

PTSD: Catastrophizing in Combat as Risk and Protection

Martin E. P. Seligman¹, Andrew R. Allen^{1,2}, Loryana L. Vie^{1,2}, Tiffany E. Ho^{1,2}, Lawrence M. Scheier¹, Rhonda Cornum³, and Paul B. Lester²

¹Department of Psychology, University of Pennsylvania; ²Research Facilitation Laboratory, Army Analytics Group, Monterey, California; and ³TechWerks, LLC, Arlington Heights, Illinois

Clinical Psychological Science
1–14

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DOI: 10.1177/2167702618813532

www.psychologicalscience.org/CPS



Abstract

We used the Army Person-Event Data Environment to explore risk and protective factors for diagnosed posttraumatic stress disorder (PTSD). We examined the entire eligible cohort of 79,438 active duty soldiers who deployed to Iraq or Afghanistan between 2009 and 2013, an unusually large and complete cohort. Soldiers highest on catastrophic thinking were 29% more likely to develop PTSD than soldiers with average catastrophic thinking, whereas soldiers lowest on catastrophic thinking were 25% less likely to develop PTSD, adjusting for demographic characteristics; psychological (including baseline depression), behavioral, and physical health; and military characteristics. Soldiers who faced four or more combat stressors were 120% more likely to develop PTSD than soldiers who experienced two combat stressors. Additionally, soldiers higher in catastrophic thinking and experiencing higher combat intensity were 274% more likely to develop PTSD than those low on both. The Army might consider interventions to reduce catastrophic thinking prior to combat to lower PTSD casualties.

Keywords

posttraumatic stress, catastrophization, risk, protection, Army

Received 4/4/18; Revision accepted 9/9/18

Posttraumatic stress disorder (PTSD) is a critical and costly concern for the U.S. Army (Army), the U.S. Department of Veterans Affairs, and most importantly, soldiers returning home from combat each year (Hoge et al., 2004; Seal, Bertenthal, Miner, Sen, & Marmar, 2007). Exposure to combat while deployed is a well-established risk factor for PTSD (Hoge et al., 2004; Smith et al., 2008). Additionally, a large, exploratory, retrospective study of pretrauma PTSD risk factors in civilians found that history of PTSD, prior trauma exposure, type of trauma experienced, and select sociodemographic characteristics may also be PTSD risk factors (Kessler et al., 2014). Poor mental health prior to deployment also predicts more PTSD (based on symptoms or self-reported diagnosis) following deployment (e.g., Kessler et al., 2014; LeardMann et al., 2009). We sought to isolate and quantify both the major protective and risk factors for PTSD using a new comprehensive

database that enabled us to investigate the entire eligible population of active duty Army soldiers, rather than just a sample.

We focused on catastrophic thinking as a primary protective and risk factor. Individuals who catastrophize attribute bad events to permanent and pervasive causes (e.g., “I won’t ever get out of this jam”; Abramson, Seligman, & Teasdale, 1978). Catastrophic thinking plays a pivotal role in learned helplessness theory and when coupled with bad events, places individuals at elevated risk for depression (Abramson et al., 1978; Beck, 1991; Ellis, 1982; see Peterson & Seligman, 1984, for a review). Similarly, cognitive models of PTSD posit that symptoms

Corresponding Author:

Martin E. P. Seligman, Positive Psychology Center, 3701 Market St., Suite 200, Philadelphia, PA 19104

E-mail: seligman@psych.upenn.edu

occur and persist when individuals process a traumatic event in a way that leaves them believing that a serious, current threat remains (Ehlers & Clark, 2000). Despite the important role of cognitive styles (e.g., rumination, appraisal styles, explanatory style, or avoidance coping strategies) in processing traumatic events, studies examining the prediction of PTSD onset by cognitive styles are rare (for a review, see DiGangi et al., 2013). Two studies provide good precedents for our interest in a catastrophic cognitive style as a predictor of PTSD: Bryant and Guthrie (2007) reported that firefighters who had negative cognitive appraisals showed increased rates of PTSD four years later, and Wild et al. (2016) found that paramedics with negative cognitive styles had worse PTSD two years later. Unfortunately, studies of pretrauma cognitive styles have typically been limited by very small sample sizes (often less than 150 participants). Such studies have assessed civilian responses to natural disasters (e.g., Asarnow, 1999; Bryant & Guthrie, 2007; Nolen-Hoeksema, 1991; Wild et al., 2016), childbirth (e.g., Soet, Brack, & DiIorio, 2003), and acts of violence (e.g., Gil, 2005; Lengua, Long, & Meltzoff, 2006; Oglesby, Boffa, Short, Raines, & Schmidt, 2016). So, the few studies on this topic have linked negative cognitive styles to a greater risk of PTSD among civilians rather than examining these relations in soldiers exposed to combat, a population in which this type of thinking could be particularly potent.

