDITIONAL COMBAT AND OPERATIONAL STRESS (COSC) INFORMATION OR ASSISTANCE, YOU CAN CONTACT MILITARY ONESOURCE AT 1-800-342-9647 OR VISIT WWW.MILITARYONESOURCE.COM.

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SURVEY TYPE	SURVEY DATE
FOLLOWUP	

APPENDIX V. PUBLISHED MANUSCRIPT: RELAXATION TRAINING ASSISTED BY HEART RATE VARIABILITY BIOFEEDBACK: IMPLICATION FOR A MILITARY PREDEPLOYMENT STRESS INOCULATION PROTOCOL

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Relaxation training assisted by heart rate variability biofeedback: Implication for a military predeployment stress inoculation protocol

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Abstract

Decreased heart rate variability (HRV) is associated with posttraumatic stress disorder (PTSD) and depression symptoms, but PTSD's effects on the autonomic stress response and the potential influence of HRV biofeedback in stress relaxation training on improving PTSD symptoms are not well understood. The objective of this study was to examine the impact of a predeployment stress inoculation training (PRESTINT) protocol on physiologic measures of HRV in a large sample of the military population randomly assigned to experimental HRV biofeedback-assisted relaxation training versus a control condition. PRESTINT altered the parasympathetic regulation of cardiac activity, with experimental subjects exhibiting greater HRV, that is, less arousal, during a posttraining combat simulation designed to heighten arousal. Autonomic reactivity was also found to be related to PTSD and self-reported use of mental health services. Future PRESTINT training could be appropriate for efficiently teaching self-help skills to reduce the psychological harm following trauma exposure by increasing the capacity for parasympathetically modulated reactions to stress and providing a coping tool (i.e., relaxation method) for use following a stressful situation.

Descriptors: Behavioral medicine, Biofeedback, Heart rate

Heart rate variability (HRV) is an important indicator of the neural correlates of the relationships between brain, body, stress, and health (Beauchaine, 2001; Berntson et al., 1997; Thayer, Ahs, Fredrikson, Sollers, & Wager, 2012), yet its potential as a tool for understanding these links has not been fully explored. The polyvagal theory (Porges, 2011) is a promising basis for better understanding these links. The polyvagal theory describes the hierarchical and phylogenetic organization of autonomic response to external challenges, and the theory links resting autonomic balance to psychological resilience. The primary response to a stressor is mediated by the most recently evolved, myelinated parasympathetic system. Failure to meet the demands of the stressor leads to activation of the older sympathetic and eventually the unmyelinated parasympathetic systems (Porges, 2009). For example, a stress response in a person with high resting parasympathetic inhibition of heart rate could be met by removing that inhibition (i.e., reducing HRV), which would functionally increase heart rate.

Subjects with posttraumatic stress disorder (PTSD) have been shown to have an imbalance in their autonomic profile with greater sympathetic activity and decreased parasympathetic activity at rest (Blechert, Michael, Grossman, Lajtman, & Wilhelm, 2007). This type of autonomic profile is a significant cardiovascular risk factor (Brook & Julius, 2000), and restoring the normal primacy of the parasympathetic branch should have an indirect effect on the sympathetic system, reducing arousal. Within the veteran population, all cardiovascular risk factors are higher among veterans with mental health diagnoses (Cohen, Marmar, Ren, Bertenthal, & Seal, 2009). Consistent with the polyvagal theory, reducing sympathetic activation should reduce fatalities in the inevitable cases of congestive heart failure among this at-risk population (Floras, 1993), and an intervention that increases resting parasympathetic control of the heart should increase capacity for autonomic reactivity, normalizing the stress response of the subject to a challenge.

Higher heart rates and decreased HRV are associated with PTSD (Minassian et al., 2014; Zucker, Samuelson, Muench, Greenberg, & Gevirtz, 2009), anxiety, and depression symptoms (Hauschildt, Peters, Moritz, & Jelinek, 2011; Hughes & Stoney, 2000; Karavidas et al., 2007; Lehrer, 2007; Moser et al., 1998; Shinba et al., 2008). Despite small sample sizes (fewer than 500), studies of individuals with PTSD or depression found that, while initial

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HRV measures in PTSD participants were lower than those of other participants, by following a training that included deep breathing and relaxation exercises, PTSD participants showed increases in HRV measures (i.e., lower arousal; Siepmann, Ayjac, Unterdorfer, Petrowski, & Mueck-Weymann, 2008; Tan, Dao, Farmer, Sutherland, & Gevirtz, 2011). Techniques such as mindfulness meditation and relaxation training have also been associated with reduced stress reactivity (Creswell, Pacilio, Lindsay, & Brown, 2014). These techniques suggest that HRV may act as a potential peripheral physiologic proxy for brain mechanisms that control behavior (Krygier et al., 2013; Thayer et al., 2012).

Because elevated heart rate is the most prominent autonomic feature of PTSD, several possible autonomic imbalances are implied in anxiety disorders such as PTSD: low resting parasympathetic inhibition, heightened sympathetic drive, or both conditions. An intervention that increases cardiac vagal tone may serve to mitigate these imbalances, since the stress reaction becomes increasingly parasympathetically driven with an increase in cardiac vagal inhibition. In other work, Cohen et al. (1998) found that PTSD patients demonstrated almost no autonomic response to the recounting of a triggering stressful event. Thus, there remains a research gap in more fully understanding the PTSD effects on autonomic stress response and the potential influence of HRV biofeedback in relaxation training on improving PTSD symptoms.

One approach to anxiety reduction as a PTSD prevention strategy is stress inoculation training (Meichenbaum & Cameron, 1983). In a pilot study, we showed that predeployment stress inoculation training (PRESTINT), including relaxation or slow-paced breathing skills training (battle breathing) supported with biofeedback and skills practice with a multimedia simulated combat engagement, was well accepted by military personnel preparing for deployment to Iraq and showed significantly increased HRV (Hourani et al., 2011). In the present study, we use the PRESTINT protocol to better understand the relationship among heart rate variability, vagal tone as measured by respiratory sinus arrhythmia (RSA), and mental health measures including PTSD and receipt of mental health counseling.

The purpose of the PRESTINT intervention was to provide participants with stress management techniques that could help the user recover from stressful events and relax prior to sleep. The general concept of this approach is that psychological damage from traumatic events is greater when the physiologic stress response is blunted or dominated by the sympathetic, rather than the parasympathetic nervous system. Parasympathetic primacy in state regulation can only be managed if cardiac activity is actively inhibited and decreased by the parasympathetic branch (Porges, 2009). We expected PRESTINT training to increase parasympathetic control of the heart, even in situations that heighten arousal. In tactical situations, we expected psychological outcomes would be linked to the physiological state change that result from stressful or traumatic events. Despite claims that low frequency heart rate variability (LF-HRV) (and the ratio of LF to RSA) represents a measure of sympathovagal balance, a review of the literature (Reyes del Paso, Langewitz, Mulder, Roon, & Duschek, 2013) suggests that LF-HRV is primarily a measure of parasympathetic control. Therefore, in the present study, HRV is reported across a frequency band that includes the traditional LF and RSA ranges as a measure of combined parasympathetic influence on cardiac activity.

The objective of the current study was to examine the impact of PRESTINT training on physiologic measures of HRV in a large sample of the military population. Specifically, this study tested two hypotheses related to predeployment stress inoculation training: (1) physiological measures of autonomic balance are related to PTSD symptoms and other mental health problems; subjects with both conditions will exhibit dampened parasympathetic and heightened sympathetic influence on cardiac output, and (2) these same physiological measures are responsive to the PRESTINT training (relaxation breathing with biofeedback); specifically, that HRV in the low- (∼0.10 Hz) and/or high-frequency (0.12–0.40 Hz) ranges will be elevated following the intervention and a subsequent stressor.

We addressed two aims in preparation of developing and testing an intervention to prevent PTSD: (1) to characterize the predeployment distributions of psychological and physiological parameters within the sample to facilitate future examination of the intervention effects postdeployment, and (2) to describe the physiological changes that occur during and following the training.

Method

Sample Selection

Participants were selected from a convenience sample of platoons of the U.S. Army's 82nd Airborne Division at Fort Bragg, NC. All participants had completed their basic and advanced military training. Platoons were randomized into either the experimental group, who received PRESTINT training, or control group, who received a didactic presentation on stress management. Randomization was based on an assigned date and time of the training session and determined prior to the training. Participants provided signed consent forms, and institutional review boards of RTI International and the U.S. Army Medical and Material Command, Office of Research Protections, Human Research Protection Office approved the study.

Procedure

We collected data during 2-h sessions with groups of up to 20 participants. Since participants arrived at the session from other training exercises, they exhibited a gradual slowing of heart rate over the course of the session. Subjects were instructed to select a seat and remove any tobacco products and chewing gum from their mouths and to abstain from eating and drinking during the training. Participants listened to an introduction to the training, signed consent forms, and completed a 30-min questionnaire that included standardized psychological scales and inquired about past breathing or relaxation training and intake of tobacco and caffeinated drinks that day. We used statistical methods to account for clustering within training sessions due to differences in the physiological and psychological state of different class sessions related to participants' prior activities that day (e.g., morning exercise, lunch, training jump). The total sample size was 891, with 422 in the control group and 469 receiving the PRESTINT training.

PRESTINT Program Development

Educational materials. Trifold brochures, developed by RTI International using the Army's Stress Management resources, were provided to all participants. Brochures identified potential stressors, described signs or symptoms of stress reactions, recommended self-help behaviors, and provided resources for seeking professional help (http://www.militaryonesource.mil). A 20-min didactic

presentation delivered to the control group was based on these materials.

The PRESTINT training consisted of the following:

Battle breathing training. A 20-min group presentation provided training on two battle breathing techniques (see Hourani et al., 2011, for additional details): (1) Attentional retraining including relaxed breathing with eyes open to allow one to become absorbed in present-focused visual and auditory sensations. Appropriately used in a tactical situation, this type of attentional or focused breathing enables an individual to experience calmness but be focused on the activities of the moment without excessive reactivity or arousal. (2) Relaxed abdominal breathing with eyes closed, which is useful for achieving deep, recuperative, restorative rest and sleep upon returning home or to base and is similar to progressive relaxation techniques.

Biofeedback. We collected heart rate data using a photoplethysmographic sensor attached to the earlobe. The sensor (Biocom HRM-02, Biocom Technologies, Poulsbo, WA) and analytic software were integrated within a commercially available biofeedback system, the Stress Sweeper Pro (Biocom Technologies). A ball moving up and down on the screen coinciding with each inhalation/exhalation provided visual and audio pacing for slow abdominal breathing. Respiration was paced at 0.10 Hz (coincident with the LF-HRV bandwidth), with even inhalation and expiration periods (e.g., a 50/50 inhale/exhale ratio). Visual feedback of the participant's heart rate variability was provided by a line graph that moved upward with increasing HRV. The line graph was superimposed upon a background with color-coded levels (lowest level in a red band, highest level in a green band). We instructed the subject to relax, focus on the breathing prompt, and attempt to keep the line in the green band. This allowed the participants to control their respiratory rate/autonomic arousal and enhance their focus during the simulated combat mission.

Multimedia stress environment. A multimedia stress environment (MSE) was employed to test physiological reactivity and speed/accuracy performance, and to provide an opportunity to practice breathing skills. Similar to other stressor environments that are designed to adapt to specific users (e.g., Ćosić et al., 2011), a set of 12-min stressor scenarios was scripted to be relevant to Operation Iraqi Freedom deployment (Hubal, Kizakevich, McLean, & Hourani, 2010). An introduction to the MSE provided the participants with the "mission objectives" to anticipate enemy engagement, and respond to in-scene cues, sudden events (e.g., explosions), loud noise, and postevent chaos while using a game controller to react to these stimuli. Footage of a stressful combat situation from a recent movie release was added to the MSE to provide three-dimensional content (Hubal, Kizakevich, & Furberg, 2007).

Psychophysiological Measures

Intermediate outcome measures of hyperarousal included a noninvasive physiologic index of autonomic arousal (i.e., heart rate and RSA) during exposure to the MSE collected using an RTI-developed field data collection system (Kizakevich et al., 2006). The most physiologically well-specified component of HRV is RSA, which is the rhythmic rise and fall in heart rate that occurs at the same frequency as respiration (Denver, Reed, & Porges, 2007). The neural systems responsible for RSA are clearly delineated (see Porges, 2007), but the mechanisms responsible for the LF-HRV pattern are less well understood. RSA provides a reliable estimate of cardiac vagal tone, a specific source of parasympathetic influence on heart rate via the myelinated fibers of the tenth cranial nerve (i.e., vagus). To measure the stress response, the Biocom system stored the complete pulse wave, which was then processed with custom software that identified pulse waves from the maximal rising slope to create a series of beat-to-beat pulse interval measures (i.e., time in milliseconds between each pulse wave).

The time series of pulse interval values was analyzed by custom software to identify artifacts in pulse wave detection. Artifacts were identified based on the distribution of beat-to-beat differences in pulse intervals using established criteria for automated pulse interval editing (Berntson, Quigley, Jang, & Boysen, 1990). We removed data with excessive artifacts from the analysis to limit the impact of the editing algorithm on the derived values. While automatic editing typically replaced a small fraction of the heart period values (e.g., mean of 4.46% of the total time in the baseline condition), we used a cutoff of 15% of the total time within each segment of the study to maximize representation of subjects across the segments for the repeated measures analyses.

From the set of valid pulse intervals, a new time series of heart rate was estimated four times per second (i.e., at 4 Hz) by piecewise cubic interpolation. If the duration of heart period values (the time between sequential heart beats in milliseconds derived from the pulse signal) excluded from the final time series was greater than 15% of the total recording, the file was excluded from analysis. Heart rate measures were in all cases statistically based upon the mean heart period (HP), the average of the time sampled pulse interval series for the given segment.

The heart rate time series contains several periodic and quasi-periodic components, the sum of which comprises heart rate variability. Heart rate and variability were then extracted according to the Porges–Bohrer method to measure RSA (Lewis, Furman, McCool, & Porges, 2012; Porges, 2007) and LF-HRV. Briefly, the heart rate time series was first convolved with a third order polynomial to generate an estimate of the lower-frequency components of the signal (below 0.039 Hz for LF-HRV and 0.078 Hz for RSA). This low-passed signal was subtracted from the original time series to create a stationary, zero-mean time series, which was further limited to variance in the respiratory range of adults by band-pass filtering within the range of spontaneous respiration (0.12 Hz to 0.40 Hz) or the low frequency range (0.05 Hz to 0.10 Hz) in the case of the LF-HRV measurement. Finally, the filtered series was divided into nonoverlapping 30-s segments for RSA and 60-s segments for LF-HRV, and the log-transformed variance of each segment was calculated. We defined the magnitude of each component as the mean of these values for each segment.

Survey Measures

PTSD was measured using the PTSD Checklist—Civilian Version (PCL-C). This 17-item PTSD screening instrument (Weathers et al., 1993) asks respondents to rate the extent to which they have been bothered by PTSD symptoms during the previous 30 days using a 5-point scale (1 = *not at all*, 5 = *extremely*). Items include problems and complaints that people sometimes have in response to stressful experiences, such as "repeated, disturbing memories, thought, or images of a stressful experience" and "feeling distant or cut off from other people." The PCL is one of the most frequently used screening instruments for PTSD in military populations—it has demonstrated good reliability (Blanchard, Jones-Alexander, Buckley, & Formeris, 1996) and is well validated in military populations (Searle et al., 2015; Wilkins, Lang, & Norman, 2011). Unlike the military version of the PCL, the civilian version

measures prior military service PTSD symptomatology. The cutoff score of 30 or greater indicates possible PTSD. This cutoff is less strict than the often-used cutoff of 50 and was used because these soldiers were about to deploy and had already completed standard predeployment screening (Bliese et al., 2008). In addition to the overall score, the PCL-C was divided into three subscales based on DSM-IV criteria: intrusions (PCL-C items 1–5), avoidance (PCL-C items 6–12), and hyperarousal (PCL-C items 13–17).

As an overall measure of mental health and help seeking, we also examined self-reported receipt of mental health counseling. Mental health counseling was measured by a combined set of items that inquired if the participant received counseling or therapy for mental health or substance abuse from any of a number of potential providers in the past 12 months.

Sociodemographics including age and the highest level of education attained were also recorded and examined as potential confounding influences. HRV amplitude has been negatively correlated with age (Liao et al., 1995), and some studies indicate a possible protective role for education on white matter integrity (Gordon et al., 2008; Teipel et al., 2009). Early life challenges have also been linked to decreased white matter integrity (Frodl et al., 2012), which has been associated with reduced HRV (Williamson et al., 2012). Overall, greater variability is indicative of parasympathetic influence on cardiac output, which is associated with cardiac and psychological wellbeing.

Statistical Analyses

We applied mixed effects models to correct for clustering at the session level, where sessions varied by time of day and included personnel in the same unit. Random intercept models using SPSS MIXED were used to generalize *t* tests and regression models for nonrepeated measures analyses. Simple change scores were calculated for each subject by subtracting LF-HRV and RSA levels during the initial stressor presentations from baseline levels.

Because the training included instruction to maintain a slow breathing rate below the range of spontaneous respiration, to the same frequency range as LF-HRV (0.10 Hz), it is inappropriate to interpret RSA and LF-HRV separately for the two groups. In the experimental group, the mechanisms for higher frequency variance had been manipulated, confounding any comparison of unique variance bandwidths. To compare heart rate variability between the subjects that received the training and those that did not, a broader measure of heart rate variability, spanning the range of LF-HRV and RSA, was calculated. Based on recent literature, this should be a measure of combined (i.e., not specific to the myelinated pathways) cardiac vagal tone (Reyes del Paso et al., 2013). We refer to this as the wideband measure of heart rate variability, HRV_{wb}.

For repeated measures analyses, we used the mixed models that controlled for both clustering at the session level and repeated measures within participants. These models were fit using the R package *nlme*. The model controlled for the effects of the covariates that were not equally distributed among the two groups: combat exposure, self-reported use of prayer as a coping tool, education level, and self-reported use of relaxation techniques. When selecting results to report, we applied the Holm-Bonferroni correction to each outcome across predictors to ensure alpha remained at .05.

Results

The sample was primarily male (95.5%), with an average age of 23.82 years ($SD = 4.39$), reflecting the predominately male gender distribution of the deploying U.S. Army. The experimental group had a slightly lower female representation (3.4% vs. 5.7%) that was not greater than expected by chance, $\chi^2_{df=1} = 3.682$, $p > .10$. Age was consistent across the experimental and control groups (experimental $M = 23.66$, $SD = 4.48$; control $M = 23.99$, $SD = 4.30$).

Physiological Differences Related to Demographic and Psychological Measures

Self-reported age in years showed a trend toward a significant correlation with both RSA, LF-HRV, and the composite wideband HRV measure at baseline, but not baseline heart period. Due to the well-established trends in HRV magnitude throughout adulthood (e.g., Liao et al., 1995), we elected to calculate age-corrected residuals for comparison of baseline physiology to psychological measures.

The highest level of education completed had a significant impact on baseline physiology, with subjects who had continued education beyond high school exhibiting HPs at the first baseline that were 23.7 ms longer, 95% CI [8.51, 38.80], $F(1,600.6) = 9.40$, $p = .002$. These subjects also had greater LF-HRV, even after correcting for age, with a difference of 0.21 $Ln(ms^2)$, 95% CI [0.06, 0.55], $F(1,617.0) = 7.99$, $p = .005$. Subjects who went beyond high school education showed greater HRV reactivity to the initial simulated combat stressor, with larger LF-HRV reduction in response to the MSE, −0.34 vs. −0.15 $Ln(ms^2)$; the difference has a 95% CI [−0.09, −0.29], $F(1,600.9) = 14.4$, $p < .001$. These subjects also showed larger RSA suppression in response to the combat video, −0.10 vs. −0.01 $Ln(ms^2)$; the difference has a 95% CI [−0.01, −0.16], $F(1,609.9) = 4.90$, $p = .03$, and larger LF-HRV suppression in response to the video, −.26 vs. −.14 $Ln(ms^2)$, CI [−0.01, −0.25], $F(1,600.9) = 4.20$, $p = .04$.

Univariate analyses also indicated that the PCL measure of PTSD symptoms was related to baseline HP, LF-HRV, and heart rate change in response to the initial MSE. Although the group differences in these measures for those above and below a screening threshold of 30 did not maintain significant separation after controlling for clustering effects, several correlations between the PCL (and its subscales) and psychophysiological measures at baseline were observed. The hyperarousal subscale was correlated with HP ($r = -.081$, $p = .039$, $N = 656$). The avoidance scale was correlated with HP change in response to the initial MSE ($r = -.084$, $p = .034$, $N = 646$). Finally, self-reported utilization of mental health counseling had a significant impact on physiological reaction to the combat video. Subjects who received counseling showed smaller RSA suppression in response to the combat video, −0.11 vs. −0.02 $Ln(ms^2)$, than those not receiving counseling, 95% CI of the difference [−0.01, −0.20], $F(1,616.5) = 4.91$, $p = .03$.

