

The Role of Perceived Threat in the Emergence of PTSD and Depression Symptoms During Warzone Deployment

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Objective: Numerous studies have shown that level of exposure to combat-related stressors is a robust risk factor for posttraumatic stress disorder (PTSD) and depression among military personnel deployed to a warzone. Threat perception of warzone experiences assessed retrospectively has been consistently linked to increased risk for PTSD and depression months or even years after returning from deployment. However, little is known about concurrent relations between perceived threat, deployment stress, and stress-related symptoms during deployment. Using a novel in-theater web-based assessment system, we investigated the unique and joint contribution of threat perception and deployment stressors in predicting the emergence of PTSD and depression symptoms during deployment. **Method:** Soldiers ($N = 150$) completed assessments of deployment stressors, perceived threat, PTSD symptoms, and depression symptoms throughout deployment to Iraq. **Results:** Results revealed that perceived threat potentiated the increase in PTSD symptoms as a result of increases in deployment stressors. In contrast, perceived threat, but not warzone stressors, uniquely predicted depression symptoms. **Conclusions:** Results highlight the important role of threat perception as a risk marker for the acute experience of depression and PTSD symptoms during deployment.

Keywords: deployment, posttraumatic stress disorder, depression, cognitive appraisal, threat perception

Combat-exposed military personnel are four to five times more likely to develop posttraumatic stress disorder (PTSD) relative to those deployed but not exposed (Smith et al., 2008), yet less than 10% develop PTSD symptoms, and fewer meet diagnostic criteria for PTSD (LeardMann et al., 2009). The heterogeneity of warzone-stress reactions (e.g., Dickstein, Suvak, Litz, & Adler, 2010) underscores the importance of identifying factors beyond combat exposure alone that increase risk for experiencing psychological symptoms as a reaction to deployment stress.

It has been well established that appraisal of threat plays a central role in general psychological functioning (Bandura, 1988), stress reactions (Lazarus & Folkman, 1984), and the onset and maintenance of emotional disorders (e.g., Beck et al., 1979). From a theoretical perspective, the impact of a stressor hinges on the

individual's appraisal of the demands of the stress relative to their capacity to cope; this cognitive appraisal dictates the response to the event (Lazarus & Folkman, 1984). The perception of threat occurs when the demands of the situation are perceived as exceeding one's capacity to cope. In the short run, perceived threat can result in activation of the hypothalamic pituitary adrenocortical (HPA) axis, leading to physiologically adaptive compensations such as increased adrenaline to boost one's strength for fleeing or fighting. However, more persistent perception of threat (i.e., chronic stress) is associated with dysregulation of the HPA axis and the onset of illness and psychopathology (Miller, Chen, & Zhou, 2007). For instance, prior studies have associated threat perception with depression (Beck, Rush, Shaw, & Emery, 1979), panic and agoraphobia (Clark, 1986; Telch, Brouillard, Telch, Agras, & Taylor, 1989), and PTSD (Ehlers & Clark, 2000).

Perceived threat of warzone experiences has been defined as "fear for one's safety and well-being in the warzone" (L. A. King, King, Vogt, Knight, & Samper, 2006, p. 98) and is conceptually distinct from the endorsement of warzone stressors. Whereas the measurement of warzone stress refers to frequency of stressors encountered in the warzone, such as endorsing "receiving hostile incoming fire" or "being wounded or injured in combat," warzone threat perception relates to the individual's evaluation of the probability and severity of danger, which can occur at any time during warzone deployment. For instance, the thought, "I was concerned that my unit would be attacked by the enemy," can occur in the absence of one of the specific warzone stressors included on standardized checklists. Furthermore, one could potentially expe-

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This research was supported by the U.S. Army Research, Development and Engineering Command (RDECOM) Acquisition Center, Natick Contracting Division, and U.S. Defense Advanced Research Projects Agency under Contract W911QY-07-C-0002 awarded to Michael J. Telch. The views expressed in this publication are those of the authors and may not necessarily be endorsed by the U.S. Army.

