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## Assessing Hormones in Response to Trauma

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**NORTHERN ILLINOIS UNIVERSITY**

**Assessing Hormones in Response to Trauma**

**A Thesis Submitted to the**

**University Honors Program**

**In Partial Fulfillment of the**

**Requirements of the Baccalaureate Degree**

**With Upper Division Honors**

**Department Of**

**Psychology**

**By**

**Corina E. Klein**

**DeKalb, Illinois**

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Capstone Approval Page

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Assessing Hormones in Response to Trauma

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# **HONORS THESIS ABSTRACT THESIS SUBMISSION FORM**

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**ABSTRACT (100-200 WORDS):**

Hormones produced in the body may be important in ameliorating the effects of traumatic stress. Previous research has shown that the concentration of several hormones, such as cortisol, dehydroepiandrosterone (DHEA) and DHEA-sulfated (DHEAS) in a given individual who has been exposed to a traumatic event may be indicative of the likelihood that the individual will develop posttraumatic stress disorder (PTSD). The current study assessed whether higher levels of cortisol in comparison to DHEA or DHEAS could indicate a predisposition toward future mental illness following an emotionally stressful event. Female students from Northern Illinois University provided salivary samples before and following a writing task intended to induce emotional stress. The samples were analyzed for cortisol, DHEA, and DHEAS levels. Results indicated both cortisol and DHEA were reduced after the writing task, although no significant relationship between the hormones and PTSD symptoms after the stressor. The participants' levels of DHEA prior to the stressor seemed to be predictive of PTSD symptom presence after the stressor.

**Assessing Hormones in Response to Trauma**

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**Abstract**

Hormones produced in the body may be important in ameliorating the effects of traumatic stress. Previous research has shown that the concentration of several hormones, such as cortisol, dehydroepiandrosterone (DHEA) and DHEA-sulfated (DHEAS) in a given individual who has been exposed to a traumatic event may be indicative of the likelihood that the individual will develop posttraumatic stress disorder (PTSD). The current study assessed whether higher levels of cortisol in comparison to DHEA or DHEAS could indicate a predisposition toward future mental illness following an emotionally stressful event. Female students from Northern Illinois University provided salivary samples before and following a writing task intended to induce emotional stress. The samples were analyzed for cortisol, DHEA, and DHEAS levels. Results indicated both cortisol and DHEA were reduced after the writing task, although no significant relationship between the hormones and PTSD symptoms after the stressor. The participants' levels of DHEA prior to the stressor seemed to be predictive of PTSD symptom presence after the stressor.

### Assessing Hormones in Response to Trauma

The way that a person interprets stress can vary broadly, depending on the stressor, past experiences or state of mind (Yehuda & Flory, 2007). However, individuals experience stress physiologically in roughly the same manner; when a stressor is perceived, the hormone cortisol is released from the adrenal glands, as well as dehydroepiandrosterone (DHEA) and its sulfated version (DHEAS). The release of cortisol in large amounts, especially over time, can be detrimental to the brain and body; whereas DHEA and DHEAS are thought to buffer these effects (Beishuizen, Thijs, & Vermes, 2002). In individuals who have experienced a traumatic event, these hormones become particularly important. The current study assessed the effects of writing about an emotional experience changes these stress-related hormones.

Past research has explored how levels of DHEA/S relative to cortisol may predict resilience or risk for the development of posttraumatic stress disorder (PTSD) following a traumatic event (Yehuda, Brand, Golier, & Yang, 2006). According to the previous studies, DHEA/S levels increase in parallel to cortisol, which responds proportionately to the perceived severity of the stress/trauma. However, the characteristics of the stress exposure can alter the hormonal changes. Following an acute trauma, cortisol levels rise based on the immediate severity of the stress presented and DHEA/S respond to a similar degree. Yet, during chronic stress, cortisol levels may increase slightly or remain steady, whereas DHEA/S levels tend to increase initially, and then decline over time (Maninger, et al., 2010). Interestingly, those individuals who present with PTSD symptoms following a trauma have been found to be lacking in the initial spike of cortisol associated with severe stress; furthermore, these individuals tend to also exhibit a steady level of cortisol over time. This would seem to be an effect of an imbalance of neurotransmitters in individuals with PTSD, which may interact in such a manner that cortisol

is reduced compared to average levels, though the symptomatic response to trauma is exaggerated overall compared to normal levels (Yehuda, 2004).

Yehuda, Brand, Golier, and Yang (2006) assessed whether the presence of higher levels of DHEA/S in individuals with PTSD may be indicative of the hormones' protective properties. The study examined the plasma levels of DHEA/S and cortisol of male veterans, those with PTSD and those without PTSD— all participants had been exposed to traumatic events. Participants with PTSD exhibited significantly higher levels of DHEA/S than did participants without PTSD; this supports previous findings (Rasmusson et al., 2004). Furthermore, participants with PTSD also had a significantly smaller cortisol/DHEA ratio than did participants without PTSD. This seems to indicate that, not only do participants with PTSD display significantly higher levels of DHEA compared to participants without PTSD, but they are also exhibiting a level of cortisol low enough to alter the typical cortisol/DHEA ratio relative to the presence of PTSD (Yehuda, Brand, Golier, and Yang, 2006). Despite these findings, it is unclear how DHEA/S and cortisol release might be triggered or altered in veterans with PTSD compared to individuals who experience trauma, but did not develop PTSD.

