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BASIC RESEARCH ARTICLE

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Low neuroticism as an indicator of resilience: a longitudinal study of Danish soldiers before, during and after deployment

Ole Melkevik [a], Lennart Schou Jeppesen [b], Sofie Folke [a,c] and Anni B. S. Nielsen [a,d]

[a]Research and Knowledge Centre, Danish Veterans Centre, Ringsted, Denmark; [b]Institute for Leadership and Organization, Royal Danish Defence College, Copenhagen, Denmark; [c]Military Psychology Department, Danish Veterans Centre, Copenhagen, Denmark; [d]The Research Unit and Section of General Practice, Institute of Public Health, University of Copenhagen, Copenhagen, Denmark

ABSTRACT

Background: Posttraumatic stress disorder (PTSD) is a serious and debilitating condition among military veterans. Exposure to potentially traumatic events (PTEs) may lead to PTSD and PTE sensitivity may be influenced by the personality trait neuroticism.

Objective: The current investigation aims to test whether exposure to PTEs during deployment is associated with changes in PTSD symptoms, and whether individual levels of neuroticism are related to resilience or sensitivity to such exposures.

Methods: The study sample included 701 Danish soldiers deployed to Afghanistan in 2009. PTSD symptoms were measured pre-, peri- and post-deployment (T1-T3) with the PTSD Checklist-Civilian Version. PTSD symptom load was modelled in a mixed linear model along with an extensive list of covariates. Interactions between time, exposure, and neuroticism were tested in order to assess whether neuroticism moderated the effect of PTEs upon PTSD symptoms.

Results: On average, PTSD symptoms decreased from T1 through T3. Factors associated with higher PTSD symptom levels included number of past trauma, neuroticism, and low age at deployment. Interaction analyses showed that individuals with low and medium neuroticism levels displayed no significant change in PTSD symptoms, and individuals with high neuroticism displayed a significant decrease in PTSD symptoms. These changes were consistent across levels of perceived exposure to danger and combat and witnessing the consequences of war.

Conclusions: Results indicate that low levels of neuroticism appear to be related to resilience. Individuals with high levels of neuroticism displayed elevated PTSD symptoms across all time points, but contrary to expectations, they reported a significant decrease in PTSD symptoms from pre- to post-deployment.

El bajo neuroticismo como indicador de resiliencia: un estudio longitudinal de soldados daneses antes, durante y después del despliegue de tropas

Antecedentes: El trastorno de estrés postraumático (TEPT) es una afección grave y debilitante entre los veteranos militares. La exposición a eventos potencialmente traumáticos (EPT) puede conducir al TEPT y la sensibilidad a los EPT puede verse influenciada por el rasgo de personalidad neuroticismo.

Objetivo: La presente investigación pretende comprobar si la exposición a EPT durante el despliegue de tropas está asociada con cambios en los síntomas de TEPT y si los niveles individuales de neuroticismo están relacionados con la resiliencia o la sensibilidad a dichas exposiciones.

Métodos: La muestra del estudio incluyó 701 soldados daneses desplegados en Afganistán en 2009. Los síntomas de TEPT se midieron antes, durante y después del despliegue (T1-T3) con el Cuestionario de TEPT, versión civil. La carga de síntomas de TEPT se modeló con un modelo lineal mixto junto con una extensa lista de covariables. Se probaron las interacciones entre el tiempo, la exposición y el neuroticismo para evaluar si el neuroticismo moderaba el efecto de los EPT sobre los síntomas del TEPT.

Resultados: En promedio, los síntomas de TEPT disminuyeron desde T1 hasta T3. Los factores asociados con niveles más elevados de síntomas de TEPT incluyeron el número de traumas pasados, el neuroticismo y la baja edad en el momento del despliegue. Los análisis de interacción indicaron que los individuos con niveles bajos y medios de neuroticismo no mostraron cambios significativos en los síntomas de TEPT, y los individuos con alto neuroticismo mostraron una disminución significativa en los síntomas de TEPT. Estos cambios fueron consistentes en todos los niveles de exposición percibida al peligro y al combate y en la presencia de las consecuencias de la guerra.

