The cortisol awakening response and combat exposure during military deployment as predictors for burnout

Prospective Research Into Stress in Military Operations

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Preface

During my studies Humanistics and Psychology I grew interested in the relationship between hormones and behavior. I was fascinated by the fact that people can act so differently in the same situation. I learned that there is a reciprocal relationship between our physiology and behavior and that experiences, thoughts and behavior can literally change our brain or the production of hormones. When the chance occurred to participate in a European study of biological and psychological factors associated with Post Traumatic Stress Disorder (PTSD), I gladly took the opportunity. A switch to the Prospective research Into Stress in Military Operations (PRISMO) study was necessary after four months in order to receive the data I needed. This gave me the opportunity to get involved in a large prospective study. This was a unique possibility to contribute to a large study and to have access to a large data base of information. It was clear to me that I wanted to continue in psychobiological research. The hormone cortisol had my special interest, since it has such a widespread effect on physical as well as on psychological symptoms. The fascination for cortisol lead me to burnout, a syndrome that is known to have a relationship with cortisol. I wondered if there would be a causal relationship between burnout and cortisol. Since no information is available as to which is the consequence of the other, this inspired me to look for possible explanations of the nature of relationship between cortisol and burnout.

During the course of my research I received support and information from a number of people, which I would like to thank. First of all I would like to thank the whole PRISMO team for allowing me to examine the data. Especially Dr. (to be) Mirjam van Zuiden, for her directions, guidance, support, constructive feedback and helping me out when I was facing SPSS difficulties. Dr. Elbert Geuze, Dr. (to be) Arthur Rademaker, Dr. (to be) Saskia van Liempt and Dr. Eric Vermetten for their support and analytical view. All the other employees and trainees; Anne, Maurits, Saskia, Maartje, Femke, Mitzy and Bart for listening to my stories and helping me continue in more difficult times. Last but not least I would like to thank Prof. Dr. Rolf Kleber for his support, time and directions.

Abstract

Objective

The purpose of this study was to investigate whether the cortisol awakening response (CAR) and the amount of combat exposure were predictors for burnout in a military sample. The CAR and burnout scores before and six months after deployment were also examined. Based on previous research, participants were hypothesized to have a lower CAR and higher burnout scores after deployment. We also expect that the number of combat related events during deployment is a significant predictor for burnout scores after deployment. Finally we expect that the CAR is a significant predictor for burnout scores after deployment.

Method

Participants are measured before deployment and six months after deployment. The sample consisted of 62 participants from the Dutch military who left for deployment to Afghanistan between April 2005 and November 2006. Burnout was assessed with the Utrechtse Burnout Schaal (UBOS) and combat exposure was measured with the Deployment exposure Scale (DES). The cortisol awakening response was analyzed from saliva. Hierarchical multiple regressions were used to perform statistic analysis.

Results

The prevalence of burnout was 9.84 % before deployment and 20 % after deployment. The CAR was significantly lower after deployment than before. After deployment, the CAR (AUC) explained 9.3 % of the variance in UBOS-subscale exhaustion. The DES explained 7.8 % of the variance in UBOS-subscale competence.

Discussion

The prevalence of burnout in our sample doubled after deployment. One out of every five participants met the criteria for burnout after deployment. A higher cortisol awakening response before deployment is a predictor for higher burnout scores six months after deployment. Furthermore, the more combat related events a person experienced, the less competent they felt six months after deployment.

Chapter 1: introduction

'Everyone has his breaking point'. This comment, made by a British military psychiatrist, implies that psychological fitness is not a stable personality trait on which persons can easily be selected, but depends on the degree in which someone is exposed to shocking experiences (Meijer, 2008*).* Nonetheless, pre-traumatic characteristics such as personality or physiology can make a person vulnerable for developing psychological problems as well (Narumoto et al., 2008). The psychological problems that a person can develop after being exposed to a stressful event can take many forms. In this paper we will focus on a disorder which affects a large number of military personnel and which is presumed to be the result of chronic stress, namely burnout. We will examine the relationship between burnout and pre-traumatic physiological characteristics and peri-traumatic stressful events in Dutch military personnel who have been deployed to Afghanistan between 2005 and 2008.

The central question we would like to investigate in this paper is: "Are the cortisol awakening response (CAR) before deployment and the amount of combat exposure during deployment predictors for burnout scores six months after deployment in military personnel?". We will elaborate on the chosen research question in chapter two.

First, we will discuss the theoretical background and recent research results concerning cortisol, burnout and combat exposure. We will end chapter two with the formulation and justification of our hypotheses. In chapter three we will discuss participants, questionnaires, methods used obtaining the biological data and the justification for the choice of statistical analyses. In chapter four the results of our analyses will be described. To conclude with, in chapter five the results will be interpreted, an evaluation of research methods will be given and future research will be discussed.

Chapter 2: theoretical background

2.1 Burnout

Burnout is a stress-induced work-related syndrome characterized by emotional exhaustion, depersonalization (a feeling of being unreal, detached or unable to feel emotion) and feelings of reduced competence (Maslach, Schaufeli & Leiter, 2001). Other symptoms that have been reported by people dealing with burnout are tension headaches, an inability to relax, gastrointestinal problems, muscle aches, disrupted sleep, concentration and memory problems and depressive symptoms (Mommersteeg, Heijnen, Kavelaars & van Doornen, 2006). Burnout has often been described in individuals with a high sense of job ideals and whose jobs require a high degree of social interaction (Kudielka, Bellingrath & Hellhammer, 2006). When the most important "instrument" to work with is oneself, failures and problems at work can easily lead up to doubts about the self (Schaufeli & van Dierendonck, 2000). Burnout is hardly mentioned in articles that study military samples. The question is whether this is justified when we take a look at the prevalence of burnout. In the Netherlands, a stable 9% of the working population report emotional exhaustion within the clinical burnout range (Mommersteeg et al., 2006). The prevalence was not reported for military subsets. However, research results from Pflanz and Ogle (2006), who examined a subset of 809 participants from the U.S. Military, showed that more than one-quarter (27.4%) of this military population reported suffering from significant job stress. The same research further showed that the report of work stress was significantly related to impaired work performance, more days of missed work and poorer physical health. These results emphasize the importance of burnout- research within military samples.