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rience a warzone stressor in the absence of perceived danger, such as going on convoy in Iraq in the absence of concerns about receiving incoming fire or encountering an improvised explosive device. Perceived threat has been reliably linked to PTSD and depression in service members across wars, branches, and nationalities (e.g., James, Van Kampen, Miller, & Engdahl, 2013; D. W. King, King, Gudanowski, & Vreven, 1995; Phillips, LeardMann, Gumbs, & Smith, 2010; van Wingen, Geuze, Vermetten, & Fernández, 2011). This association has remained after controlling for combat exposure (James et al., 2013; Vogt, Proctor, King, King, & Vasterling, 2008), and importantly, perceived threat has been shown to mediate deployment stressors' impact on postdeployment PTSD (Franz et al., 2013; D. W. King et al., 1995; Renshaw, 2011).

Two fundamental limitations exist in prior investigations of perceived warzone threat and its association with warzone stressors and the development of psychopathology. First, warzone threat perception has been assessed retrospectively, months or even years after returning from the warzone (e.g., D. W. King et al., 1995; Renshaw, 2011). However, experiencing deployment-related psychopathology may inflate recall of both the frequency of stressors and of threat perception—a hypothesis supported by longitudinal evidence that PTSD amplifies retrospective reports of both threat (Heir, Piatigorsky, & Weisaeth, 2009) and combat exposure (Engelhard, van den Hout, & McNally, 2008; Southwick, Morgan, Nicolaou, & Charney, 1997). Second, studies have yet to test whether perceived threat potentiates the emergence of PTSD and depression symptoms during deployment in response to varying levels of warzone stress exposure.

Here, we present new data from the Texas Combat PTSD Risk Project (Lee, Goudarzi, Baldwin, Rosenfield, & Telch, 2011; Telch, Rosenfield, Lee, & Pai, 2012), a proof-of-concept prospective risk study focused on identifying risk and resilience factors associated with the emergence of PTSD and depression. A unique feature of the project was the use of a web-based in-theater assessment system in which soldiers provided repeated assessments of warzone stress variables and symptom ratings of PTSD and depression while deployed in Iraq. This study reports new data on the association between perceived threat in the warzone and the in-theater emergence of PTSD and depression symptoms. We hypothesized that threat perception would be associated with symptoms of PTSD and depression, beyond the effects of warzone stressors and key predeployment covariates, including lifetime history of psychopathology. Based on previous work (e.g., D. W. King et al., 1995), we also predicted that threat perception would potentiate warzone stressors' impact on symptoms of PTSD and depression.

Method

Participants

To enroll in the study, soldiers had to meet the following criteria: (a) Age 18 or older, (b) no prior military deployments, and (c) planned deployment to Iraq within 3 months of consent. Among those briefed about the study, 82% ($N = 184$) provided consent, six did not deploy, one withdrew, and 16 did not complete assessments, leaving 161 soldiers with viable data. Assessments were excluded if they did not include measures used in this

analysis, leaving 308 observations from 150 soldiers, and 302 observations from 146 soldiers for the PTSD and depression models, respectively. According to the last in-theater survey completed, deployment lasted an average of 14.98 months ($SD = 2.25$; range = 8.00 to 18.43). The sample was predominantly male (88%), White (73%), and young ($M = 25.33$ years, $SD = 6.08$, range = 19 to 49 years). Among the soldiers included in the data set, 54% screened positive for lifetime history of an Axis I disorder.

Procedures

The principal investigator (PI; Michael J. Telch) and project director briefed soldiers from nine units selected by Army command that were scheduled to deploy from Ft. Hood to Iraq between August 2007 and August 2009. These nine units included four combat units, four combat service support units, and one combat support unit. Unit leaders agreed to uphold the principle of voluntary participation in the study and were not present during the briefing and consent process to mitigate the potential for perceived coercion. During the briefing, soldiers were informed that study participation was completely voluntary and that consent could be withdrawn at any time without penalty. Participants were informed that their data would be deidentified and were reassured by the PI and an appointed Army ombudsman (not connected to the project) that the Army would not have access to their data.