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PALABRAS CLAVE

Veteranos; trauma; TEPT; neuroticismo; resiliencia; rasgos de personalidad; estudio longitudinal

HIGHLIGHTS

- High levels of neuroticism, past trauma, and a younger age at deployment were associated with higher PTSD symptom levels among soldiers.
- Soldiers with low and medium neuroticism levels exhibited stable and low PTSD symptom levels irrespective of perceived exposure to potentially traumatic events during deployment.
- Contrary to expectations, soldiers with high neuroticism levels experienced a reduction in PTSD symptoms from pre- to post-deployment.

CONTACT Ole Melkevik Vetc-vic10@mil.dk Research and Knowledge Centre, Danish Veterans Centre, Veterancentret, Garnisonen 1, 4100 Ringsted, Denmark

Conclusiones: Los resultados indican que los niveles bajos de neuroticismo parecen estar relacionados con la resiliencia. Las personas con altos niveles de neuroticismo mostraron síntomas elevados de TEPT en todos los puntos temporales, pero, contrariamente a las expectativas, informaron una disminución significativa de los síntomas de TEPT desde antes hasta después del despliegue de las tropas.

1. Background

Posttraumatic stress disorder (PTSD) is a serious and debilitating condition which has been found to lead to reduced work and family functioning (Vogt et al., 2017), reduced health-related quality of life (Pacella et al., 2013), and increased risk of mortality independent of conventional risk factors (Ahmadi et al., 2011).

While PTSD can develop in individuals of all ages and in all populations, deployed soldiers are at an increased risk (Magruder & Yeager, 2009). The primary hypothesis for this increased risk is that deployment increases the likelihood of being exposed to potentially traumatic events (PTE) in the form of combat or witnessing distress among locals (King et al., 2006; Polusny et al., 2014; Xue et al., 2015). However, a meta-analysis by Galatzer-Levy and colleagues (2018) found that most people who experience PTEs are resilient as they do not develop PTSD. On average, 65.7% of participants across 63 studies did not show an increase in symptoms despite experiencing PTEs.

The fact that only a subgroup of those who are exposed to PTEs experience changes in PTSD symptoms suggests that there is a great preventive potential if it were possible to identify specific characteristics of those who are more or less sensitive to the negative effects of PTEs.

Neuroticism has been proposed to be one of the most important predisposing factors for PTSD (Bowman, 1999) and to have a potentially moderating role in the relationship between PTE and PTSD. This moderating role is implied by the characteristics of neuroticism, including strong stress reactivity followed by negative emotions including anxiety, fear, irritability, anger and sadness. In contrast, low levels of neuroticism is associated with relatively less emotional reactivity (Barlow et al., 2014; Costa & McCrae, 1992).

A strong link between neuroticism and PTSD have been found across a number of studies including high levels of neuroticism has been found in veteran populations diagnosed with PTSD (Talbert et al., 1993) and among individuals with high levels of PTSD symptoms (Rubin et al., 2008). There are several proposed mechanisms which aim to explain this relationship, which all have some level of empirical support. One such mechanism is that individuals with high levels of neuroticism are more prone to perceive the world as a more dangerous place (Breslau et al., 1995; Specht et al., 2011; Yin et al., 2019). This mechanism could lead to a greater risk of PTSD as highly neurotic individuals may be more likely to rate events as PTEs.

Another potential mechanism is that neuroticism acts like a magnifier for the effects of PTEs (Breslau & Schultz, 2013; Lauterbach & Vrana, 2001; Rubin et al., 2008). This would imply that similar PTEs have different effects upon PTSD symptoms among individuals, depending on their levels of neuroticism.

Finally, Engelhard and colleagues (2003, 2009) propose that the frequently reported association between PTSD and neuroticism may be reflective of content-overlap where PTSD simply reflects a specific expression of neuroticism.

Irrespective of mechanism, we perceive a great preventive potential in exploring the extent to which neuroticism, as measured prior to deployment, may provide a useful indicator of resilience or trauma-sensitivity among soldiers during their deployment to an active war-zone.

Given the reviewed evidence, we expect that soldiers characterized by high levels of neuroticism are more likely to experience an increase in PTSD symptoms, if exposed to PTE's. In contrast, we expect soldiers low in neuroticism to experience a resilient symptom pattern, characterized by little or no symptom fluctuation irrespective of exposure to PTEs.