2.1.2 Psychological and physiological correlates of burnout

Results concerning psychological correlates of burnout have been quite consistent. From previous research it is known that higher emotion-oriented coping and higher neuroticism are predictors of burnout (Narumoto et al., 2008). Moreover, Maslach found that "those individuals that appear to be weak and unassertive, reserved and conventional, and unable to express or control their emotions (e.g. hostility, impatience, empathy, fear) are more prone to burnout" (as cited in Stearns & Moore, 1993, p. 129). Physiological correlates of burnout on the other hand are much more disputed and results have been inconsistent. Higher salivary cortisol levels were found in participants with burnout compared to participants without burnout symptomatology (Melamed et al., 1999). However, lower cortisol levels in participants with high burnout (Pruessner et al., 1999) and no association between burnout and cortisol have been found as well (Grossi, Theorell, Jurisoo & Setterlind, 1999; Grossi, Perski, Evengard, Blomkvist & Orth-Gomer, 2003). The negative feedback system in our body that is responsible for the production of cortisol is the Hypothalamic-pituitary-adrenal axis (HPA-axis). A review of all studies about the HPA-axis in burnout pointed out that the controversial results may be a consequence of methodological issues (Kudielka, Bellingrath & Hellhammer, 2006). We will further elaborate on this when we discuss the association between burnout and cortisol

2.2 Combat exposure

Research indicates that deployment to combat zones and witnessing atrocities are associated with increased prevalence of psychological (Sareen et al., 2007) as well as physical problems (Elder, Shanahan & Colerick, 1997). In the study by Sareen et al. (2007) the prevalence of mental disorders was investigated in a sample from the Canadian military. The three most common disorders in order of prevalence were major depression (6.8%), alcohol dependence (3.8%) and social phobia (3.2%). The prevalence of post traumatic stress disorder (PTSD) in this study was 2.3%. Dohrenwend and coworkers (2006) demonstrated a dose-response relationship between the amount of combat exposure and mental disorders within Vietnam veterans. This result is supported in the study by Sareen et al. (2007), where after adjusting for the effects of exposure to combat and witnessing atrocities, deployment to peacekeeping operations was not associated with increased prevalence of mental disorders. The researchers suggest that the increased risk for mental health problems after deployment is caused by traumatic experiences during the deployment, rather than deployment per se.

2.3 Hypothalamic-pituitary-adrenal axis (HPA-axis) and cortisol

As mentioned, not only peri-traumatic experiences, but pre-traumatic characteristics as well can contribute to the development of psychological problems. We know that burnout is a stress-induced disorder (Maslach et al., 2001). We also know that a connection exists between stress and the hormone cortisol. How does this connection work? We can find the answer when we examine the HPA-axis. During acute stress the HPA-axis is activated and corticotrophin-releasing hormone (CRH) is released by the hypothalamus under the influence of serotonin from the amygdala. CRH then stimulates the pituitary to release adrenocorticotropic hormone (ACTH), which results in the production of glucocorticoids (cortisol) in the adrenal cortex (Meewisse et al., 2007).

Cortisol is the end-product of the HPA-axis and has a wide range of physiological effects. For instance, cortisol is critically involved in metabolism by mobilizing resources to provide energy. It also influences other important physiological systems, such as the immune system, the sympathetic-adrenal-medullary (SAM) axis, the cardiovascular system, and affective and cognitive processes (Heim et al., 2000). It has been suggested that a disrupted HPA-axis, with either hypo- or hyper functioning, could therefore act upon these systems resulting in burnout symptoms as a possible consequence of these dysregulations (Mommersteeg, Doornen van & Heijnen, 2003). Cortisol can circulate in the blood free or bound to proteins such as corticosteroid binding globulin (CBG) and serum albumin. Free or unbound cortisol represents the biologically active hormone fraction in individuals and is less than 6 % of total cortisol levels (Lewis, Bagley, Elder, Bach & Torpy, 2005). Only free cortisol is available to bind to most receptors**.** In this research, we use salivary cortisol, which contains only free cortisol that has entered into the saliva glands primarily by passive diffusion (Levine, Zagoory-Sharon, Feldman, Lewis & Weller, 2007).

2.3.2 Cortisol Awakening Response (CAR)

In this research we will use the cortisol awakening response (CAR) as our pre-traumatic characteristic. Recent studies have demonstrated that the free cortisol response to awakening can serve as a useful index of HPA-axis activity (Kudielka et al. 2006). Awakening acts as a mild stressor and the increase in cortisol during awakening gives an indication of the stress-responsivity of the HPA-axis (Roberts, Wessely, Chalder, Papadopoulos, & Cleare, 2004). In healthy individuals, cortisol rises rapidly after awakening, reaching a peak within 30-45 minutes. Within those first 30-45 minutes after awakening, free cortisol levels rise by 50-60% and remain elevated for at least 60 minutes (Pruessner et al., 1997, Schulz, Kirschbaum, Pruessner &

Hellhammer, 1998). Cortisol levels gradually fall over the day, rising again in late afternoon. In the late evening, cortisol levels fall again, reaching a trough during the middle of the night.