PRESTINT Impact on Heart Rate Variability Over Time

Wideband HRV increased for experimental subjects during PRESTINT training (Figure 1). By analyzing group differences, we found a significant impact of the PRESTINT intervention on autonomic regulation of the heart during the initial, eyes closed section of the battle breathing training. Estimates of the group effect sizes are summarized in Table 1. Significant effects range from small to medium in scale, according to Cohen's suggested interpretation (Cohen, 1992). Due to the significant time effect on autonomic levels, HRV change scores from initial to final baseline were used to test for any intervention effect on basal autonomic control. As

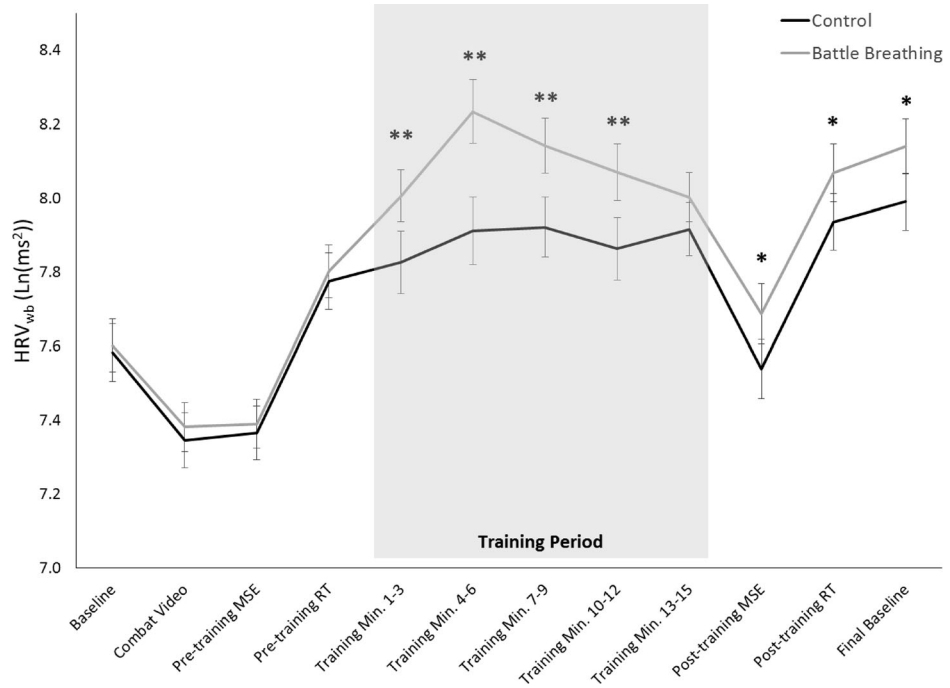

Figure 1. Impact of battle breathing training on HRVwb. *Significant difference in HRV at < .05 level, **at < .01 level.

shown in Figure 2, the battle breathing group showed a larger increase in LF-HRV, $F(1,37.98) = 5.78$, $p = .02$, 95% CI of the difference [−0.03, −0.37]. There was no significant difference in baseline-to-baseline changes for HP or RSA.

Discussion

This study demonstrates that heart rate variability is correlated with psychological measures of PTSD and self-reported use of counseling services, as well as the age and education level of the subjects. It has shown that use of biofeedback-assisted relaxation training was associated with a reduction of HRV following a multimedia stressor. This type of training could reduce the psychological harm following trauma by increasing the capacity for nonsympathetically modulated reactions to stress and providing a coping tool (i.e., relaxation method) for use following a stressful situation. Our initial hypothesis was partially substantiated within this large sample of active-duty military personnel in that it replicated findings of increased heart rate in subjects with greater trauma symptomatology, as in, for example, Hauschildt et al. (2011). However, our replications were limited to heart rate levels and heart rate changes, and we did not replicate their findings of HRV parameter differences, likely due to our broader recruitment target that did not include a population of diagnosed PTSD patients. Our second hypothesis, that parasympathetic influence of cardiac output would be increased following the PRESTINT training, and that this increase would persist following an additional stressor period (the MSE), was strongly supported. While the findings of LF-HRV changes are mixed with an overall rising level in LF-HRV across the entire study (due to the recruitment of subjects right out of their daily schedules on post), the LF-HRV changes highlighted in Figure 2 support our aims of creating an intervention that could increase parasympathetic control and potentially boost the physiological regulation mechanisms that are negatively impacted by trauma. The long-term impact of such a physiological realignment is yet to be proven, but the tested intervention is a promising avenue for such an investigation.

Table 1. *Effect Size Estimates During Intervention*

Segment	Value (*SE*)	*t* value (1,6182)	*p*
Intervention (minutes 1–3)	0.157 (0.063)	**2.47**	**.014**
Intervention (minutes 4–6)	0.240 (0.062)	**3.85**	**< .001**
Intervention (minutes 7–9)	0.118 (0.064)	1.85	.065
Intervention (minutes 10–12)	0.093 (0.062)	1.50	.134
Intervention (minutes 13–15)	−0.020 (0.066)	−0.30	.761

Note. Significant values are in bold.

The strong relationship between education and autonomic physiology (both levels and responses) suggests reduced parasympathetic regulation of the cardiac system (and reduced autonomic flexibility) in the less-educated sample. Since we have limited our variability measures to those that are parasympathetic in nature, greater magnitude HRV reactivity to a stressor can be considered to be a protective factor for psychological harm, in line with the findings in PTSD (e.g., Cohen, 1992). These findings also lend tangential support to a possible role for education in protecting the myelination of regulation centers more broadly, as in the white matter studies.

The polyvagal theory (Porges, 2011) provides a model that synthesizes these findings. Healthy social interactions depend upon the coordinated regulation of parasympathetic control mechanisms. Interference in the social engagement system, either through psychological factors or environmental stresses, reduces the opportunities to exercise this regulation. Development along this trajectory leads to a resting autonomic balance that is shifted toward fight-or-flight reactions and does not exhibit high resting levels of parasympathetic tone. Since heightened sympathetic tone is a cardiovascular risk factor (and heightened parasympathetic tone is protective of cardiovascular and psychological damage), then interventions that increase resting parasympathetic tone should provide a buffer

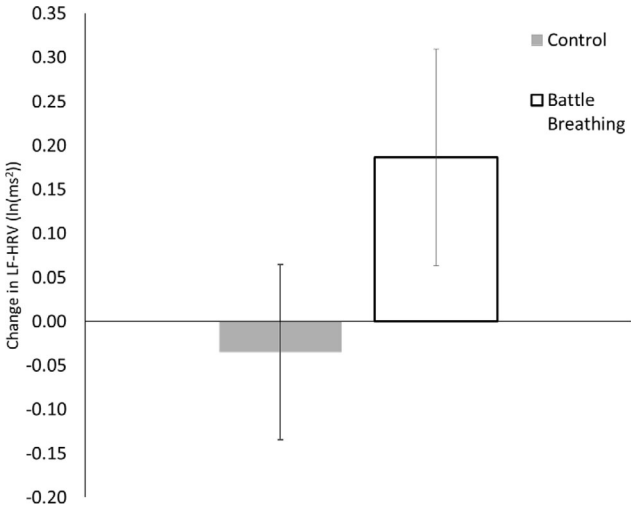

Figure 2. Group difference in within-subject change in LF-HRV from initial to final baseline.

against future stressors. A large resting parasympathetic influence on the heart (i.e., a larger vagal "brake" to remove) should be a target for any type of predeployment inoculation against traumatic stress.

This research study extended protocol aspects of previous research studies of PTSD and had findings similar to existing studies of PTSD and HRV response control using techniques such as deep breathing and focus exercises to affect HRV levels in a larger-scale, randomized control trial consisting of active-duty soldiers in a military population (Tan et al., 2011; Wood, Wiederhold, & Spira, 2010). Our finding of elevated low frequency HRV (compared to baseline levels) in the final resting baseline, with no difference in RSA magnitude calculated over the same span, supports the premise that the battle breathing intervention had a positive impact on autonomic balance in the experimental group (see Figure 2). The smaller changes of RSA suppression in response to the combat video suggest a stress response for individuals in counseling that is less parasympathetically controlled than those subjects that were not seeking counseling services. A novel focus of this research study was to target groups of active-duty personnel prior to deployment, while other studies (e.g., Wahbeh & Oken, 2013) focused on veterans.

Limitations

Some of the reported correlations were small ($r = .1$ and lower). Despite statistical significance, clinical significance may be low and require further research to establish the utility of these effect sizes. In order to measure parasympathetic influence on cardiac activity, we modified the Porges-Bohrer method for RSA magnitude calculation. The HRV_{wb} metric maintains several of the benefits of the RSA metric: independence from variance slower than the signal of interest and normal distribution within and between subjects. However, the new metric makes it impossible to separate the influence of the myelinated vagal fibers uniquely capable of generating rapid oscillations in heart rate from the slower variance derived from the unmyelinated fibers. This type of metric should only be used in situations where one is comparing across groups that have different respiratory rate parameters, with one or more groups being instructed to breathe at a rate slower than spontaneous respiration. Although some techniques for measuring RSA magnitude are confounded by individual differences in respiration rate or volume, this confound can be eliminated by preprocessing the heart period time series to remove slower variance (see Lewis et al., 2012, for a detailed explanation). While our method of measuring RSA magnitude during preintervention periods has been demonstrated to be independent of respiratory parameters, and the HRV_{wb} metric adopted a similar approach, the comparison of HRV_{wb} across groups with demonstrably different respiratory parameters (i.e., slow, deep breathing in only the experimental group) is unique to this publication and should be interpreted cautiously until findings can be replicated.

Future PTSD and depression research focusing on PTSD and HRV characteristics can address gaps in existing research through focus in areas, including adaptive and customized stress induction methods, and technological advances in physiological monitoring in real-world situations. Many studies focusing on PTSD and HRV used some method of inducing stress in a controlled environment. Research studies have employed stress-inducing methods including exposure to video (Hauschildt et al., 2011), trauma recall and mental arithmetic (Keary, Hughes, & Palmieri, 2009), and speaking and cold pressor tasks (Hughes & Stoney, 2000). This research effort, as well as Wood et al. (2010), used immersive virtual reality simulations to induce stress. A potential testing bias exists with repeated exposure to the same stress stimuli where the individual becomes sensitized to the effect of the exposure over time. With virtual simulation methods, Wood's research study includes some flexibility in the stress-inducing task (Wood et al., 2010). Controlled research studies in laboratory environments, even with virtual reality simulation, differ from stress experienced in real life. New advances in portable technologies are enabling measuring of physiological parameters outside of the laboratory environment. For example, researchers are developing smartphone systems to measure HRV (Heathers, 2013; Kizakevich et al., 2012, 2014). Portable physiological measurement systems offer portable means for on-demand training refreshment as well as taking measurements during or shortly after stressful events.

Future studies will follow up on these subjects and evaluate, for example, the feasibility of the suggested techniques during deployment, the frequency of practice, and the long-term impact on development of PTSD within the sample. In conclusion, this study found that autonomic measures of parasympathetic influence on cardiac activity (i.e., heart rate variability levels) can be manipulated over the short term by the battle breathing intervention and that these changes persist through a series of stressors following the intervention. These findings support the theoretical framework for using the PRESTINT training as a predeployment stress inoculation.

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APPENDIX VI. POSTER PRESENTATION: RELAXATION TRAINING ASSISTED BY HEART RATE VARIABILITY BIOFEEDBACK: IMPLICATION FOR A MILITARY PREDEPLOYMENT STRESS INOCULATION PROTOCOL

Relaxation Training Assisted by Heart Rate Variability Biofeedback: Implication for a Military Predeployment Stress Inoculation Protocol

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Introduction

- A predeployment stress inoculation training (PRESTINT) has been developed with slow-paced relaxation breathing skills training (battle breathing), physiological biofeedback, and skills practice in a multimedia simulated combat engagement.
- In a pilot study, the PRESTINT protocol was well accepted by military personnel preparing for deployment to Iraq and showed significantly increased heart rate variability (HRV) (Hourani et al., 2011).
- In the present study, we use the PRESTINT protocol to better understand the relationship among HRV, vagal tone as measured by respiratory sinus arrhythmia (RSA), and mental health measures including PTSD and receipt of mental health counseling.

Background

- Decreased HRV is a common symptom in PTSD and depression; however, PTSD's effects on the autonomic stress response and the potential influence of HRV biofeedback in stress relaxation training on improving PTSD symptoms are not well understood (Tan et al., 2011).
- Because elevated heart rate is the most prominent autonomic feature of PTSD, several possible autonomic imbalances are implied in anxiety disorders such as PTSD, including low resting parasympathetic inhibition, heightened sympathetic drive, or both.
- According to the Polyvagal Theory (Porges, 2009), an intervention that increases resting cardiac vagal tone may serve to mitigate these imbalances, as a greater parasympathetic capacity will be available for regulating a stress reaction, reducing the demand on sympathetic activation.

Objective and Hypotheses

The **objective** of this study was to examine the impact of a PRESTINT protocol on physiological measures of HRV in a large sample of soldiers randomly assigned to experimental HRV biofeedback-assisted relaxation training versus a control condition.

Hypotheses:

1. Physiological measures of autonomic balance are related to PTSD symptoms and other mental health problems; subjects with both conditions will exhibit lower parasympathetic and higher sympathetic influences on cardiac output.
2. These physiological measures are responsive to the PRESTINT protocol (relaxation breathing with biofeedback); specifically that HRV in the low- (~0.10 Hz) and/or high-frequency (0.12–0.40 Hz) ranges will be elevated following the intervention and a subsequent stressor.

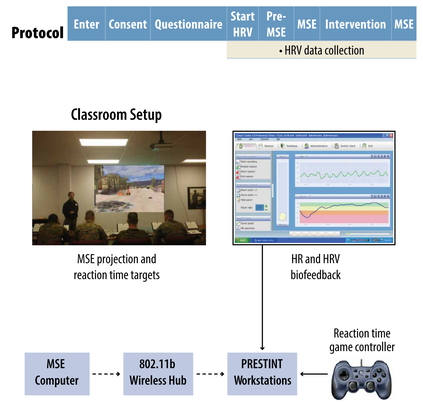
Method—Subjects

- Participants were selected from a convenience sample of platoons of the U.S. Army's 82nd Airborne Division at Fort Bragg, North Carolina.
- Platoons were randomized into either the experimental group, who received the PRESTINT protocol, or the control group, who received a didactic presentation on stress management.
- Total sample consisted of 891 (469 PRESTINT condition; 422 controls).

PRESTINT Program Components

- **Educational Materials.** Trifold brochures, developed by RTI International using the Army's stress management resources, were provided to all participants.
- **Battle Breathing Training.** A 20-minute group presentation provided (1) attentional retraining including relaxed breathing with eyes open, and (2) relaxed abdominal breathing with eyes closed.
- **Multimedia Stress Environment (MSE).** A MSE was employed to test physiological reactivity and speed/accuracy performance, and to provide an opportunity to practice breathing skills. A set of 12-minute stressor scenarios was scripted to be relevant to Operation Iraqi Freedom (OIF) deployment. An introduction to the MSE provided the participants with the "mission objectives" to anticipate enemy engagement and to respond to in-scene cues, sudden events (e.g., explosions), loud noise, and postevent chaos while using a game controller to react to these stimuli.

Design and Methodology (Predeployment)



Procedures

- **Control group** received a 20-minute didactic presentation on stress management.
- **PRESTINT group** received a 20-minute relaxation breathing skills lesson with biofeedback (Battle Breathing).
- **Both groups** received pre- and post-training MSE practice with HRV and reaction time data measurement.

Physiological Measures

- Intermediate outcome measures of hyperarousal included a noninvasive physiological index of autonomic arousal (i.e., HR and RSA) during exposure to the MSE, collected using a Biocom system to store and analyze a time series of pulse interval values.
- Heart rate was estimated to be four times per second and based upon the mean heart period (the average of the time-sampled pulse interval series for a given segment).
- HR and HRV were extracted according to the Porges–Bohrer method to measure RSA (Lewis, Furman, McCool, & Porges, 2012; Porges, 2007) and low-frequency heart rate variability (LF-HRV).
- HRV changes were also analyzed within a broad frequency band spanning the LF-HRV and RSA ranges, due to the experimental demand to shift respiration. HRV measures reflect combined effects on RSA and LF-HRV.
- Heart period is the time between sequential heart beats in milliseconds derived from the pulse signal.

Survey Measures

- **PTSD** was measured using the PTSD Checklist—Civilian Version (PCL-C). A cutoff score of 30 or greater was used to indicate possible PTSD. This cutoff is less strict than the often-used cutoff of 50 and was used because these soldiers were about to deploy and had already completed standard predeployment screening.
- **Mental health counseling** was measured as an overall measure of mental health and help-seeking behavior. A combined set of items inquired if the participant received counseling or therapy for mental health or substance abuse from any of a number of potential providers in the past 12 months.
- **Sociodemographics**, including sex, age, and the highest level of education attained, were also recorded and examined as potential confounding influences.

Results

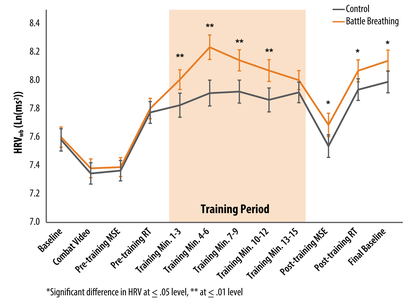
- The sample was primarily male (95.5%), with an average age of 23.82 years, consistent across the experimental and control groups.
- Subjects with an education level beyond high school showed greater HRV reactivity to the initial simulated combat stressor, with reduced LF-HRV in response to the MSE. These subjects also showed increased RSA suppression in response to the combat video and increased LF-HRV suppression in response to the video.
- The PCL-C hyperarousal subscale was correlated with HP. The avoidance scale was correlated with HP change in response to the initial MSE. Subjects who received counseling showed decreased RSA suppression in response to the combat video than those who did not receive counseling.
- PRESTINT altered the parasympathetic regulation of cardiac activity, with experimental subjects exhibiting greater HRV (less arousal) during a post-training combat simulation designed to heighten arousal.
- Autonomic reactivity also was found to be related to PTSD and self-reported use of mental health services.

Table 1. Effect Size Estimates of PRESTINT Intervention on HRV During Battle Breathing Training

Segment		Value (SE) t-value (1,62)	*p*
Intervention (minutes 1–3)	0.157 (0.063)	**2.47**	**0.014**
Intervention (minutes 4–6)	0.240 (0.062)	**3.85**	**<0.001**
Intervention (minutes 7–9)	0.118 (0.064)	1.85	0.065
Intervention (minutes 10–12)	0.093 (0.062)	1.50	0.134
Intervention (minutes 13–15)	−0.020 (0.066)	−0.30	0.761

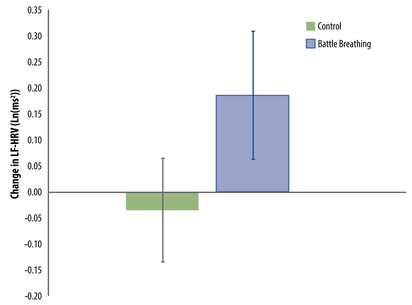
Note: significant values are in bold.

Figure 1. Impact of Battle Breathing Training on HRV



*Significant difference in HRV at ≤ .05 level, ** at ≤ .01 level

Figure 2. Group Difference in Within-Subject Change in LF-HRV From Initial to Final Baseline



Conclusions

- HRV is correlated with psychological measures of PTSD and self-reported use of counseling services, as well as the age and education level of the subjects. The use of biofeedback-assisted relaxation training was associated with a reduction of HRV following a multimedia stressor.
- Future PRESTINT training could be appropriate for efficiently teaching self-help skills to reduce the psychological harm following trauma exposure by increasing the capacity for parasympathetically modulated reactions to stress and providing a coping tool (i.e., relaxation method) for use following a stressful situation.