Emotional writing has shown to be an effective method of trauma symptom reduction in times of stress. Previous research has found that writing tasks have ameliorative effects on participants' well being (Pennebaker & Francis, 1996). Pennebaker and Francis (1996) examined how writing about the stressors of transitioning into college might create change in grade point average (GPA) and health visits in a population of college undergraduates. During the study, two groups were assigned to write in an emotional manner (describing the deepest thoughts and feelings associated with beginning college) or to write in an objective manner (writing about anything in as dispassionate a manner as possible). The results of the study



indicated that those participants in the emotional writing condition had fewer visits to the health center as compared to the control group two months after the study; as well as higher GPA in the semester following the study. These results suggest an ameliorative effect of writing about one's emotions surrounding a stressful time. However, the Pennebaker and Francis studies did not address whether their writing paradigm also could reduce the traumatic symptoms and biological components associated with a specific traumatic event.

Smyth, Hockemeyer, and Tulloch (2008) suggest that emotional writing may impact hormonal response in individuals with PTSD. The study utilized a sample of participants who had a confirmed diagnosis of PTSD due to an event which had occurred at least six months prior to the study; participants were randomly assigned to an experimental or control group. Over the course of three 20-minute sessions, participants were asked to complete narratives related to their specific trauma exposure (experimental) or related to daily time-management (control). The greatest improvement in mood was observed following the emotional writing as compared to the non-emotional writing. However, there was also a significant difference between the groups for cortisol levels. Comparatively, the emotional writing group had higher baseline salivary levels of cortisol compared to control; this could be due to participants' anticipation of writing about their traumatic experience. Furthermore, the post-relaxation period level of cortisol for the experimental group was lower than that of the control group. These findings indicate that emotional writing tasks for those individuals with PTSD may aid in the reduction of biological responses, which can reinforce PTSD symptoms. It is not known whether an emotional writing task would also alter other adrenal hormones, such as DHEA, in plasma or specifically cortisol.

The current study examined whether the re-experience of emotional distress by remembering a traumatic event may alter salivary DHEA/S and cortisol levels. Though a

number of individuals may experience at least one trauma in their lifetimes, few experience high levels of PTSD symptoms (Yehuda & LeDoux, 2007). We hypothesize that an individual who recalls a traumatic event but does not experience PTSD symptoms, should exhibit 'normal' patterns of DHEA/S and cortisol— cortisol should spike slightly or remain the same, and DHEA/S should parallel the cortisol, but decline sooner. Whereas, those individuals who report PTSD symptoms should exhibit DHEA/S and cortisol levels comparable to prior studies— a lower level of cortisol than normal, and higher DHEA/S (Yehuda, McFarlane, & Shalev, 1998; Yehuda, Brand, Golier, & Yang, 2006). Though research has shown a reduction in hormonal response following an emotional writing task (Smyth, Hockemeyer, & Tulloch, 2008), the relative intensity of the trauma experienced by the participants in the current study is posited to override this effect; as such, the act of recalling the event will be acutely stressful and should produce a biological response to reflect that state. Participants had been enrolled in a prior study which required them to provide salivary samples prior to the shooting trauma for this study. As such, these samples will be included as a pre-shooting comparison of hormones relative to the salivary samples provided for this study. Overall, the study will test 2 hypotheses: 1) whether the presence of PTSD symptoms relates to the pattern of adrenal hormone release following an emotional writing task; and 2) whether hormone levels prior to the NIU shooting differs between individual experiencing PTSD symptoms.

## **Methods**

### **Participants**

The current study utilized data from a previous study conducted with female undergraduate students at Northern Illinois University (NIU; Fergus, Rabenhorst, Orcutt, & Valentiner, 2009). A mass shooting occurred on the NIU campus on February 14, 2008; the

participants for this study were drawn from a study that was already in progress at the time (1,045 participants). Of that number, 812 were qualified for the initial post-shooting assessment, which was conducted via online survey. A total of 173 of those women assessed were invited to participate in an expressive writing study by phone or email, of whom, 77 agreed to schedule an appointment to participate. Fifty-eight women actually participated; of those women, 24 (41.4%) identified as having no PTSD symptoms after the shooting, whereas 34 (58.6%) reported having PTSD symptoms after the shooting. The majority of the participants were Caucasian (81%). The mean time between the shooting and participation in the study was 8.8 ( $SD = 2.0$ ) weeks.

### **Procedure**

Participants were invited to schedule appointments to participate in the study; however, before an appointment was actually made, participants were informed of what the study would entail (writing about the shooting), how much time they could expect to be in the session, and how much they would receive in compensation (\$40). Once participants arrived at the laboratory, the women were told what procedures would be involved during participation. The participants were informed that during participation, several self-report measures would be completed, several saliva samples would be collected, and small electrodes would be attached to the torso, two of their fingers, and the forehead. The electrodes would monitor pulse rate, skin reactivity and facial muscle tension. All participants agreed to participate after being fully informed of the process.