2.4 Burnout and cortisol

There is empirical evidence that changes in the CAR are related to chronic work stress. Previous studies have concluded that chronic social stress (Wust et al., 2000b) leads to an enhanced awakening response. Melamed and coworkers (1999) observed higher morning and afternoon salivary cortisol levels in industrial workers with both non-chronic and chronic burnout compared to employees without burnout symptomatology. However, Pruessner and coworkers (1999) found a lower CAR in participants with a higher burnout score. Moreover, two studies by Grossi and coworkers (Grossi et al.,1999; Grossi et al., 2003) could not reveal associations between burnout and cortisol. According to Kudielka et al. (2006), these insignificant results can presumably be attributed to the chosen blood sampling designs (namely single venipunctures). All the studies mentioned above included relatively healthy participants from a working population divided into subgroups according to their score on a burnout questionnaire. In a study which compared HPA-axis functioning in clinically diagnosed burnout participants and healthy controls, no differences were observed in the CAR, day-curve (12 AM, 6 PM, 10:30 PM) or CAR after the low-dose (0.5 mg) dexamethasone suppression test (Mommersteeg et al., 2005). We can conclude that all these results show that there is no consistent type of HPA-axis dysregulation in burnout.

2.5 Hypotheses

To the best of our knowledge, the present study is the first to explore the association between burnout (as defined by the Utrechtse Burnout Schaal (UBOS)) and both a pre-traumatic- (CAR before deployment) and a peri-traumatic (the amount of combat exposure) characteristic within a military sample. As far as we know, there is no literature available in which the causal relationship between cortisol and the development of burnout is explored. However as shown above, multiple researchers have found an association between cortisol and burnout. These results form the basis of our hypotheses.

We hypothesized that:

1. *Cortisol levels will be significantly lower after deployment than before deployment*. This hypothesis is supported by previous research where lower cortisol levels were found in participants who had been deployed in comparison with healthy control participants (de Kloet et al., 2007, Meewisse et al., 2007).
2. Since deployment can be a stressful experience during which job demands can be particularly high s*cores on the UBOS will be significantly higher after deployment than before deployment*.
3. *Morning cortisol levels before deployment are a significant predictor for burnout scores after deployment*. Since cortisol affects the immune system, systems that provide energy and cognitive and affective processes (Heim et al, 2000), dysregulations in the level of cortisol may be related to symptoms that are found in individuals with burnout (Mommersteeg et al., 2003). We have chosen not to specify the direction of the association, since previous research results have shown both directions.
4. *The number of traumatic events military personnel have experienced will correlate positively with scores on the UBOS*. This last hypothesis is based on an article by Sareen and colleagues (2007) where the researchers demonstrated that the increased risk for mental health problems after deployment is caused by traumatic experiences during the deployment, rather than deployment per se.

Chapter 3 Methods

Prismo (Prospective Research Into Stress in Military Operations).

Prismo is a large prospective study into risk factors for the development of deployment-related disorders. Approximately a thousand participants from the Dutch Army were included in cohorts. There were no selection criteria other than that participants had to be selected for deployment. The project follows each participant for a time period of ten years after deployment to Afghanistan and will presumably be finished in 2018. Prior to deployment, psychological as well as biological parameters are measured. These measurements are repeated approximately 1-3 months and six months after deployment. There is a follow-up of psychological measures after 1, 2, 5 and 10 years. To recruit participants, info-meetings were held at barracks and participants were asked to participate. Participants were given a detailed verbal explanation and all participants provided written informed consent before participation. All participants received a study pack for the first measurement. It contained full standardized written instructions for the study questionnaires and saliva assessment. The study pack also contained questionnaires and saliva tubes. Furthermore, blood was drawn from all participants.

3.1 Participants

Participants for this study were drawn from the design described above. The assessment before deployment and six months after deployment were both included in the current study. Our sample consisted of 62 participants from the Dutch Military (mean age during deployment: 33.45, SD= 10.09, range: 18-55 years, 57 men and 8 women). This sample is much smaller than the original number of participants because only a small percentage of these participants had completed all the measurements required for this study yet. All participants of the current study left for deployment to Afghanistan between April 2005 and November 2006. Sample characteristics are presented in table 1.

Table 1. Sample characteristics

Characteristic	Prevalence %
Sex	
M	87
F	13
Age during deployment	
18-25	27,4
26-34	33,9
36-45	24,2
46-55	14,5
education	
bachelor's degree or higher	24,6
postsecondary school below bachelor's degree	41
high school or less	34,4
smoking	
yes	45
no	55
alcohol (units per week)	
0-10	68,3
10-20	28,3
>20	3,3
year of deployment	
2005	40,3
2006	32,3
2007	27,4
type of mission	
PRT*	56,5
TFU**	43,5
Rank	
junior grouping	36
non-commissioned officers	41
officers	23
Previous deployment	
yes	55
no	45

* PRT = Provincial Reconstructing Team

** TFU = Task Force Uruzgan

3.2 Questionnaires

During the assessment before and six months after deployment, participants completed questionnaires to assess demographic items and levels of burnout. A month after participants returned from deployment, a questionnaire to assess combat experience was included as well.