We find it important to highlight that previous studies have investigated related questions using the same study population (Andersen et al., 2014; Berntsen et al., 2012). Both studies examined PTSD symptom trajectories based on repeated measurements before, during, and after deployment using latent growth mixture modelling (LGMM). These studies found fluctuating symptom trajectories to be characterized by higher levels of neuroticism, a greater number of past traumatic events, and more PTEs during deployment when compared to stable symptom trajectories. Even though these results are in line with our expectations, they simply reflect mean differences between trajectory groups and do not provide tests for the predictive potential of neuroticism or PTEs.

The current investigation will aim to build upon the reviewed literature by testing the extent to which PTSD symptom trajectories between individuals who experience PTEs or not, and whether soldiers resilience or sensitivity to PTEs are dependent upon their level of neuroticism. We will address our research questions by testing the following hypotheses:

H1: Individuals who experience higher levels of self-reported PTEs will exhibit increased PTSD symptoms during and after deployment.

H2: Individuals with lower levels of neuroticism will demonstrate a resilient PTSD symptom trajectory in response to PTEs.

H3: Individuals with higher levels of neuroticism will be more sensitive to the impact of PTEs, resulting in greater increases in PTSD symptoms, compared to those who report lower levels of neuroticism.

2. Methods

2.1. Description of sample

The study uses data from a longitudinal study of a team of Danish soldiers with a 6-month's deployment to the Helmand Province in Afghanistan in 2009 as part of the joint International Security Assistance Force (ISAF). A total of 704 soldiers deployed and 605 responded to the baseline questionnaire approximately 1–2 months before deployment (T1 = response rate: 85.9%). In total 589 soldiers responded to the questionnaire three months into the deployment (T2, response rate: 83.6%), and 557 responded to the questionnaire 1–3 weeks after homecoming (T3, response rate: 79.1%). Participation in the study was voluntary, and all respondents gave written informed consent.

2.2. Measurements

PTSD was measured by the PTSD Checklist civilian version (PCL-C) at T1-T3. PCL-C is a 17-item measure of PTSD corresponding to PTSD according to the DSM-IV (Weathers et al., 1993). Each item has five response categories (1 = not at all; 5 = extremely), and from this an average score was calculated for all individuals who answered at least 14 of the 17 items. The score was multiplied by 17 in order to generate a scale with a theoretical range from 17 to 85. The internal consistency for this scale was high across all measurement points T1 ($\alpha = 0.87$), T2 ($\alpha = 0.89$) and T3 ($\alpha = 0.91$).

Sociodemographic information such as sex, age and educational level (primary and upper secondary school level vs. higher education) at the start of deployment was indicated at T1. Educational level was split into high and low in the analysis. Sex is included as a dichotomous variable where female was coded 1 and male 0. For the regression models, age was centred at the mean (26.2 years).

Cognitive ability was assessed at conscription using the Børge Prien's Prøve (BPP), a 45-minute test with 78 items designed to assess logical, verbal, numerical and spatial reasoning. A total score was calculated based on the number of correct answers. The BPP has been found to have satisfactory reliability and validity, with the total score correlating 0.82 with the full-scale Wechsler Adult Intelligence Scale IQ (Mortensen et al., 1989; Teasdale et al., 2011). This variable was standardized with a mean of zero. Consequently, regression estimates for this variable can be interpreted as standard deviations.

The number of unique past traumatic experiences was assessed at T1 by the Trauma Life Events Questionnaire (TLEQ) (Kubany et al., 2000), which lists 19 traumatic events that could have happened in a person's life (e.g. natural disaster, robbery involving a weapon, childhood trauma). Respondents are asked to indicate how many times each trauma had occurred, with an upper limit of six or more times. The variable was used by dichotomizing 18 of the 19 items, with 1 indicating the event had occurred one or more times, resulting in a theoretical range of 0–18. One specific item was removed from this list as this was used as an independent indicator of *past deployments*.

Morale was assessed at T1 based on the work of Jeppesen and Elrond (2021). This variable was based on responses to two questions 'How do you rate the level of your unit's sense of duty right now?' and 'How do you rate the level of morale/commitment in your unit right now?' each measured on a five-point Likert scale (0 = very low; 4 = very high). A sum score ranging from 0 to 8 points was calculated, with higher numbers indicating higher levels of morale.

