Skin Conductance Response during Laboratory Stress in Combat Veterans with Post Traumatic Stress Disorder

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Abstract

Objective: The primary objective was to assess Skin Conductance Response (SCR) to a laboratory stressor in combat veterans with Posttraumatic Stress Disorder (PTSD) compared to controls. The secondary objective was to evaluate the relationship between SCR and PTSD symptom clusters.

Method: 15 combat/PTSD, 15 combat/no PTSD, 15 no combat/no PTSD veterans had their SCR recording during aversive pictures from the International Affective Picture Scale.

Results: The groups had similar demographics and medical history (all p>0.05). SCR was different between groups (F(2,42)=4.34, p=0.02). The combat/PTSD group had the highest response compared to both control groups. Numbing-avoiding was predictive of SCR (F(1,42)=12.72, p=0.001), while re-experiencing and hyper-arousal were not (p>0.05).

Conclusions: Increased SCR in the PTSD group validates previous studies (Numbing-avoiding). PTSD cluster scores correlated with SCR values. These findings support current PTSD therapies that reduce avoidance behaviors.

Keywords: Skin conductance response; Posttraumatic stress disorder

Introduction

Skin conductance response is a commonly used psychophysiological measure due to the ease of collection and low cost. Skin Conductance Response (SCR) reflects sympathetic activation because palmar sweat glands are innervated by the sympathetic chain of the autonomic nervous system [1]. There is also a high correlation between bursts of sympathetic nerve activity and SCR [2]. Additionally, activation of cortical emotion regulation areas known to be altered in posttraumatic stress disorder is associated with elicitation of SCR [1].

A number of studies have assessed SCR in people with Posttraumatic Stress Disorder (PTSD). Most studies have observed increased reactivity to a variety of stimuli [3-6] while others have not [6,7]. However, no study has examined the relationship between SCR and the PTSD symptom clusters of re-experiencing, numbing-avoiding, and hyper-arousal. Assessing the relationship between the individual PTSD symptom components and SCR may elucidate which aspects of PTSD psychopathology are most indicative of heightened sympathetic activity.

The primary objective of this study was to assess SCR in combat veterans with posttraumatic stress disorder compared to combat-exposed and non-combat exposed controls in response to a laboratory stressor. The primary hypothesis was that combat veterans with PTSD would have increased SCR compared to controls. The secondary objective was to evaluate the relationship between SCR and posttraumatic stress disorder symptom clusters.

The secondary hypothesis was that increased hyper-arousal symptoms would correlate to increased SCR and re-experiencing and numbing-avoiding would not. Hyper-arousal symptoms represent hyper-activation of the autonomic nervous system and would be expected to increase SCR.

Methods

Potential participants were recruited through flyers at the Portland Veterans Administration Medical Center, Portland Veterans Center, and other veterans groups throughout the Portland Metropolitan area. The three age and gender-matched participant groups were 15 combat veterans with PTSD, 15 combat veterans without PTSD, and 15 non-combat veterans without PTSD. Veterans were excluded if they were over the age of 70, had a current significant chronic medical illness, bipolar, schizoaffective, or psychotic disorders; any DSM-IV cognitive disorder; substance dependence disorder within 3 months; current substance use other than alcohol (≤ 2 drinks/day); or sexual assault as primary PTSD event/s. Participants could be on medications (stable doses ≥ 4 weeks). The study was approved by the Portland Veterans.

Administration Medical Center and Oregon Health and Science University institutional review boards. Written informed consent was obtained from all participants. Volunteers were interviewed by trained clinicians using the Clinician-Administered PTSD Scale for DSM-IV (CAPS) [8] to validate the presence or absence of PTSD. Participants in the PTSD group met DSM-IV-TR criteria A-F; criteria B, C, and D were met when the frequency plus intensity score were ≥ 4. Other traumas were assessed with the Life Events Checklist (LEC), which is administered as part of the CAPS and is used to identify traumatic stressors experienced. It asks about lifetime trauma exposure based on the following scale (1=happened to me, 2=witnessed it, 3=learned about it, 4=not sure, and 5=does not apply) on 16 commonly experienced traumas (Natural disaster, Fire/explosion, Motor vehicle accident, Other serious accident, Exposure to toxic substance, Physical assault, Assault with weapon, Sexual assault, Other unwanted sexual

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experience, Combat, Captivity, Life-threatening injury/illness, Severe human suffering, Witness violent death, Sudden, unexpected death of loved one, Caused serious injury/death of another, Other very stressful event. Since the LEC is administered as part of the CAPS to determine trauma exposure for PTSD diagnosis, there is no official way to score the instrument. In order to assess differences between groups on past trauma with this instrument, the number of traumas endorsed where the response was "Happened to me" or "Witnessed It" were totaled for each person (total possible score = 16). Participants in the non-PTSD groups did not meet full PTSD criteria. The Structured Clinical Interview for DSM-IV-Patient Edition (SCID) was performed by the same clinicians to screen for excluded DSM-IV disorders [9]. Combat exposure was determined with the Combat Exposure Scale (CES) [10].