Catastrophic thinking may play a critical role in how individuals cognitively process traumatic events, and it can be modified through cognitive therapy (e.g., Beck & Weishaar, 1989), as well as in military settings through training programs administered before (e.g., Master Resilience Training; Reivich, Seligman, & McBride, 2011) or after deployment (e.g., Battlemind debriefing and training; Adler, Bliese, McGurk, Hoge, & Castro, 2009). Quantifying the prediction of PTSD by catastrophic thinking could inform treatment and intervention efforts to reduce PTSD among soldiers.

Intensity of trauma, in this case combat intensity, is a likely risk factor for PTSD (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2003; Smith et al., 2008). We focused on the impact of combat intensity as well as the joint effect of combat intensity and catastrophic thinking on the incidence of PTSD.

In 2009, the Army began assessing catastrophic thinking, along with a number of other psychological attributes, with the newly launched Global Assessment Tool (GAT), which soldiers complete annually (Peterson, Park, & Castro, 2011). Considerable work has now established the psychometric soundness of this instrument (Vie, Scheier, Lester, & Seligman, 2016). A recent study examined the GAT responses of Army soldiers who enlisted between 2009 and 2012 and found that

catastrophic thinking was not significantly related to screening positive for PTSD symptoms following deployment (Shen, Arkes, & Lester, 2017). This null finding is surprising and worthy of additional attention because related studies suggest cognitive styles may indeed predict PTSD outcomes in the military. A study of 122 Air Force health care professionals who deployed for four months, for example, reported that greater trait anxiety prior to deployment was associated with more PTSD symptoms following deployment (McNally et al., 2011). However, this study assessed anxiety in a very small sample and within the context of a narrow occupational group, so it remains unknown whether catastrophic thinking increases the risk of developing PTSD. Furthermore, any link between catastrophic thinking and PTSD could be an artifact of depression or anxiety given the established comorbidity between these disorders (e.g., Campbell et al., 2007; Kroenke, Spitzer, Williams, Monahan, & Löwe, 2007; Wanklyn et al., 2016). As a result, we attempted to quantify the effect of catastrophic thinking and intensity of combat on the development of PTSD both by controlling for depression and a host of other potential confounds and by excluding soldiers who developed a depression or anxiety disorder from follow-up analyses.

Our ability to undertake this study stemmed from a landmark military–civilian collaboration that leverages data housed in the Person-Event Data Environment (PDE). The PDE is a secure, virtual repository that centralizes disparate data sources covering millions of service members (current and former), their family members, and Department of Defense civilian personnel (Vie et al., 2015; Vie, Griffith, Scheier, Lester, & Seligman, 2013). The PDE is fed by numerous active electronic data management systems that are updated regularly. PDE contents include but are not limited to demographic characteristics, pay, occupation, awards, promotions and demotions, combat deployments, civilian and military education, family dependent information, trainings, misconduct, survey data (e.g., entrance exams, psychological data), and medical records. Although access to the PDE is currently quite limited, military leadership is exploring ways to securely open the PDE to civilian scientists. Doing so will help the research community push the boundaries of social and medical science, and our study is intended as a proof of concept. At any rate, even though our focus was on combat exposure and prior catastrophic thinking, the database afforded us the opportunity to examine with an unusually large and complete population a variety of other risk and protective factors for PTSD such as gender, age, and ethnicity, and we report these effects as well.

To our knowledge, this is the first report to examine prospectively pretrauma cognitive style as a risk and

protective factor for PTSD in a very large cohort of deployed soldiers. Analyzing this large database in the PDE affords three major opportunities: (a) prospectively examine over four years the full, eligible population of active duty Army soldiers who deployed to Iraq or Afghanistan during the study window, completed the necessary paperwork, and indicated that their responses could be used for research purposes; (b) examine the risk and protective effects of a large variety of demographic factors, such as ethnicity, gender, and age, on PTSD; and (c) statistically control for these demographic factors as well as a wide range of other important covariates and potential confounds, including combat intensity, baseline psychological traits, and physical health.

We focused on identifying a modifiable psychological risk and protective factor—catastrophic thinking—which, if found to be an important predictor of later PTSD, would improve knowledge of PTSD etiology in soldiers, aid in identification of soldiers vulnerable to the disorder, and provide an additional intervention target for preventing PTSD.

Method

Participants

A total of 243,077 active duty Army soldiers completed the required assessments in the baseline year (April 2009–March 2010) and also indicated through an electronic opt-in procedure that their responses could be used for research purposes (on average, two-thirds of soldiers opt in). From this group, 53,727 soldiers were excluded because of preexisting mental health conditions. Of the remaining soldiers, 79,438 deployed to Iraq or Afghanistan during the observation period and constituted the analytic sample. From this group, a total of 21,568 soldiers deployed to Iraq and 61,458 to Afghanistan; 3,588 soldiers deployed to both theaters. Soldiers were observed until one of the following events occurred: diagnosis of PTSD, separation from Army service, mortality unrelated to PTSD, or the end of follow-up (March 31, 2013). This constitutes the entire eligible cohort of active duty Army soldiers and not a random sample.