Neuroticism was assessed at T1 by the neuroticism scale in the NEO Five-Factor Inventory (NEO-FFI) (Costa & McCrae, 1989). The NEO-FFI is a 60-item short version assessing each of the five personality factors (Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness) with 12 items, measured on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree). A total score was calculated for individuals who answered at least 8 of the 12 items. The score was divided into tertiles to test whether low levels of neuroticism are associated with resilience to PTEs and if high levels of neuroticism are associated with sensitivity to PTEs.

Sense of purpose was assessed at T1 by an average score of three items (1) 'Do you think it is important that the Danish defense participates in international and peace support operations' (2) 'Do you think that Danish participation in this specific mission is meaningful' (3) 'Do you think it is right to use Danish forces to solve problems for people in other countries'. Each question was measured on a four-point scale (1 = yes to a great extent; 4 = no, not at all). The average score was based upon respondents who completed two or more of these questions, with a high score indicating a high sense of meaning or purpose. The scale had was found to have a good internal consistency ($\alpha = 0.81$).

Social support was assessed by the 12-item Multidimensional Scale of Perceived Social Support (MSPSS) (Zimet et al., 1988) at T1. Each item is measured on a

seven-point Likert scale (1 = very strongly disagree; 7 = very strongly agree). The MSPSS includes three subscales covering social support from family, friends, and significant others. Each scale was constructed by utilizing data from all respondents who had answered at least three of the four questions in the scale.

Rank was assessed at T1 by respondents indicating their rank (private, non-commissioned officer, or commissioned officer). In the current analyses, rank was included as a dichotomous variable where higher rank (non-commissioned officer or commissioned officer) was coded 1 and lower rank (private) was coded 0.

Perceived exposure to danger during deployment, i.e. *PTEs,* was measured at T3 by the Exposure to Danger and Combat (EDC) Scale (α = 0.79) and Witnessing the Consequences of War (WCW) Scale (α = 0.73). Both scales asked respondents how frequently they had experienced various scenarios during deployment. The EDC scale included six statements (e.g. 'being threatened with a weapon', 'being in areas with roadside bombs or mines') and the WCW scale included statements such as 'seeing dead people' and 'being witness to assaults on civilians'. These scales have been psychometrically validated utilizing Rash models (Karstoft et al., 2018). In the current analyses, sum scores for each scale were divided into tertiles to test whether low, medium and high exposure is associated with differences in PTSD symptom development.

2.3. Description of modelling approach and statistical tests

To describe the development of PTSD symptoms before, during and immediately after deployment (T1-T3), we utilized a mixed linear model with a random intercept. Change in PTSD symptoms across time was modelled by including dummy variables to attain estimates for the average change across time. This approach was chosen to accommodate potential non-linearities in symptom development and to allow the effects of PTEs to vary over time in interaction analyses.

The mixed linear models were estimated using the 'mixed' command in Stata version IC 16.1 (StataCorp, 2013), utilizing the default maximum likelihood estimation. While the growth curve model used all available data, listwise deletion was applied when independent variables were included in the analysis.

To test whether PTSD symptoms changed at different rates between high, medium and low levels of PTEs, we ran models with a three-way interaction between time and each PTE, adjusting for all covariates from M2 (Table 2). Tests of whether neuroticism moderated the effect of EDC and WCW across time were conducted in separate models for EDC and WCW, to limit complexity. These interaction models generated predicted estimates for each combination of time, neuroticism, and PTE (EDC and WCW) using the margins command (Williams, 2012). Interaction models were tested by likelihood ratio-tests, where a significant test result implied that a model including the interaction-terms provided an improved likelihood compared to a model with only main-effects. Finally, differences in the rates of symptom change across low, medium and high levels of EDC and WCW were tested by utilizing contrasts of marginal effects (Jann, 2013). The presence or absence of a statistically significant change in symptoms was indicated by the extent to which the 95% confidence intervals (CI) around the change coefficient overlapped with 0.

2.3.1 Planned sensitivity analyses

While the presented estimates are extracted from growth curve models that include three time points, we also replicated all models including an even longer timespan using data collected at 7.5 months after returning home from deployment. This data point is not included in the main analyses, as it reduces the statistical power and precision of the estimates due to lower sample sizes ($N = 395$ for regression models), and because minor differences in results may detract from the main points of the current investigation. Nevertheless, all main findings related to the hypotheses are replicated and addressed in the results section.