**Study Procedures**

Study procedures, inclusion/exclusion criteria, and the risks and benefits of participating were explained during a telephone screening. Informed consent procedures, CAPS, SCID, and CES administration were completed at a screening visit. SCR data was collected during a stressor at a laboratory visit scheduled within one week of the screening.

The laboratory visit occurred in a light and sound attenuated room, between 10:30 am-1:30 pm. Participants were seated with a 52 cm monitor placed approximately 60 cm away. A constant current (1 μA) was applied with two 10 mm flat silver/silver chloride electrodes, one on the palmar thenar eminence and the other on the dorsal aspect between the first and second digits. The SCR data was collected with two active Biosemi electrodes (Active 2, Biosemi, Amsterdam, Netherlands) that were next to but not touching the silver/silver chloride electrodes.

All electrodes were placed on the left hand. Participants were seated for 30 minutes prior to the stressor. The stressor entailed viewing 162 aversive pictures from the International Affective Picture Scale (IAPS) and lasted 13 minutes. Pictures were chosen for their low pleasure, high arousal, and high dominance ratings. The average ratings of all 162 pictures were (low pleasure (valence mean=2.1), high arousal (arousal mean=5.8), high dominance (dominance mean=3.8)) [11]. The IAPS includes emotionally-evocative color photographs and is known to affect skin conductance [12]. The 162 pictures included four picture categories, Snake, War, War Control, and Other.

The four picture categories were matched for pleasure, arousal, and dominance ratings. War Control pictures were chosen to match the valence, arousal, and dominance ratings of the War Pictures (valence 3.0, arousal 5.7, dominance 3.8). There were 6 blocks with 27 pictures per block, where each block had at least 3 Snake, 6 War, 6 War Control, 12 Other and no more than 3 War or 3 War Control in a row. The task was created and presented in EPrime 2.0 (Psychology Software Tools, Inc., Pittsburgh, PA). Pictures were shown for four seconds with a one second inter-stimulus interval. Participant attention was ensured by asking them to click the right hand button upon seeing a snake. After completing the task, participants rated subjective stress on a scale of 1-10, with 10 being the most stressed.

The skin conductance signal was digitized at 1024 samples per second and analyzed with Brain Vision Analyzer 2.0 (Brain Products GmbH, Inc., Gilching, Germany). Data was segmented according to stimulus onset (-100 ms to 4500 ms). Each segment was baseline corrected based on -100ms to stimulus onset. Peak voltages were exported for each segment.

Any segment with a peak change greater than 650 μV was counted as a response. The number of responses per person was summed (total for all 162 pictures and by picture category) as the primary outcome measure.

All statistical analyses were performed with SPSS 18.0 (SPSS, Chicago, IL, USA). Means, standard deviations, and box plots were observed for each continuous variable and normality was assessed by the Shapiro-Wilk test. Group differences in continuous variables were assessed with analysis of variance (ANOVA) if normally distributed and independent samples Kruskal-Wallis non-parametric test if not normally distributed. Post-hoc tests for significant values were assessed with least square difference for parametric tests and mean rank paired comparisons for non-parametric tests [13]. Categorical variables were assessed with the chi-square test. The primary outcome measure was the SCR for all 162 IAPS pictures (SCR Total). Post-hoc analysis also entailed a repeated measures ANOVA including picture category type (Snake, War, War Control, Other), (group, type, type*group). This was done to see if there was any difference in how the participants responded to picture type both within participant and across groups. Stepwise linear regression analysis was conducted to assess re-experiencing, numbing-avoiding, and hyperarousal symptom components ability to predict SCR.

Normality, linearity, and outliers were assessed through normal probability plots and scatter plots of the standardized residuals. None of these assumptions were violated. Zero-order Spearman rank correlation coefficients were examined to determine any collinearity between measures. Criteria probability of F for inclusion in the model was ≤ 0.050, and ≥ 0.100 for exclusion. SCR Total was entered as the dependent measure and re-experiencing, numbing-avoiding, and hyper-arousal were entered as independent measures. Confirmatory bivariate correlations were conducted and adjusted with a Bonferroni correction. When comparing pictures categories, percent responded divided by total number of pictures per category was used to account for the different number of pictures in each group (i.e. War percent equaled number of responses/36).

**Results**

Demographics and medical history were similar for all groups (all p>0.05) for gender, years in service, era, race, education, marital status, exercise, sleep, handedness, post traumatic history, past major depressive disorder, antidepressant use, past or current drug, alcohol, or cigarette use, and age (PTSD-55.9 ± 10.4; Combat/no PTSD-51.0 ± 13.0; no combat/ no PTSD- 54.8 ± 9.1). As expected, there were group differences in CAPS, CES, and LEC reflecting PTSD symptomology (Table 1). There was no difference between the two combat groups on the LEC (p=0.26). The group differences were driven by differences between the two combat groups and non-combat group.