Data sources and measures

The PDE contains inpatient and outpatient medical data from the Military Health System Data Repository (MDR) and Theater Medical Data Store (TMDS). The MDR contains complete information on billing codes for purchased and direct medical care received stateside and reimbursed by the insurer TRICARE. The TMDS contains complete information on billing codes for medical care received in combat theater. A PTSD diagnosis corresponds to the first occurrence of a primary *International*

Classification of Diseases, Ninth Revision (ICD-9) code of 309.81. A diagnosis of depression corresponds to a primary ICD-9 code of major depression (296.2), recurrent major depression (296.3), dysthymic disorder (300.4), or unclassified depressive disorder (311). A diagnosis of anxiety disorder corresponds to a primary ICD-9 code of anxiety state, unspecified (300.00); panic disorder without agoraphobia (300.01); generalized anxiety disorder (300.02); agoraphobia with panic disorder (300.21); agoraphobia without mention of panic attacks (300.22); social phobia (300.23); other isolated or specific phobias (300.29); or obsessive-compulsive disorders (300.3).

We obtained demographic information from the Defense Manpower Data Center's (DMDC) electronic administrative records. Additional DMDC data included the Contingency Tracking System-Deployment file, which tracks the number, length, and location of deployments. The Social Security Administration Death File provided information on mortality, and the Transaction File provided dates and reasons for discontinuation of Army service.

We used measures of catastrophic thinking, coping strategies, social support, and depressive symptoms obtained from the GAT (Peterson et al., 2011). Seven catastrophic thinking items written by Aaron Beck and Martin Seligman and distilled from the Attributional Style Questionnaire (i.e., Peterson et al., 1982) captured the essence of explanatory style:

- “When bad things happen to me, I expect more bad things to happen.”
- “When bad things happen to me, I blame myself for them.”
- “I have no control over the things that happen to me.”
- “When bad things happen to me, I cannot stop thinking about how much worse things will get.”
- “When I have a physical problem, I am likely to think that it is something very serious.”
- “When I fail at something, I give up all hope.”
- “I respond to stress by making things worse than they are.”

Items were presented to respondents using a 5-point Likert response format ranging from 1 (*not like me at all*) to 5 (*very much like me*). Higher scores indicated more catastrophizing. These items had an internal consistency of $\alpha = .87$. We also grouped soldiers by quintiles of catastrophic thinking (lower 20th, 21st–40th, 41st–60th, 61st–80th, and upper 20th percentiles); the higher the score, the worse the thinking style.

Five items assessed problem-focused coping strategies (e.g., “When something stresses me out, I try to solve the problem”): $\alpha = .78$; Carver, 1997; Carver,

Scheier, & Weintraub, 1989). Items were presented to respondents using a 5-point Likert response format ranging from 1 (*not like me at all*) to 5 (*very much like me*). In addition, a single item assessed social support ("Number of people you can count on if you have a serious problem"). Eight items adapted from the Patient Health Questionnaire assessed depressive symptoms (e.g., feeling down, depressed, or hopeless over the past four weeks: $\alpha = .91$; Kroenke, Spitzer, & Williams, 2001; Spitzer, Kroenke, & Williams, 1999). Items were presented to respondents using a 5-point Likert response format ranging from 1 (*not at all*) to 5 (*every day*). Higher scores indicated better coping strategies, greater social support, and more depressive symptoms. We standardized these four measures using the means and standard deviations from the complete population of available GAT surveys completed during the baseline year and included each soldier's earliest GAT during the baseline year.

Data from the Periodic Health Assessment, an annual health physical, provided a 19-item unit-weighted index of physical health symptoms (e.g., "Do you or have you ever had: stroke, frequent headaches, diabetes, or chronic pain?") and a measure of heavy alcohol use (Alcohol Use Disorders Identification Test [AUDIT-C]; Bradley et al., 2006). A seven-item measure of combat intensity from the Post-Deployment Health Assessment surveyed war zone experiences related to a blast or explosion, vehicular accident or crash, fragment or bullet wound, a fall or other injury; encountering dead bodies or seeing people killed or wounded; direct combat requiring discharging a weapon; and feeling in great danger of being killed (Army Medical Department Center and School, 1998). Although combat intensity was self-reported, six of the seven items were reports of objective experiences, for example, being in a vehicular accident, and only one, feeling in great danger, was markedly subjective. The following results do not change when we exclude the item assessing feeling in great danger. Higher scores indicated that soldiers encountered more of these combat situations. Combat intensity and catastrophic thinking were uncorrelated ($r = .02$), which suggests that earlier catastrophization did not significantly influence the intensity of combat later reported.