3. Results

Table 1 shows that the mean age at deployment was 26.1, ranging from 19 to 57, and was strongly skewed towards the lower end of the scale. Only 5% of the sample were women, 27.7% were leaders, and 45.3% had previously been deployed. The mean number of past traumas was 4.3, ranging from 0 to 15, and was strongly skewed towards the lower end of the scale. The mean PTSD symptom scores showed a slightly decreasing trend from T1 to T3. The distribution of the PTSD scores was all heavily skewed towards the lower end of the scale. WCW is somewhat skewed towards the lower end, while EDC appears relatively normally distributed, suggesting that a roughly equal proportion of participants indicate high and low levels of EDC.

Table 2 Shows predicted PTSD symptom levels across the three-time points, along with fixed-effect regression coefficients for both crude models and a mutually adjusted regression model. The predicted symptom levels over time show a gradual decrease from T1 to T3 for both Model 1 (M1) and M2.

The M1 regression coefficients show the predicted changes in symptoms associated with each respective independent variable. The estimates indicate higher PTSD symptoms for females, individuals with past traumatic experiences, and those with medium or

Table 1. Descriptive statistics, and additional background information.[a]

Variables		Range	*N* total
Pre-deployment (T1)			
Age at deployment	26.1 (7.0)	19–57	599
Female, *N* (%)	30 (5.0)		604
High rank, *N* (%)	167 (28.7)		603
Higher education	56 (9.3)		603
Previously deployed, *N* (%)	250 (45.3)		552
Standardized cognitive ability score	0 (1.0)	−2.8–2.5	604
Perceived social support			
Friends	4.7 (1.1)	0–6	600
Family	4.7 (1.2)	0–6	600
Significant others	4.9 (1.2)	0–6.5	600
Morale	5.9 (1.6)	0–8	599
Number of past trauma experience	4.3 (2.8)	0–15	592
PTSD score	22.6 (7.2)	17–55	605
Neuroticism (%)			
Low	212 (36.6)		579
Med	193 (33.3)		579
High	174 (30.05)		579
During deployment (T2)			
PTSD score	21.7 (6.7)	17–66	589
Post deployment (T3)			
PTSD score	21.3 (7.2)	17–57	557
Exposure to anger and Combat (EDC), *N* (%)			
Low	197 (36.3)		543
Med	193 (35.5)		543
High	153 (28.2)		543
Witnessing the Consequences of War (WCW), *N* (%)			
Low	242 (44.6)		543
Med	175 (32.2)		543
High	126 (23.2)		543

Notes: [a]Average and standard deviation (SD), unless percentage is indicated (%). T1 = Baseline (1–2 months before deployment); T2 = three months into the deployment, T3 = 1–3 weeks after deployment.

high levels of neuroticism. Respondents with leadership responsibilities, perceived social support from friends or family, and those who were older at time of deployment were found to have lower symptom levels based on estimates from this model.

M2 shows the mutually adjusted estimates where only age at deployment, past traumatic events and neuroticism were found to be significantly associated with PTSD symptom levels. This implies that the associations for being female, social support, previous deployment(s), and high rank are either mediated or confounded by the other independent variables in the model.

The random effect parameters show that there is a significant amount of random variance in both M1 and M2. Additionally, the intraclass correlation coefficient (ICC) is somewhat lower for M2, suggesting that approximately 48% of the variation in PTSD symptoms is due to between-individual factors, while 52% is due to within-individual variability.

For the sake of reducing the complexity of this table, we omitted estimates of non-significant crude associations. These include *morale* (β = −0.65, 95% CI: – 1.83–0.54), *sense of purpose* (β = 0.34, 95% CI: – 0.69–1.37), perceived social support from a significant other (β = 0.11, 95% CI: – 0.50–0.28), *high educational level* (β = 0.11, 95% CI: – 1.53–1.75), and cognitive ability score (β = −0.08, 95% CI: – 0.58–0.43).

3.1. Associations between PTE's and changes in symptom trajectory

In order to test whether PTEs were associated with changes in PTSD symptom levels, we performed a three-way interaction test between time, EDC, and WCW. Given that we do not know whether the PTEs occurred prior to or after T2, we allowed associations between EDC and WCW and PTSD symptoms to vary freely across each time point. This model tested H1, expressed as an expectation that individuals who

Table 2. Crude and adjusted estimates between repeated measures of PTSD symptoms and independent variables.