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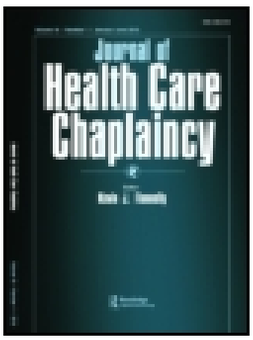
APPENDIX VII. PUBLISHED MANUSCRIPT: HELP-SEEKING BEHAVIORS AMONG ACTIVE-DUTY MILITARY PERSONNEL: UTILIZATION OF CHAPLAINS AND OTHER MENTAL HEALTH SERVICE PROVIDERS



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Help-Seeking Behaviors Among Active-Duty Military Personnel: Utilization of Chaplains and Other Mental Health Service Providers

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Military chaplains not only conduct religious services, but also provide counseling and spiritual support to military service members, operating as liaisons between soldiers and mental health professionals. In this study, active-duty soldiers (N = 889) reported help-seeking behaviors and mental health. Using logistic regressions, we describe the issues for which soldiers reported seeking help, then outline the characteristics of those who are most likely to seek help from a chaplain. Of the soldiers who sought help from a chaplain within the previous year, 29.9% reported high levels of combat exposure, 50.8% screened positive for depression, 39.1% had probable PTSD, and 26.6% screened positive for generalized anxiety disorder. The participant's unit firing on the enemy, personally firing on the enemy, and seeing dead bodies or human remains predicted seeing a chaplain. Future research should examine ways to engage soldiers who have had more combat experiences with the chaplain community to address spiritual issues.

KEYWORDS *chaplaincy, mental health, military, moral injury, stigma*

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Active-duty (AD) military personnel have several options for seeking help for emotional or mental health concerns, including mental health professionals at a military facility, a general medical doctor at a military facility, a military chaplain, civilian mental health professionals, a general medical doctor at a civilian facility, a civilian pastor, rabbi, or other pastoral counselor, and self-help groups (Bray et al., 2009). Reasons for choosing which options for help-seeking behaviors are important to understand in order to develop procedures for providing the best and most relevant care to those most likely to take advantage of them. One option that has received very little research attention is the utilization of military chaplains by AD soldiers.

Military chaplains are responsible not only for conducting religious services, but also for providing counseling and spiritual support to service members of the United States military (Besterman-Dahan, Gibbons, Barnett, & Hickling, 2012). A recent nationwide representative survey of post-9/11 veterans found that roughly one-fifth had spoken to a "pastoral counselor" within the previous year (Elbogen et al., 2013; Nieuwsma, Fortune-Greeley, et al., 2014). Oftentimes, military chaplains operate as liaisons between service members and other mental health professionals (Besterman-Dahan et al., 2012) and many of those for whom they care have mental health issues (Nieuwsma et al., 2013). In fact, in the Department of Defense (DoD) Health-Related Behaviors Surveys (HRB Survey), Bray et al. (2009) showed that 21.4% of Army personnel received counseling or therapy for mental health or substance abuse in the past 12 months; 8% (more than a third of all those who sought help) received services from a military chaplain. In a study of active-duty members of the United Kingdom (UK) armed forces, non-medical sources of help, such as chaplains, were used more often than medical professional help for mental health concerns (Iversen et al., 2010). Another study of UK forces who were currently deployed in Iraq found that, for the less than half who actually received help for a problem, help was more commonly sought through informal channels (such as from a friend, chain of command, or chaplain), than from a medical professional (Mulligan et al., 2010).

Issues of stigma are a concern in the military with regard to help-seeking for both mental health and substance abuse issues, and those who screen positive for mental health issues are more likely to report concerns of stigma than those who do not (Hoge et al., 2004; Rae Olmsted et al., 2011). These concerns include endorsing reasons such as "It would be too embarrassing," "It would harm my career," "Members of my unit might have less confidence in me," "My leaders would blame me for the problem," and "I would be seen as weak" (Hoge et al., 2004; MHAT VII, 2011). Veterans who reported speaking to pastoral counselors were more likely to have indicated concerns regarding distrust of mental health care or stigma than those who had not spoken with pastoral counselors (Nieuwsma, Fortune-Greeley, et al., 2014). These concerns have led to an increased interest in understanding the roles

that chaplains play within the DoD and the Department of Veterans Affairs (VA) (Nieuwsma, Jackson, et al., 2014).

The magnitude of mental health problems among service members, especially upon return from deployment and following exposure to combat, is fairly well-documented (Hoge et al., 2004; Milliken, Auchterlonie, & Hoge, 2007). However, there is limited information on the extent to which AD soldiers seek help from chaplains, and for what conditions they tend to seek such help. There is also a dearth of information on the mental health status and combat experiences of those service members who seek care from chaplains. This is critical given that our previous work has highlighted the complex relationship between spirituality and mental health in veterans with various levels of combat exposure (Hourani et al., 2012). Interestingly, we have found that spirituality had a buffering effect against depression and PTSD, but only in those who had experienced low or moderate levels of combat (Hourani et al., 2012). In addition to PTSD, there is emerging evidence of what is referred to as *moral injury*—defined as "potentially morally injurious events, such as perpetrating, failing to prevent, or bearing witness to acts that transgress deeply held moral beliefs and expectations may be deleterious in the long-term, emotionally, psychologically, behaviorally, spiritually, and socially" (Litz et al., 2009)—following combat and war, whereby veterans report challenges to their spiritual beliefs because of combat experiences (Drescher et al., 2011; Vargas, Hanson, Kraus, Drescher, & Foy, 2013). For these reasons, we will examine the relationship between combat exposures and seeking help from a chaplain, as they may be uniquely positioned to provide support for such concerns.

A better understanding of the reasons that service members and veterans choose to seek care from a chaplain is necessary to address current gaps in both help-seeking behaviors and training for mental health professionals (Chevalier et al., 2015). The present study extends previous research by describing the issues for which AD service members report seeking help and by describing the service members who are most likely to seek such help from a chaplain.

SPECIFIC AIMS

This study has five complementary aims: (1) determine the proportion of soldiers seeking any help for mental health issues in the previous year; (2) identify overall patterns in the problems for which help was sought and the types of professionals from whom the help was sought; (3) examine the mental health status of soldiers who sought help from chaplains; (4) ascertain predictors of seeking care from any mental health professional; and (5) describe key predictors of seeking care from a chaplain among those who sought help.

METHOD

Sample and Procedures

Based on the researcher's request to the installation for a sample of deployable combat platoons, fifty-two platoons of the 82nd Airborne at Ft. Bragg, NC were assigned by their command to attend a short on-site introduction to the study and its volunteer nature. A total of 891 attending soldiers agreed to participate (only two soldiers declined to participate). All participants had completed their basic and advanced military training. Data were collected on-site during two-hour sessions with platoons of up to 26 soldiers. Participants provided signed consent forms, and institutional review boards of RTI International and the US Army Medical and Material Command, Office of Research Protections, Human Research Protection Office approved the study. Soldiers filled out anonymous 30 minute self-report questionnaires that included several standardized psychological scales, and assessments of coping behaviors, combat exposure, and help-seeking behaviors (see Measures section). Additional details on procedures are available in Lewis et al. (2015).

Measures

Demographic characteristics were assessed to describe the sample and to use as control variables in all analyses. Age was coded continuously in years. Gender was coded as 0 = male and 1 = female. Additionally, we assessed level of education and used a dichotomous variable (0 = high school education or less, 1 = some college or trade school and higher) in all analyses.

Receipt of counseling was assessed by asking respondents to report on whether they had received counseling or therapy for mental health or substance abuse in the past 12 months from seven different sources of help: (1) a mental health professional at a military facility (e.g., psychologist, psychiatrist, clinical social worker, or other mental health counselor), (2) a general medical doctor at a military facility, (3) a military chaplain, (4) a civilian mental health professional (e.g., psychologist, psychiatrist, clinical social worker, or other mental health counselor), (5) a general medical doctor at a civilian facility, (6) a civilian pastor, rabbi, or other pastoral counselor, or (7) a self-help group (e.g., AA, NA). Participants were instructed to check all that apply, resulting in seven dichotomous variables (0 = no, 1 = yes).

Mental health concern was assessed using self-report and options included depression, anxiety, family problems, substance use problems, anger management, stress management, and combat/operational stress. Respondents were asked to indicate for which of these concerns they sought counseling or therapy within the past 12 months. Participants were instructed to check all that apply, resulting in 7 dichotomous variables (0 = no, 1 = yes).

Prayer as a coping behavior was measured by asking participants how often they said a prayer when they felt pressured, stressed, depressed, or anxious. Response options ranged from 1-*not at all* to 4-*a lot*.

Combat Exposure was measured using the Combat Experiences Scale, Section D of the Deployment Risk and Resilience Inventory-2 (DRRI-2; Vogt, Smith, King, & King, 2012), which assesses experiences related to combat (e.g., firing a weapon or being fired on). Respondents were asked to think about their last deployment, and to report how many times they experienced each of 17 items. Response options for each item were coded from one to five, indicating zero, 1-3, 4-12, 13-50, or 51 or more times for each experience. Totals were then used to create a dichotomized variable of combat exposure (no/low/moderate combat exposure vs. high combat exposure). High combat exposure was considered a total of 10 or greater as a combat experiences sum. In addition to using the entire scale, we also examined the following nine individual items, which we hypothesized were related to seeking help from a chaplain: (1) the participant's unit firing on the enemy, (2) the soldier personally firing his/her weapon at the enemy, (3) engaging in hand-to-hand combat, (4) witnessing members of the participant's unit or an ally unit being seriously wounded or killed, (5) the participant's unit suffering casualties, (6) seeing dead bodies or human remains, (7) handling, uncovering, or removing dead bodies or human remains, (8) someone the participant knew well being killed in combat, and (9) taking care of injured or dying people. We anticipated these items being related to seeking help from a chaplain due to the nature of these experiences and their association with death and dying.

Depression was measured using the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977), a 20-item self-report measure to assess symptoms associated with depression that have been experienced in the past week. An example item is "I felt like everything I did was an effort." Responses are on a 4-point scale where 0 = *rarely or none of the time* and 3 = *most or all of the time*. The scale provides a total score ranging from 0 to 57 ($M = 11.63$, $SD = 9.87$). CES-D scores showed excellent internal reliability in this sample (Cronbach's $\alpha = .90$). A standard cutoff score of 16 indicated probable depression (0 = no, 1 = yes).

Generalized anxiety disorder (GAD) symptoms were assessed using the seven Patient Health Questionnaire (PHQ) items to measure GAD (Spitzer, Kroenke, & Williams, 1999). An example item is "During the past month, how often have you been bothered by each of the following?: Feeling nervous, anxious, on edge, or worrying a lot about different things." Response options ranged from 0 = *not at all* to 2 = *more than half of the days*. The scale produces a total score ($M = 5.19$, $SD = 3.72$, range 0–14), with scores over 10 indicative of a probable GAD diagnosis. PHQ scores showed good internal reliability in this sample (Cronbach's $\alpha = 0.85$). Probable GAD diagnosis was coded as 1 = yes and 0 = no.

Perceived stress was measured using the Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983), a 10-item scale to assess a person's perception of stress and control. An example item is "In the last month, how often have you felt nervous and stressed?" Response options range from 0 = *never* to 4 = *very often*. The scale provides a total perceived stress score ranging from 0 to 35 (continuous), with higher scores indicating more perceived stress. The mean in this sample was 14.22 ($SD = 7.08$). Scores showed good internal consistency in this sample (Cronbach's $\alpha = 0.86$).

PTSD symptoms were measured using the PTSD Checklist-Civilian Version (PCL-C) (Weathers, Litz, Herman, Huska, & Keane, 1994), a 17-item screening instrument for PTSD. The civilian version was chosen to capture PTSD symptomatology prior to military service; it has been used frequently with military populations and has demonstrated good reliability (Wilkins, Lang, & Norman, 2011). A PCL-C cut-off score of 43 was used to indicate probable PTSD (1 = yes, 0 = no), which is a midpoint cutoff between strictest and broadest screening definitions (Bliese et al., 2008; National Center for PTSD, 2012).

Data Analysis

All analyses were run using SAS software, Version 9.4 (SAS Institute Inc., Cary, NC). Descriptive statistics were obtained to assess how frequently soldiers reported seeing various mental health professionals, as well as the most common concerns for which soldiers sought help. PROC SURVEYFREQ was used to identify significant associations between receipt of counseling or therapy for mental health or substance abuse from a variety of mental health professionals and the type of concern for which they sought help. Since receipt of counseling in each of the seven categories was coded 0 or 1 (no or yes, respectively), as were mental health concerns, we used Phi correlations in a 2×2 table to assess these associations. Additionally, for those who had seen a chaplain within the previous year, PROC SURVEYFREQ was used to determine the percentage who screened positive for mental health conditions, including depression, PTSD, and GAD, as well as those who reported high levels of combat exposure.

Lastly, logistic regressions were run using PROC SURVEYLOGISTIC to determine predictors of seeking counseling from any mental health professional within the previous year as well as specifically seeking counseling from a chaplain. In all analyses, we controlled for demographic variables including age, gender, and education. For the logistic regression model predicting whether a soldier sought counseling within the previous year, predictors included high combat exposure, GAD, depression, PTSD, and total stress scores. In the logistic regression model predicting whether a soldier reported seeing a chaplain within the previous year, predictors included the 9 items of the Combat Experiences Scale and reporting prayer as a coping behavior.

These 9 items were chosen a priori for theoretical reasons, namely their relation to death and dying, and in light of prior findings about the unique experience of killing (Maguen et al., 2010).

RESULTS

Descriptive Analyses

The sample ($N = 889$) consisted mostly of men with a mean age of 23.82 years ($SD = 4.39$, range = 18–41). Participants were mostly single or never married, followed closely by married or living as married. Most soldiers were E-4 or above in rank and slightly more than half reported having at least some college or trade school education. More than half of the sample had never been deployed, but almost a quarter of the sample reported high combat exposure. More than a quarter of the sample had CES-D scores indicative of probable depression, 14.7% were indicated for probable GAD, and 13% had PCL-C scores above 43, which indicated probable PTSD. Table 1 provides demographic, deployment, combat, and mental health descriptive results.

Of the total sample, 17.4% ($n = 155$) reported seeing any mental health professional in the past 12 months. Soldiers most often reported seeing a mental health professional at a military facility (e.g., psychologist, psychiatrist, clinical social worker, or other mental health counselor) (9.5%; $n = 85$), followed by a military chaplain (7.3%, $n = 65$), and general medical doctor at a military facility (5.2%; $n = 46$). Participants also reported seeing a civilian mental health professional (4.4%; $n = 39$), civilian pastor, rabbi, or other pastoral counselor (3.3%, $n = 29$), and attending a self-help group (e.g., AA, NA) (2.4%, $n = 21$). Respondents were least likely to report seeing a civilian general medical doctor (1.3%, $n = 12$). The most common concerns for which soldiers reported seeking mental health counseling were family problems (8.2%, $n = 73$), depression (6.3%, $n = 56$), anxiety (6.1%, $n = 54$), stress management (6.1%, $n = 54$), and anger management (4.5%, $n = 40$). Participants also reported seeking mental health treatment for combat or operational stress (2.6%, $n = 23$), substance abuse problems (1.5%, $n = 13$), and other concerns (3.6%, $n = 32$).

Bivariate Analyses

Mental Health Professionals Related to the Military

Soldiers were most likely to report seeing a *military* mental health professional for stress management, followed by depression, anxiety, combat or operational stress, anger management, family problems, and substance use problems. Results indicated that soldiers were most likely to report seeing a *chaplain* for family problems, followed by depression, anxiety, stress

TABLE 1 Descriptive Statistics of Demographic, Deployment, Combat Exposure, and Mental Health Variables

Variable	*n*	Percent
Gender		
Male	851	95.5%
Female	40	4.5%
Education		
High school or less	423	47.5%
Some college or trade school	458	51.4%
Paygrade		
E1-E3	369	41.4%
E4-E6	476	53.4%
E7-E9	23	2.6%
W1-W5	2	0.2%
O1-O3	21	2.4%
Marital Status		
Married/living as married	410	46.0%
Single, never married	437	49.0%
Separated/widowed/divorced	42	4.7%
Ever Deployed		
Yes	364	40.9%
No	508	57.0%
Combat Exposure		
No combat exposure	517	58.0%
Low/Medium combat exposure	149	16.7%
High combat exposure	209	23.5%
Depression Indicated		
Yes	233	26.2%
No	653	73.3%
GAD indicated		
Yes	131	14.7%
No	757	85.0%
PTSD indicated		
Yes	116	13.0%
No	773	86.8%

Note. $N = 891$. Some columns do not total 100% due to missing data. GAD = generalized anxiety disorder; PTSD = posttraumatic stress disorder.

management, anger management, and combat or operational stress. Soldiers did not report seeking help from a chaplain for substance use problems. Participants who reported seeing a *general medical doctor at a military facility* most often reported depression as a mental health concern, followed by stress management, anxiety, combat or operational stress, family problems, and anger management. Soldiers did not report seeing a general medical doctor at a military facility for substance use problems (see Table 2).

Mental Health Professionals Not Related to the Military

For participants who reported seeing a *civilian mental health professional*, the most commonly reported concern was stress management, followed

TABLE 2 Phi (φ) Correlations Between Mental Health Professional Sought and Mental Health Concern

	Mental health professional at a military facility	General medical doctor at a military facility	Military chaplain	Civilian mental health professional	General medical doctor at a civilian facility	Civilian pastor, rabbi, or other pastoral counselor	Self-help group (e.g., AA, NA)
Depression	.49***	.32***	.40***	.39***	.10*	.22***	.09*
Anxiety	.46***	.27***	.39***	.33***	.14**	.25***	.06
Family problems	.34***	.21***	.53***	.35***	.12**	.35***	.04
Substance use problems	.19***	.02	−.03	.12*	−.01	−.02	.63***
Anger management	.44***	.17***	.26***	.23***	.08	.18***	.16***
Stress management	.55***	.29***	.37***	.39***	.14**	.25***	.22***
Combat/operational stress	.44***	.22***	.26***	.29***	.18**	.14**	.07

Note. ***$p < .001$. **$p < .01$. *$p < .05$.

closely by depression, family problems, anxiety, combat or operational stress, and anger management. Soldiers also reported seeing civilian mental health professionals for substance use problems. Participants who saw a *civilian pastor, rabbi, or other pastoral counselor* most often reported family problems as a concern. In addition, they cited anxiety, stress management, and depression, followed by anger management and combat or operational stress. Soldiers who reported seeing a civilian pastoral counselor did not report substance use problems as a concern. Those who reported attending a *self-help group* were also most likely to report a substance use problem as their main concern. These participants also reported stress management, anger management, and depression as mental health concerns. Lastly, the most commonly reported concerns for those who reported seeing a *general medical doctor at a civilian facility* were combat or operational stress, anxiety, stress management, family problems, and depression (see Table 2).

Overall, these results highlight which mental health professionals soldiers were most likely to seek when also reporting certain concerns. Participants who reported stress management, depression, anxiety, combat or operational stress, or anger management as a concern were most likely to report seeing a mental health professional at a military facility. Soldiers who reported family problems as a concern were most likely to report seeing a military chaplain, and those who reported substance use problems were much more likely to report attending a self-help group than seeing any other mental health professional (see Table 2).

Mental Health Status and Combat Experiences of Those Who Saw Chaplains

It is important to understand the mental health status and combat experiences of soldiers who sought help from a chaplain, regardless of whether the chaplain was sought for this specific concern. Of soldiers who sought help from a chaplain within the previous year, 29.9% reported high levels of combat exposure ($n = 19$), 50.8% screened positive for depression ($n = 33$), 39.1% reported levels of symptoms indicative of a probable PTSD diagnosis ($n = 25$), and 26.6% screened positive for GAD ($n = 17$).

Multivariate Analyses

Results of a logistic regression indicated that those who had probable PTSD and higher levels of perceived stress were more likely to report seeking counseling within the previous year, after controlling for age, education, gender, high levels of combat exposure, depression, and GAD (see Table 3). Among those who sought counseling within the previous year, four variables significantly predicted specifically seeing a chaplain. Results of the logistic regression revealed that reporting that the participant's unit fired on the enemy, the soldier personally firing on the enemy, a member of the soldier's

TABLE 3 Logistic Regression Model Parameters Predicting Receipt of Counseling in the Previous Year

Independent Variables	Receipt of Counseling in Previous Year OR (95% CI)
High combat exposure	1.44 (0.97–2.13)
Depression Indicated (CESD > 16)	0.91 (0.50–1.64)
Perceived Stress	1.07 (1.04–1.11)*
PTSD Indicated (PCL-C > 43)	2.23 (1.24–4.03)*
GAD Indicated (GAD > 10)	1.56 (0.96–2.54)
Gender	1.45 (0.57–3.87)
Education	0.93 (0.82–1.07)
Age	1.03 (0.98–1.07)

Note. *$p < .05$. PTSD = posttraumatic stress disorder; GAD = generalized anxiety disorder.

unit or ally unit being seriously wounded or killed, and seeing dead bodies or human remains significantly predicted seeing a chaplain (see Table 4). Engaging in hand-to-hand combat; the soldier's unit suffering casualties; handling, uncovering, or removing dead bodies or human remains; having someone the participant knew well killed in combat; taking care of injured or dying people; saying a prayer as a coping behavior; probable depression, GAD, or PTSD; and age, gender, and education were nonsignificant predictors (see Table 4).