Statistical analysis

For descriptive purposes, we computed effect sizes of the bivariate associations between baseline model characteristics and PTSD status. We computed relative risk for categorical measures and Cohen's d for continuous measures. These effect sizes should, however, be interpreted with caution because they do not incorporate

information regarding time to event or changes in catastrophic thinking, problem-focused coping, social support, or combat intensity over time. We also computed effect sizes of the bivariate associations between baseline model characteristics and baseline catastrophic thinking, the predictor of the greatest theoretical interest in this study. In the case of catastrophic thinking, we computed Cohen's d for categorical measures and Pearson r correlation for continuous measures.

We used Cox proportional hazards regression to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) for incident PTSD predicted by catastrophic thinking (Cox, 1972). Repeated assessments of catastrophic thinking, social support, coping, and combat intensity were constructed as time-dependent measures and updated when available (roughly annually for catastrophic thinking, coping, and social support and after each deployment for combat intensity). This accounted for fluctuations over time in psychological risk factors and combat intensity that might contribute to or exacerbate PTSD. Demographic factors, depressive symptoms, health symptoms, and heavy alcohol use were assessed at baseline. Multiple imputation procedures were used to impute missing values on physical health symptoms and heavy alcohol use (missing ~26%), combat intensity (missing ~11%), as well as other variables with lower missingness (e.g., catastrophic thinking; missing < 1%). Multiple inference procedures were used to pool estimates from 10 imputed data sets adjusting for missing data uncertainty (Schafer, 1997). This number of imputations was considered sufficient because the gain in relative efficiency of standard errors is trivial with more (i.e., Graham, Olchowski, & Gilreath, 2007).

All models adjusted for demographic characteristics; psychological (including coping, social support, and depressive symptoms), behavioral, and physical health; and military service measures. We estimated separate models using catastrophic thinking as either a standardized, continuous variable or according to quintiles to assess the possibility of discontinuous effects. Because of the focus on the joint effect of combat intensity and catastrophic thinking on the incidence of PTSD, we tested for a two-way interaction between these measures. To correct for the possibly confounding effects of anxiety and depression with catastrophic thinking, we repeated each PTSD analysis removing all soldiers diagnosed with depression or anxiety disorder in the follow-up window. We also examined PTSD risk at five levels of combat intensity. For the catastrophic thinking quintile and combat intensity subgroup analyses, we examined pairwise comparisons with both the middle (average) group and, separately, the low (best) group as the reference group. In addition, we examined the unique PTSD risk associated with relatively high

catastrophic thinking (1 *SD* or more above the mean), high combat intensity (two or more stressors), or being high on both. Correlations between the Schoenfeld residuals and functions of time in the primary model supported the Cox proportional hazard assumption for both catastrophic thinking and combat intensity. All statistical analyses were conducted using SAS software (version 9.4) in the PDE.

Results

We organize our results as follows: (a) demographic characteristics and PTSD, (b) the effect of catastrophic thinking on PTSD, (c) the effect of combat intensity on PTSD, and (d) the joint effects of catastrophic thinking and combat intensity on PTSD.

Demographic characteristics

At the 2009–2010 baseline, soldiers were fairly young (mean age = 28.14 years, range = 17–66) and predominantly male (89.90%) and White (70.31%). Most soldiers had up to a high school education (76.71%) and were of enlisted rank (81.23%), and approximately half were married (55.69%).

We observed a total of 3,084 diagnosed cases of PTSD among the 79,438 soldiers, a PTSD rate of 3.88%, in over 246,721 person-years of follow-up (mean \pm *SD* follow-up = 3.11 \pm 0.38 years). During the observation period, soldiers were deployed on average for 9.44 \pm 3.75 months and a mean number of 1.09 \pm 0.30 times. Soldiers diagnosed with PTSD had a significantly shorter follow-up because the analysis ended with the first PTSD diagnosis by design.

Bivariate associations with PTSD status

Table 1 shows higher PTSD rates among various demographic subgroups: gender (male = 3.94% vs. female = 3.40%), race/ethnicity (White, non-Hispanic = 4.09% vs. other = 3.39%), education (no college = 4.44% vs. college = 2.04%), marital status (married = 4.26% vs. not married = 3.41%), and rank (enlisted = 4.45% vs. officer = 1.44%). In addition, we report relative risk as a measure of effect size between each categorical baseline characteristic and PTSD risk (upper portion of Table 1, right column). We see, for example, that males were 1.16 times as likely as females to be diagnosed with PTSD.

For continuous measures, we report Cohen's *d* as a measure of effect size between baseline characteristics and PTSD status (lower portion of Table 1, right column). Soldiers who developed PTSD reported lower levels of problem-focused coping strategies and social

support at baseline and endorsed a greater number of depressive and physical health symptoms.