	Model 1: Crude estimates*		Model 2: Mutually adjusted estimates	
Variables	Estimate	95% CI	Estimate	95% CI
Predicted symptom levels across time				
T1	22.65	(22.11–23.19)	22.56	(22.02–23.09)
T2	21.51	(20.96–22.05)	21.41	(20.85–21.98)
T3	21.43	(20.88–21.99)	21.34	(20.76–21.92)
Fixed-effect regression coefficients				
Female	2.20	(0.03–4.37)	0.04	(−2.07–2.15)
Age	−0.18	(−0.25 to – 0.12)	−0.09	(−0.17 to – 0.02)
High rank	−1.99	(−3.04 to – 0.93)	0.27	(−0.79–1.33)
Previously deployed	−1.14	(−2.14 to – 0.16)	0.19	(−0.78–1.16)
Past trauma experience	0.63	(0.46–0.79)	0.56	(0.40–0.71)
Perceived social support				
Friends	−0.48	(−0.93 to – 0.03)	0.00	(−0.46–0.46)
Family	−0.44	(−0.82 to – 0.05)	0.09	(−0.30–0.49)
Neuroticism	Ref.		Ref.	
Low				
Med	2.64	(1.57–3.71)	2.50	(1.42–3.57)
High	5.65	(4.56–6.75)	5.11	(3.94–6.29)
Random-effect Parameters				
Random intercept (variance)	27.74	(24.10–31.92)	18.08	(15.07–21.69)
ICC	0.57	(0.52–0.61)	0.48	(0.42–0.54)
Residual variance	21.30	(19.54–23.21)	19.54	(17.75–21.52)

Notes: * Crude estimates are adjusted for the effect of time, CI = Confidence interval, ICC = Interclass correlation coefficient, T1 = Baseline (1–2 months before deployment); T2 = three months into the deployment, T3 = 1–3 weeks after deployment.

experience higher levels of self-reported PTEs would exhibit increased symptoms during or after deployment, but this was not found in our results.

Overall, there was no indication that PTEs are associated with changes in PTSD symptom levels. The three-way interaction was not significant as indicated by the likelihood ratio test (LR $Chi^2 = 23.28$ (20), $p = .275$). Furthermore, when investigating predicted estimates from these models, we found no statistically significant differences in contrasts in changes across time between the low, medium, and high levels of EDC and WCW (for WCW ($Chi^2 = 6.27$ (4), $p > .18$) and for EDC ($Chi^2 = 0.24$ (4), $p > .99$)). These results indicate that exposure to PTEs was not, on average, associated with an increase in symptoms in the study population.

3.2. Associations between neuroticism and symptom change across time

Table 3 shows the contrast between predicted symptoms at T1 vs. T3 across all combinations of low, medium, and high EDC and WCW with low, medium, and high levels of neuroticism. These were estimated from three-way interaction models between time, neuroticism and PTEs (EDC and WCW). Each of these interactions was found to be statistically significant as indicated by LR tests for EDC (LR $Chi^2 = 52.66$ (20), $p = .000$) and WCW (LR $Chi^2 = 56.86$ (20), $p = .000$).

The results show support for H2, as individuals with low and medium levels of neuroticism were found to be resilient to the effects of PTEs. There were no significant changes in symptoms for the low and middle tertile of neuroticism, irrespective of the levels of PTEs. Individuals reporting high levels of neuroticism were, according to H3, expected to report an increase in PTSD symptoms after experiencing PTEs. However, we did not find support for this hypothesis as levels of PTSD symptoms showed significant attenuation across all levels of PTEs.

3.3. Planned sensitivity analyses

While the presented estimates are extracted from growth curve models including three-time points, we also replicated all models utilizing an extra time point (7.5 months after returning home from deployment). These results show that all main findings referring to the hypotheses, H1, H2, H3, are replicated. This includes tests referring to H1, as there were no statistically significant differences in the change rates between individuals who are exposed to high vs low levels of PTEs. For tests of H2, results show that individuals with low levels of neuroticism reported stable or decreasing levels of PTSD symptoms across the time period. Results referring to H3 were also in line with the main results as predicted PTSD symptoms were found to show a statistically significant reduction for all individuals with high levels of neuroticism, irrespective of PTE exposure.