Soldiers whose units fired on the enemy were almost four times as likely to seek help from a chaplain as those whose units did not fire on the enemy,

TABLE 4 Logistic Regression Model Parameters Predicting Seeking Help From a Chaplain

Independent Variables	Seeking Help from Chaplain in Previous Year OR (95% CI)
Unit fired on enemy	3.89 (1.06–14.23)*
Soldier fired on enemy	0.22 (0.06–0.85)*
Member of soldier's unit or ally unit seriously wounded or killed	0.23 (0.07–0.84)*
Seeing dead bodies or human remains	6.86 (2.11–22.34)*
Engaging in hand-to-hand combat	0.42 (0.02–7.95)
Unit suffered casualties	0.64 (0.19–2.15)
Handling, uncovering, or removing dead bodies or human remains	1.39 (0.38–5.05)
Someone soldier knew well was killed in combat	0.52 (0.07–3.91)
Took care of injured or dying people	1.81 (0.46–7.20)
Used prayer as a coping behavior	0.67 (0.26–1.70)
Depression Indicated (CESD > 16)	1.14 (0.18–7.24)
Perceived Stress	1.24 (0.93–1.66)
PTSD Indicated (PCL-C > 43)	0.85 (0.09–8.38)
GAD Indicated (GAD > 10)	0.15 (0.02–1.14)
Gender	0.60 (0.05–7.26)
Education	1.07 (0.50–2.31)
Age	1.04 (0.83–1.32)

Note. *$p < .05$. Analysis includes only those who received counseling in previous year.

but those who personally fired on the enemy were 78% less likely. Soldiers who reported that a member of the soldier's unit or ally unit was seriously wounded or killed were 77% less likely to see a chaplain than those who did not. The strongest predictor of seeking help from a chaplain was seeing dead bodies or human remains, with soldiers who reported seeing dead bodies or human remains being nearly seven times more likely to seek help from a chaplain than soldiers who did not. Interestingly, those who reported praying as a coping behavior were no more or less likely to seek a chaplain's help for a mental health concern.

DISCUSSION

This study sought to describe patterns of help-seeking behaviors in Active-duty soldiers, in particular the utilization of military chaplains for mental health concerns. Results revealed that slightly more than one in six soldiers reported seeking help for mental health concerns within the previous year. Chaplains were the second most reported source of help, after mental health professionals at a military facility. The most common concern for which most soldiers sought help from a chaplain was family problems, but it is important to acknowledge the mental health issues that these soldiers were also facing. Despite not reporting mental health concerns as the primary reason for seeing a chaplain, more than half screened positive for depression, more than a third reported levels of symptoms indicative of a probable PTSD diagnosis, and more than a quarter screened positive for GAD. Additionally, almost one third of soldiers who sought help from a chaplain reported high levels of combat exposure. These results highlight the need for military chaplains to be adequately trained to understand these comorbid or underlying issues and the ways in which these mental health concerns and combat experiences may interact with presenting spiritual problems.

Not surprisingly, soldiers who reported high levels of PTSD symptoms and higher levels of stress were the most likely to report seeking counseling within the previous year. Of particular note were the results of the logistic regression predicting specifically seeking help from a chaplain. It was our original belief that each of the combat exposure items that were related to death would significantly increase the likelihood of a soldier seeking out a chaplain. In addition, we hypothesized that those who reported praying as a coping behavior would be more inclined to reach out to a chaplain than to other mental health professionals. The results did not support this conclusion.

There may be several explanations for these null findings. These results would suggest that there are other reasons for the preference of talking to a chaplain, which requires an understanding of what chaplains offer that other mental health professionals do not. The first reason is absolute confidentiality. Because communication with a chaplain is a formal act of religion or as a

matter of conscience, chaplains are protected from disclosing information to third parties (see Carver, 2007). A second reason is related to the issue of stigma regarding help-seeking behaviors. It is possible that chaplains offer AD soldiers an opportunity to informally discuss mental health or emotional concerns without the perceived stigma of seeking help from a mental health or medical professional.

The second surprising finding was the differential effects of certain combat experiences to seeking help from a chaplain. Although we anticipated that all death-related combat experiences would be positively associated with the utilization of chaplains, this was not the case. Soldiers whose units fired on the enemy were more likely to see a chaplain, as were soldiers who reported seeing dead bodies or human remains. In contrast, soldiers who personally fired on the enemy, or whose unit or allied unit suffered casualties, were less likely to see a chaplain. Although these were not the expected results, one could speculate as to what makes these experiences qualitatively different from one another. One possibility is that the first two experiences (i.e., seeing dead bodies or human remains and the unit firing on the enemy) are more passive experiences, which do not preclude the soldier from seeing the chaplain as a viable option for emotional or mental health. This is juxtaposed with more engaging experiences (i.e., personally firing on the enemy or having an allied member being wounded or killed), which may result in either moral injury from personal actions taken or spiritual doubt from losing a comrade. These results are congruent with prior findings of the unique effect of indirect or direct killing on PTSD, alcohol abuse, anger/hostility, and relationship problems, even after controlling for overall combat exposure (Maguen et al., 2010). What is most concerning about this pattern of results is that, presumably, many of these experiences could benefit from the spiritual and emotional guidance of a military chaplain or pastoral counselor.

There are a few limitations to this study that should be mentioned. First, all of the data analyzed here were collected cross-sectionally, so the predictive nature of the analyses does not equate to causation. In addition, some analyses used one-item measures, which prevents the assessment of measurement error. This was done intentionally, however, with the view that there was more to be gained by looking at individual experiences and behaviors separately. Finally, the analyses discussed here utilized self-report measures, which can be vulnerable to self-report bias. It may be that soldiers under-reported their utilization of certain help-seeking behaviors or mental health symptoms.

Despite these limitations, this study provides valuable information for both chaplains and the military community as a whole. These results present data critical to understanding the patterns of help-seeking behaviors in the Active-Duty community, which can be leveraged to address gaps in training across all mental health and pastoral counselors. It is particularly crucial to understand that, although soldiers may not report seeking help for mental

health issues from military chaplains, there are possible co-occurring disorders that may affect treatment. Chaplains should be offered additional training about the ways in which common concerns, like depression, anxiety, PTSD, and combat exposure, present themselves in their military constituents. Finally, future research should examine ways to engage those soldiers who may have had more active combat experiences with the chaplain community, as this is where issues of spirituality and moral injury are best addressed.

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APPENDIX VIII. SUBMITTED MANUSCRIPT: RELATIONSHIPS BETWEEN ACTIVE AND AVOIDANT COPING BEHAVIORS AND MENTAL HEALTH OUTCOMES IN MILITARY PERSONNEL

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Health-Related Coping Behaviors and Mental Health in Military Personnel

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Keywords: coping behavior, mental health, stress, anxiety, depression, military

Abstract

This study examined the predictive validity of individual health-related coping behaviors and mental health longitudinally after controlling for cross-sectional relationships and stability across time. Soldiers ($N = 263$) were assessed on measures of mental health and coping behaviors at baseline (Time 1) and follow-up (Time 2; $M = 69.87$ weeks). We used a two-wave, cross-lagged regression design using structural equation modeling. Findings showed that talking, exercising, engaging in a hobby, and planning how to solve the problem were associated with fewer anxiety, stress, and depressive symptoms. Smoking, drinking, and thinking about hurting oneself were associated with more symptoms. Drug use was associated with more depressive symptoms. Praying was not related to mental health. Depressive symptoms at baseline predicted talking to friends and exercising less at follow-up. Stress at baseline predicted engaging in a hobby less at follow-up. Exercising at baseline predicted less stress at follow-up. All other cross-lagged effects were nonsignificant. It is possible that the cross-sectional relationships are interdependent and reinforcing and that engaging in more positive coping behaviors may help to reduce mental health symptoms. Clinically, this knowledge is critical to more efficiently target behaviors with the greatest associations to mental health in military personnel.

In 1980, the Department of Defense (DoD) began collecting information about the behavioral and health readiness of Active-Duty (AD) military personnel using the Survey of Health Related Behaviors among Military Personnel.[1] For the past 20 years the DoD has used the HRB Surveys to assess the use of coping behaviors when feeling pressured, stressed, depressed, or anxious, including thinking of a plan to solve the problem, talking to someone, exercising, engaging in a hobby, saying a prayer, having a drink, smoking a cigarette, taking drugs, or thinking about hurting oneself.[1] Previous factor analyses have suggested a two-factor structure that includes a factor of drinking, smoking, taking drugs, and self-harm (what we conceptualize as maladaptive health behaviors) and another factor that includes planning, talking to someone, exercising, engaging in a hobby, and praying, which are typically more adaptive.[1] Our previous research has highlighted the important link between these coping behaviors and mental health outcomes in military personnel.[2] Specifically, service members who reported maladaptive coping behaviors were at greater risk of depression, generalized anxiety disorder (GAD), posttraumatic stress disorder (PTSD), suicidal ideation, and psychological distress, whereas adaptive coping behaviors were associated with decreased risk of these negative outcomes.[2] This study seeks to extend these findings and further understand these relationships by examining each coping behavior and mental health outcome individually. We use a two-wave, cross-lagged autoregression design with structural equation modeling to disentangle elements of temporality and to examine the predictive value of mental health status vis-à-vis coping behaviors and vice versa.

Stress and Coping

Consistent with most major civilian models of coping, as well as those used in military research such as the stressor-strain model that has examined a single coping mechanism,[3] or have

examined coping factors such as the demand-control model[4] or the Lazarus and Folkman's model,[5] individuals dealing with stressors tend to use different coping styles, including avoidant or active styles, as well as coping strategies, such as problem-solving or emotion-focused coping.[6] These styles and strategies can be used in combination and are most successful when appropriately matched to the given stressor.[6-8] Coping often involves engaging in specific health-related behaviors, which may be more or less adaptive as well as differentially related to health risks.[9] However, Dolan and Ender[3] noted that coping strategies that are usually viewed as positive (such as talking to family and friends) can also be stress inducing within the context of the military. We included several coping behaviors in this study that could be considered maladaptive, including drinking, smoking, using drugs, and thinking about hurting oneself. The following is a brief summary of mental health-related findings regarding maladaptive coping behaviors.

Extant research indicates a strong association between alcohol use and mental health issues, particularly PTSD.[10] Postdeployment research with military veterans has validated these findings, as well as correlations between depression and alcohol abuse.[11] Longitudinal data using a population-based military cohort revealed that new onset of alcohol-related problems occurred after the development of PTSD or depression.[12] Heavy alcohol use was one of the negative health behaviors found to be increasing among military service members within the past decade.[13] Smoking has also been associated with several mental health issues, including depression, trait anxiety, and PTSD within the military population.[14] Interviews with Army and Air Force personnel revealed that common reasons for smoking (particularly on deployment) include managing stress, boredom, anxiety, and sleep deprivation.[15]

Substance use disorders are highly comorbid with mood and anxiety disorders[16] and self-medication of anxiety has been identified as a pathway to substance use disorders.[17] According to the HRB Surveys, rates of illicit drug use among military personnel were trending downward from 1980 to 2002, but saw an increase after prescription drug misuse—which increased from 1.8% in 2002 to 11.1% in 2008—was included in the trend.[13] Research on self-harm and mental health has been somewhat inconsistent, with numerous replications of associations between self-harm and anxiety, PTSD, and personality disorders but mixed results for substance abuse and depression.[18] In a recent study of military recruits, participants who reported a history of self-harm behaviors also reported higher levels of both anxiety and depression.[18]

We also assessed a number of adaptive coping behaviors, including thinking of a plan to solve the problem, talking to a friend or family member, exercising or playing sports, engaging in a hobby, and saying a prayer. *Planning* refers to coming up with the best ways to cope with a specific stressor and determining what actions are best in a given situation.[19] Thinking of a plan, as a coping behavior, has been associated with lower levels of both depression and anxiety.[20] It has also been linked to improved health,[21] although these findings were not replicated in a more recent study in a military sample.[22] Analyses of coping strategies have also included *support seeking*, which includes talking to someone about the problem.[23] In a study of military personnel who deployed in support of a peacekeeping mission (e.g., to Bosnia), speaking with someone else about one's experiences was significantly related to lower levels of distress.[24]

Decades of research have linked exercise to psychosocial health.[25] Exercise has been proven to reduce chronic stress[26] and symptoms of anxiety, negative affect (mood), and depression.[27] In terms of depression, exercise operates as both a preventive measure[27] and an effective treatment; a meta-analysis by North, McCullagh, and Tran[28] showed exercise to be as

or more effective than traditional therapies. Another, less often studied, coping behavior is having a hobby. In a longitudinal study, police officers who had experienced a trauma and did not have a hobby were 2.87 times more at risk of developing PTSD by 12 months after the trauma than peers who had a hobby.[29] This predictive nature, however, is not evidence to establish causality. In fact, brief mental health screeners typically assess loss of interest in hobbies as a symptom or indicator of a mental health issue[30] rather than the cause.

Last, considerable research has documented the impacts of religiosity or spirituality and its related practices on mental health outcomes (for a review, see Koenig, 2009[31]). The topic has become of increased interest in military populations recently, with the implementation of Comprehensive Soldier Fitness,[32] a resilience training for military personnel, which includes an aspect of Spiritual Fitness.[33] In some groups of AD military personnel, spirituality has been linked with lower rates of depression and PTSD symptoms.[34] Daily spiritual experiences, private practices, and organizational religiousness at intake to a Veterans Health Administration PTSD residential treatment program have also been negatively associated with PTSD symptoms at discharge.[35] These coping behaviors will be investigated as correlates and predictors of mental health outcomes in this sample of AD military personnel.

Objectives and Aims

Previous research has shown the correlation between coping behaviors and mental health; maladaptive coping behaviors have been implicated as predictive of worse mental health, whereas adaptive coping behaviors have been identified as predictive of better mental health though much has been associated with posttraumatic stress disorder or suicidal ideation.[36-38] The present study seeks to extend this research by assessing and comparing the value of individual coping behaviors as associated with mental health outcomes (perceived stress, depression and

anxiety) cross-sectionally (at Time 1), as well as the impact of earlier coping behavior and mental health (at Time 1) on later coping and mental health (at Time 2), after controlling for baseline levels of each. Additionally, we will assess which coping behaviors differentially predict mental health. Theoretically, there is no reason to believe that individual coping behaviors would have the same magnitude of association with various mental health outcomes. Clinically, this becomes important to more efficiently target behaviors with the greatest known associations to positive or negative mental health in military veterans. To date, no study of which the authors are aware has examined each of the above coping behaviors individually. We have developed hypotheses (outlined below) about which behaviors we anticipate will have greater or lesser magnitude. Our hypotheses are based on what is reasonable to expect given the extant literature.

This study has four specific aims. The first is to test whether previously reported cross-sectional relationships between coping behaviors and mental health outcomes replicate at baseline and follow-up in our data and to estimate the magnitude of each. We hypothesized that previous findings would be replicated, with maladaptive coping behaviors' being associated with negative mental health indicators and adaptive coping behaviors' being associated with better mental health. We expected that all associations would be significant, that the greatest magnitude of associations for adaptive coping behaviors would link talking to friends and family and thinking of a plan with decreased mental health issues, and that the greatest magnitude of associations for maladaptive coping behaviors would link alcohol use and smoking with increased mental health concerns.

The second aim was to examine the association of each variable with itself (autoregressive effect) from baseline to follow-up. We hypothesized that there would be significant stability of coping behaviors and mental health outcomes from Time 1 to Time 2.

The third aim was to determine the predictive nature of baseline mental health status for later coping behaviors and the predictive nature of baseline coping behaviors for later mental health outcomes. We hypothesized that (1) adaptive coping behaviors at baseline would predict better mental health outcomes at follow-up and (2) better mental health at baseline would predict fewer maladaptive coping behaviors at follow-up.

The fourth aim was to assess the magnitude of each effect to evaluate the differential predictive value of each coping behavior at baseline on each mental health outcome at follow-up.

Methods

Sample

A convenience sample of platoons of the 82nd Airborne was surveyed. Participants (N = 889) were mostly men (n = 851, 95.5%) with a mean age of 23.82 years (SD = 4.39, range 18–41). Slightly more participants were single or never married (n = 437, 49%) than married or living as married (n = 410, 46%), and only 4.7% were separated, widowed, or divorced (n = 42). Soldiers represented all enlisted ranks, with 41.4% (n = 369) being E1–E3, 53.4% (n = 476) being E4–E6, and 5.2% (n = 46) being E7 or above. Additionally, about half reported having at least some college or trade school education (n = 458, 51.4%), and slightly fewer (n = 423, 47.5%) had a high school education. More than half of the sample (n = 508, 57%) had never been deployed.

Procedure

This study was approved by the RTI Institutional Review Board (IRB) and the US Army Medical Research and Materiel Command (USAMRMC), Office of Research Protections (ORP), Human Research Protection Office (HRPO). At baseline, soldiers completed self-report, anonymous questionnaires at their duty sites. Soldiers were contacted for an 18-month follow-up via e-mail and onsite at Fort Bragg. At follow-up (M = 69.87 weeks, range = 59.14–97.29 weeks), participants (N = 263) were assessed using the same measures of mental health and coping. To assess missingness, a dummy indicator was created for whether or not participants completed the follow-up survey. Logistic regressions were run predicting this dummy variable with each baseline variable as the independent variable. Results suggest that the data were missing completely at random at the bivariate level, given the available predictors. In our analyses, we used only those participants who had completed both baseline and follow-up, resulting in a final sample size of 263 soldiers.

Measures

Perceived stress was measured using the Perceived Stress Scale,[39] a 10-item scale to assess a person's perception of stress and control. An example item is, "In the last month, how often have you felt nervous and stressed?" Response options range from 0 = *never* to 4 = *very often*. The scale provides a total perceived stress score ranging from 0 to 35, with higher scores indicating more perceived stress (M = 14.22, SD = 7.08). Scores showed good internal consistency in this sample (Cronbach's α = 0.86).

Depression was measured using the Center for Epidemiologic Studies Depression Scale (CES-D),[40] a 20-item self-report measure to assess symptoms associated with depression that have been experienced in the past week. An example item is, "I felt like everything I did was an effort." Responses are on a 4-point scale where 0 = *rarely or none of the time* and 3 = *most or all*

of the time. The scale provides a total score ranging from 0 to 57 (M = 11.63, SD = 9.87). CES-D scores showed excellent internal reliability in this sample (Cronbach's α = .90).

GAD symptoms were assessed using the seven Patient Health Questionnaire items to measure GAD.[41] An example item is, "During the past month, how often have you been bothered by each of the following: Feeling nervous, anxious, on edge, or worrying a lot about different things." Response options range from 0 = *not at all* to 2 = *more than half of the days.* The scale produces a total score (M = 5.19, SD = 3.72, range 0–14), with scores over 10 indicative of a probable GAD diagnosis. Patient Health Questionnaire scale scores showed good internal reliability in this sample (Cronbach's α = 0.85).

Coping strategies were assessed using 10 single-item questions that asked participants to report how often they engaged in certain activities when "feeling pressured, stressed, depressed, or anxious." Coping strategy options included talking to a friend or family member, lighting up a cigarette, having a drink, saying a prayer, exercising or playing sports, engaging in a hobby, smoking marijuana or using other illegal drugs, thinking of a plan to solve the problem, and thinking about hurting or killing oneself. Each item was assessed on a 4-point scale: *frequently, sometimes, rarely,* or *never*. In strong support of the necessity for this study, internal reliability was weak for the combined measures of adaptive coping (Cronbach's α = 0.64) and for the maladaptive coping behaviors (Cronbach's α = 0.38). Therefore, there was great interest in examining each item individually in relation to mental health.

Data Analysis

Descriptive. Frequency analyses were run to assess in what types of coping behaviors participants were engaged at both baseline and follow-up. All analyses were run using Mplus version 7.3.[42]

Hypothesis testing. This study used structural equation modeling to assess a two-wave longitudinal, crossed and lagged regression design (a.k.a. cross-lagged panel design)[43] to analyze baseline and follow-up mental health and coping strategies. Separate analyses were performed with each coping strategy and each mental health outcome. This design allowed for the analysis of two synchronous associations (i.e., cross-sectional correlations between the coping strategy and mental health outcome at each time point), two autoregressive effects (i.e., baseline mental health predicting mental health at follow-up and baseline coping predicting coping at follow-up), and two cross-lagged effects (i.e., baseline coping strategy predicting mental health at follow-up and baseline mental health predicting follow-up coping). A statistically significant cross-lagged effect in the model indicates that one variable at Time 1 uniquely predicts another variable at Time 2, after the synchronous and autoregressive effects are controlled for. The models were saturated, implying perfect fit. Consequently, fit indices are not reported. Figure 1 depicts this model.