Bivariate associations with catastrophic thinking

Given the focus on catastrophic thinking, we also investigated the association between catastrophic thinking and each baseline characteristic. For categorical demographic characteristics, the Cohen's *d* effect size statistics for the standardized mean difference (95% CI) were generally modest: gender = 0.10, 95% CI = [0.07, 0.12]; race/ethnicity = 0.08, 95% CI = [0.06, 0.09]; education = 0.22, 95% CI = [0.21, 0.24]; marital status = -0.14, 95% CI = [-0.16, -0.13]; and officer rank = 0.24, 95% CI = [0.23, 0.26]. Positive effect sizes reflect more catastrophic thinking in Row 1 within a given characteristic relative to Row 2, whereas negative effect sizes reflect associations in the opposite direction.

For continuous measures, we examined Pearson *r* correlations. We found that catastrophic thinking was moderately correlated with the three other psychological measures derived from the GAT: problem-focused coping, $r = -.32$, 95% CI = [-.33, -.31]; social support, $r = -.25$, 95% CI = [-.25, -.24]; and baseline depression, $r = .52$, 95% CI = [.51, .52]. We also observed a small negative correlation between catastrophic thinking and age ($r = -.13$; 95% CI = [-.13, -.12]); however, the magnitude of all other pairwise correlations between catastrophic thinking and continuous baseline characteristics was below $r = .10$.

Predicting PTSD from catastrophic thinking

When modeled as a continuous variable, the risk of PTSD increased by 21% with each standard deviation increase in catastrophic thinking (HR = 1.21; 95% CI = [1.17, 1.26]) after controlling for demographic characteristics; psychological, behavioral, and physical health; and military characteristics (including combat intensity).

Low catastrophic thinking protected soldiers against PTSD, and high catastrophic thinking was a risk factor. Table 2 presents the PTSD risk comparing levels of catastrophic thinking against the average level of catastrophic thinking (the 41st–60th quintile; left column) and against the best level of catastrophic thinking (the 1st–20th quintile; right column), adjusting for demographic characteristics; psychological, behavioral, and physical health; and military characteristics (including combat intensity).

Soldiers who were lowest on catastrophic thinking were protected, having 25% less risk of PTSD than the

Table 1. Baseline Characteristics of Active Duty Soldiers

Characteristic	PTSD (<i>n</i> = 3,084)	No PTSD (<i>n</i> = 76,354)	Effect Size (95% CI)
	3.88	96.12	
Person-years of follow-up	6,782	239,939	—
Years of follow-up: Mean (<i>SD</i>)	2.20 (0.65)	3.14 (0.31)	—
	<i>n</i> (%)	<i>n</i> (%)	Relative Risk
Gender			
Male	2,811 (3.94)	68,601 (96.06)	1.16 [1.02, 1.31]
Female	273 (3.40)	7,753 (96.60)	
Race/ethnicity			
Non-Hispanic White	2,284 (4.09)	53,566 (95.91)	1.21 [1.11, 1.30]
Other	800 (3.39)	22,788 (96.61)	
Education			
Up to a high school diploma	2,681 (4.44)	57,748 (95.56)	2.17 [1.95, 2.41]
More than high school	375 (2.04)	17,974 (97.96)	
Marital status			
Married	1,885 (4.26)	42,356 (95.74)	1.25 [1.16, 1.34]
Other	1,199 (3.41)	33,998 (96.59)	
Officer rank			
Enlisted	2,870 (4.45)	61,660 (95.55)	3.10 [2.70, 3.55]
Officer	214 (1.44)	14,694 (98.56)	
	Mean (<i>SD</i>)	Mean (<i>SD</i>)	Cohen's <i>d</i>
Catastrophic thinking	2.15 (0.80)	2.03 (0.75)	0.15 [0.11, 0.18]
Age, in years	28.00 (7.17)	28.15 (7.27)	-0.02 [-0.06, 0.01]
Problem-focused coping	3.68 (0.76)	3.73 (0.70)	-0.07 [-0.11, -0.03]
Social support	3.90 (1.28)	4.08 (1.18)	-0.15 [-0.19, -0.11]
Baseline depression	1.87 (0.90)	1.61 (0.76)	0.31 [0.27, 0.35]
Health symptom index	2.06 (1.32)	1.76 (1.14)	0.24 [0.19, 0.29]
Alcohol use	2.54 (2.47)	2.32 (2.21)	0.09 [0.05, 0.14]
No. previous deployments	1.12 (1.13)	1.06 (1.17)	0.05 [0.02, 0.09]
No. deployments in the study window	1.02 (0.13)	1.09 (0.30)	-0.33 [-0.36, -0.31]
Months deployed during follow-up ^a	9.51 (3.05)	9.23 (3.13)	0.09 [0.05, 0.13]
Combat intensity ^a	2.23 (1.75)	1.27 (1.46)	0.60 [0.55, 0.64]

Note: The test statistics (independent samples *t* test for mean comparisons and chi-square test of independence for percentages) for all characteristics other than age and gender were significant at the $\alpha = .01$ level. Effect size estimates based on Cohen's *d* statistics assumed unequal variances. No. = number of.