Soldiers consented to the parent project, the Texas Combat PTSD Risk Study, a longitudinal study evaluating risk factors for the onset of PTSD and depression in soldiers deployed to Iraq (see Lee et al., 2011, for additional details). Consented soldiers were transported to The University of Texas at Austin to complete a comprehensive predeployment assessment battery, including genetic, cognitive, neuroimaging, hormonal, and psychosocial measures. During deployment, soldiers received monthly e-mail reminders to complete the Combat Experience Log (CEL), a deidentified, web-based assessment of warzone stressors and warzone stress reactions. Because it was unlikely that soldiers would be able to complete web-based assessments each month because of the logistical constraints of the deployed setting, they were instructed to complete assessments as frequently as possible. Out of the total number of study participants ($N = 177$), over 90% ($n = 161$) completed at least one CEL during deployment. Assuming a deployment cycle of 14 months on average, the full data set for the CEL included 42% of the total possible observations (Lee et al., 2011). After elimination of data points with missing data for one or more of the variables used in the present analysis, the final data set for this study included 12% of the total possible observations, with a range of one to six observations per soldier ($M = 2.07$ observations per soldier, $SD = 1.62$ for the depression data set; $M = 2.05$ observations per soldier, $SD = 1.61$ for the PTSD data set). Data for the present study were drawn from the predeployment assessment and the CEL.

Predeployment Measures

Soldiers completed a comprehensive predeployment assessment from which demographics and clinical diagnostic data from the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I-IV; First, Spitzer, Gibbon, & Williams, 1996) were used

for the present analysis. Doctoral students with at least one year of experience in diagnostic interviewing administered the SCID-I-IV, and diagnoses were confirmed in a follow-up interview with the PI, with perfect agreement between evaluators.

In-Theater Measures

Stressors were assessed with a checklist adapted from the Deployment Risk and Resilience Inventory (DRRI; D. W. King, King, & Vogt, 2003), including 18 items assessing incidence of common deployment stressors, and two items allowing report of stressors not on the checklist. Perceived threat during the prior month was assessed using the 15-item Deployment Concerns section of the DRRI (D. W. King et al., 2003). PTSD symptoms within the last month were reported using the validated four-item version of the PTSD Checklist (Bliese et al., 2008; Weathers, Litz, Herman, Huska, & Keane, 1993), and depression within the past week was reported using the validated 10-item version of the Center for Epidemiological Studies Depression Scale (Andresen, Malmgren, Carter, & Patrick, 1994).

Statistical Analyses

Data were analyzed with random intercept multilevel models using the nlme package in R (Pinheiro, Bates, DebRoy, & Sarkar, 2014; R Core Team, 2014), with repeated observations nested within soldiers. All candidate predictors were entered into the initial model, and then backward elimination of nonsignificant effects ($p > .05$) was used to select the final models. Initial models included (a) gender (male = 0; female = 1), (b) minority status (White = 0; non-White = 1), (c) lifetime Axis I disorder based on the SCID-I-IV (absence = 0; presence = 1), (d) months since the start of deployment (linear and quadratic effects), (e) number of deployment stressors, (f) perceived threat, and (g) the stressors by perceived threat interaction. All variables were z -transformed (including gender, minority status, and lifetime Axis I disorder) to allow comparison across standardized effect estimates. To probe interactions, perceived threat was centered one standard deviation above and below the mean to determine the conditional effects of stressors, given low or high perceived threat (Aiken & West, 1991). Maximum likelihood estimation was used to compare nested models, whereas restricted maximum likelihood estimation was used to generate reported results (Maas & Hox, 2005; Raudenbush & Bryk, 2002). Descriptive statistics for the data set are presented in Table 1.