SCR Total was different between groups (F(2,42)=4.34, p=0.02) with the combat, PTSD group having the highest responses to the IAPS aversive pictures overall the whole condition compared to the combat, no PTSD group (p=0.007), and the no combat, no PTSD group (p=0.04) (Figure 1).

Post-hoc analysis with repeated measures showed no difference in SCR between groups across the picture categories (group interaction; p=0.05). There were picture category differences within subjects (F(2,40)=8.98, p=0.005). Within each participant’s responses, the snake pictures (targets) had significantly greater SCR responses compared to the other categories. There was no difference in SCR response within each participant to the War, War control and other picture categories. The combat with PTSD group rated the laboratory stressor as more stressful than the control groups (F(2,44)=4.30, p=0.02).
For the linear regression, the numbing-avoiding symptom cluster stayed in the model (F(1,42)=12.72, p=0.001), while the re-experiencing and hyper-arousal were excluded (p's>0.05). The collinearity assumption was violated, so bivariate correlations were conducted for all symptom clusters and SCR. Numbing-avoiding (NA) was highly correlated, followed by hyperarousal (HA), and re-experiencing (RE) (NA $\rho=0.42$, p=0.005, HA $p=0.03$, RE $p=0.29$, p=0.06). Bonferroni correction renders only numbing-avoiding as significant (0.05/3=0.017).

**Discussion**

The primary objective to assess SCR in combat veterans with PTSD compared to controls revealed increased SCR in the PTSD group compared to both trauma and non-trauma exposed controls. This was also reflected, in their increased subjective stress. Our results validate other findings that show increased SCR in people with PTSD.

There were many methods to assess SCR response. We choose a method that required a specific threshold to be reached before a
response was designated for each stimuli. Using this method, rather than magnitude, amplitude, or averaging allowed for a more accurate representation of the response to each stimuli.

There were as no group differences on any of the picture categories (Snake, War, War Control, and Other). Thus, the combat, PTSD group had a larger SCR to the stressful condition as a whole compared to the other two groups; there was no distinction between being more or less stressed to the different category pictures. Within each participant, the SCR was greater for the Snake pictures compared to the other three picture types. Thus, the participants had a greater stress response to the Snake pictures than the other stressful pictures. The increased response within participants to the Snake pictures probably resulted from the Snake category being a button push target despite SCR being collected on the opposite hand. While the Snake pictures received an increased response within a participant compared to the other picture categories that does not mean that there was no response to the other picture categories. It is just that the Snake category had a greater response above those. All of the pictures were aversive and "stressful" whether they were War or non-war stimuli. All picture categories were aversive and equal in arousal, valence, and dominance values. This equality in high arousal, negative valence, and high dominance may have overridden any difference in response to the war versus non war content.

The increased SCR in the combat, PTSD group reflects increased reactivity to stressful stimuli in general and is not specific to War triggers. This reactivity to stressful triggers that are not related to the person's primary trauma exposure is reflected in the PTSD symptom picture that includes generalized hyperarousal and numbing and avoiding to any stressful trigger (driving, loud noises, etc.). This information may be useful for therapies that include exposure focused on the primary PTSD trauma. Additional support to teach autonomic regulation and behavioral modification for any stressful trigger rather than just their primary trigger may also be helpful.

The secondary objective was to evaluate the relationship between SCR and PTSD symptom clusters. We hypothesized that hyper-arousal symptoms would positively correlate with SCR, while re-experiencing would not. Interestingly, the numbing-avoiding component was the only predictive one in our small study. Numbing-avoiding encompasses the behavioral symptoms of avoiding thoughts, feelings, conversations, people, places, and events that remind the person of their trigger and also the number of emotions such as feelings of detachment or estrangement from others or restricted range of affect [14]. People with PTSD who are more avoidant or numb to their emotions may be more reactive to stress and/or triggers, thus perpetuating the avoidant behavior. Hyper-arousal was neither predictive in the regression model nor significantly correlated after correction. The hyper-arousal was neither predictive in the regression with PTSD who are more avoidant or numb to their emotions may be. Interestingly, the numbing-avoiding component was the only predictive one in our small study.

The study did have limitations such as small sample size, which made it statistically unfeasible to include covariates in the analysis. It was limited to veterans in a particular age range. Also, the SCR was not collected during a non-stressful task to assess if these differences existed during non-stress.

The findings of this study does lend support to current therapies for PTSD that incorporate a reduction of avoidance behaviors, acceptance, or exposure to triggers (whether of their primary PTSD event or other stressful triggers) such as prolonged exposure therapy, dialectical therapy, behavioral activation, and mindfulness meditation. The next step in research is to assess whether this increased SCR to stressors in people with PTSD will change after treatment.

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