^aTaken from the first deployment in the follow-up window.

middle catastrophizing group, whereas those highest in catastrophic thinking had a 29% greater PTSD risk than the middle catastrophizing group (Table 2, left column). Similarly, soldiers in the highest catastrophic thinking quintile had a 72% greater risk of developing PTSD compared with soldiers in the lowest quintile, adjusting for relevant covariates (Table 2, right column).

Because depression, anxiety disorder, and catastrophic thinking correlate with one another, we removed these confounds to better examine the unique effects of catastrophic thinking on PTSD. To do so, we excluded 8,911 soldiers with a primary ICD-9 depression or anxiety disorder diagnosis in the follow-up

window, which resulted in a sample of 70,527 soldiers (and 1,204 of the original 3,084 PTSD cases). Overall, the prediction of PTSD from catastrophic thinking alone, removing soldiers with anxiety and depressive disorders, was largely unchanged. Compared with the middle catastrophizing group, soldiers best in catastrophic thinking had a 28% reduced risk of PTSD (HR = 0.72; 95% CI = [0.60, 0.87], $p < .001$), and soldiers worst in catastrophic thinking had a 38% greater risk of PTSD (HR = 1.38; 95% CI = [1.15, 1.66], $p < .001$). Similarly, compared with soldiers best in catastrophic thinking, soldiers worst in catastrophic thinking had a 92% greater risk of PTSD (HR = 1.92; 95% CI = [1.58, 2.31], $p < .001$).

Table 2. Hazard Ratios (95% Confidence Intervals) for the Association of Catastrophic Thinking and Risk of Incident PTSD, 2009–2013, Full Cohort

Variable	Reference = 41st–60th Percentile	Reference = 1st–20th Percentile
Catastrophic thinking		
1st–20th percentile	0.75** [0.67, 0.84]	1.00 [Reference]
21st–40th percentile	0.90 [0.80, 1.01]	1.20* [1.07, 1.35]
41st–60th percentile	1.00 [Reference]	1.33** [1.19, 1.50]
61st–80th percentile	1.26** [1.12, 1.42]	1.69** [1.49, 1.90]
81st–100th percentile	1.29** [1.16, 1.45]	1.72** [1.53, 1.94]
Age (in decades)	1.10* [1.03, 1.17]	1.10* [1.03, 1.17]
Gender	0.95 [0.83, 1.08]	0.95 [0.83, 1.08]
Race/ethnicity	1.25** [1.15, 1.36]	1.25** [1.15, 1.36]
Education	0.74** [0.65, 0.85]	0.74** [0.65, 0.85]
Marital status	1.28** [1.18, 1.39]	1.28** [1.18, 1.39]
Problem-focused coping	0.89** [0.86, 0.93]	0.89** [0.86, 0.93]
Social support	0.89** [0.86, 0.93]	0.89** [0.86, 0.93]
Baseline depression	1.17** [1.12, 1.22]	1.17** [1.12, 1.22]
Health Symptom Index	1.17** [1.13, 1.21]	1.17** [1.13, 1.21]
Alcohol use	1.03 [0.98, 1.07]	1.03 [0.98, 1.07]
Officer rank	0.40** [0.34, 0.48]	0.40** [0.34, 0.48]
No. previous deployments	0.99 [0.96, 1.03]	0.99 [0.96, 1.03]
Months deployed during follow-up	0.71** [0.68, 0.74]	0.71** [0.68, 0.74]
Combat intensity	1.35** [1.31, 1.38]	1.35** [1.31, 1.38]

Note: Values are hazard ratios with 95% confidence intervals in brackets. Demographic reference groups were as follows: gender = female; race/ethnicity = non-White; education = up through high school diploma; marital status = nonmarried; and officer rank = enlisted. HR = hazard ratio; CI = confidence interval; No. = number of.

* $p < .01$. ** $p < .001$

Predicting PTSD from combat intensity

Combat intensity was a major risk factor for PTSD. When we controlled for demographic characteristics; psychological (including catastrophizing), behavioral, and physical health; and military characteristics, soldiers who experienced the most intense combat had 2.2 times the risk of PTSD as those who experienced two combat stressors (Table 3, left column) and 3.8 times the risk compared with those who experienced no combat stressors (Table 3, right column).

Predicting PTSD from catastrophic thinking and combat intensity

The combination of high intensity combat and high catastrophic thinking resulted in a PTSD risk 3.74 times that of those with low combat intensity and catastrophic thinking, the reference group.