During the expressive writing task, participants were brought to a room, which was insulated to blunt sound, where they were seated in a comfortable chair. Electrodes were attached to monitor the participant's heart rate, the conductivity of the skin, and the facial muscle

tension via facial electromyography (EMG). Closed circuit video and audio allowed the participant to communicate with the researchers, while still allowing them comfortable privacy. Once the pertinent instruments were set, the participant provided a baseline saliva sample, and then completed 3 questionnaires. A five-minute relaxation period followed completion of the self-report measures.

Once the relaxation period ended, participants were instructed to do the following:

For the next 20 minutes, write about your deepest thoughts and feelings regarding the mass shooting at Northern Illinois University on February 14, 2008. In your writing, really let go and explore your deepest emotions and thoughts. You might tie your topic to your relationships with others, including parents, significant others, friends or relatives, to your past, your present, or your future, or to who you have been, who you would like to be or who you are now. You may write about one specific thought or emotion or you may write about the experience more generally. Don't worry about using complete sentences or being logical. Just write whatever comes to your mind about this experience. Use as many pages as you need.

A second saliva sample was collected immediately following the expressive writing task. Once the self-report was finished, participants were allowed to rest for about two minutes, after which they were asked to read out loud what they had written during the expressive writing task. A 10-minute recovery period followed this verbal task, after which the participants provided a third saliva sample. At this point, participants were allowed to select a DVD to watch for approximately 45 minutes; after this final resting period, a fourth saliva sample was provided.

The entire session lasted about two hours; once completed, the participants were thoroughly debriefed, thanked and dismissed. Information was provided to participants, such as a list of mental health services in the surrounding area, and how to contact the researchers of the experiment. Forty-eight hours after completion, participants were contacted by researchers to assess whether any problems had arisen as a result of participation in the study. No adverse reports were present at the time.

### **Hormone Analysis**

All samples collected from the participants were frozen. Before analysis, samples were thawed and centrifuged (1500 x g at 3000 rpm for 15 minutes) to separate saliva from extraneous particles. Saliva samples were analyzed for cortisol, DHEA and DHEAS with immunoassay kits from Salimetrics LLC. Each sample was assessed in duplicate wells on a plate pre-coated with antibodies for either cortisol, DHEA or DHEAS.

Assays were conducted in accordance with the instructions included with the kit from Salimetrics LLC. Briefly, samples were added to wells, followed by a conjugate. The plate was rinsed and 200  $\mu$ L of tetramethylbenzidine (TMB) was added. Reactions were stopped after 30 minutes with sulfuric acid. Plates were read within 10 minutes of stopping the reaction at 450 nm.

### **Data Analyses**

Participants were grouped on PTSD symptom presence based on a cut-off score of 18 on the Distressing Events Questionnaire (DEQ; Kubany, Leisen, Kaplan, & Kelly, 2000). Kubany, Leisen, Kaplan and Kelly (2000) determined that 18 was the optimal score to use as an indicator of PTSD symptoms post-trauma, after comparison on the DEQ to several convergent and divergent measures. Therefore, those participants who scored above an 18 at during the administration of self-report measures during baseline were determined to have PTSD symptoms; whereas those participants who scored below 18 were determined to lack the presence of sufficient PTSD symptoms.

To assess group differences over time, a mixed factorial ANOVA was used to analyze each of the hormones within and between PTSD groups. Additionally, a multivariate ANOVA was used to assess pre-shooting hormone levels' relationship with post-shooting PTSD symptom

presence. Finally, an independent samples t-test was used to compare pre-shooting DHEA levels between PTSD groups.

### Results

The current study utilized a multivariate ANOVA to assess hormone levels prior to the shooting related to the presence of PTSD symptoms after the event. The test yielded no significant results for cortisol ( $F(1, 36) = 0.03, p = 0.86$ ) or DHEAS ( $F(1, 36) = 0.10, p = 0.75$ ; Table 1); however, a trend was present for DHEA ( $F(1, 36) = 3.96, p = 0.054$ ). Due to this finding, an independent samples t-test was performed for post-event PTSD symptoms and pre-event DHEA levels. A significant difference in DHEA levels was present between PTSD symptom groups ( $t(54) = -2.18, p = 0.03$ ; Figure 1). Higher levels of DHEA were present prior to the event in participants who reported PTSD symptoms after the event ( $M = 305.05, SD = 174.49$ ) than were present in participants who did not report PTSD after the event ( $M = 219.95, SD = 117.72$ ).

To examine how hormone levels during participation in this study related to the presence of PTSD symptoms after the event, a 2 (PTSD symptoms: yes vs. no) x 4 (time: baseline vs. after writing vs. after reading vs. after rest) mixed factorial ANOVA was computed for each of the hormones. It was hypothesized that all participants would experience a spike in cortisol after the writing task as compared to baseline levels. However, no increase was observed; in fact, there was a significant main effect of time which indicated a decline in cortisol levels over the course of the session ( $F(3, 162) = 27.63, p < 0.001$ ; Figure 2). There was no significant interaction between the presence of PTSD symptoms and cortisol levels, nor was there a main effect of PTSD.