Insert Figure 1 about here

Results

Descriptive

Results of descriptive statistics at baseline revealed that the most frequently reported coping behavior was thinking of a plan to solve the problem ($M = 3.09$, $SD = 0.95$), followed by talking to a friend ($M = 2.94$, $SD = 1.02$), engaging in a hobby ($M = 2.92$, $SD = 1.02$), and exercising or playing sports ($M = 2.81$, $SD = 1.05$). The least often endorsed coping behaviors were smoking marijuana or using illicit drugs and thinking about hurting or killing oneself (less than 2% each), followed by having a drink ($M = 2.02$, $SD = 1.06$) or lighting up a cigarette ($M =$

2.04, *SD* = 1.25). At follow-up, these trends remained, with the exception that saying a prayer was *less frequently* endorsed than having a drink, a slight change from baseline (Table 1).

Insert Table 1 about here

Hypothesis Testing

Replication of cross-sectional relationships. Results of the structural equation modeling verified many previously reported cross-sectional relationships between coping behaviors and mental health outcomes. Specifically, talking to a friend, exercising or playing sports, engaging in a hobby, and thinking of a plan were associated with fewer anxiety, perceived stress, and depression symptoms, whereas smoking a cigarette, having a drink, and thinking about hurting or killing oneself were associated with more anxiety, perceived stress, and depressive symptoms. In addition, marijuana and illicit drug use was also associated with higher depressive symptoms. Saying a prayer was not significantly related to mental health. The strongest positive associations (all r's > 0.25) were between drinking and stress, self-harm and depression, and self-harm and stress. The strongest negative relationships (all r's ≤ -0.25) were between talking and depression, exercise and depression, talking and stress, and exercise and stress (see Tables 2–4).

Insert Tables 2–4 about here

Autoregressive effects. Significant autoregressive effects indicate stability in a variable over time. As hypothesized, depressive symptoms, anxiety, and stress showed substantial stability from baseline to the 1.5- to 2-year follow-up. The mental health construct with the greatest magnitude of stability was depression (β_1's = .45–.50). Additionally, there was statistically significant stability of all coping behaviors except for one: thinking about hurting or killing oneself, which did not reach significance because of the small number of soldiers who endorsed this coping behavior. The greatest autoregressive effect in maladaptive coping

behaviors was smoking a cigarette (β_4's = .72, .73, and .72); the greatest autoregressive effect in adaptive coping behaviors was saying a prayer (all β_4's = .65).

Cross-lagged effects and magnitude. Interestingly, the vast majority of cross-lagged effects were nonsignificant, indicating that after the stability of each variable over time and the cross-sectional associations were controlled for, there was little predictive value of either mental health on coping behaviors or vice versa. However, four cross-lagged effects were significant, two for depressive symptoms and two for stress. First, those who reported more depressive symptoms at Time 1 reported talking to friends and family less and exercising or playing sports less as coping behaviors at Time 2. Second, in terms of perceived stress, two cross-lagged effects were significant. Baseline perceived stress predicted less likelihood of engaging in a hobby at follow-up, whereas exercising or playing sports as a coping behavior at baseline predicted lower perceived stress at follow-up.

Discussion

The results of this study are congruent with previous findings that maladaptive coping behaviors such as using alcohol, smoking cigarettes, and thinking about self-harm behaviors are significantly correlated with mental health outcomes, including perceived stress, anxiety, and depressive symptoms. Our study elucidates the relative importance of these individual maladaptive coping behaviors by highlighting the magnitude of association between having an alcoholic drink and stress, as well as between self-harm behavior and both depression and stress.

This study also replicated prior research suggesting that adaptive coping behaviors—such as talking to a friend, exercising or playing sports, engaging in a hobby, and thinking of a plan—are related to better mental health outcomes. The strength of relationships in this study also provides evidence that exercising and talking to friends and family are particularly valuable as

coping behaviors, with their strong negative associations with both stress and depression. In addition, having a hobby and thinking of a plan to solve the problem were strongly associated with decreased stress, anxiety, and depressive symptoms.

Of interest is the lack of an association between prayer as a coping behavior and mental health outcomes. This result may suggest that, although spirituality is documented to be related to lower rates of depression and PTSD,[34] the act of praying itself may not be the mechanism by which this association exists. Perhaps most importantly, this study is the first to determine the predictive validity of coping and mental health over time after controlling for cross-sectional relationships and stability across time. Depressive symptoms at baseline significantly predicted lower likelihood of talking to friends and family, as well as exercising or playing sports, at follow-up. Stress at baseline also predicted engaging in a hobby less at follow-up. Exercising or playing sports at baseline predicted less stress at follow-up. All other cross-lagged effects were nonsignificant.

It is possible that the cross-sectional relationships are interdependent and reinforcing and that engaging in more positive coping behaviors may help to reduce mental health symptoms, even if the adaptive behaviors are not causal. For example, those with fewer mental health symptoms may be more willing to engage in exercise, which in turn helps promote positive mental health. The same can be posited for maladaptive coping behaviors, in that although engaging in smoking, drinking, illicit drug use, and self-harm may not be the cause of mental health distress, these activities may exacerbate symptoms. Furthermore, the variation in magnitudes of each coping behavior supports the notion that mental health may differentially affect, and be affected by, specific behaviors.

As a whole, these data do not support the idea of combining measures of these adaptive coping behaviors, particularly prayer. Similarly, these patterns of results do not support the use of a single measure of maladaptive behaviors. Future studies should take into account these potential differences when assessing coping styles. Because the match between the situation and the coping strategy or style is also important (i.e., avoidance if the situation is uncontrollable or active if the situation can be controlled), future studies should assess for which types of events military service members use each behavior.

Several limitations to this study should be mentioned. First, each coping behavior was assessed using a single-item measure rather than items in standardized scale, which does not allow for assessment of measurement error. Second, this study relied on self-report measures, which may be biased by the willingness of soldiers to report behaviors accurately. Third, because so few respondents reported certain coping behaviors (e.g., self-harm), these individual analyses may be unreliable because of lack of variance. Fourth and finally, participants were assessed for follow-up more than 1.5 years later; predictive validity between coping and mental health may be greater over less time.

Despite these limitations, this study expands the evidence for the associations between coping behaviors and psychological health or distress (4-5) to specific mental health outcomes, particularly in military service members, and provides comparisons of magnitude of each association. Findings from this study also elucidate the four predictive relationships and the lack of predictive value for many of these associations longitudinally. Clinically, these findings have important implications in recognizing behaviors most strongly related to mental health and thus worthy of more focus in interventions. Specifically, our results implicate exercise and talking to friends and family as particularly useful as adaptive coping strategies, and drinking and self-

harm as particularly detrimental or associated most strongly with negative mental health outcomes. Further research should introduce additional variables that may be implicated in mediating mental health and coping behaviors, as well as assess participants at varying lengths of time.

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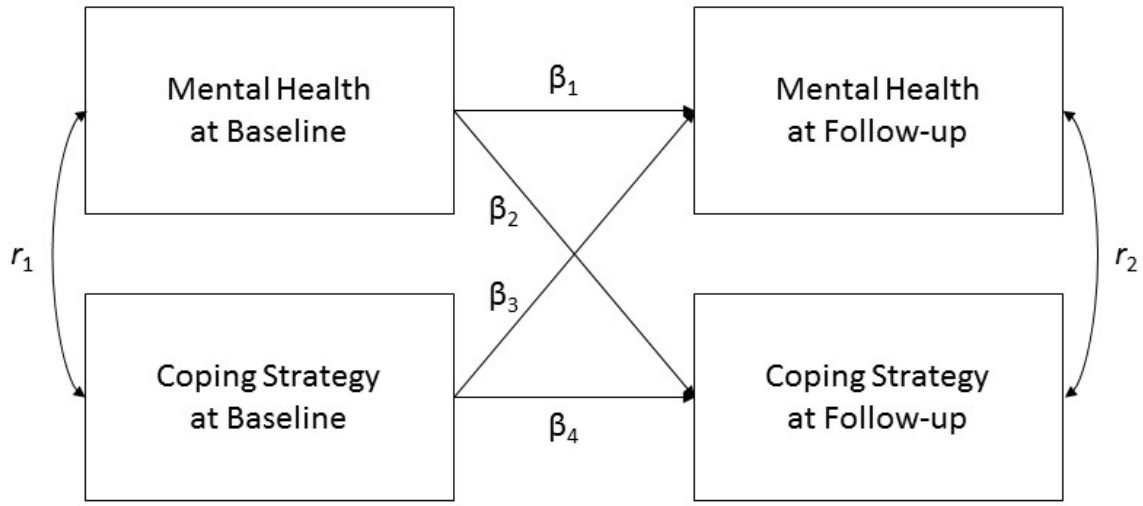

Figure 1. Structural equation model with crossed and lagged regression effects of mental health outcomes and coping strategies at baseline and follow-up.

Table 1

Frequency and Percentages of Coping Behaviors Endorsed at Baseline

Coping Behavior	Frequency							
	Not at All		A Little		Some		A Lot	
	Freq	Pct	Freq	Pct	Freq	Pct	Freq	Pct
Baseline								
Talk to a friend	96	10.9	197	22.3	258	29.2	332	37.6
Smoke a cigarette	476	54.0	94	10.7	115	13.1	196	22.2
Have a drink	374	42.5	227	25.8	168	19.1	112	12.7
Say a prayer	347	39.5	200	22.8	153	17.4	179	20.4
Exercise or play sports	127	14.4	206	23.3	256	29.0	293	33.2
Engage in a hobby	107	12.1	179	20.3	274	31.0	323	36.6
Smoke marijuana/ Use illicit drugs	863	98.2	7	0.8	5	0.6	4	0.5
Think of a plan	69	7.8	151	17.1	295	33.4	367	41.6
Think about hurting/killing self	845	96.0	19	2.2	9	1.0	7	0.8
Follow-up								
Talk to a friend	15	5.6	44	16.6	104	39.2	102	38.5
Smoke a cigarette	134	50.8	38	14.4	41	15.5	51	19.3
Have a drink	80	30.3	78	29.5	64	24.2	42	15.9
Say a prayer	101	38.4	67	25.5	55	20.9	40	15.2
Exercise or play sports	21	8.0	51	19.4	95	36.1	96	36.5
Engage in a hobby	17	6.4	40	15.2	91	34.5	116	43.9
Smoke marijuana/ Use illicit drugs	249	94.3	4	1.5	4	1.5	7	2.7
Think of a plan	18	6.8	22	8.3	93	35.2	131	49.6
Think about hurting/killing self	233	88.9	12	4.6	11	4.2	6	2.3

Table 2

Summary of Two-Wave, Cross-Lagged Regression Analyses for Coping Behaviors and Depression Symptoms

Coping Behavior	r_1	r_2	β_1	β_2	β_3	β_4
Talk to a friend	-.31***	-.07	.50***	-.16**	.07	.27***
Smoke a cigarette	.07	.17**	.48***	.05	.04	.72***
Have a drink	.14*	.23***	.49***	-.01	-.03	.40***
Say a prayer	-.04	-.07	.48***	-.04	-.06	.65***
Exercise or play sports	-.09	-.25***	.48***	-.18**	-.02	.38***
Engage in a hobby	-.20***	-.16**	.47***	-.10	-.04	.33***
Smoke marijuana/ Use illicit drugs	.13*	.21***	.48***	-.03	.01	.20***
Think of a plan	-.21***	-.16**	.49***	.04	.06	.40***
Think about hurting/killing self	.47***	.44***	.45***	.10	.03	.07

Note. $N = 263$. r_1 = correlation at baseline. r_2 = correlation at follow-up. β_1 = autoregressive effect of mental health. β_2 = cross-lagged effect of mental health to coping strategy. β_3 = cross-lagged effect of coping strategy to mental health. β_4 = autoregressive effect of coping strategy.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3

Summary of Two-Wave, Cross-Lagged Regression Analyses for Coping Behaviors, Generalized Anxiety Disorder Symptoms, and Perceived Stress

Coping Behavior	Generalized Anxiety Disorder					
	r_1	r_2	β_1	β_2	β_3	β_4
Talk to a friend	-.18***	-.04	.46***	-.09	.01	.31***
Smoke a cigarette	.09	.12*	.46***	-.02	.04	.73***
Have a drink	.22***	.20***	.45***	-.01	.05	.40***
Say a prayer	-.02	-.11	.46***	-.03	.01	.65***
Exercise or play sports	-.10	-.18**	.46***	-.07	-.06	.39***
Engage in a hobby	-.09	-.15**	.46***	-.11	-.04	.34***
Smoke marijuana/ Use illicit drugs	.09	-.01	.46***	-.07	.03	.20***
Think of a plan	-.13*	-.08	.46***	.01	-.04	.39***
Think about hurting/killing self	.19***	.19***	.45***	.01	.05	.10
Coping Behavior	Perceived Stress					
	r_1	r_2	β_1	β_2	β_3	β_4
Talk to a friend	-.26***	-.11	.46***	-.01	.08	.32***
Smoke a cigarette	.05	.21***	.43***	.03	.09	.72***
Have a drink	.22***	.26***	.45***	.01	-.05	.40***
Say a prayer	.01	-.10	.44***	.01	.03	.65***
Exercise or play sports	-.08	-.28***	.43***	-.10	-.13*	.39***
Engage in a hobby	-.18**	-.20***	.42***	-.15**	-.09	.33***
Smoke marijuana/ Use illicit drugs	.10	.08	.44***	.03	.02	.19***
Think of a plan	-.14*	-.10	.43***	.01	-.05	.39***
Think about hurting/killing self	.34***	.28***	.42***	.04	.05	.10

Note. $N = 263$. r_1 = correlation at baseline. r_2 = correlation at follow-up. β_1 = autoregressive effect of mental health. β_2 = cross-lagged effect of mental health to coping strategy. β_3 = cross-lagged effect of coping strategy to mental health. β_4 = autoregressive effect of coping strategy.
*$p < .05$. **$p < .01$. ***$p < .001$.

APPENDIX IX. SUBMITTED MANUSCRIPT: EFFECTS OF SLEEP DISTURBANCES ON SUICIDAL AND VIOLENT IDEATION IN A MILITARY SAMPLE: THE MEDIATING ROLE OF MENTAL HEALTH

Effects of Sleep Disturbances on Suicidal and Violent Ideation in a Military Sample: The Mediating Role of Mental Health

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Abstract

Study Objectives. The goal of this study was to examine the relationship between sleep disturbances, mental health (perceived stress, posttraumatic stress disorder [PTSD] symptoms, and depressive symptoms), and suicidal ideation (SI) or violent ideation (VI) in a sample of military service members.

Methods. Mediation analyses were performed using the Hayes PROCESS macro for mediation, moderation, and conditional process analyses. Bias-corrected 95% bootstrap confidence interval estimates of the indirect effects using 10,000 bootstrap samples were obtained, and normal theory (Sobel) tests for indirect effects were also calculated.

Results. Sleep disturbances were significantly related to SI and VI. Sleep issues were also significantly related to stress, PTSD, and depression. PTSD, perceived stress, and depression significantly mediated the relationship between sleep disturbances and SI; after accounting for mental health symptoms, sleep no longer had a significant direct effect on SI. Although PTSD, perceived stress, and depression also significantly mediated the relationship between sleep and VI, sleep continued to have a significant direct effect on VI in simple mediation models of stress and depression. Simple moderation analyses were nonsignificant and are therefore not reported.

Conclusions. Our results do not support the multiplicative or synergistic effects of sleep and mental health. Instead, our findings suggest that sleep disturbances may operate as a risk factor or symptom of mental health issues and SI, and that they may be a unique predictor of VI above and beyond stress and depression.

Keywords: sleep disturbances, suicidal ideation, violent ideation, PTSD, depression, stress

Statement of Significance

This study examined the complex relationship between sleep, mental health, and suicidal and violent ideation. Our results suggest that sleep disturbances operate as a risk factor for mental health issues, such as perceived stress and symptoms of depression and posttraumatic stress disorder, which, in turn, increase risk for suicidal and violent ideation. The data in this study support the notion that, in addition to contributing to risk of mental health issues, sleep disturbances directly contribute to violent ideation, possibly by depleting one's self-regulation resources and thereby disinhibiting aggression. Future work should examine whether targeting sleep disturbances may reduce suicidal and violent ideation. Mental and behavioral health interventions, including those focused on suicide and violence prevention, should incorporate sleep hygiene.

Introduction

It is well-documented that lack of quality sleep is a pervasive health issue among military service members.[1-3] Recent active duty service members and veterans are more likely to report daily insufficient sleep than their counterparts with no history of service.[4] Sleep issues have been documented across a number of military samples, including soldiers undergoing Basic Combat Training,[5] cadets at the U.S. Military Academy,[6] and soldiers in simulated combat exercises.[7] In a sample of deployed military personnel, nearly three-fourths rated their sleep as worse than prior to deployment,[8] and insomnia is the most common complaint of soldiers returning from deployment.[9] This issue is of significant concern given that sleep is a core component of the Performance Triad (the Army's health initiative to improve readiness and increase resilience),[10] coupled with the reported link between poor sleep in soldiers and psychosocial health (including emotional, social, family, and spiritual fitness), as well as physical health.[11]

Sleep and Suicide

Research supports the putative relationship between sleep and suicide,[12] but research on sleep and suicide is plagued by concomitant mental health disorder comorbidity. In depressed patients, those with sleep disturbances were more likely to report suicidality,[13,14] and global insomnia has predicted completed suicide in depressed patients as well.[15] Although depression was the most robust predictor of suicide in a community sample of elderly adults, poor sleep quality had a unique and significant effect on suicide as well.[16] Several sleep issues measured using electroencephalographic (EEG) methods have been associated with suicide attempts in depressed patients, including fewer late-night delta counts (delta waves are associated with deep stage 3 non-

rapid eye movement [NREM] sleep and characterizes depth of sleep), a lower sleep efficiency (i.e., the proportion of sleep in the episode potentially filled by sleep), and a longer sleep latency (i.e., the length of time that it takes to accomplish the transition from full wakefulness to sleep).[17] Ağargün and Cartwright[18] have also examined suicidality and rapid eye movement (REM) sleep in depressed patients, with patients reporting suicidality having shorter REM sleep latency and higher REM percentage. As with research on sleep and mental health, there are likely common etiological factors between sleep disturbances and suicidality, including neurobiological factors such as low cerebrospinal fluid (CSF) concentrations of 5-hydroxyindoleactic acid (5-HIAA) and serotonergic dysfunction.[12]

Results are mixed on whether the association between sleep and suicide remains after accounting for depression,[12] but in the general population, short sleep (i.e., less than 5 hours of sleep on average in a 24-hour period) was found to be related to suicidal ideation (SI) and suicide attempts after controlling for comorbid mental health issues[19]; this unique relationship has also been found between sleep problems and completed suicide.[20] In a sample of veterans, poor sleep quality was associated with increased odds of SI[21] and in veterans who died by suicide, sleep disturbances were predictive of time to death (the number of days since the last visit to a Veterans Health Administration site and date of suicide), even after controlling for psychiatric and substance abuse symptoms.[22] A meta-analysis of sleep disturbances and suicidal thoughts or behaviors recently showed that depression did not moderate the risk of suicide conferred by sleep disturbances.[23] In a military sample, insomnia symptoms predicted SI above and beyond depressive symptoms, hopelessness, posttraumatic stress disorder (PTSD) diagnosis, anxiety

symptoms, and drug and alcohol abuse.[24] Furthermore, a cognitive behavioral therapy for insomnia intervention has been shown to reduce SI in veterans.[25] Taken together, these results suggest that interventions related to sleep may be useful in the prevention of suicide[26] and that further research into potential mediating models is needed to understand these complex relationships.

Sleep and Violent Ideation

Limited data exist on the relationship between sleep and violent ideation (VI). A recent review has addressed the dearth of empirical evidence on the relationship between sleep and aggression, hostility, and irritability, concluding that anecdotal evidence and clinical observations suggest a link between sleep and aggression, but research is limited due to heavy reliance on animal models, small samples in human research, and varying definitions of terms resulting in mixed results in adult samples.[27] Potential mechanisms between sleep and aggression, hostility, or anger have been proposed, including prefrontal cortex, serotonergic, and Hypothalamic–Pituitary–Adrenal (HPA) axis system dysfunction,[27] but these have yet to be fully explored or explained. Notably, in military populations, PTSD (particularly the hyperarousal dimension) has been shown to be strongly related to aggression.[28]

Despite the scant empirical evidence on the relationship between sleep and VI, there is a theoretical foundation that may elucidate the mechanism by which sleep disturbances would lead to violence. I^3 theory (pronounces *I-cubed theory*) proposes that risk factors for intimate partner violence, in particular, operate as factors of instigation, impellance, or inhibition and that anything that increases instigation or impellance, or decreases inhibition, would increase the risk of violence.[29-32] The inhibitory forces

include aspects of *self-regulation* ("the many processes by which the human psyche exercises control over its functions, states, and inner processes"[33, p. 1]), which is known to be a limited, depletable, and renewable resource.[34-36] Lack of sleep may be depleting; in fact, one of the items of the Concurrent Depletion Scale is "I felt tired."[37] We therefore propose that sleep disturbances may contribute to resource depletion, decreasing inhibition and increasing the risk for VI.