Results

PTSD Model

Starting with the full model for PTSD symptoms, the first step in the backward elimination of nonsignificant effects was removal of the main effect of minority status from the model ($\beta = -.04$, standard error [SE] = .08, $p = .584$). The second step was removing the quadratic effect of months deployed at the time of survey completion ($\beta = -.05$, $SE = .04$, $p = .190$), the third step was removing the main effect of gender ($\beta = .09$, $SE = .07$, $p = .196$), and the fourth step was removal of the main effect of lifetime history of an Axis I diagnosis ($\beta = .10$, $SE = .07$, $p =$

Table 1
Descriptive Statistics for Modeled Variables

| Variable | <i>n</i> | % | <i>M</i> | <i>SD</i> |
|---|----------|----|----------|-----------|
| Male | 132 | 88 | — | — |
| Caucasian | 110 | 73 | — | — |
| Lifetime Axis I disorder ^a | 81 | 54 | — | — |
| Total deployment duration (months) ^b | 150 | — | 14.98 | 2.25 |
| Monthly deployment stressors ^{b,d} | 150 | — | 2.79 | 2.90 |
| Perceived threat ^{b,e,f} | 150 | — | 27.60 | 10.94 |
| PCL-4 ^{b,e,f} | 150 | — | 5.26 | 2.13 |
| CES-D-10 ^{c,e,f} | 146 | — | 7.16 | 4.86 |

Note. PCL-4 = PTSD Checklist-4 Items; CES-D-10 = Center for Epidemiological Studies Depression Scale-10 Items.

^a Reflects presence of lifetime, including current, *DSM-IV-TR* Axis I disorders based on predeployment SCID-IV interview. ^b Based on 308 observations from 150 soldiers. ^c Based on 302 observations from 146 soldiers. ^d Calculated across soldiers. ^e Calculated across soldiers and deployment months. ^f Questionnaire from the Combat Experience Log.

.144). This produced the final model for PTSD symptoms, which included months deployed at the time of survey completion, the main effects of deployment stressors and threat perception, and their interaction (see Table 2).

The finalized model revealed that soldiers reported lower levels of PTSD symptoms at later months in the deployment cycle ($\beta = -0.26$, $SE = .05$, $p < .001$). Assessments included in the present analyses were completed on average closer to the end of the deployment cycle ($M = 12.42$ months, $SD = 3.60$ months). This downward trajectory of PTSD symptoms over time is consistent with prior analyses demonstrating that PTSD symptoms decline over the course of the last half of the deployment cycle (Lee et al., 2011). In regard to the primary variables of interest, the final model revealed a significant interaction between deployment stressors and perceived threat, indicating that perceived threat amplified the effect of stressors on PTSD symptoms ($\beta = .24$, $SE = .04$, $p < .001$). Probing revealed a significant impact of stressors on PTSD symptoms for those with high ($\beta = .40$, $SE = .06$, $p < .001$), but not low ($\beta = -.08$, $SE = .07$, $p = .295$) perceived threat (see Figure 1). After the removing the interaction term to examine independent main effects, perceived threat ($\beta = .18$, $SE = .06$, $p = .002$) and stressors ($\beta = .20$, $SE = .05$, $p < .001$) both independently contributed to PTSD symptoms.

Depression Model

Starting with the full model for depression symptoms, the first step in the backward elimination procedure was removal of the impact of minority status from the model ($\beta = -.04$, $SE = .07$, $p = .586$). The second step was removal of the stressor by threat interaction ($\beta = .07$, $SE = .05$, $p = .168$). After removing this interaction from the model, the main effect of stressors was nonsignificant ($\beta = .04$, $SE = .06$, $p = .537$), whereas perceived threat was significantly associated with depression ($\beta = .23$, $SE = .06$, $p < .001$).