3.2.1 The Utrechtse Burnout Schaal (UBOS).

The Utrechtse Burnout Schaal (UBOS) is the Dutch version of the Maslach Burnout Inventory (MBI) and is developed by Schaufeli. The UBOS is constructed from an original compilation of 28 items on the basis of regression-, factor- and reliability analyses (Schaufeli, Leiter & Kalimo, 1995). The questionnaire consists of three subscales; exhaustion, competence and depersonalization and has fifteen items. Burnout measured by the UBOS is therefore a three dimensional construct. The exhaustion subscale consist of items such as: "I feel mentally exhausted from my job" and "At the end of a working day I feel empty". The depersonalization subscale consists of items such as: "I am cynical about the effects of my work" and "I notice that I have too much distance when it comes to my work". Finally the competence subscale consists of items such as: "I feel very confident at work" and "I have achieved a lot of great things during this job".

The exhaustion subscale has a strong correlation with workload (overburdening, job demands) and with complaints of all types (e.g. health-, anxiety-, psychological- and job-related complaints). The depersonalization subscale has a moderate to strong correlation with complaints of all types. The competence subscale has a significant but small correlation with job satisfaction, anxiety and commitment. Test-re test reliability is high. The exhaustion subscale is the most stable subscale (33-70% shared variance over the period of one year), followed by the competence subscale (37-47%) and the depersonalization subscale (31-44%) For the classification of burnout, a score above the 75^{th} percentile (a score classified as high or exceptional high) on the subscale exhaustion is required in combination with a score above the 75^{th} percentile on the subscale depersonalization or a score below the 25^{th} percentile (classified as low or extremely low) on the competence subscale. In general a more differentiated diagnosis in terms of three separate subscale scores is preferred. This information is more clinically relevant for possible interventions or treatment (Schaufeli et al., 2000).

3.2.2 Deployment Exposure Scale

The questionnaire contains 19 dichotomous items, which assess combat experiences ("Have you witnessed any shootings directly at you?"), suffering of others ("Have you witnessed human suffering?"), lack of control ("Did you have the feeling that you had no control over the situation?") and feelings about the mission ("Did you have the feeling that the mission was pointless?") (Appendix I). This questionnaire was developed for the PRISMO study by employees of the research centre of the Military Mental Health Service; therefore no validation of this questionnaire exists yet. However most questions are derived from validated combat exposure lists such as the Combat Exposure Scale (CES) which has an internal consistency of .85 (Coefficient alpha) and a test-retest reliability of r = .97 (Keane et al., 1989).

3.3 Endocrine measure; cortisol awakening response

The CAR is a rather consistent endocrine marker, which shows good intra individual stability over time and appears to be able to uncover subtle changes in HPA-axis regulation (Wust, Federenko, Hellhammer & Kirschbaum, 2000b). Results from a study in more than 500 participants suggest that the CAR is not significantly affected by age, sleep duration, time of awakening, use of an alarm clock, smoking or use of an oral contraceptive (Wust et al, 2000a). Therefore we did not control for these variables.

Salivette saliva sampling devices (Sarstedt, Niimbrecht, Germany, No. 51.1534) were used for collecting saliva. Participants kept the cellulose tampon in their mouth for approximately 1 minute and were advised to let it circulate so that the tampon would absorb enough saliva. Thereafter, the tampon was directly transferred to the inner of the two polystyrene tubes. Participants were instructed to collect saliva immediately upon awakening and 15, 30 and 60 minutes after awakening on two consecutive days. Participants mailed their samples to the research centre in Utrecht (ideally within two weeks), where the samples were frozen and send to Germany for analysis (technical University of Dresden, Germany). Prior to analysis the samples are thawed and centrifuged so that the salivary liquid is transferred to the outer tube. Clear saliva can be pipetted from the outer polystyrene tube after discarding inner tube and tampon. Saliva samples which are diagnosed to be contaminated with blood are excluded from analysis. The salivary cortisol is then analyzed with a time-resolved immunoassay with fluorescence detection (DELFIA) (Dressendorfer, Kirschbaum, Rohde, Stahl, & Strasburger, 1992).

3.4 Statistical analyses

First of all, area under the curve with respect to the ground (AUC) was calculated as indice for the CAR. The AUC measurements were also recalculated corrected for the reported sampling time (for details about the formula see: Pruessner, Kirschbaum, Meinlschmid & Hellhammer, 2002). We decided to use the AUC and not the mean increase, since we were mainly interested in the effect of cortisol levels on exhaustion. Investigating the effect of the slope of the curve, i.e. how rapidly cortisol levels increase in the morning, is beyond the goal of this current research.

To select the important variables out of the many available variables, relationships between 10 cortisol variables, 8 burnout variables, total DES-scores and demographic variables were investigated. Pearson product-moment correlation coefficients were used for the variables which met the criteria of normality, linearity and homoscedasticity. For the variables which violated these assumptions, Spearman rank order correlations were used.

Subsequently, a one-way repeated measures ANOVA was conducted to compare scores on cortisol awakening levels at Time 1 (prior to deployment) and Time 2 (6 months following deployment). A normal distribution was obtained by performing a square root transformation on the cortisol data collected immediately, 30 and 60 minutes after awakening. Although cortisol data collected 15 minutes after awakening were already normally distributed, the square root transformation was performed here as well to ensure valid comparisons between variables.

Since we were unable to obtain a normal distribution for the results on the burnout questionnaire, we chose a non-parametric alternative (Wilcoxin Signed Ranks test) to the repeated measures t-test. The Wilcoxin Signed Ranks test was performed to compare scores on UBOS subscales at Time 1 and Time 2.