It was hypothesized that DHEA would increase for all participants after the writing task; with those participants who reported PTSD symptoms also then maintaining a higher level of DHEA compared to those without PTSD symptoms. A main effect of time was again observed, with DHEA levels decreasing from baseline regardless of PTSD symptoms ( $F(3, 156) = 13.24$ ,  $p < 0.001$ ; Figure 3). No interaction was found between DHEA and the presence of PTSD symptoms, nor was there a main effect of PTSD symptoms. DHEAS was measured for this study, and expected to parallel DHEA for all participants. However, all effects for DHEAS were non-significant (Figure 5).

To examine the interaction of cortisol and DHEA with PTSD symptoms, a ratio was computed (cortisol/DHEA). It was hypothesized that the ratio would be much smaller for those participants with PTSD symptoms, in accordance with past research that indicated a higher level of DHEA relative to cortisol for those with PTSD symptoms compared to those without (Yehuda, Brand, Golier & Yang, 2006). A main effect of time was again observed, with all participants' ratios decreasing over the course of the session,  $F(3, 156) = 17.79$ ,  $p < 0.001$ ; Figure 4. However, there was not an interaction of the cortisol/DHEA ratio and PTSD symptoms, nor was a main effect of PTSD present.

### **Discussion**

The current study tested 2 separate hypotheses: 1) whether salivary hormone levels prior to the shooting on campus at NIU would predict PTSD symptoms after the event; and 2) whether the pattern of hormonal response to recalling the day of the shooting would differ in individuals reporting higher levels of PTSD symptoms than those individuals who were not. Hypothesis one was partially supported in that DHEA salivary levels were different. However, cortisol did not appear to play a factor in relationship to PTSD symptom presence. This could be due to the low

cortisol levels that are often present in individuals with PTSD (Kellner, Yehuda, Arlt, & Wiedemann, 2002); which might cause those participants with PTSD to exhibit cortisol levels similar to those without PTSD as an effect of the acute stress of participation. The low levels of cortisol would support prior research which indicates that while DHEA and cortisol are loosely correlated and have similar diurnal patterns, DHEA exhibits more stability over time than does cortisol (Hucklebridge, Hussain, Evans, & Clow, 2005). These findings support past research which targets DHEA as a component to determining PTSD symptom progress, with higher levels of DHEA being related to improvement of PTSD symptoms (Yehuda, Brand, Golier, & Yang, 2006).

It was also hypothesized that individuals, regardless of PTSD symptoms, would experience an initial spike in cortisol and DHEA following the emotional writing task, as the writing was thought to act as an acute stressor. In addition, those individuals reporting the presence of PTSD symptoms were hypothesized to experience higher levels of DHEA relative to cortisol, compared to the individuals not reporting PTSD symptoms. These hypotheses were not supported by the data. Published research has found an ameliorative effect of writing about emotional states during a stressful time (Pennebaker & Francis, 1996). In particular, Smyth, Hockemeyer, and Tulloch (2008) found that salivary cortisol levels of participants in the emotional writing group dropped significantly as compared to the levels found in the control group. Therefore, the lack of support for these hypotheses could be due to a genuine effect of the reduction of hormones by the task itself; however, as no comparison writing group was used (e.g. non-emotional writing), it is difficult to interpret the reduction in hormone response.

Finally, the results could be explained by an effect of anticipatory anxiety leading up to participation in the study. Though the presence of a main effect of time across the session could



have been due to the writing task reducing the stress response, it could also be due to a falsely elevated baseline levels. Due to the sensitive nature of the event and in consideration of the emotional component of the manipulation, researchers fully informed individuals what would be happening before an appointment for participation was arranged. As such, the baseline levels of hormones could have been elevated in anticipation of potentially upsetting tasks; if this effect was present, then it would be almost impossible to say whether the observed effect of time was due to the task, or due to the baseline elevation reducing the other effects.

### **Limitations**

Though there is the possibility of the writing manipulation being powerful enough to have caused a reduction in stress hormones, there are limitations to attributing that effect to this data set. Specifically, in the case of cortisol reduction, it is difficult to assess whether the current study mirrored the 2008 study in a manner which allows the findings to translate to this situation. Smyth, Hockemeyer, and Tulloch (2008) utilized a control group of objective writing compared to an experimental group of emotional writing; whereas the current study only used an emotional writing group, with no comparison. Furthermore, that study also only used participants with a confirmed diagnosis of PTSD; whereas the current study used a non-clinical sample consisting of individuals reporting clinical levels of PTSD or not.

The procedure for defining the groups could be another potential difficulty with the current study. The participants were grouped by PTSD symptoms vs. non-PTSD symptoms based on a single total score of 18 and not computed on a continuum. By doing this, it is difficult to interpret whether a participant with a score of 17 was truly different from a participant with a score of 19; as such, the data may not properly display a lack of effect between PTSD symptoms vs. no PTSD symptoms. Interpretation of the data in this manner is limited and

may not detect interesting differences. A more complete picture might be presented if the participants were grouped based on a range of scores; rather than including anyone below a score of 18 in the “no PTSD symptoms” group, it might be more useful to allow participants who scored between 0 and 10 to be comprise the “no PTSD symptom” group. Likewise, a score of 11-18 would then indicate “potential PTSD symptoms” and scores above 18 would still indicate the presence of PTSD.