After backward elimination of all nonsignificant predictors, the final model for depression symptoms included gender, lifetime history of an Axis I disorder, the linear and quadratic effect of deployment month, and perceived threat. In regard to gender, women reported higher levels of depression symptoms during

Table 2
Final Models of PTSD (PCL-4) and Depression (CES-D-10)
Symptoms During Deployment

| Variable | β | SE β | <i>p</i> |
|-------------------------------------|---------|------------|----------|
| PTSD symptoms ^a | | | |
| Intercept | -.07 | .07 | .369 |
| Months | -.26 | .05 | <.001 |
| Deployment stressors | .16 | .05 | .002 |
| Perceived threat | .13 | .05 | .020 |
| Stressors \times Perceived Threat | .24 | .04 | <.001 |
| Depression symptoms ^b | | | |
| Intercept | -.02 | .06 | .780 |
| Gender | .13 | .07 | .051 |
| Lifetime Axis I disorder | .13 | .06 | .044 |
| Months | -.23 | .06 | <.001 |
| Months \times Months | -.14 | .05 | .007 |
| Perceived threat | .23 | .06 | <.001 |

Note. PCL-4 = PTSD Checklist-4 Items; CES-D-10 = Center for Epidemiological Studies Depression Scale-10 Items.

^a Based on 308 observations from 150 soldiers. ^b Based on 302 observations from 146 soldiers.

deployment relative to men on average ($\beta = .13$, $SE = .07$, $p = .051$). The final model also revealed that lifetime history of an Axis I disorder conferred risk for depression symptoms during deployment ($\beta = .13$, $SE = .06$, $p = .044$). Furthermore, the combined linear ($\beta = -.23$, $SE = .06$, $p < .001$) and quadratic ($\beta = -.14$, $SE = .05$, $p = .007$) effect of deployment month demonstrated a downward sloping convex relationship, such that the predicted values for depression symptoms increased slightly and then declined across the remaining deployment months. Because assessments included in the present analyses were completed, on average, closer to the end of the deployment cycle, this downward trajectory of depression symptoms over time is consis-

tent with prior analyses showing the decline in depression symptoms during the latter half of the deployment cycle (Lee et al., 2011). After accounting for gender, history of an Axis I disorder, and the month during deployment at which the survey was completed, increases in perceived threat were found to be associated with increases in depression symptoms during deployment ($\beta = .23$, $SE = .06$, $p < .001$). Final models generated after the removal of all nonsignificant effects are reported in Table 2.

Discussion

Summary of Findings

Our overarching aim was to investigate the association between service members' perceived threat of the warzone environment and the emergence of PTSD and depression symptoms. Consistent with our first prediction, perceived threat was associated with the emergence of depression and PTSD symptoms during deployment, independent of warzone stressors. These findings are consistent with prior evidence linking warzone threat perception with PTSD and depression (Franz et al., 2013; James et al., 2013; D. W. King et al., 1995; Renshaw, 2011; Vogt et al., 2008). However, prior studies assessed threat perception months, or even years, after deployment (e.g., D. W. King et al., 1995; Renshaw, 2011; Vogt et al., 2008). The in-theater assessments used in this investigation thus strengthen existing evidence by providing support that these effects are not a mere reflection of psychological symptoms inflating retrospective reports of threat perception and stressors in the warzone.

Interestingly, findings also suggest that in-theater reports of warzone stressors and perceived warzone threat impact PTSD and depression symptoms differently. Whereas both warzone stressors and perceived threat independently predicted the emergence of