Sleep and Mental Health

Sleep and mental health models. Sleep deficiency has been identified as both a risk factor for mental health issues as well as a symptom.[2] Sleep disturbances are often comorbid with substance abuse, psychiatric, and medical issues, making it difficult to determine the temporal order of occurrence.[38] In terms of sleep disturbances as a risk factor for mental health issues, epidemiological studies have determined that those with sleep disturbances are at increased risk for depression over the following 1 to 2 years (reported at a fortyfold increase in the level of risk) compared to their peers without sleep disturbances, a risk that seems to persist across the lifetime,[38,39] and sleep disturbances predict persistence of depression symptoms over time.[40] Cognitive behavioral therapy for insomnia has also increased treatment efficacy for depression in patients with comorbid disorders.[41] Several etiological and pathophysiological models of depression and sleep disturbances have been presented,[39] but further research is needed to understand the complicated relationship between sleep disturbances as a risk factor for depression, as a symptom of depression, and its multiplicative or synergistic effect on depressive symptoms.

Similar concerns of the temporality of sleep and PTSD are prevalent in the literature, for the aforementioned reasons and because of the difficulty in treating PTSD.[42] A review of the literature on PTSD-sleep comorbidity and temporality suggests that the following: "(1) exposure to a traumatic event can interfere with sleep, (2) PTSD is related to the development of self-reported sleep problems, but evidence is less clear regarding objective indices of sleep, and (3) limited evidence suggests sleep problems may interfere with recovery from elevated posttraumatic stress levels."[42, p. 16] Sleep disturbances may also be a contributing factor in the development of PTSD,[43] and promoting sleep hygiene immediately following trauma exposure may have preventive effects.[44]

Sleep and mental health in the military. Within active duty military personnel, sleep disorders have been associated with anxiety, PTSD, and pain,[45,46] and short sleep duration among redeploying soldiers has been associated with depression, PTSD, panic, and suicide attempts.[47] Results from a study of active duty soldiers following deployment indicated that self-reported insomnia 4 months following deployment significantly predicted PTSD and depression at 12 months postdeployment,[48] suggesting that sleep disturbances may be an antecedent to mental health issues in this population. Congruent with these findings, new-onset cases of PTSD and depression postdeployment have been reported as higher among those with predeployment insomnia[45] and reports of insomnia immediately following deployment predict PTSD severity at a 3-month follow-up.[9] Similarly, active duty service members who reported higher PTSD symptoms reported more difficulty falling asleep for both somatic and cognitive reasons[49]; therefore, research suggests that "disturbed sleep is a precipitating and perpetuating factor in PTSD

symptomatology, creating a perpetual circle."[50, p. 1] Similar associations between PTSD and poor sleep quality have been reported in military veterans.[21,51,52]

Objectives and Aims

The goal of this study is to examine the relationship between sleep disturbances, mental health (perceived stress, PTSD symptoms, and depressive symptoms), and SI or VI in a sample of military service members. In the sleep literature, researchers and clinicians use many terms, including sleep deficiency, sleep quality, sleep disturbances, sleep issues, and sleep disorders. Throughout this article, the term *sleep disturbances* is defined as changes in sleeping patterns or habits that can negatively affect health.

Specific Aims and Hypotheses

In support of the objective, we have four specific aims:

1. Estimate associations between sleep disturbances and mental health and SI/VI.
2. Examine mental health symptoms as a mediator or moderator of the sleep disturbances and SI/VI relationship.
3. Examine sleep disturbances as a mediator or moderator of the mental health and SI/VI relationship.
4. Assess multiple mediation models of these relationships.

For each analysis, SI and VI are assessed in separate models. Related to Aim 1, we hypothesized that sleep disturbances would be positively related to mental health symptoms (H1) and that sleep disturbances would be positively related to SI/VI (H2). We also hypothesized that mental health issues would be positively related to SI/VI (H3). For Aims 2–4, we did not have a priori hypotheses about which constructs would act as mediators or moderators, as the literature on these relationships is inconclusive.

Methods

Sample and Procedure

The data collected and analyzed herein are part of a larger study on the development of a predeployment stress inoculation protocol wherein baseline measures were assessed.[53] Participants were soldiers recruited from a convenience sample of platoons of the 82nd Airborne Division at Ft. Bragg, NC. Data were collected on site during 2-hour sessions with groups of up to 20 participants (clusters). Participants filled out anonymous 30-minute self-report questionnaires that included several standardized psychological scales, and assessments of sleep (see Measures section). Participants provided signed consent forms, and the study was approved by the institutional review boards of RTI International and the U.S. Army Medical and Material Command, Human Research Protection Office.

Measures

Perceived stress was measured using the Perceived Stress Scale (PSS),[54] a 10-item scale designed to assess a person's perception of stress and control. An example item is "In the last month, how often have you felt nervous and stressed?" Response options range from 0 = "never" to 4 = "very often." The scale provides a total perceived stress score ranging from 0-40, with higher scores indicating more perceived stress. The mean in this sample was 14.22 (*SD* = 7.08). Scores showed good internal consistency in this sample (Cronbach's $\alpha = 0.86$).

PTSD symptoms were measured using the PTSD Checklist-Civilian Version (PCL-C),[55] a 17-item screening instrument for PTSD. The civilian version was chosen to capture PTSD symptomatology prior to military service. It has demonstrated good

reliability in use with military populations (Cronbach's α in this sample = 0.94; *M* = 28.81, *SD* = 12.71).[56]

Depression symptoms were measured using the Center for Epidemiologic Studies Depression Scale (CES-D),[57] a 20-item measure designed to assess symptoms associated with depression that have been experienced in the past week. An example item is "I felt like everything I did was an effort." Responses are on a 4-point scale ranging from 0 = "rarely or none of the time" to 3 = "most or all of the time." The scale provides a total score ranging from 0-57 (*M* = 11.63, *SD* = 9.87). CES-D scores showed excellent internal reliability in this sample (Cronbach's α = .90).

Sleep disturbances were assessed using three questions regarding sleep issues. An example item is "My sleep was restless." The range was 0 to 3, with a mean of 1.02 (*SD* = 1.11) sleep issues in this sample. Sleep issue scores showed excellent internal reliability with Cronbach's α = .91.

Self-harm or suicidal ideation (SI) was assessed using a single dichotomized (yes or no) item: "Over the past month, have you been bothered by thoughts that you would be better off dead or of hurting yourself in some way?"

Violent ideation (VI) was measured for a subset of participants who had been deployed (*n* = 361) with a single item: "Since your return from your last deployment, have you had thoughts or concerns that you might lose control or hurt someone?" Response options were yes, no, and unsure. Because of the safety concerns associated with VI, those who reported being unsure were combined with those who reported "yes" for increased sensitivity. In analyses, "yes" or "unsure" were coded as 1, and "no" was coded as zero.

Analytic Strategy

All data were analyzed using SAS 9.4 software (SAS Institute Inc., Cary, NC, USA). Descriptive statistics were run to describe the sample and estimate average levels of sleep disturbances, mental health, and frequency of SI. Bivariate correlations were analyzed to assess collinearity and in support of Aim 1. For continuous measures (i.e., sleep disturbances, depression, perceived stress, and PTSD), Pearson correlations were calculated; for dichotomous variables (i.e., SI and VI), tetrachoric correlations were used. Clustering was controlled for in all multivariate models. Mediation and moderation analyses were performed using the Hayes PROCESS macro for mediation, moderation, and conditional process analyses.[58] Simple moderation analyses were performed using Hayes' Model 1 (Figure 1). Simple mediation and multiple mediation models with mediators operating in parallel were analyzed with Hayes' Model 4 (Figure 1). Multiple mediation models with mediators operating in serial were calculated using Hayes' Model 6 (Figure 1). See Hayes[58] for statistical models and equations of each model. In support of Aim 2, the first multivariate models analyzed were simple mediation models, with sleep as the predictor, mental health symptoms (i.e., depression, PTSD, and perceived stress) as the mediator, and SI as the outcome (Models 1-3). In support of Aim 3, simple mediation models were also tested that proposed mental health symptoms as the predictor of SI, with sleep as the mediator (Models 4-6). In support of Aim 4, the next set of mediation models tested mental health symptoms operating in parallel, initially with PTSD and perceived stress (Model 7), and then adding depression (Model 8). Finally, in support of Aim 4, serial mediation models were tested that ordered the three mental health variables (perceived stress, PTSD, and depression) in all six possible combinations

as mediators. This is necessary because in serial mediation, sequential mediators are conceptually in causal links, with the first mediator affecting the second.[58] Bias-corrected 95% bootstrap confidence interval estimates of the indirect effects using 10,000 bootstrap samples were obtained, and normal theory (Sobel) tests for indirect effects were also calculated.[58]

(Figure 1 goes about here.)

Results

Descriptive Results

Descriptive statistics of demographic, combat exposure, and mental health variables are presented in Table 1. The vast majority of participants were male, and slightly more than half reported having some college or trade school education. The sample was roughly split between those who were single or never married and those who were married or living as married. Descriptive statistics revealed that 3.35% of participants (n = 26) reported SI in the prior month. Within the subset of the sample who had ever deployed, 15.2% (n = 55) reported VI since returning from their last deployment, and an additional 7.48% (n = 27) reported that they were unsure. In all analyses, we dichotomized the VI variable yielding 22.71% for yes/unsure (n = 82) and 77.29% for no (n = 279).

(Table 1 goes about here.)

Bivariate Results

Hypotheses 1-3 were supported by the bivariate analyses reported in Table 2. Specifically, sleep disturbances were significantly positively associated with the mental health issues of depression, perceived stress, and PTSD (H1); sleep disturbances were

significantly positively associated with SI/VI (H2); and the three mental health issues were all significantly positively associated with SI/VI (H3). In addition, depression, perceived stress, and PTSD were strongly and positively correlated. Depression was the most strongly associated mental health issue with SI (r = .42), sleep (r = .52), and other mental health symptoms (perceived stress: r = .74, PTSD: r = .77; Table 2). PTSD was the most strongly associated mental health issue with VI (r = .56; Table 2).

(Table 2 goes about here.)

Multivariate Results

Simple moderation analyses were nonsignificant and are therefore not reported. All eight mediation models predicting SI and all eight mediation models predicting VI showed significant total effects, indicating that the overall models were significant. Results of simple mediation analyses revealed significant normal theory tests for indirect effects for models with sleep as the predictor of SI and mental health symptoms as the mediator (Models 1-3), while normal theory tests for indirect effects were not significant for models that positioned mental health as the predictor and sleep as the mediator (Models 4-6; see Table 3). Specifically, adding mental health symptoms to the model resulted in a nonsignificant relationship between sleep disturbances and SI, indicating that mental health symptoms accounted for this association. In contrast, sleep disturbances did not account for the predictive nature of mental health on SI (i.e., did not mediate this relationship), and this was the case for all three mental health variables (i.e., PTSD, perceived stress, and depression). The multiple mediation model with PTSD and stress operating in parallel (Model 7) revealed that both variables mediated the relationship between sleep disturbances and SI. However, when depression was added as

an additional parallel mediator (Model 8), PTSD and perceived stress became nonsignificant, and depression accounted for the full mediating effect (see Table 3). Finally, results of the serial mediation models produced similar results, with all total effects equaling -.66 (SE = .17). Because they are all equivalent models,[59,60] determining the ordering of the mental health variables (perceived stress, depression, or PTSD) is not possible. Importantly, all paths were significant between all variables until depression was entered, after which depression accounted for all of the variance. These results are congruent with the parallel mediation models, where depression was indicated as the strongest factor. For the eight models predicting VI, normal theory tests for indirect effects revealed significant mediation in all but one model (Model 4), in which sleep did not mediate the relationship between PTSD and VI. Although seven models indicated significant mediation, indirect effects were largest for Models 1-3, in which mental health mediated the relationship between sleep and VI. In these models, PTSD was revealed as the most robust predictor, and results of parallel mediation models (Models 7 and 8) confirmed this finding.

(Table 3 goes about here.)

Discussion

This study sought to test multiple models of sleep, mental health, and SI and VI in a military sample. We tested several prominent theoretical models of sleep and mental health, including sleep as a risk factor for mental health issues, sleep as a symptom of mental health issues, and sleep as having multiplicative or synergistic effects with mental health issues. We also examined whether sleep was a unique and significant predictor of SI or VI after accounting for mental health symptoms. We conducted moderation

analyses to determine whether the level of sleep disturbances influences the magnitude of the relationship between mental health symptoms and SI/VI, as well as whether the level of mental health symptoms exacerbated the relationship between sleep and SI/VI. Our null results for all moderation models do not support the theoretical model of sleep as having multiplicative or synergistic effects on mental health in this sample, which is consistent with recent research by Pigeon and colleagues.[22] This means that the relationship between sleep and SI/VI did not differ for those reporting higher or lower levels of stress, depression, or anxiety, nor did the relationship between mental health and SI/VI depend on levels of sleep disturbances (i.e., this relationship was not exacerbated or attenuated by levels of sleep disturbances).

We next sought to examine the mechanism by which mental health and sleep affect SI/VI. Nonsignificant indirect effects in the models where sleep was the mediating variable in the relationship between mental health and SI indicate a lack of support for the theory of sleep disturbances as solely a symptom of mental health. That is, sleep was not found to be the mechanism by which the mental health–SI relationship existed. Instead, our data support the process model of sleep influencing mental health symptoms, and mental health symptoms influencing SI.

The next question was related to sleep having a unique direct effect on mental health in this process. In our simple mediation model, after accounting for PTSD symptoms, sleep no longer had a direct effect on SI; only the indirect effect remained significant. The same pattern of results was seen for both stress and depression: after accounting for mental health symptoms, the relationship between sleep and SI was no longer significant. In models that included all three mental health variables as possible

mechanisms for SI, depression was the most robust mediator of SI, accounting for all variance. As there is significant comorbidity between stress, depression, and PTSD, our findings suggest that after controlling for sleep, stress, and PTSD, depression is the most predictive variable of SI. These results imply that among the pathways examined herein, depression was the most important mechanism between sleep issues and SI.

Our results on sleep and SI support sleep as a risk factor of mental health, but not as a unique contributor to SI. These findings are incongruent with prior research that found sleep as a unique predictor of suicidal thoughts or behaviors.[16,19,22,24] However, these findings are important in light of the epidemiological studies that have shown sleep disturbances to be a risk factor for persistent depression over the entire lifespan,[38,39] particularly in cases where military service members experience significant periods of sleep disturbances following deployment.[9,48]

This pattern of results differed considerably from our findings on sleep and VI. Consistent with our SI findings, there was also a lack of support for the moderating effects of sleep and mental health; that is, neither sleep nor mental health influenced the magnitude of the association with VI. Incongruent with the results in the SI models, we did find evidence of a unique relationship between sleep and VI in simple mediation models. For instance, in our simple mediation model of VI, after accounting for PTSD, sleep no longer had a direct effect. In contrast, although stress and depression both significantly mediated the relationship between sleep and VI, the direct effects of sleep remained significant. This means that even after accounting for mental health symptoms, sleep impacted VI both directly and indirectly. These results are congruent with our assertion that sleep disturbances may be viewed within the I^3 theory framework[29-32] as

contributing to resource depletion and therefore decreasing inhibition. When PTSD and stress were included together, and when depression was added as well, sleep was no longer significant. PTSD, then, was the strongest mechanism by which sleep influenced VI among soldiers who had deployed.

En masse, these results have several clinical and research implications. First, in terms of SI, sleep may be best conceptualized as a risk factor for the development of mental health issues, which in turn are risk factors for SI. Therefore, any interventions to improve sleep quality may prevent or attenuate the effects of depression, stress, or PTSD on SI. Second, sleep may be a critical intervention point in the prevention of VI, aggression, or hostility, as both a risk factor for mental health issues and as a disinhibiting factor of violence. Third, future research should attempt to measure multiple mental health issues in tandem with sleep over time to predict crucial time points of vulnerability to SI and VI.

When evaluating these findings, the limitations and strengths of this study should be considered. The first limitation is that the data analyzed here are cross-sectional and therefore preclude the determination of causation. The low incidence of prior month SI (*n* = 26) suggests this was a relatively rare event and therefore warrants caution in terms of generalizability. Additionally, all measures are self-reported and therefore may be subject to bias or underreporting. Finally, this study should be framed in terms of suicidal and violent *ideation*, rather than behaviors or actions, although ideation has been shown to significantly predict behavior in the case of suicidality.[61]

Several strengths of the study also warrant mention. This study benefited from both the simultaneous assessment of several mental health issues in conjunction with

sleep, as well as sophisticated statistical techniques, which allowed for the modeling of common comorbidities. Results of this study also permit direct comparison of several simple and multiple mediation models, providing evidence for some theoretical models of sleep and mental health at the exclusion of others. Namely, we found support for sleep as a risk factor of mental health and mental health as a risk factor for both SI and VI. In addition, sleep uniquely contributed to VI above and beyond stress and depression.

Conclusions

We found that sleep disturbances were significantly related to SI and VI in a sample of United States military service members. Sleep issues were also significantly related to stress, PTSD, and depression. Our findings suggest that sleep disturbances may operate as a risk factor of mental health issues and that sleep may be a unique predictor of VI above and beyond stress and depression. Clinical implications include targeting the improvement of sleep as a risk-reduction strategy for VI, aggression, and hostility, and as a mitigation strategy against the development of mental health issues, including depression, PTSD, and stress.

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Figure 1

Conceptual models for mediation and moderation.

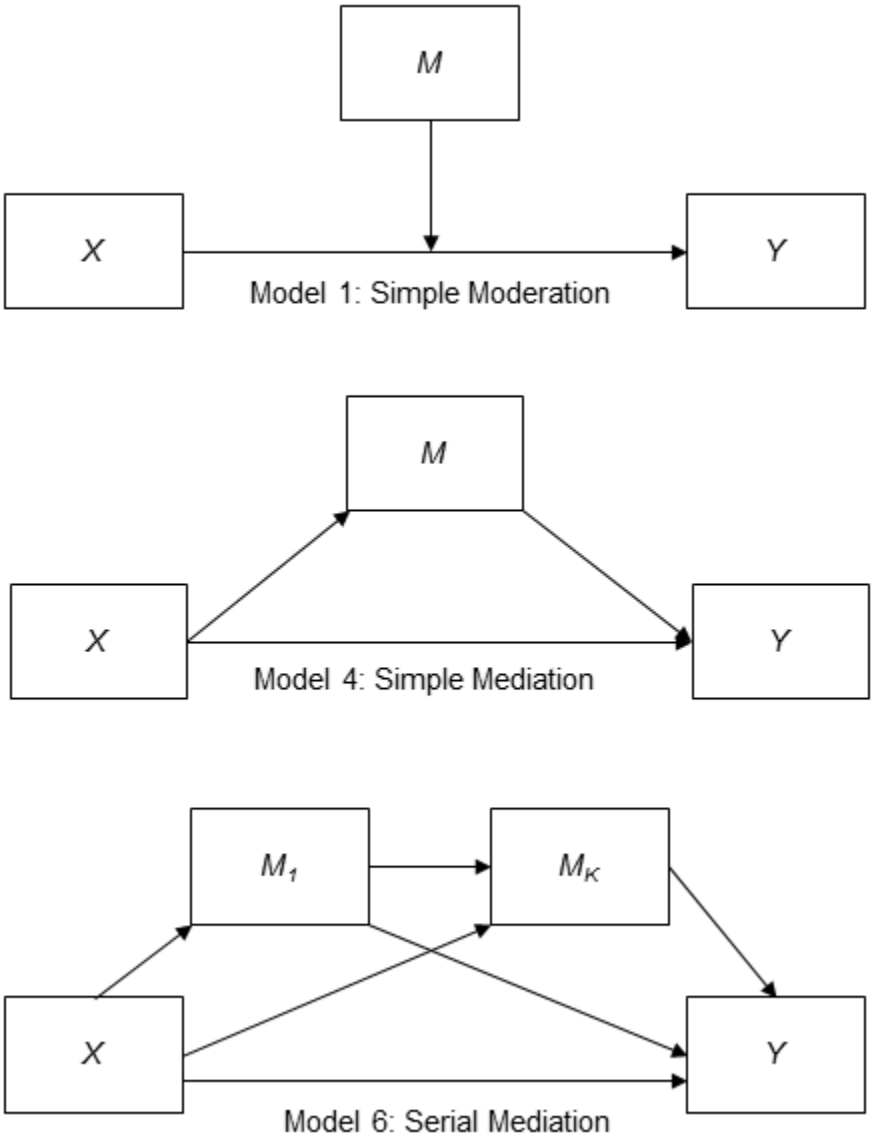

Table 1

Descriptive statistics of demographic, combat exposure, and mental health variables.