Additionally, the sample was solely female, between the ages of 18-28. Past research has shown that men and women react differently to trauma (Christiansen & Elklit, 2008). As such, it could be postulated that the hormonal states of men as compared to women during a task such as the one completed for this study may differ in a crucial manner. Moreover, the hormones being measured in this study have been shown to have a distinct diurnal rhythm (Maninger et al, 2010); because the time of day that the participants were providing samples was not controlled, it is difficult to interpret the data with accuracy.

### **Future Directions**

Future studies should attempt to eliminate, or better control the limitations presented for this study. Any future studies should utilize men in the sample as well as females, so that the combination of gender can be assessed as a component of the outcome. Additionally, the time of day individuals participate in the task and provide samples should be carefully controlled and monitored, to provide a clearer picture of the interaction of the task and the hormones. Future studies should also address a manner of informing participants of potentially upsetting tasks such that the baseline hormone levels will not be artificially elevated, or that such an effect could be detected. The use of a control group may also aid in determining how the hormones actually reacted to the task itself. Finally, the grouping of individuals on PTSD symptoms should be

done by using a range of scores rather than a cut-off score to help ensure that the groups are distinctly different.

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Table 1

*Comparison of hormone means pre-shooting to the presence of PTSD symptoms immediately after shooting.*

Hormones	PTSD Symptoms	
	Yes	No
Cortisol	283.8 (241.07)	286.0 (249.06)
DHEA	305.05 (174.49)*	219.95 (117.72)
Cortisol/DHEA Ratio	1.45 (2.99)	1.72 (1.82)
SDHEA	5889.36 (6297.19)	6250.49 (6879.78)