Figure 1 shows PTSD risk across catastrophic thinking and combat intensity levels. At low levels of combat intensity (left portion of Fig. 1), we see that soldiers high in catastrophic thinking have nearly double the

risk of developing PTSD (HR = 1.95; 95% CI = [1.68, 2.27]) compared with soldiers low in catastrophic thinking (the reference group). Additionally, soldiers who experienced high combat intensity (right portion of Fig. 1) were at significantly greater risk of developing PTSD relative to the reference group, particularly if they were high rather than low in catastrophic thinking (HR = 3.74; 95% CI = [3.06, 4.57] vs. HR = 2.82; 95% CI = [2.35, 3.39]; $p < .006$). We did not observe a meaningful two-way interaction between catastrophic thinking and combat intensity.

Discussion

Leveraging the PDE, a vast Army data repository and potential national treasure, we discovered a robust protective and risk factor for PTSD using all eligible active duty soldiers: Preexisting high catastrophic thinking placed soldiers at 29% higher risk for developing PTSD than soldiers with average catastrophic thinking levels. Hypothetically, had this been known beforehand and had the Army somehow decided not to allow soldiers from the high catastrophizing group to be exposed to

Table 3. Hazard Ratios (95% Confidence Intervals) for the Association of Combat Intensity and Risk of Incident PTSD, 2009–2013, Full Sample

Combat intensity	Reference = 2	Reference = 0
0	0.58** [0.50, 0.67]	1.00 [Reference]
1	0.60** [0.50, 0.72]	1.04 [0.90, 1.19]
2	1.00 [Reference]	1.72** [1.49, 1.99]
3	1.32** [1.10, 1.59]	2.28** [1.98, 2.62]
4+	2.20** [1.88, 2.58]	3.80** [3.33, 4.33]

Note: Values are hazard ratios with 95% confidence intervals in brackets. CI = confidence interval; Reference = combat intensity reference group. ** $p < .001$.

intense combat, over 400 of the PTSD cases might have been prevented. As for protection, preexisting low catastrophic thinking protected soldiers, placing them at 25% less risk than soldiers with average catastrophic thinking levels. This effect was independent of demographic characteristics; psychological, behavioral, and physical health; and military characteristics (including combat intensity).

Soldiers who experienced the most intense combat (i.e., four or more combat stressors), dismayingly but unsurprisingly, had 2.2 times the PTSD risk compared with those with two combat stressors and almost four times the risk compared with soldiers who experienced no combat stressors. This finding is consistent with prior research, which has found that combat exposure

predicts PTSD symptoms (e.g., Hoge et al., 2004; Smith et al., 2008). In addition, the combination of high catastrophic thinking and experiencing two or more combat stressors placed soldiers at nearly four times the risk for PTSD compared with soldiers low in catastrophic thinking and who did not experience combat stressors.

The present findings can be viewed from a useful protection perspective as well as the usual risk perspective. Through the risk lens, war is surely not good for fragile people, and exposing soldiers high in catastrophic thinking to intense combat can be very costly because it magnifies the human suffering caused by PTSD. Conversely, taking a protection approach, the Army might seek to identify and recruit soldiers from the best 20th percentile in catastrophic thinking because these soldiers' thinking styles may buffer them against PTSD and enhance combat outcomes. Choosing soldiers low in catastrophic thinking for intense combat could lead to lower casualties, less human suffering, and lower health care costs.

Catastrophic thinking and PTSD: correlation or causation?

Is catastrophic thinking a cause or merely a marker of PTSD? Our data cannot answer this because even though we controlled for many possible confounds, the data are essentially correlational. It is possible that thinking of bad events as catastrophic itself causes or magnifies the symptoms of PTSD, but it is also possible