To test the predictive value of our variables we performed hierarchical multiple regression analyses. Two different hierarchical multiple regressions were used, since the predictors we were interested in (AUC and the DES) correlated with two different subscales of the UBOS. This resulted in two different dependent variables and therefore the decision was made to perform two hierarchical multiple regressions. The use of UBOS subscales as dependent variable instead of the total score is based on the fact that the UBOS total score is a categorical variable, which only provides information about whether a participant meets burnout criteria or not. By using the total scale, important information would get lost. Regression analyses were performed to assess the ability of cortisol levels prior to deployment to predict levels of exhaustion post deployment, after controlling for the influence of exhaustion levels prior to deployment. Preliminary analyses were conducted to ensure the assumptions of normality, linearity, multicollinearity and homoscedasticity were not violated. To obtain a normal distribution for the levels of exhaustion after deployment, the following transformation was used: 1/sqrt(y). To compute the best possible transformation, different box-cox transformations were executed in minitab (www.minitab.com). Another hierarchical multiple regression was performed to assess the predictive ability of the DES-scores on the competence subscale scores post deployment, after controlling for the influence of competence levels as measured by the UBOS prior to deployment. Preliminary analyses were conducted here as well.

3.4.2 Missing responses

Non-response on the assessment of salivary cortisol in the total PRISMO data set was high. Possible reasons for non-compliance are that saliva was collected at home and no further reminders were given. The unpleasant sensation of the salivettes and the large amount of saliva tubes (ten) may have added to the non-compliance as well. For inclusion in the current study, participants had to have valid and complete cortisol data for both assessments (for exact criteria see Wust et al. (2000b)). Due to technical problems and handling of the saliva tubes, less data than expected could be used. Only 62 out of the 228 participants had already returned from deployment for six months and met the inclusion criteria for the current study. Per sample point, cortisol data deviating over two standard deviations from the range as drawn up by Wust et al (2000) were excluded from further analysis. Missing cortisol data and outliers made up 1.6% of the dataset for this study (which consisted of 62 participants). The DES was filled out by 51 out of 62 participants. Fifteen participants did not fill out the questionnaire due to the fact that this questionnaire was later added to in the research. However, ten of them were called back and we were able to use their results. Five participants could not be reached and six participants did not fill out the DES at all, although they received the bundle of questionnaires with the DES already included.

Chapter 4 Results

4.1 Correlations

Pearson product-moment correlations between UBOS-variables, AUC and the DES are presented in Table 2. UBOS variables not presented in this table violated assumptions of normality, linearity and/or homoscedasticity. The Spearman rank order correlations of these variables can be found in Appendix II. Several observations can be made when observing the correlations coefficients in Table 2. First, the small to moderate (positive) correlation between exhaustion after deployment and the AUC before deployment is notable. The second interesting correlation is the moderate (negative) correlation between the DES and competence after deployment.

Table 2
Pearson Product-Moment Correlations between measures of the cortisol awakening response, burnout and combat exposure.

	1	2	3	4	5
1. Exhaustion after deployment	-	.397**	.288*	.099	-0.047
2. Competence after deployment		-	.215	.070	-0.303*
3. AUC before deployment			-	.293*	-0.149
4. AUC after deployment				-	-0.013
5. DES					-

* $p < .05$ (2-tailed), ** $p < .01$ (2-tailed)

4.2 The effect of deployment on cortisol levels

A one-way repeated measures ANOVA was conducted to assess whether cortisol awakening levels changed from Time 1 (prior to deployment) to Time 2 (6 months following deployment) (table 2). The awakening curve consists of cortisol measurements at four different time points (i.e. 0, 15, 30 and 60 minutes following awakening). Repeated measures were performed per time point. In table 3 non-transformed values are reported.

Table 3. Descriptive statistics for cortisol values prior and 6 months following deployment for 0, 15, 30, and 60 minutes after wakening

Time of measurement	**N**	**Mean** (nmol/l)	**Standard deviation**
Time 1 (pre-deployment)			
T0	61	16,03	8,23
T15	61	20,85	10,13
T30	60	21,76	11,74
T60	58	17,56	11,89
AUC*	56	1208,51	529,6
Time 2 (post-deployment)			
T0	61	13,45	8,01
T15	61	16,8	9,5
T30	60	17,6	11,2
T60	58	16,6	11,56
AUC	56	996,7	502,62

*AUC = area under the curve {T0 + T15}/{2*15} + {T15+T30}/{2*15} + {T30+T60}/{2*30}).

As shown in Table 3 and Figure 1, cortisol levels were significantly altered after deployment for the following time points: immediately after awakening (Wilks' $\lambda = .91$, $F(1,60) = 5.84$, $p < .05$, $\eta^2 = .089$), 15 minutes after awakening, (Wilks' $\lambda = .9$, $F(2,59) = 6.53$, $p < .05$, $\eta^2 = .098$) and 30 minutes after awakening (Wilks' $\lambda = .92$, $F(1,59) = 5.25$, $p < .05$, $\eta^2 = .082$). There was no significant alteration over time of cortisol levels 60 minutes after awakening (Wilks' $\lambda = 1$, $F(2,56) = .16$, $p = .69$, $\eta^2 = .003$).

In addition, there was a significant alteration of the AUCG after deployment (Wilks' $\lambda = .89$, $F(1,55) = 6.621$, $p < .05$, $\eta^2 = .11$).