\* $p < 0.05$

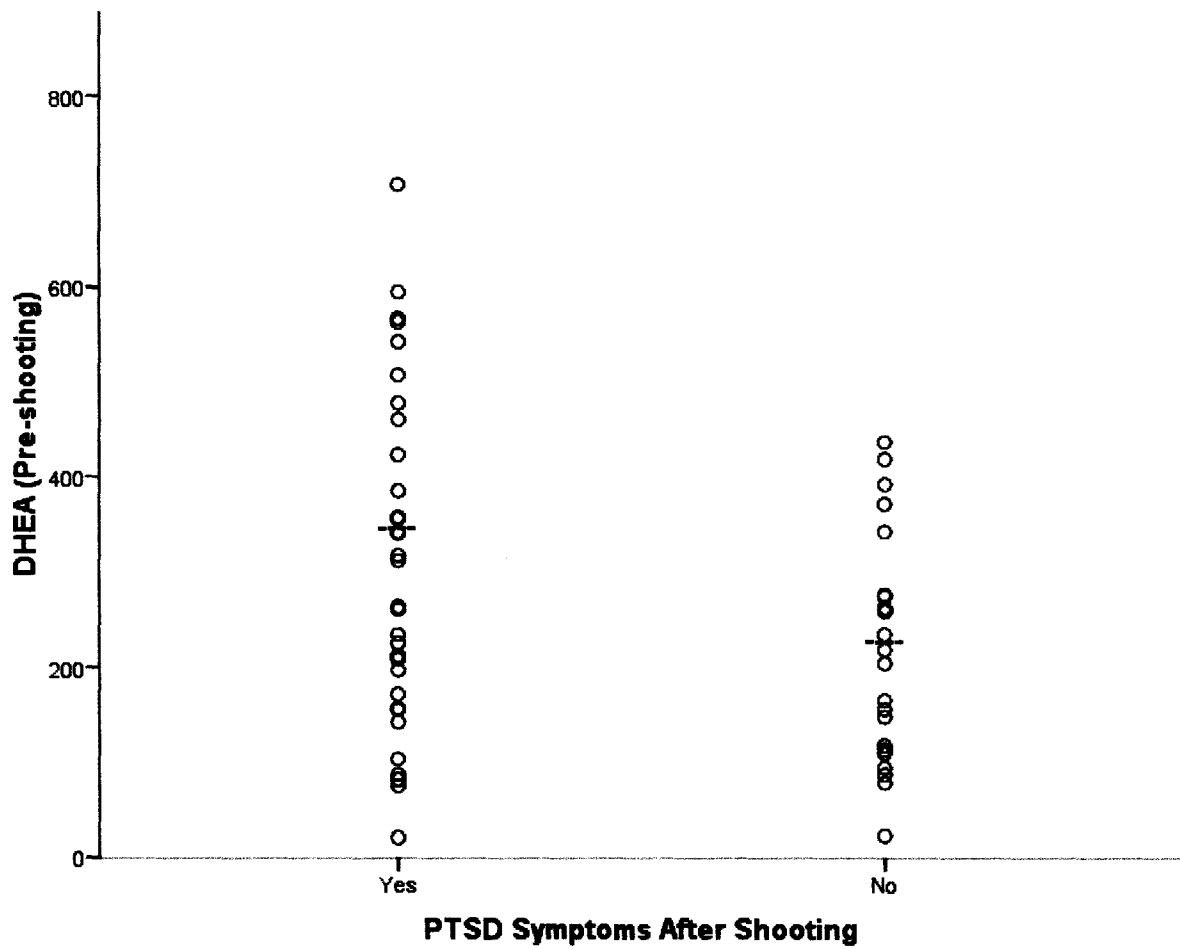
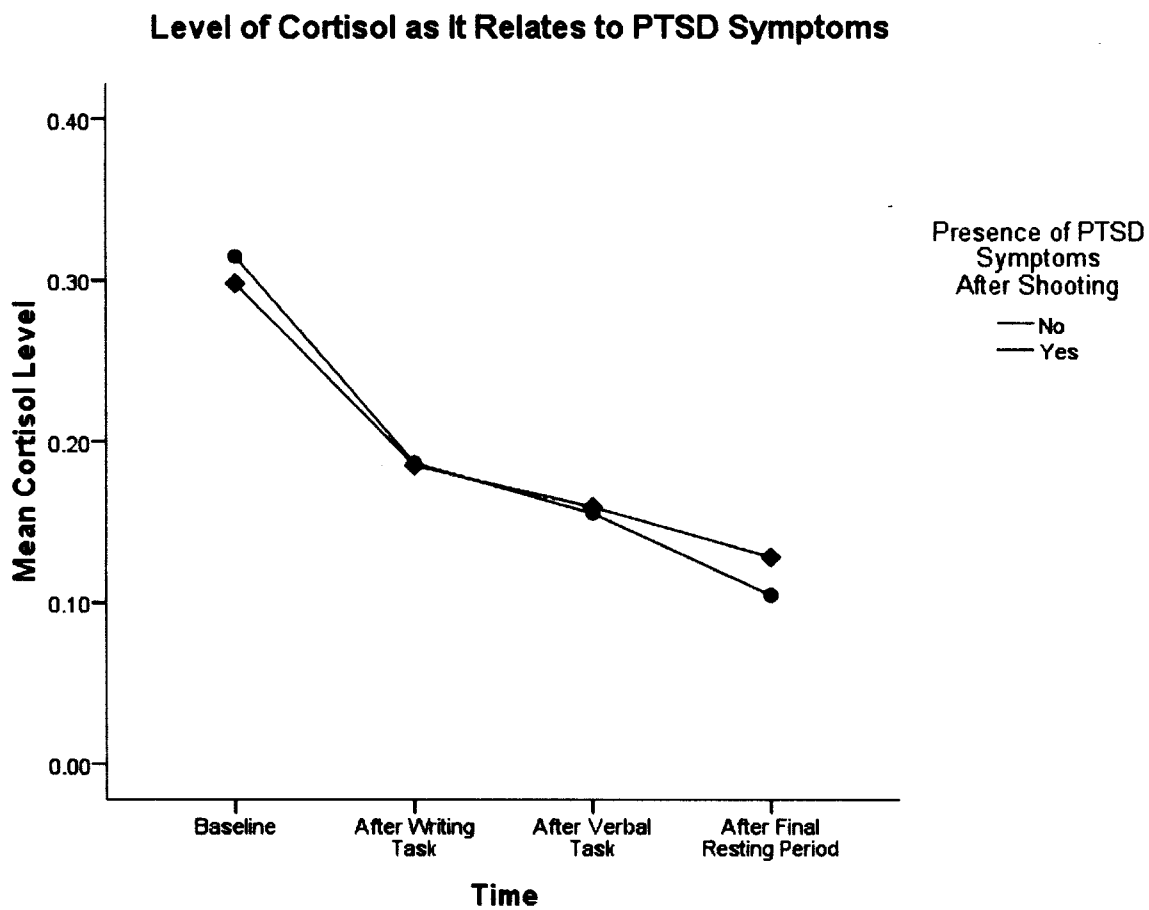


Figure 1. Comparison of the mean level of pre-shooting DHEA levels to the presence of PTSD symptoms immediately after the shooting. There was a significant difference between the group means in DHEA levels prior to the shooting ( $p < .05$ ).



*Figure 2.* Cortisol decreased over the session regardless of the presence of PTSD symptoms, across all time points.