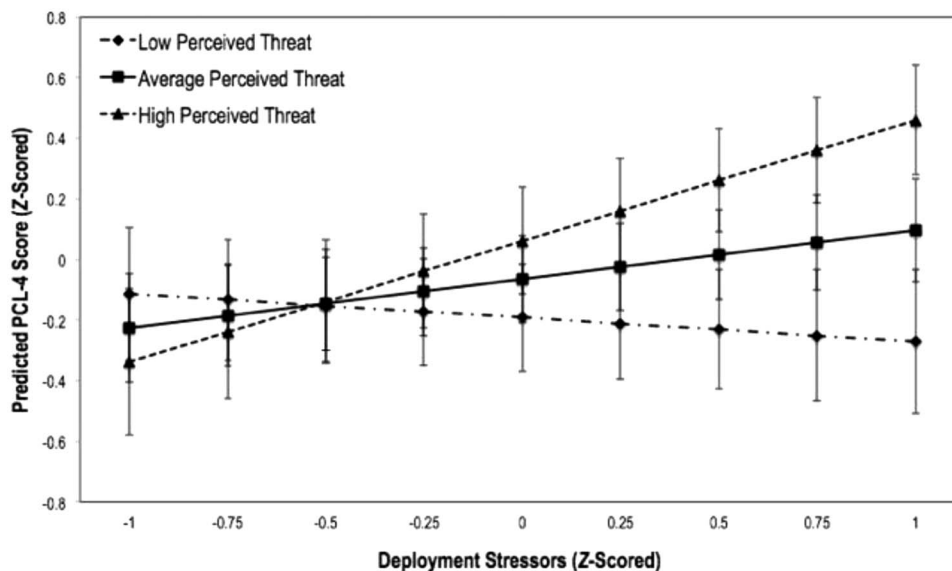


Figure 1. Simple effects of low (-1 SD), average, and high ($+1$ SD) perceived threat on PTSD symptoms (PCL-4) across levels of stressor exposure. PCL-4 = PTSD Checklist-4 Items. Error bars reflect 95% confidence intervals.

PTSD symptoms, warzone stressors were not associated with depression symptoms after controlling for the effects of perceived threat. Furthermore, our second prediction, that perceived threat would potentiate the effects of warzone stressors, was supported for PTSD symptoms but not for depression. These data provide additional support for prior studies demonstrating the critical role of threat perception in mediating the impact of warzone stressors on PTSD symptoms (Franz et al., 2013; D. W. King et al., 1995; Renshaw, 2011).

Implications

Overall, these data reveal the important association between perceived threat and the onset of PTSD and depression symptoms during warzone deployment. In terms of theoretical implications, findings demonstrate that it is the *perception* of stressors, and not just their occurrence, that contributes to the development of psychopathology during deployment. Interestingly, findings reveal that threat perception potentiated the onset of PTSD with increased number of warzone stressors, whereas threat perception, but not warzone stressors, predicted depression.

The discrepant effects for perceived threat and warzone stress on depression compared with PTSD could be related to specific subtypes of stressors associated with these disorders. For example, meta-analytic findings have demonstrated that PTSD is robustly associated with endorsing the perception of threat to one's life (Ozer, Best, Lipsey, & Weiss, 2003), and it is likely that more frequent warzone stressors increase the probability of experiencing one or more life-threatening events. Findings for depression, however, emphasize that the number of warzone stressors has no predictive utility, after controlling for threat perception. Though prior research has demonstrated that life stressors precipitate the onset of depression (Hammen, 2005), all deployed personnel share the general stress associated with military deployment, which includes the interpersonal stressor of displacement from the home environment and support network. Because extensive research has documented the role of interpersonal loss experiences, such as separations, as predictive of the onset of depression (Paykel, 2003), it is possible that the quantity of deployment stressors, over and above the general stress associated with military deployment, is not predictive of depression in the warzone. It may be useful to conduct further research to determine whether specific categories of stressors, such as interpersonal stressors versus life-threatening stressors, increase the likelihood of depression versus PTSD.

In addition to the theoretical implications, these findings have practical implications. For example, deployed military psychologists could use assessment of perceived threat to identify those service members most at risk for the onset of depression and PTSD symptoms during deployment. This at-risk group could be followed with more frequent screenings and provided with preventative interventions as needed. At-risk service members additionally may benefit from brief psychoeducation on the profiles of PTSD and depression symptoms, so that they will have the information needed to recognize when they may benefit from seeking out treatment.