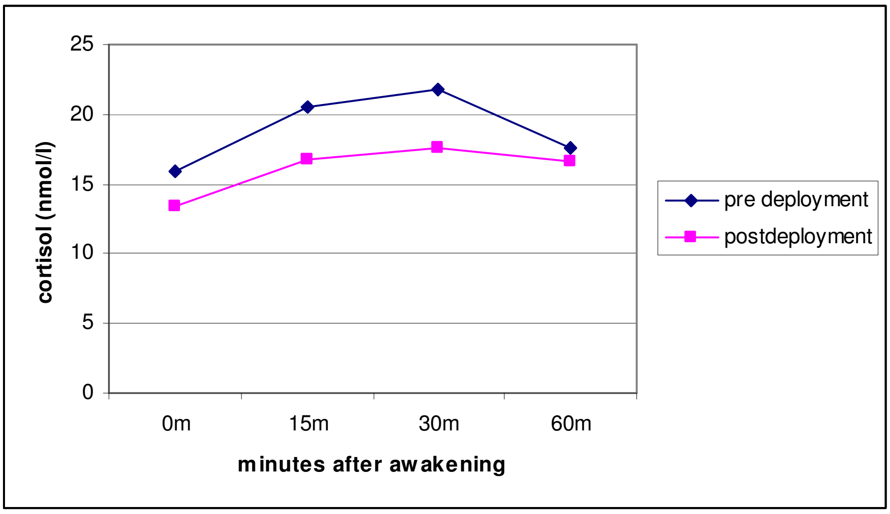

Figure 1. Mean salivary cortisol levels after awakening in our sample (n=62) before deployment and 6 months after deployment.

4.3 The effect of deployment on burnout

To test alterations in burnout scores after deployment, we chose to use the three subscale scores of the UBOS (i.e. competence, exhaustion and depersonalization) as outcome measure. Since the scores were not normally distributed, the nonparametric alternative for the repeated measures anova (Wilcoxin signed ranks test) was used to test whether there were significant alterations in subscale scores after deployment. Table 4 shows the mean subscale scores for burnout before deployment and after deployment.

Table 4. Descriptive statistics for UBOS scores prior and 6 months following deployment.

Subscales UBOS	N	mean	SD	burnout (N)
before deployment				
competence	61	4,57	0,94	
exhaustion	61	0,88	0,61	
depersonalization	61	1	0,75	
burnout	61			6 (9,84%)
after deployment				
competence	60	4,59	0,84	
exhaustion	60	1,31	1,08	
depersonalization	60	1,66	1,21	
burnout	60			12 (20%)

As shown in Table 4, 9.84 % of our sample met the criteria for burnout before deployment. Six months after deployment, 20 % of our sample met the burnout criteria. Furthermore, the wilcoxin signed ranks test revealed a statistically significant increase in levels of perceived exhaustion (z = -3.021, p< 0.005, small effect size (r= -.27)). The median score on the exhaustion subscale increased over time (before deployment (*Md* = 1); after deployment (*MD* = 1.2)). There was a statistically significant increase in levels of depersonalization as well (z =-3.84, p<0.001) medium effect size (r=.35)). The median score on the depersonalization subscale increased over time (before deployment (*Md* = 1); post deployment (*MD* = 1.25)). No significant changes in levels of competence were found (z =- 4.99, p = .618, effect size r=.05). The median score (4.67) remained the same.

4.4 The effect of cortisol on burnout

Hierarchical multiple regression analysis was used to assess the ability of the AUC before deployment to predict levels of exhaustion after deployment, after controlling for the influence of exhaustion levels before deployment. Preliminary analyses were conducted to ensure assumptions of normality, linearity, multicollinearity and homoscedasticity were not violated. As shown in table 5, exhaustion levels before deployment were entered at step 1, explaining 24.8 % of the variance in exhaustion levels after deployment. The area under the curve explained an additional 9.3 % of the variance in exhaustion after deployment (R^2 Δ = .093, FΔ (1, 56) = 7.95, p < .01). The total variance explained by the model at step 2 was 34.2 %, F (2, 56) = 14.54, p < .001). Both the level of exhaustion and the area under the curve before deployment were statistically significant in step 2.

Table 5

Multiple Regression of cortisol before deployment (AUC_1) on exhaustion 6 months after deployment (exhaustion_2), after controlling for exhaustion before deployment (exhaustion_1)

Variable	R^2	R^2 Δ	FΔ	β	t-value	p
Step 1						
exhaustion_1	0,24	0,25	18,33	0,51	4,7	<0.01
Step 2						
AUC_1	0,32	0,09	7,95	0,31	2,8	<0.01

Note. Adjusted R^2 values are presented. Beta coefficients in the overall model are presented.

Another hierarchical multiple regression analysis (Table 6) was performed to assess the ability of the DES total score to predict scores on the burnout competence scale after deployment. We controlled for the competence subscale score before deployment. Again, preliminary analyses were conducted to ensure the assumptions of normality, linearity, multicollinearity and homoscedasticity were not violated. Competence levels before deployment were entered at step 1, explaining 31.5 % of the variance in competence levels after deployment. The DES explained an additional 7.8 % of the variance in competence after deployment (R^2 Δ = .078, *F*Δ (1, 56) = 6.19, $p < .05$). The total variance explained by the model at step 2 was 39.3 % (*F* (2, 48) = *p*< .001). Both the level of competence before deployment and the DES were statistically significant at step 2.

Table 6

Multiple Regression of combat exposure (DES) on competence 6 months after deployment (competence_2), after controlling for competence before deployment (competence_1)

Variable	R^2	R^2 Δ	FΔ	β	t-value	p
Step 1						
competence_1	0,3	0,32	22,26	0,55	4,75	<0.01
Step 2						
DES	0,37	0,08	6,19	-0,28	-2,5	<0.05

Note. Adjusted R^2 values are presented. Beta coefficients in the overall model are presented.