Variable	n	Percent
Gender		
Male	851	95.5%
Female	40	4.5%
Education		
High school or less	423	47.5%
Some college or trade school	458	51.4%
Paygrade		
E1-E3	369	41.4%
E4-E6	476	53.4%
E7-E9	23	2.6%
W1-W5	2	0.2%
O1-O3	21	2.4%
Marital Status		
Married/living as married	410	46.0%
Single, never married	437	49.0%
Separated/widowed/divorced	42	4.7%
Ever Deployed		
Yes	364	40.9%
No	508	57.0%
Combat Exposure		
No combat exposure	517	58.0%
Low/medium combat exposure	149	16.7%
High combat exposure	209	23.5%
Depression Indicated		
Yes	233	26.2%
No	653	73.3%
PTSD indicated		
Yes	116	13.0%
No	773	86.8%

Note. N = 891. Some columns do not total 100% due to missing data. PTSD = posttraumatic stress disorder.

Table 2

Descriptive statistics and bivariate correlations between model variables

	SI	VI	Sleep issues	Depression	Perceived stress	PTSD
N	776	361	866	862	864	864
SI	--	0.25**	0.15**	0.42**	0.28**	0.34**
VI		--	0.37**	0.49**	0.42**	0.56**
Sleep issues			--	0.52**	0.42**	0.59**
Depression				--	0.74**	0.77**
Perceived stress					--	0.66**
PTSD						--
Mean (SD)			1.02 (1.11)	11.62 (9.87)	14.19 (7.10)	28.81 (12.71)
n (%)	26 (3.35)	82 (22.71)				

Note. **Correlation is significant at the 0.001 level (2-tailed). Tetrachoric correlations are reported for dichotomous variables. Pearson correlations are reported for continuous variables.

Table 3

Simple and parallel mediation models predicting suicidal ideation

Model	X	M	Y	Coefficient (SE)			Effect of X on Y (SE)		
				X-M	M-Y	X-Y	Indirect	Direct	Total
1	Sleep	PTSD	SI	6.42(.32)*	-.10(.02)*	.17(.24)	-.66(.13)$^{+}$	.17(.24)	-.66(.17)*
2	Sleep	Stress	SI	2.67(.21)*	-.24(.04)*	-.21(.19)	-.63(.15)$^{+}$	-.21(.19)	-.66(.17)*
3	Sleep	Depression	SI	4.41(.27)*	-.19(.03)*	.15(.23)	-.82(.13)$^{+}$	.15(.23)	-.66(.17)*
4	PTSD	Sleep	SI	.05(.00)*	.17(.24)	-.10(.02)*	.01(.02)	-.10(.02)*	-.10(.01)*
5	Stress	Sleep	SI	.07(.00)*	-.21(.19)	-.24(.04)*	-.01(.01)	-.24(.04)*	-.25(.04)*
6	Depression	Sleep	SI	.06(.00)*	.15(.23)	-.19(.03)*	.01(.02)	-.19(.03)*	-.18(.02)*
7	Sleep	PTSD	SI	6.42(.32)*	-.06(.02)*	.13(.23)	-.38(.16)$^{+}$	.13(.23)	-.66(.17)*
		Stress		2.67(.21)*	-.17(.04)*		-.45(.12)$^{+}$		
8	Sleep	PTSD	SI	6.41(.32)*	-.01(.02)	.16(.26)	-.02(.18)	.16(.25)	-.66(.17)*
		Stress		2.67(.21)*	-.04(.05)		-.10(.19)		
		Depression		4.41(.27)*	-.17(.04)*		-.74(.17)$^{+}$		

Note. $N = 773$. Bootstrap samples = 10,000. *$p < .01$. $^{+}$Normal theory test for indirect effects is significant. Models 1-6 are simple mediation models. Models 7 and 8 are parallel mediation models.

Table 4
Simple and parallel mediation models predicting violent ideation

Model	X	M	Y	Coefficient (SE)			Effect of X on Y (SE)		
				X-M	M-Y	X-Y	Indirect	Direct	Total
1	Sleep	PTSD	VI	7.07(.47)*	.10(.02)*	.14(.15)	.72(.14)$^{+}$	.14(.15)	0.76(.12)*
2	Sleep	Stress	VI	2.48(.28)*	.14(.03)*	.52(.13)*	.35(.07)$^{+}$	.52(.13)*	0.76(.12)*
3	Sleep	Depression	VI	4.61(.38)*	.01(.02)*	.37(.14)*	.45(.08)$^{+}$	.37(.14)*	0.75(.12)*
4	PTSD	Sleep	VI	.06(.00)*	.14(.15)	.10(.02)*	.01(.01)	.10(.02)*	.11(.01)*
5	Stress	Sleep	VI	.07(.01)*	.52(.13)*	.14(.03)*	.04(.01)$^{+}$	.14(.03)*	.17(.02)*
6	Depression	Sleep	VI	.06(.01)*	.37(.14)*	.10(.02)*	.02(.01)$^{+}$	.10(.02)*	.12(.02)*
7	Sleep	PTSD	VI	7.07(.47)*	.08(.02)*	.14(.15)	.58(.15)$^{+}$	.14(.15)	0.76(.12)*
		Stress		2.48(.28)*	.07(.03)*		.17(.08)$^{+}$		
8	Sleep	PTSD	VI	7.05(.47)*	.08(.02)*	.12(.16)	.55(.15)$^{+}$	.12(.16)	0.76(.12)*
		Stress		2.49(.29)*	.06(.04)		.14(.09)		
		Depression		4.64(.38)*	.01(.03)		.06(.11)		

Note. N =359. Bootstrap samples = 10,000. *$p < .01$. $^{+}$Normal theory test for indirect effects is significant. Models 1-6 are simple mediation models. Models 7 and 8 are parallel mediation models.

APPENDIX X. SUBMITTED MANUSCRIPT: EFFECTS OF PREDEPLOYMENT STRESS INOCULATION TRAINING WITH RELAXATION BREATHING ON MENTAL HEALTH OUTCOMES IN THE MILITARY: A LONGITUDINAL STUDY

Effects of Stress Inoculation Training with Relaxation Breathing on Mental Health Outcomes in the Military: A Longitudinal Study

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Abstract

In a previous study, we developed and evaluated a pilot predeployment stress inoculation training (SIT) program designed to teach relaxation breathing skills to minimize negative mental health consequences of combat stress. This study extends the investigation of the effectiveness of a SIT program of relaxation breathing on perceived stress symptoms and other mental health outcomes in a longitudinal randomized control trial. Heart rate variability (HRV) was used to test the effect of SIT in reducing autonomic arousal in response to simulated combat-related stressors. Soldiers were randomized into SIT versus control groups at baseline and followed for 1–2 years. SIT did not have an overall effect on perceived stress scores or posttraumatic stress disorder (PTSD) symptoms when controlling for covariates. Consistent with previous findings in which SIT mitigated the risk of PTSD in those without baseline mental health problems, the current study showed that SIT may prevent possible PTSD among mentally healthy military personnel who are not otherwise interested in learning stress-control techniques but was not supported as a general predeployment mental health prevention strategy. An HRV increase in response with relaxation breathing training suggests future research is warranted into mental health effects of self-regulation techniques.

Keywords: stress inoculation, PTSD, military, longitudinal, heart rate variability

Promising strategies for promoting resiliency and positive mental health outcomes in military members have included biofeedback, relaxation breathing, stress inoculation training, and virtual reality technologies (Author citation et al., 2011a). The use of complementary and alternative (CAM) therapies for mental health problems has become widespread in veteran populations; an estimated 96% of the Department of Veterans Affairs (VA) treatment programs include at least one CAM treatment in their treatment protocols (Libby, Pilver, & Desai, 2012). A potential low-cost predeployment CAM option to mitigate stress-related conditions has been the teaching of relaxation techniques. A range of techniques have found support in military and civilian studies (e.g., preliminary support has been found for a pilot group-based mind-body stress-management and resilience program, "Resilience Warrior" [Sylvia et al., 2015]). A breathing-based meditation study resulted in a reduction in PTSD scores among veterans in a longitudinal trial (Seppälä et al., 2014), and applied muscle relaxation has improved PTSD symptoms in veterans (Vaughan et al., 1994). Various forms of relaxation breathing have resulted in anger and guilt reduction (Stapleton, Taylor, & Asmundson, 2006), improvements in insomnia (Zucker, Samuelson, Muench, Greenberg, & Gevirtz, 2009) and anxiety symptoms (Williams, Gierish, McDuffie, Strauss, & Nagi, 2011). Relaxation breathing exercises have also been found to improve male adolescent aggressive behavior (Gaines & Barry, 2008) and aggressive driving (Galovski, Blanchard, Malta, & Freidenberg, 2003). Also, breathing exercises are commonly found on military websites related to self-help and resilience building (e.g., (Defence Centers of Excellence for Psychological Health & Traumatic Brain Injury, 2011)). However, several studies have found relaxation techniques to have nonsignificant or only modest effects on PTSD treatment (Silver, Brooks, & Obenchain, 1995; Watson, Tuorila, Vickers,

Gearhart, & Mendez, 1997) and to be less effective than cognitive behavioral therapy for treating anger problems (Shea, Lambert, & Reddy, 2013).

Some research, however, suggests that relaxation breathing techniques used with stress inoculation training (SIT) might be effective in *preventing* PTSD and other mental health symptoms (Author citation et al., 2011a, 2011b, 2016). Unlike other relaxation techniques, SIT is quick and easy to learn in groups by either military or civilian personnel; it provides both education and skills training, and a practice environment that simulates potential stressful situations (Meichenbaum & Cameron, 1989). It can also utilize technologies that are attractive to the military population, especially younger male enlisted personnel. A recent review of the Department of Defense (DoD) and VA Clinical Practice Guidelines for PTSD found that SIT was one of the most effective evidence-based interventions for PTSD treatment (Sargent, Campbell, Richter, McLay, & Koffman, 2013).

Stress Inoculation Training and Heart Rate Variability

Emerging technological advances (Serino et al., 2014; Vakili, Brinkman, Morina, & Neerincx, 2014) provide the ability to create virtual reality environments in which stressful stimuli and their resulting physiological arousal can be observed and used (Bouchard, 2014) to develop group-based simulation environments (Author citation et al., 2011b). An example of this technology is the ability to observe heart-rate variability (HRV) changes in soldiers, who have received SIT training and practiced the skill, in response to a multimedia stressor environment (MSE) (Author citation et al., 2011b). HRV, the beat-to-beat alterations in heart rate, reflects the autonomic influence on the cardiovascular system and is thought to be a potential marker of dysfunctional arousal regulation (minimal HRV indicating higher physiologic arousal) (Hauschildt, Peters, Moritz, & Jelinek, 2011), hyperarousal (Zucker et al., 2009), and stress and

health (Thayer, Ahs, Fredrikson, Sollers, & Wager, 2012). Higher HRV has been associated with relaxation states (Sarang & Telles, 2006), whereas use of relaxation techniques have been shown to increase HRV (Author citation et al., 2015; Leonaite & Vainoras, 2010; Terathongkum & Pickler, 2004). An association between PTSD symptoms and reduced HRV has also been found by several researchers (Author citation et al., 2015; Hauschildt et al., 2011; Minassian et al., 2014); lower HRV before deployment has been associated with increased risk of PTSD diagnosis after deployment (Minassian et al., 2015). Also, limited evidence suggests HRV biofeedback may be associated with reductions in PTSD symptoms (Reiner, 2008; Whited, Larkin, & Whited, 2014; Zucker et al., 2009) and work-related stress (Prinsloo, Derman, Lambert, & Laurie Rauch, 2013).

This study extends the investigation of the effectiveness of a predeployment stress inoculation training (PRESTINT) program of relaxation breathing (referred to as Battle Breathing [BB]) on PTSD scores to perceived stress symptoms, and other stress-related conditions in a longitudinal randomized control trial with a nondeploying population. HRV-assisted biofeedback is used to support the SIT relaxation training and to test the effect of the program in reducing autonomic arousal.

In a previous pilot study, we developed and evaluated a predeployment stress inoculation training (then referred to as PRESIT) program for Marines designed to teach relaxation breathing skills to minimize negative mental health consequences of combat stress (Author citation et al., 2011b, 2016). Results indicated that Marines who received PRESIT demonstrated reduced levels of physiological arousal through increased respiratory sinus arrhythmia (RSA), a component of HRV, both during and after training compared with Marines who received a stress management (SM) presentation based on content from current best practices (Author citation et al., 2016).

Additionally, after controlling for baseline mental health problems, participants in the SM group were more likely to meet PTSD criteria than those in the PRESIT group postdeployment.

Current Study

The current longitudinal study builds on baseline findings of decreased physiological arousal, as measured by RSA, after stress inoculation training (Author citation et al., 2015) and examines the effects of the training in a larger sample of Army personnel about 1–2 years later. We also examine the effect of sustaining the training, via guided SIT narration, using MP3 players as practice facilitators and incentives. To test and evaluate the SIT program, we use follow-up data to compare PTSD and perceived stress outcomes of military service members who received SIT with those who received SM. It was hypothesized that the SIT group will have fewer PTSD and stress-related symptoms at follow-up than the participants in the SM group. Specific aims were to (1) evaluate the SIT effectiveness versus SM training in reducing the primary outcomes of PTSD symptoms and perceived stress at follow-up and the secondary outcomes of anxiety, and loss of control or aggression; (2) examine the effect of SIT practice on primary and secondary outcomes; and (3) identify potential subgroups of effectiveness (e.g., among those without mental problems at baseline).

Method

Participants

Participants were members of the United States Army who volunteered to participate in a stress management study from a convenience sample of companies expected to deploy from a large East Coast Army installation. Within those companies, platoons were randomly assigned to either experimental (SIT) or control groups. Following on-site baseline data collection (see Author citation, 2015 for details), interim emails were sent bimonthly to those who provided a

valid address, requesting an assessment of the use of the techniques they learned at baseline (n=891). Between 1 and 2 years postbaseline (*M* = 69.87 weeks, range = 59.14 - 97.29 weeks), a final follow-up survey was administered on-site to 149 participants and via email to 118 participants who completed the survey online. Response rates are shown in the CONSORT diagram in Figure 1. The study was approved by the institutional review boards of the U.S. Army Human Research Protection Office and RTI International. All participants provided voluntary written informed consent.

Key Outcome Measures

Perceived stress was measured using the Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983), a 10-item scale to assess a person's perception of stress and control. An example item is "In the last month, how often have you felt nervous and stressed?" The scale provides a total perceived stress score ranging from 0 to 35, with higher scores indicating more perceived stress. The mean in this sample was 14.22 (*SD* = 7.08), and scores showed good internal consistency (Cronbach's α = 0.86).

PTSD Symptoms were measured at baseline using a 17-item screening instrument, PTSD Checklist-Civilian Version (PCL-C; Weathers, Litz, Herman, Huska, & Keane, 1993). The civilian version, chosen to capture PTSD symptomatology prior to military service, has been used frequently with military populations (Hoge et al., 2004; Wilkins, Lang, & Norman, 2011). A midpoint cutoff of 43, between recommended highest and lowest cut points, was used on the PCL-C to indicate possible PTSD (Bliese et al., 2008; National Center for PTSD, 2012). PCL-C scores showed excellent internal reliability in this sample (Cronbach's α = .94). At follow-up, we used the PCL-Military Version (PCL-M; Weathers, Huska, & Keane, 1991), which included the same 17 items and scoring as the civilian version but referred to "military experiences" instead

of "experiences." It was used because all participants were expected to be deployed postbaseline data collection (Weathers et al., 1991). PCL-M scores also showed excellent internal reliability (Cronbach's $\alpha = .96$). Four latent variables were computed from the PCL representing the four key diagnostic criteria subscales for PTSD: avoidance, re-experiencing, hyperarousal, and emotional numbing (Author citation et al., 2010).

To screen for generalized anxiety disorder (GAD) symptoms, seven items adapted from the Patient Health Questionnaire (Spitzer, Kroenke, & Williams, 1999) were used. Responses were scored on a 5-point scale from 0 (none of the time) to 4 (all of the time). If respondents indicated that they had been feeling nervous, anxious, or on edge, or had been worrying about different things (the first questions in the set) for several days or more in the past 30 days, the analysis examined whether they reported any of the other symptoms. Using the standardized scoring algorithm, we used a cutoff of 10 to indicate GAD. *Loss of control or aggression* was measured with the item, "During the past year, have you had thoughts or concerns that you might lose control or hurt someone?" Response options were yes, no, and unsure.

Potential covariates and control variables included sociodemographics (age, sex education, marital status) and military-related variables such as paygrade, time since returning from deployment, and combat exposure, HRV, and mental health measures. *Combat exposure* was assessed with the Combat Experiences Scale from the Deployment Risk and Resilience Inventory to capture the various dimensions of stress experienced during combat situations and was measured at baseline only, given that the units did not deploy as expected. Mean scores were calculated from the frequency that each type of event was experienced during deployments. In addition, *HRV* was measured with a pulse signal obtained from a photoplethysmograph sensor attached to the earlobe and monitored continually from 3 minutes before the pretraining MSE

began to 3 minutes after the post-training MSE was administered. A measure of the delta (or change) between pre- and post-training RSA was calculated from the pulse interval data and used as an indicator of SIT effectiveness. Additional information about HRV measurements used in this study have been published elsewhere (Author citation et al., 2015, 2016). *Taking mental health medication* was measured using the yes-no item, "Are you currently taking medication prescribed by a doctor or other health professional for depression, anxiety, or sleeping problems?" Substance abuse was measured by the Two-Item Conjoint Screen (TICS). TICS is composed of two items measuring alcohol/drug use in the past year and feeling the need to cut down on this use. One positive response indicates a 45% likelihood of having a substance use disorder; two positive responses indicate a 75% chance. Sensitivity and specificity are both approximately 81% (Brown, Leonard, Saunders, & Papasouliotis, 1997, 2001).

At baseline, use of relaxation techniques ("What relaxation techniques do you practice?") and interest in learning about stress reduction ("How interested are you in learning techniques that may reduce stress?") were examined. Use of the SIT techniques was measured at follow-up through multiple items. First, participants were asked "Were you taught the breathing technique called Battle Breathing?" Brief descriptions of the two techniques were included for reference. Through single yes/no items, participants were asked if they "used the Battle Breathing focused breathing technique with [their] eyes open to help [them] focus or manage stress" and whether they "used the Battle Breathing relaxation breathing technique with [their] eyes closed to help [them] sleep or relax." Perceived usefulness of SIT was assessed by asking participants to rate, on a scale from a lot to none at all, how much each technique (focused breathing and relaxation) helped them focus or manage their stress and helped them sleep or relax. Participants were asked "Do you think the Battle Breathing technique would be helpful to others?" Participants were also

asked to indicate whether they used the MP3 player they received to "listen to the Battle Breathing technique during the last 6 months," had "downloaded and listened to any additional relaxation or breathing music or videos (on [their] MP3 player or other device) in the past year," and had "used relaxation techniques other than Battle Breathing to help [them] sleep or to help manage stress since the training," and how often and how much the other techniques helped. Finally, differences in the control and experimental groups were examined by mode of follow-up survey completion (i.e., in-person, paper-pencil survey vs. Web-based survey).

Procedures

Baseline data collection on-site. Soldiers attended 90-minute sessions in a classroom with 20–26 soldiers per session. Groups were randomly assigned to receive the control or experimental (SIT) training. Following a brief orientation, participants completed a 25-minute confidential questionnaire on their mental health and health behaviors. Both groups received a stress management information pamphlet to serve as the educational component of the SIT program. The control groups received SM, which included a 20-minute taped narrative and slideshow presentation on stress management. SIT was provided during a 20-minute group presentation on two separate relaxation breathing techniques: abdominal or relaxation breathing with eyes closed and attentional retraining or focused breathing with eyes open (see Author citation et al., 2011b for details). HRV data were gathered from both SIT and SM groups. Pre- and post-training presentations of an MSE, a video in which participants had to respond to triggers in an operational scenario using a game controller, were presented to both groups. The scenario, a 3-D virtual simulation with enemy combatants, hazards, explosions, etcetera, had been shown to increase arousal as measured by heart rate in previous studies (Author citation et al., 2016) and was used to allow participants to practice the breathing skills learned in training

(controls were asked to think about the stress management skills presented in the slideshow), and to test physiological reactivity (Author citation et al., 2011b). Following the training, participants in both groups received MP3 players that contained the group-specific stress reduction training they received. SIT participants were encouraged to use the MP3 recording to practice the SIT technique or recall stress management practices, respectively.