Limitations

Several study limitations deserve mention. First, although over 90% of our soldier cohort completed one or more in-theater assessments, soldiers often missed monthly assessments (additional information about the missing data and the reasons for it can be found in Lee et al., 2011). The data set used for this study included a maximum of six observations per soldier, though soldiers received monthly e-mail reminders to complete assessments, and they were deployed, on average, for over one year. Future researchers may be able to capture data more consistently during deployment as technology continues to advance, and service members have greater capabilities for accessing web-based surveys throughout the deployment cycle. Furthermore, though data were captured during warzone deployment, the analyses are still cross-sectional, in that threat, stressors, and symptoms were measured simultaneously during deployment, which limits conclusions about the causal influence of warzone stress and threat perception on psychological symptoms. Capturing data more frequently than once per month may allow researchers to produce more powerful prospective models, such as cross-lagged models, to assess whether warzone stressors and threat perception precede the onset of PTSD and depression symptoms during the subsequent days or weeks. Second, the limited number of observations for several soldiers precluded parsing of the month-to-month changes (time variant effects) from the average (time invariant effects) of perceived threat and deployment stressors. Additionally, this convenience sample of first-time deployed soldiers from nine units stationed at Fort Hood represents a small proportion of the military service personnel deployed to Iraq and may not be representative of military personnel from other Army units or service branches.

Furthermore, because of the necessity for a brief in-theater assessment battery, we used a short, validated assessment of warzone threat perception, rather than assessing the perception of threat associated with each specific warzone stressor. Future researchers may benefit from a more fine-grained assessment, including investigating the variability in threat perception among military personnel in the same unit who experience who experience the same combat stressor. However, even such a fine-grained analysis may have inherent problems regarding differences in each individual's unique experience during the same stressful event; for example, in a unit under enemy fire, some personnel may receive incoming fire at closer proximity than others in their unit.

Finally, the mean levels of PTSD and depression symptoms in our sample indicate that the average soldier assessed during deployment was asymptomatic. Although one might argue that the use of such a sample would limit our ability to draw conclusions regarding the development of psychopathology, it is important to bear in mind that postdeployment data suggests that the military personnel who develop PTSD or depression in reaction to warzone stress are in the minority (Smith et al., 2008; Wells et al., 2010). Furthermore, the rates of PTSD and depression observed in our sample during deployment are similar or higher than those observed in prior research at postdeployment (e.g., Smith et al., 2008; Tanielian & Jaycox, 2008; Wells et al., 2010). Applying cutoff criteria from prior psychometric research to our sample, we averaged soldiers' scores across surveys completed during deployment, and found that 13% exhibited clinically significant levels of PTSD symptoms (total ≥ 7 ; Bliese et al., 2008) and 23% exhibited

clinically significant levels of depression symptoms (total ≥ 10 ; Andresen et al., 1994). Not only does this document that we have sufficient levels of psychopathology in our sample to test our hypotheses, it also provides evidence that a significant minority of service members experience symptoms of PTSD and depression while still in the deployed setting. The early emergence of PTSD and depression symptoms highlights the need for the identification of acute markers of risk (such as high threat perception) and the development of preventative intervention strategies.

Conclusions

Our findings are novel in suggesting that in-theater assessment of threat perception is associated with the emergence of PTSD and depression, and that perceived threat amplifies the effects of warzone stressors on PTSD symptoms. The in-theater assessment of these warzone variables provides increased confidence that prior findings are not merely a reflection of psychological symptoms inflating service members' retrospective reporting of warzone stressors and threat perception. Future studies are warranted to determine whether in-theater assessment of warzone and soldier variables more effectively capture the reciprocal interplay between warzone stressors, threat perception, and the emergent trajectories of adaptive and maladaptive stress-reactions.

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Received August 19, 2015

Revision received December 16, 2015

Accepted February 3, 2016 ■