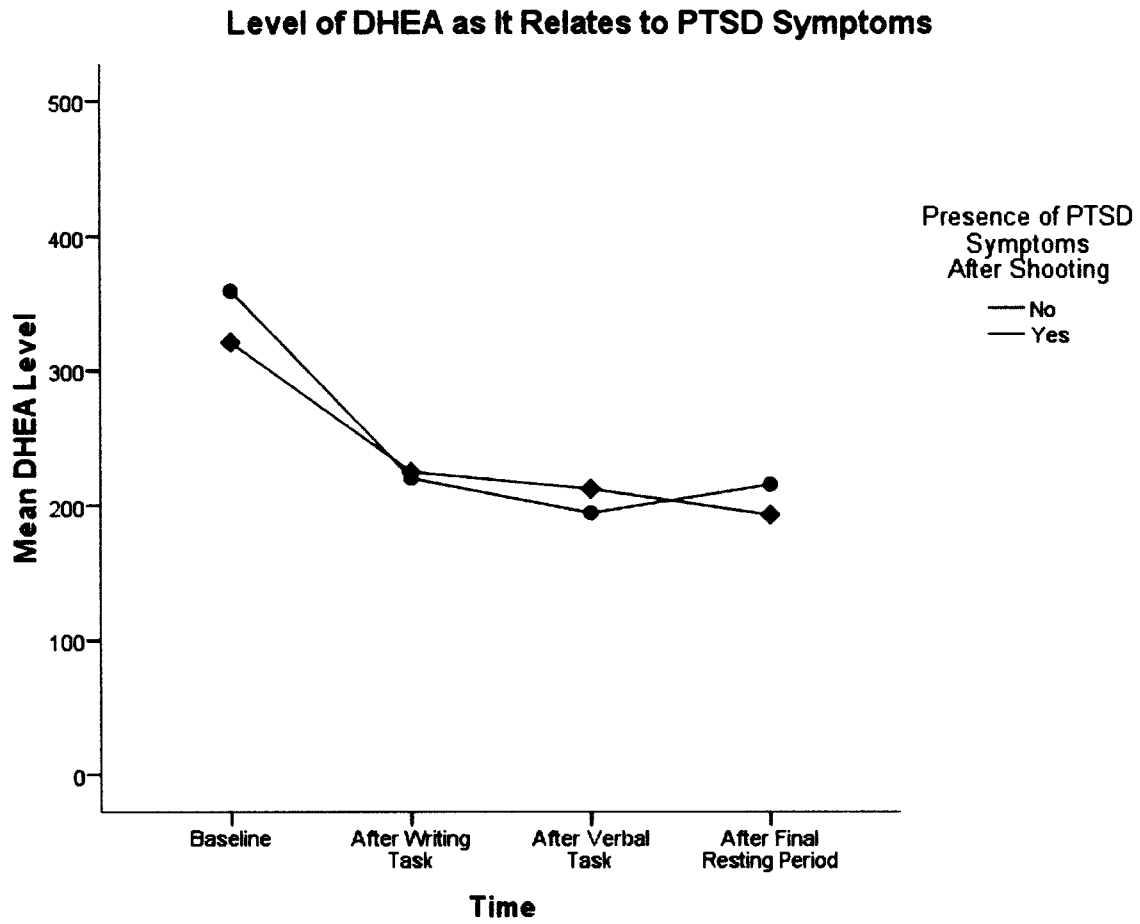


Figure 3. Mean level of DHEA according to the presence of PTSD symptoms immediately after the shooting.