Chapter 5: discussion

5.1 Altered cortisol levels following deployment

This study demonstrates that in a group of military personnel, who were deployed to Afghanistan, deployment had a long-term effect on the HPA-axis, since lower cortisol levels were present six months after deployment. This supports earlier findings by de Kloet et al.(2007) and Meewisse et al. (2006). Our finding appears to fit unto the theory of sustained activation. Sustained activation can be a result of prolonged or repeated exposure to stressors, which a person cannot adequately cope with. During periods of chronic stress these body systems can become either unable to mount an appropriate response or overly sensitive, and become overloaded by the normal cascade of stress hormones (Pizarro, Silver & Prause, 2006). During deployment - when there are life threatening situations - the stress system becomes hyper activated. However after deployment, the HPA-axis glides into a state of hypo activation, in which the hpa-axis is not able to adequately respond on stressors anymore. This may cause diminished immune functioning and might result in infections and a feeling of sickness (van Houdenhove, 2005). It has been suggested earlier that where hyperactivity is associated with chronic stress, hypo-activity is associated with the period after a stressful situation (Heim, et al. 2000). Our finding supports this. However, we have not investigated if participants noticed these changes in immune functioning. Future research should address this as well.

5.2 The effect of deployment on burnout

In our sample 9.8 % of the military personnel met the criteria for burnout before deployment. More notable are the results six months after deployment, where 20 % of the military personnel in our sample met the criteria for burnout. This means that the percentage of participants with serious burnout symptoms has been more than doubled after deployment. Moreover, it means that one out of every five participants suffers from serious burnout symptoms six months after deployment. Again, this result demonstrates the long-term effect of deployment. However, the fact that 20% of our subset met the criteria for burnout six months after deployment does not mean that 20 % of our sample dropped out from work, called in sick or looked for help. It is likely – since the work culture might not be sensitive for this type of complaints- that the larger part did not seek professional help. In a US military sample it was demonstrated that most soldiers who met the screening criteria for a mental disorder had not used any mental health services (Sareen et al., 2007). In addition, military personnel were more likely to report "attitudinal barriers" (e.g. "I would be seen as weak"). Burnout can have a serious impact on the wellbeing of military personnel, especially since they tend to not seek any help for their symptoms. One can imagine that symptoms such as feelings of exhaustion, depersonalization and feelings of reduced competence can have a serious effect on the wellbeing of personnel. Employees who do not feel connected to the work they do, call in sick due to the exhaustion symptoms or do not feel competent in their work, will not have a positive influence on their coworkers. Especially in the military field, where group cohesion is important, this can be seen as a great loss. When it comes to burnout, it is therefore important that there is enough attention for the consequences on the work environment.

5.3 The CAR as a predictor for exhaustion

Several studies have demonstrated a relationship between burnout and cortisol (Pruessner et al., 1999; Melamed et al., 1999). To these findings, the present study adds evidence that a significant causal relationship exists between the cortisol awakening response and the later development of the burnout symptom of exhaustion, which is the most important symptom of burnout. A higher cortisol awakening response before deployment is a predictor for higher exhaustion scores six months after deployment. No correlation between the CAR and the competence and depersonalization subscales were found. Furthermore, no causal relationship between the CAR and burnout total score has been established by this study. One could speculate that if we had a burnout scale which consisted of the sum of the three subscales in stead of a dichotomous category, a causal relationship between the burnout total score and the CAR might very well be found.

Our results imply that higher cortisol awakening levels may be a vulnerability factor for the development of burnout. Recent research results indicate that there might be personality factors that mediate the relationship between the CAR and burnout. Rademaker et al. (2009) found that harm avoidance explained 9% of variance in cortisol levels after awakening in a sample from the same study as the current participants were drawn from. Harm avoidance is a personality dimension associated with inhibition of behavior. It is positively correlated with trait anxiety

(Jiang et al., 2003) and neuroticism (De Fruyt et al., 2000). Individuals with an anxious disposition (i.e., neurotic and/or high harm avoidant) display an increased CAR and high cortisol levels after awakening, whereas people low on these traits can be expected to show flattened awakening cortisol curves (Polk et al, 2005). Also, there is evidence that harm avoidance and neuroticism may reflect a genetic predisposition for certain mental disorders (Ono et al., 2002). Previous research showed that higher emotion-oriented coping and higher neuroticism are predictors for burnout (Narumoto et al., 2008). Since neuroticism is related to both burnout and high cortisol levels after awakening, this can indicate that neuroticism can explain the relationship between an elevated CAR before deployment and burnout after deployment. The CAR could act as a mediator as well, however more research is needed to find out more about the relationship between neuroticism, burnout and cortisol levels.

5.4 Combat exposure as a predictor for burnout

In general, feelings of competence stayed the same before and after deployment. However, our results show that there is a negative relationship between the amount of combat exposure during deployment and competence scores six months after deployment. The more combat related events a person experienced, the less competent they felt six months after deployment. No relationship was found between competence and the cortisol awakening response. Competence is one of the basic needs of wellbeing. Furthermore, the need for competence is fulfilled by the experience that one can effectively bring about desired effects and outcomes (Reis, Sheldon, Gable, Roscoe and Ryan, 2000). Lacking feelings of control might therefore lead to feelings of reduced competence. One could speculate that traumatic events generate feelings of lack of control, since the outcome of those events can often not be controlled and not always have the outcome as desired. More in depth interviews would be needed to find out more about the personal experiences and the impact of those experiences on feelings of competence. Our deployment exposure scale (see appendix 1) only consists of dichotomous questions, therefore no information is available about personal experiences or the impact of those experiences.