Interim emails. To keep participants engaged in the study between baseline and follow-up surveys and to examine practice and stress levels postbaseline, email reminders with brief questions were sent to baseline participants who had provided useable email addresses at baseline. Approximately every 2 months, participants were asked to complete a short 5-question survey. The five items were completed online and gathered information on use of the MP3 players, stress management information, and a review of the group-specific relaxation technique training. In addition, participants were asked to rate their stress. A total of 145 participants completed at least one of the bimonthly surveys. On completion of a bimonthly survey, participants were sent a code for a $10 Amazon gift via email.

Follow-up data collection on-site and online. About 18 months after the baseline training, participants were asked to complete an online follow-up survey, which included the baseline survey measures as well as items to assess the use and helpfulness of the MP3-recorded SIT instructions. Because of a drawdown in troops in Afghanistan, participants did not deploy as anticipated and stayed at the installation, transferred to another installation, or were released from active duty. With the support of a battalion's behavioral health officer, individuals who participated in the baseline training and were still on the installation were identified and invited to attend a 30-minute on-site session to complete the follow-up questionnaire. During the on-site session, 149 participants completed the questionnaire. Participants who did not complete the

follow-up on-site, including those who possibly transferred to other units and for whom we had email addresses, were invited to complete the questionnaire online. These participants, contacted via email, were provided a secure login and password to access the survey. At this follow-up, participants were offered $20 in Amazon gift cards, provided through an online code, on completion of the survey. After several months of a continued poor response, a code for an additional $10 gift card was provided prior to survey completion. These efforts, combined with email reminders sent approximately every 2 weeks, resulted in 146 participants who completed the online version of the survey.

Statistical Analysis

Response rate. Of the 891 baseline participants (469 treatment, 422 controls), 267 participants (149 treatment, 118 controls) had sufficient baseline and follow-up data for analyses (see Figure 1). In nonresponse analyses, a dummy code was created to indicate whether participants had completed the follow-up survey, and logistic regression models were run with each baseline variable as the independent variable. After applying a Bonferroni correction for multiple testing, we found that none of the variables were significant predictors of dropout.

Data analysis. Preliminary analyses checked for outliers and examined patterns of missing data. All analyses controlled for clustering at the session (two platoon) level using the SAS survey procedures. Descriptive statistics and covariates (see Table 1) were computed for the full sample and separately for each group. Bivariate group differences were assessed using linear regression (for continuous outcomes and covariates) or Wald chi-square tests for two-way contingency tables (for categorical outcomes and covariates). Linear and logistic regression analysis models tested the SIT treatment effect on each outcome in Table 2 controlling for the

covariates in Table 1 that were significantly or near significantly different by SIT and control groups (see Table 3).

Analyses were run using the SURVEYREG and SURVEYLOGISTIC procedure (SAS, version 9.4, Cary, NC). Because of possible contamination in the experimental and control groups (i.e., controls reporting using SIT despite not being in the experimental group and experimental group personnel reported using other relaxation breathing techniques), the intent-to-treat principle was used for all analyses when estimating the impact of the baseline SIT on subsequent PTSD and perceived stress outcomes. Models were adjusted for group differences at baseline and interaction effects were included to test moderation hypotheses about potential subgroup effects. For example, an interaction term was used to test the hypotheses that exposure to SIT at baseline, combined with reporting practicing SIT techniques that were learned during training, is associated with a decreased risk of PTSD and/or perceived stress at follow-up, after controlling for covariates.

Results

Descriptive analyses. Descriptive results are given in Table 1. At baseline, SIT and SM groups were similar on most demographic, psychosocial, and physiologic variables, except that controls were more likely to report having ever practiced relaxation techniques, and a greater proportion of those in the SIT group were interested in learning relaxation techniques. At follow-up, controls were more likely than the SIT group to have reported downloading additional relaxation techniques and to be currently taking medication prescribed by a doctor or other health professional for depression, anxiety, or sleeping problems. In bivariate analyses, those with high school education or less had less prior experience practicing relaxation techniques than those with some college education; thus education, prior relaxation practice, and interest variables

were controlled for in the multiple regression analyses. A positive RSA change, reflective of cardiac vagal tone changes within each subject, showed that the SIT group had higher RSA after training than controls and indicated that SIT was effective in increasing the relaxation response to the stress of the MSE.

Table 2 provides the descriptive statistics of both primary and secondary outcome measures at baseline by group, the unadjusted estimates of the intervention effect at follow-up, and the intervention effect among new cases that met screening criteria only at follow-up. No group differences were found in either baseline or follow-up samples. A reported 13% of all participants met screening criteria for possible PTSD at baseline (PCL > 43) and 21% at follow-up; 36 new cases of possible PTSD (16%) met the screening criteria at follow-up. No group differences were observed even when additional measures of probable PTSD (PCL > 50), symptom means, or improvement or deterioration scores, were examined (not tabled). On the other hand, rates for possible PTSD significantly increased from baseline to follow-up for the SIT group. Both mean perceived stress and hyperarousal increased in both groups from baseline to follow-up.

Increased rates of symptoms could be due to one of two reasons: (1) symptoms actually increased; or (2) soldiers with more symptoms at baseline may have participated in the follow-up in greater proportion than those with fewer symptoms at baseline. The first is actual change, the second is bias in follow-up. To assess whether the latter biasing situation might have affected the results, we examined the baseline outcomes between those who did and those who did not participate in the follow-up study. Results did not significantly differ from the baseline values of the outcomes reported in Table 2, suggesting lack of this type of bias.

Multiple regression analyses. Results of multiple regression modeling revealed that after controlling for indicators of baseline mental health problems (i.e., receiving mental health counseling or medication), practicing relaxation techniques prior to training, being interested in learning stress reduction techniques at baseline, having downloaded additional relaxation techniques after training, and education level, no significant intervention effects on perceived stress scores or possible PTSD were found (see Table 3). However, the SIT group had significantly lower hyperarousal scores at follow-up than the SM group. Mental health problems at baseline also predicted hyperarousal at follow-up even after controlling for all other covariates in Table 3. Importantly, taking psychoactive medications at follow-up was a significant predictor for every outcome even after controlling for mental health problems and taking medications at baseline. Those reporting GAD were significantly more likely to report practicing relaxation techniques prior to the study, and those reporting loss of control or aggression were more likely to have downloaded additional relaxation methods to their MP3 players.

In addition, examination of possible interaction terms for potential subgroup effects were not significant, suggesting that practice, having baseline mental health problems, or being interested in learning stress-reduction techniques did not moderate the impact of SIT on study outcomes. However, in posthoc analyses, those who *practiced* SIT were almost twice as likely to be interested in learning stress control (i.e., 62.9% vs. 34.4%). Those with a baseline mental health problem were also more interested in learning stress-reduction techniques than those without mental health problems (65.9% vs. 34.1%). Additional analyses revealed that SIT participants who did not practice the technique and who were not interested in stress-reduction techniques had fewer average symptoms than the SM group across all outcomes. Given that this noninterested, nonpracticing group was also less likely to have high perceived stress and possible

PTSD, this finding suggests that the effect of SIT may be limited to those who do not have an interest in and/or do not have high stress or prior mental health problems.

Discussion

This and previous studies were initiated to determine whether perceived high stress levels and stress-related mental health outcomes could be mitigated by training military personnel on strategies to reduce their physiological arousal level following an acute or traumatic stressor. The current study extends the findings of the first randomized trial of the effect of relaxation breathing on PTSD and other mental health–related outcomes using stress inoculation training with relaxation breathing (Author citation et al., 2016). Although the current study found an intervention effect in decreasing hyperarousal symptoms among SIT participants at follow-up, the hypothesis that SIT would mitigate perceived stress in nondeploying soldiers was not supported.

Unadjusted estimates showed controls to be twice as likely to be taking prescribed medications at follow-up than the SIT group, when controlling for covariates, but SIT was effective only among the SIT group without mental health problems at baseline who were interested in learning stress-reduction techniques. Because those with mental health problems were more likely to be interested in learning stress-control techniques and may also have been taking prescribed medications, we might infer that they did not have a reason to learn SIT and were therefore not protected. This is consistent with previous findings in which SIT was significant in reducing the risk of PTSD only among those with no mental health problems at baseline (Author citation et al., 2016), and extends the previous finding to those who are also uninterested in learning stress-reduction techniques. In addition, this finding reinforces the notion that SIT has poor utility as a treatment (i.e., reducing PTSD among those with prior

mental health problems) but may have potential as a preventive intervention in reducing hyperarousal symptoms among mentally healthy military personnel.

Several factors limit the conclusions of this study. The long follow-up period (1.2–2 years) resulted in a lower sample size than expected and concomitant fewer anticipated PTSD cases. This long follow-up period also appeared to affect recall of the specific training, because many controls responded that they had received the training. Despite being the only training in which free MP3 players were provided, to our knowledge, it is very possible that participants mistook other forms of training to be SIT (and vice versa), thus resulting in contamination across groups. Using the intent-to-treat analyses helped to control for these possibilities. The sample's failure to deploy as expected also probably resulted in less stress and possible PTSD cases than expected, which adversely affected the power to obtain significant differences between the SIT and SM groups. Further, because of a restricted period of time allotted for the on-site follow-up, we were unable to obtain HRV measurements from participants to collate with questionnaire findings. Also, a few variables were collected only at follow-up, preventing baseline and follow-up comparisons. Because deployments were cancelled after baseline data were collected, thus limiting combat exposure during follow-up, the hypothesis that SIT would mitigate PTSD risk among deploying soldiers could not be adequately tested.

Ongoing studies evaluating the effectiveness of relaxation techniques, such as yoga, mindfulness, and meditation, on PTSD symptoms usually have small samples (Seppälä et al., 2014; Wahbeh, Goodrich, Goy, & Oken, 2016). Such studies have incorporated much longer individual training programs than the single SIT session. However, the SIT program was designed specifically as a primary prevention program to fit quickly and easily into a group-administered, predeployment training regimen supplemented with a cost-effective means of an

MP3 player to post-training support. Unfortunately, limiting the program to only those with no mental health problems who are uninterested in learning stress control also limits its implementation as a fully integrated training program.

Nevertheless, this study has contributed several important findings to the literature. Specifically, it has suggested that the preventive effect of relaxation breathing training may be limited to those who essentially think they do not have a use for it either in terms of current mental health problems or interest. This would be consistent with recent findings that deep breathing is easier to learn under nonstressful conditions (Kinn, 2016) and argues against the application of stress inoculation training with relaxation breathing. We have also shown that it is possible to train soldiers to reduce physiological arousal in response to a mission-related stressor in a manner that is easily compatible with predeployment training regimens (Author citation et al., 2016). Of special significance is the observed HRV increase in response to SIT, which suggests the importance of future work to more fully examine the role of self-regulation and biofeedback to mitigate potential mental health problems and increase resilience in military populations. Future work will explore ways to extend this effect on a long-term basis to those with mental health problems.

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Table 1. Descriptive Indices of SIT and SM Groups at Baseline and Follow-up

Baseline Variables	Control		Experimental		Total		
N	422		469		891		
	Mean		Mean		Mean		p-Value
Age (mean)	23.99		23.66		23.82		NS
RSA Change [Post-MSE minus Pre-MSE] (mean)	−0.05		0.06		0		**0.01**
	n	Percent	N	Percent	n	Percent	
Sex							NS
Male	398	94.3%	453	96.6%	851	95.5%	
Female	24	5.7%	16	3.4%	40	4.5%	
Education							0.07
High school or less	184	44.0%	239	51.6%	423	48.0%	
Some college, 2-year college, or trade school	194	46.4%	195	42.1%	389	44.2%	
College graduate	40	9.6%	29	6.3%	69	7.8%	
Paygrade							NS
E1–E3	173	41.0%	196	41.8%	369	41.4%	
E4–E9	237	56.2%	262	55.9%	499	56.0%	
W1–O3	12	2.8%	11	2.3%	23	2.6%	
Marital Status							NS
Married/living as married	205	48.6%	205	43.9%	410	46.1%	
Single	217	51.4%	262	56.1%	479	53.9%	
High combat exposure	101	24.4%	108	23.4%	209	23.9%	NS

Practices relaxation techniques (ever)	221	52.7%	205	43.8%	426	48.0%	**0.01**
Interested in learning stress reduction	45	10.8%	72	15.4%	117	13.2%	0.09
Number of deployments since 2002 with special combat pay							NS
0–1	104	62.3%	142	70.3%	246	66.7%	
2 or more	63	37.7%	60	29.7%	123	33.3%	
Prescribed medication for depression, etc., in past year (Yes)	10	2.4%	12	2.6%	22	2.5%	NS
Practices relaxation techniques (more than rarely)	142	33.6%	130	27.7%	272	30.5%	**0.05**

Follow-up Variable	**Control**		**Experimental**		**Total**		
N	**118**		**149**		**267**		
	n	**Percent**	**N**	**Percent**	**n**	**Percent**	**p-Value**
Sex (baseline) of those who did follow-up							NS
Male	110	93.2%	143	96.0%	253	94.8%	
Female	8	6.8%	6	4.0%	14	5.2%	
Education (baseline) of those who did follow-up							**0.00**
High school or less	40	34.2%	75	51.0%	115	43.6%	

Some college, 2-year college							
or trade school	60	51.3%	59	40.1%	119	45.1%	
College graduate	17	14.5%	13	8.8%	30	11.4%	
Paygrade							NS
E1–E3	7	6.0%	17	11.6%	24	9.1%	
E4–E9	105	90.5%	122	83.0%	227	86.3%	
W1–O6	4	3.4%	8	5.4%	12	4.6%	
Marital Status							NS
Married/living as married	76	64.4%	80	54.1%	156	58.6%	
Single	42	35.6%	68	45.9%	110	41.4%	
Returned from last deployment							NS
Deployed in the past	56	47.5%	77	51.7%	133	49.8%	
Never deployed	62	52.5%	72	48.3%	134	50.2%	
Taught Battle Breathing							**0.00**
Yes	80	68.4%	133	90.5%	213	80.7%	
No	7	6.0%	6	4.1%	13	4.9%	
Don't know	30	25.6%	8	5.4%	38	14.4%	
Used SIT MP3 player (yes)	35	30.2%	50	34.0%	85	32.3%	NS
Downloaded additional							
relaxation method to MP3 (yes)	28	24.1%	19	12.8%	47	17.8%	**0.04**
Would SIT be helpful to others?							0.10
Yes	51	43.6%	82	55.4%	133	50.2%	
No	10	8.5%	14	9.5%	24	9.1%	
Don't know	56	47.9%	52	35.1%	108	40.8%	

TICS—two-item substance abuse							NS
No substance abuse problem	87	78.4%	104	72.7%	191	75.2%	
Probable or likely substance abuse problem	24	21.6%	39	27.3%	63	24.8%	

Follow-up Variable	**Control**		**Experimental**		**Total**		
N	**118**		**149**		**267**		
	n	**Percent**	**N**	**Percent**	**n**	**Percent**	**p-Value**
Currently taking medication for depression, etc. (yes)	12	10.8%	7	4.9%	19	7.5%	**0.05**
Follow-up questionnaire source							NS
Keyed	57	48.3%	94	63.1%	151	56.6%	
Web	61	51.7%	55	36.9%	116	43.4%	
Use of Battle Breathing (yes)	55	47.0%	85	57.4%	140	52.8%	NS
Use of other techniques (yes)	52	44.4%	47	31.8%	99	37.4%	0.06
Used both SIT and other techniques (yes)	38	32.5%	37	25.0%	75	28.3%	NS
Did Battle Breathing technique help (yes)	39	33.1%	59	39.6%	98	36.7%	NS

Note. MSE = multiple stressor environment; PRESINT = predeployment stress inoculation training; TICS = Two-Item Conjoint Screen.

p-values were calculated using a chi-square test; *p*-values for means were calculated using a t-test; * mean value comparisons and DSM criteria were nonsignificant; NS is not significant to the .10 level.

Table 2. Prevalence and Incidence of Primary and Secondary Outcomes

													Comparing	
									Not high at baseline				**baseline with**	
	Baseline				**Follow-up**				**New at follow-up**				**follow-up**	
Primary outcomes	**Total**	**Control**	**BB**	**p-Value**	**Total**	**Control**	**BB**	**p-Value**	**Total**	**Control**	**BB**	**p-Value**	**Control**	**BB**
N	**891**	**422**	**469**		**267**	**118**	**149**						**p-Value**	**p-Value**
Stress (PSS) total	14.1	14.2	14.1	0.79	15.9	15.6	16.2	0.51	N/A	N/A	N/A	N/A	**0.04**	**0.01**
mean (se)	(0.28)	(0.44)	(0.36)		(0.46)	(0.55)	(0.69)							
PTSD 43				0.71				0.39				0.82	0.28	**0.01**
≥ 43	116	57	59		55	21	34		36	15	21			
	(13)	(14)	(13)		(21)	(18)	(23)		(16)	(15)	(16)			
Hyperarousal	1.1	1.1	1.1	0.98	1.4	1.4	1.5	0.48	N/A	N/A	N/A	N/A	**0.04**	**0.02**
mean (se)	(0.05)	(0.08)	(0.07)		(0.11)	(0.1)	(0.19)							
Anxiety (GAD)				0.99				0.57				0.61	0.98	0.49
GAD not indicated	757	359	398		221	99	122		197	86	111			
	(85)	(85)	(85)		(84)	(85)	(83)		(87)	(86)	(88)			

GAD indicated	131	62	69		42	17	25		29	14	15		
	(15)	(15)	(15)		(16)	(15)	(17)		(13)	(14)	(12)		
Loss of control or				0.41				0.31				0.22	0.26	0.11
aggression													
Yes	82	33	49		60	30	30		51	27	24		
	(22)	(18)	(24)		(23)	(26)	(21)		(21)	(11)	(10)		

Note. BB = Battle Breathing; GAD = generalized anxiety disorder; MH = mental health; N/A = not applicable; PSS = Perceived Stress Scale; PTSD = posttraumatic stress disorder.

Table 3. Multiple Regression of Primary and Secondary Outcomes

	Stress (PSS)[a]		**PTSD 43**[b]		**Hyperarousal**[b]		**Anxiety (GAD)**[b]	**Loss of control or aggression (yes or unsure vs. no)**[b]		
	β	*p*	β	*p*	β	*P*	β	*P*	β	*P*
SIT (ref: control)	−1.38	0.58	−0.72	0.36	−0.57	**0.05**	−0.44	0.59	−0.44	0.55
SIT (ref: control) X Practiced SIT (ref: did not practice)	−2.28	0.10	−0.84	0.17	−0.46	0.08	−0.38	0.62	−1.00	0.10
Mental health problems, medication, sleep problems, or seeing a counselor at baseline[c] (ref: no problems)	1.30	0.26	0.85	0.20	0.61	**0.02**	0.75	0.28	0.16	0.71
Interested in learning stress reduction (ref: uninterested)	1.90	0.21	0.54	0.37	0.26	0.38	−0.54	0.46	0.24	0.69
Ever practiced relaxation techniques prior to the study (ref: did not practice)	−1.57	0.12	−0.23	0.59	−0.41	0.09	−1.35	**0.01**	−0.70	0.08
Downloaded additional relaxation method to MP3 (ref: did not download)	1.24	0.37	0.31	0.56	0.14	0.65	0.05	0.93	1.03	**0.03**

High school or less (ref: at least some college/trade school)	−0.19	0.83	−0.08	0.80	0.18	0.34	−0.28	0.50	0.33	0.38
Currently taking medication for depression, etc. at FUP (ref: no)	5.96	**0.01**	1.73	**0.01**	1.94	**0.00**	2.58	**0.01**	2.21	**0.00**
SIT (ref: control) X Currently taking medication for depression, etc. at FUP (ref: no)	−3.28	0.20	−0.64	0.55	−0.76	0.40	−0.99	0.45	−0.24	0.85
SIT (ref: control) X Mental health problems, medication, sleep problems, or seeing a counselor at baseline[c] (ref: no problems)	0.53	0.74	0.63	0.43	0.25	0.42	−0.46	0.59	−0.30	0.61
SIT (ref: control) X Interested in learning stress reduction (ref: uninterested)	2.24	0.28	0.60	0.45	0.71	0.12	1.66	0.08	0.25	0.73

[a] Linear regression

[b] Logistic regression (β can be exponentiated to obtain adjusted odds ratios)

[c] At baseline, was participant indicated for depression, anxiety, PTSD, or had a prescription for depression, anxiety, or sleeping problems.

Figure 1. Consort Diagram of Study Participants