4. Discussion

The main results of this study highlight three main results with implications for the understanding of the development of PTSD symptoms, from before, during and after deployment (T1-T3), and their relationship with commonly studied risk factors. The presented results show that, in the current sample: H1) PTEs were not, on average, related to changes in PTSD symptoms; H2) individuals with either low or medium levels of neuroticism did not experience changes in PTSD symptoms across the study period, irrespective of exposure to PTEs; and H3) individuals with high levels of neuroticism reported the highest levels of PTSD symptoms, but contrary to expectations, exhibited a significant decreases in symptoms, irrespective of their level of PTE exposure. Other notable results include the indication that older age at deployment was related to lower symptom levels and that the number of past unique traumas was related to higher symptom levels at all points in time.

The lack of an average effect of PTEs is probably due to the relatively large group reporting low, stable PTSD symptoms, as indicated by past studies utilizing this sample (Andersen et al., 2014; Berntsen et al., 2012), which corresponds well with the findings across longitudinal studies (Galatzer-Levy et al., 2018). Also, the overall average symptom trajectory in the current sample was negative, indicating that detecting a significant increase in PTSD symptoms would require a relatively large effect. Nevertheless, we were somewhat surprised by the fact that PTSD symptoms did not increase in the group with high levels of neuroticism

Table 3. Predicted changes in PTSD symptoms from before until after deployment (T1 and T3) across Neuroticism, exposure to danger and combat, and witnessing of consequences of war.

	Exposure to danger and combat (EDC)			Witnessing consequences of war (WCW)		
	Low	Medium	High	Low	Medium	High
Neuroticism						
Low	0.29	0.02	0.04	0.33	0.02	−0.15
Medium	0.46	−0.78	−0.62	−0.86	0.44	−0.62
High	−4.54*	−2.84*	−4.19*	−4.31*	−1.93*	−6.30*

Notes: * Indicates that the change in symptoms is statistically significant as indicated by 95% CI not including zero. T1 = Baseline (1–2 months before deployment); T2 = three months into the deployment, T3 = 1–3 weeks after deployment.

and high levels of PTE exposure. Contrary to our expectations, the results showed that high levels of neuroticism were associated with a decrease in PTSD symptoms from T1 to T3 across all levels of PTEs. We speculate that these results could related to very high levels of nervousness prior to deployment, followed by subsequent relief when arriving safely in the camp and finally at home. Pre-deployment stress has recently been highlighted as a largely neglected area of research which may have implications for regulation and coping with stress during deployment (Kokun et al., 2023). Given the novelty of these results, we encourage researchers to critique and aim to replicate this study design in future empirical studies.

Results did align with our expectations regarding PTSD symptom development for soldiers with low levels of neuroticism, as their symptom levels did not change significantly during the follow-up period. These results are in line with the reviewed literature (Andersen et al., 2014; Berntsen et al., 2012; Breslau & Schultz, 2013; Lauterbach & Vrana, 2001) and imply that low levels of neuroticism, may have some utility as a pre-deployment indicator of resilience.

The results of the current study indicate that there is substantial stability in the symptom load within individuals, across time. This is not surprising, given that trajectory models typically identify two-thirds of populations to have a type of stable and low trajectory (Galatzer-Levy et al., 2018). While we did not plan for this specific comparison, we find it notable that our results also show that two-thirds, as indicated by the middle and low tertiles of neuroticism, report no significant changes in symptoms from baseline to follow up.

Despite some level of correspondence between the presented results, and past studies, it is important to note that many results are not directly comparable due to fundamentally different statistical approaches. While the current study utilizes mixed linear models to test theory-driven relationships between variables, most other longitudinal studies utilize variations of latent class growth analysis and growth mixture modelling (Andersen et al., 2014; Berntsen et al., 2012; Galatzer-Levy et al., 2018) to extract and describe the differences between groups with similar trajectories. Both approaches have distinct strengths and limitations, discussed elsewhere (Jung & Wickrama, 2008; West et al., 2022).

We are surprised that individuals with high levels of neuroticism and high levels of PTE exposure did not display increases in PTSD symptoms. This implies that further research is needed to clarify which specific factors may serve as effective indicators of sensitivity to PTEs.