5.5 Strengths, limitations and implications

Our study is the first to investigate the predictive value of the CAR on burnout scores within a military sample. Our results are relevant for the society since burnout affects a large part of the working population. Investigating burnout and possible predictors contribute to the opportunity of preventing burnout in the future and can therefore reduce mental health service use costs. Furthermore, we used validated research methods and questionnaires - with the exception of the DES- which was created for this research and not validated yet. We also used a rather consistent biological marker: the cortisol awakening response. Another strength of this research is that we have been accurate in the use of our data, since participants with abnormalities in their cortisol awakening response have been excluded from analyses. Moreover, our results are comparable to other publications, since we replicated earlier research results (de Kloet et al., 2007; Meewisse et al., 2008).

However, this study has some limitations. For the measurement of salivary cortisol, this design depended on the compliance and punctuality of the participants. The risk that participants did not measure cortisol at the right moment or did not fill in the form correctly is not ruled out. Since we relied on self-report data exclusively, the results we present in this paper may have been biased. The possible influence of response bias, which is known to be inherent in the use of self-report measures, cannot be excluded. Furthermore confounders that we have not investigated might be of possible influence. For instance, we have not investigated whether burnout was related to other psychiatric diagnoses such as PTSD and depression. Since we have a rather small sample, we recommend repeating this research within a larger sample size. However, the question remains whether the present findings can be generalized to the general population. Therefore research in other populations is needed. An important note as well is that although the UBOS is a validated instrument for burnout screening, the validity of the results may not match that of diagnoses made by trained clinicians.

In the light of these strengths and limitations we can conclude that the present study aids in understanding and disentangling the complicated relationship between physiological and mental processes related to deployment. Not only have we provided evidence for physiological as well as psychological effects of deployment, we also demonstrated that these are long-term effects. This research shows that the effects of deployment should not be underestimated at any time. The results show that it is necessary that more attention needs to go to the screening and treatment of burnout, both before as well as after deployment. A physiological screening can provide useful information concerning the vulnerability for developing burnout or the neurotic disposition people have. These methods can be found questionable since there are many (unknown) factors that can influence cortisol levels. Therefore the risk of interpreting the results wrongfully cannot be ignored.

In general, a more equal balance between physical training and a training to create more psychological resilience could be beneficial for military personnel. Physical training is an important part in military training already, but although physical hardiness may have acted as a buffer for physical disease, it has been found not to protect against the ill effects of war on mental health (Pizarro et al., 2006). As mentioned before, all post deployment intervention strategies should be sensitive for the screening and treatment of burnout. Post deployment intervention strategies should also continue targeting soldiers who have had high levels of exposure to traumatic events during deployment. Finally, future studies assessing personality factors, burnout and cortisol are warranted to disentangle the relationship among these variables.

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Appendix 1

Deployment Exposure Scale
(DES)

1. beschietingen niet op u gericht?	nee/ja		
2. beschietingen op u gericht?	nee/ja		
3. onder schot gehouden? (wapen op u gericht)	nee/ja		
4. gijzeling van uzelf	nee/ja	………….	………….
5. gijzeling van collega's uit uw eenheid	nee/ja	………….	………….
6. persoonlijk gevaar oplopen ten gevolge van oorlogshandelingen, ongelukken of bedreiging	nee/ja	………….	………….
7. gedood of gewond persoon binnen de eigen eenheid	nee/ja	…………..	…………..
8. zelf gewond geraakt	nee/ja	…………..	…………..
9. afwijzing door plaatselijke bevolking	nee/ja	…………..	…………..
10. het zien van menselijk leed	nee/ja	…………..	…………..
11. aanblik van doden	nee/ja	…………..	…………..
12. aanblik van ernstig gewonden	nee/ja	…………..	…………..
13. gillen van gewonden	nee/ja	…………..	…………..
14. getuige geweest van het sneuvelen of ernstig gewond raken van mensen	nee/ja	…………..	…………..
15. onvoldoende mogelijkheden hebben om in te grijpen	nee/ja	…………..	…………..
16. geen controle over situatie hebben	nee/ja	…………..	…………..
17. het idee dat de missie zinloos was geworden	nee/ja	....	....
18. herinneringen aan eerdere uitzendingen kwamen boven	nee/ja	…………..	…………..
19. verkeersongeval	nee/ja	…………..	…………..

Appendix II: Spearman correlations table

Spearman rank order correlations between measures of cortisol, burnout and combat exposure

	1	2	3	4	5	6	7	8	9	10	11
1.exhaustion_1	-	.677**	-.336**	.455**	-.446**	.209	-.198	.183	.073	.097	-.032
2.depersonalization_1		-	-.566**	.488**	-.311*	.395**	-.345**	.315*	-.091	.075	-.121
3. competence_1			-	-.316*	.297*	-.386**	.559**	-.325*	-.073	-.104	.005
4.totalscore_1				-	-.124	.219	-.299*	.167	-.026	-.158	-.017
5.exhaustion_2					-	-.423**	-	-.586**	-	-	-
6.depersonalization_2						-	-.622**	.602**	-.176	-.084	.174
7.competence_2							-	-.379*	-	-	-
8.totalscore_2								-	.000	-.101	-.020
9.AUC_1									-	-	-
10.AUC_2										-	-
11.DES											-

* p < .05 (2-tailed), ** p < .01 (2-tailed)
Correlations that are missing can be found in the Spearman product-moment correlations table in chapter 4