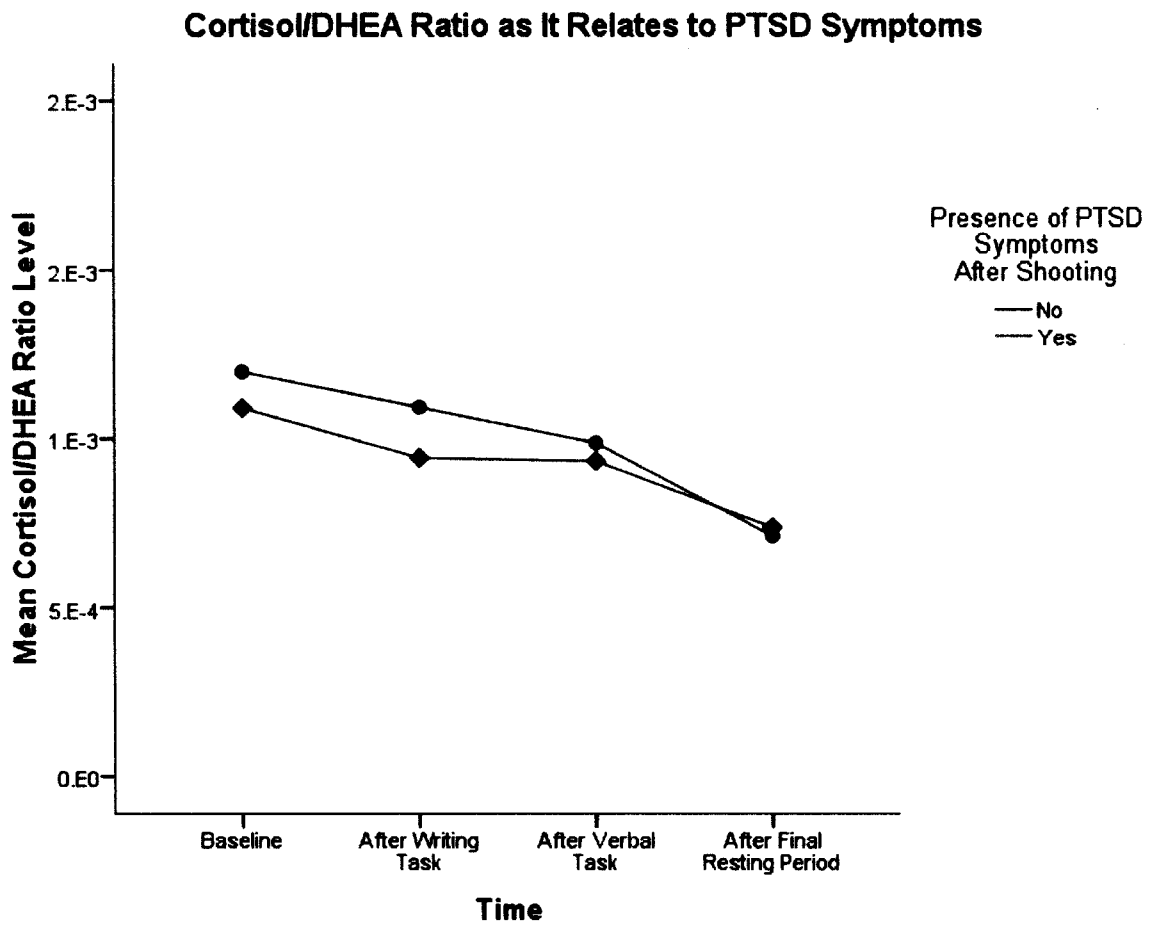


Figure 4. Ratio of cortisol/DHEA for the presence or lack of PTSD symptoms.

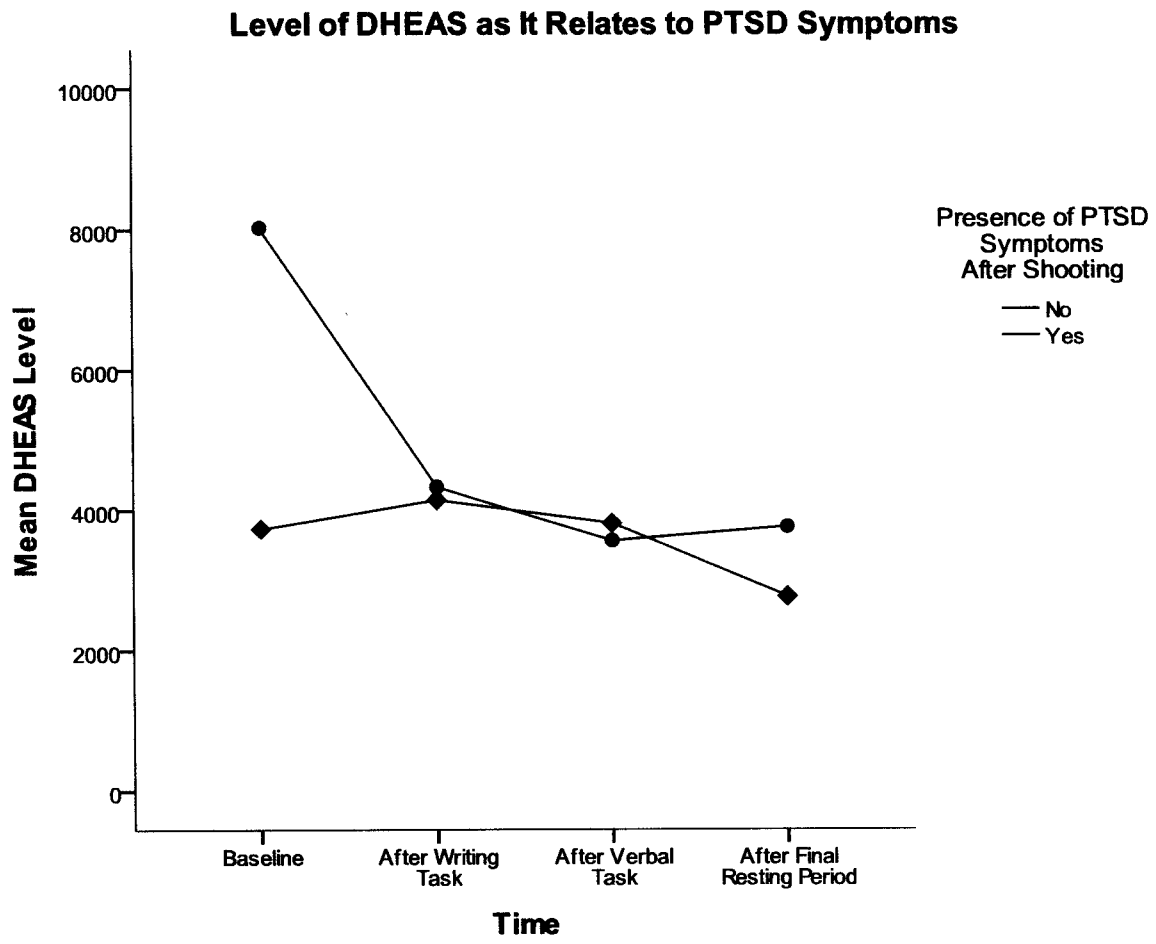


Figure 5. Mean levels of DHEAS relative to PTSD symptom presence.