4.1. Strengths and weaknesses

The main strength of this study is the utilization of a true longitudinal design with a sample of soldiers deployed to an active war zone. In contrast to the commonly used trajectory models, which categorize individuals into categorical trajectory patterns, we aimed to utilize all available variance by modelling PTSD symptom load as a dimensional factor that changes gradually across time. Consequently, the current analyses provide substantially increased statistical power for identifying associations between symptom level and change with risk factors and moderators.

Our study also has some limitations. First, we suspect that the time points of the baseline data collection may have influenced the response pattern, as the first time point (T1) was collected 1–2 months prior to deployment. It is possible that nervousness and work pressure may be particularly high at this time point, potentially influencing the response pattern. Ideally, baseline measures should reflect participants' typical level of symptoms, prior to the point when they knew that they would be deployed. Thus, we speculate that the decrease in symptoms during the study period could be influenced by pre-deployment nervousness and/or high work pressure, rather than changes relative to their typical baseline. However, we have not been able to find empirical studies to support this assumption.

Another limitation is the unknown validity of self-reported PTE assessments. Even though all other comparable studies utilize self-reported PTEs (Bramsen et al., 2000; Breslau & Schultz, 2013; Cox et al., 2004; Engelhard et al., 2003, 2009), we believe that conclusions could be stated more definitively if objective assessments of PTEs had been available.

Furthermore, the self-reported PTEs are not time specific, making it impossible to determine the exact time between exposure and symptom assessments. Consequently, results should be interpreted with caution regarding the specific rate of change in PTSD symptoms.

Finally, we wish to point out that 95% of the included sample consists of male soldiers, suggesting limited generalizability to non-male and non-military samples.

4.2. Implications

The presented results suggest that soldiers with specific traits such as high neuroticism, multiple past trauma, and young age are likely to have high levels of PTSD symptoms prior to deployment and may thus be at risk for exceeding clinical thresholds with only minor increases in symptom loads. Consequently, we suspect that baseline PTSD symptom levels may provide a useful indicator of which soldiers are likely to develop compromised mental well-being during and/or after deployment, irrespective of whether they are exposed to PTEs. However, this hypothesis needs further empirical validation before

making any specific recommendations regarding pre-deployment screening or continuous symptom monitoring.

The fact that soldiers with low to moderate levels of neuroticism were found to have stable symptom levels throughout the deployment period suggests that neuroticism is related to resilience and could therefore be useful in screening processes prior to deployment or in selection of which soldiers to send on particularly demanding missions.

The presented results highlight the advantages of theory-driven longitudinal analyses. While most of the published longitudinal studies on PTSD rests on data-driven segmentation of discrete symptom trajectories, we believe that many of the existing cohorts could provide useful complementary evidence if re-analyzed with theory-driven models investigating how or whether pre-existing conditions interact with exposure to produce changes in PTSD symptoms.

Although we identified predictors for stable and low PTSD symptoms, we were not able to predict increasing PTSD symptoms with the combination of self-reported PTEs and neuroticism. Therefore, we propose that future investigations critique and expand on the presented results to build a solid theoretical understanding of what risk factors, or combination of factors, lead to increases in symptoms over time.

While the current analyses are conducted on a military population, it appears highly likely that the identified relationships between neuroticism, PTSD symptoms and exposure to PTEs reflect general psychological mechanisms which are equally applicable to other professional groups including police, ambulance-personnel and firefighters.

5. Conclusions

The current study has found that soldiers deployed in an active war zone do not, on average, experience increases in PTSD symptoms when exposed to PTEs. Irrespective of exposure to PTE's, we found resilient symptom trajectories in soldiers with low or medium levels of neuroticism. Contrary to expectations, we did not find symptom increases for individuals with high levels of neuroticism, but rather found that this group of soldiers experienced significant decreases in PTSD symptoms from pre- to post-deployment.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

Due to privacy and data protection regulations of the Danish Defence, data from the current study cannot be shared.

ORCID

Ole Melkevik http://orcid.org/0000-0003-4679-8807
Lennart Schou Jeppesen http://orcid.org/0000-0003-4438-3763
Sofie Folke http://orcid.org/0000-0003-3871-1580
Anni B. S. Nielsen http://orcid.org/0000-0003-1260-2933

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