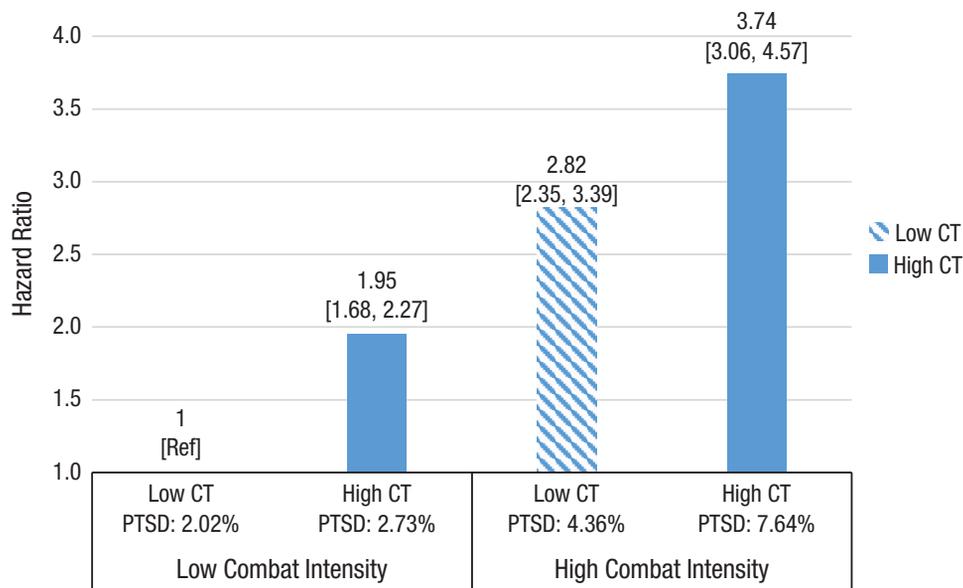


Fig. 1. Hazard ratios for catastrophic thinking, combat intensity, and posttraumatic stress disorder among soldiers. CT = catastrophic thinking; Ref = reference group; low CT = 1 SD or more below the mean; high CT = 1 SD or more above the mean; low combat intensity = 0 stressors; high combat intensity = 2 or more stressors. Brackets contain the 95% confidence interval for each hazard ratio.

that catastrophic thinking merely reflects a deeper underlying cause of PTSD. Underlying neuroticism, traumatic events prior to enlistment, a stressful childhood, or bad genes, for example, might be the underlying cause of both PTSD and catastrophic thinking. It also seems important that we found no interaction of catastrophic thinking with intensity of combat in predicting PTSD. In the usual “diathesis-stress” models, thinking style is a diathesis predicted to interact with stress such that the poor thinking style magnifies the effects of stress in producing an outcome such as depression or PTSD (Hollon et al. 2005). We found no such interaction, merely what appears to be two additive main effects with both prior catastrophic thinking and later intensity of combat contributing independently to PTSD.

One way to test whether catastrophic thinking is itself causal or merely a marker of some underlying cause is to determine if lowering catastrophic thinking lowers PTSD. Resilience training programs, such as those offered through Comprehensive Soldier and Family Fitness (CSF2), should examine whether reducing catastrophic thinking reduces PTSD risk (a program objective) and thereby improves combat outcomes (Cornum, Matthews, & Seligman, 2011; Reivich et al., 2011). Such training teaches soldiers how to curtail catastrophic thinking, and the results confirm this empirically: Over the course of six months, soldiers who received this training significantly decreased their catastrophic thinking compared with controls who showed no significant change (Lester, Harms, Herian, Krasikova, & Beal, 2011). These techniques give soldiers the chance to create positive emotion, keep from becoming passive or demoralized, maintain a realistic perspective, and reframe situations using mentally tough, resilient thinking. Whether these programs, and specifically the ingredient of reducing catastrophic thinking, actually reduce PTSD is still unknown (Harms, Herian, Krasikova, Vanhove, & Lester, 2013).

Given the symptom overlap and comorbidity of PTSD with depression and anxiety disorders, we asked whether catastrophic thinking alone puts one at risk for PTSD independent of depression and anxiety disorders. To test this, we adjusted for baseline depression (self-report) in our primary analyses, and we excluded soldiers from our follow-up analyses who were diagnosed with depression or anxiety disorders during the study. In all cases, catastrophic thinking robustly predicted PTSD risk, even after we removed soldiers who were also diagnosed with depression or anxiety disorders, who represented over 60% of the PTSD cases. It is possible, of course, that some third variable, such as neuroticism or preservice traumatic events or genes, underlies catastrophic thinking, but these are not

measured by the Army. Future research should continue to disentangle the underlying mechanisms linking catastrophic thinking to PTSD, depression, and anxiety, as well as the etiological pathways that contribute to such risks.

Despite this strong prediction of increased PTSD risk, a recent study investigating a similar research question yielded null results (Shen et al., 2017). Three critical differences may explain the disparate findings. First, our study used medical records to examine PTSD diagnoses rather than mere symptom screens for PTSD. Second, we examined catastrophic thinking as a continuous measure and grouped it into quintiles, whereas Shen and colleagues (2017) primarily compared soldiers in the worst 5% on catastrophic thinking with those in the best 95% on catastrophic thinking. If the association between catastrophic thinking and PTSD risk is linear, dichotomizing the catastrophic thinking measure may make it more difficult to detect an effect. Third, Shen et al. removed the effects of 13 other psychological attributes assessed on the GAT, including optimism, which has been shown to load on the same factor as catastrophic thinking (Vie et al., 2016). We were careful not to control for variables that are conceptually similar to catastrophic thinking.

Identifying additional PTSD risk and protective factors

Because our cohort was not a small study sample, but was large and comprehensive, we were able to identify several additional PTSD risk and protective factors. For example, although being an officer has consistently been associated with protection against PTSD, associations between education and PTSD risk have proved more elusive (e.g., LeardMann et al., 2009; Smith et al., 2008; Wild et al., 2016). In our study, we found that higher education protected soldiers against PTSD. It may be that officer training and education both provide soldiers greater opportunities to acquire some cognitive skills that will buffer against the stress of combat and thus protect against PTSD. In particular, command leadership training entails mental preparation that maximizes mission critical skills relevant to combat. It is also possible that low catastrophizers are more likely to pursue education and officer training.

Although associations between age and PTSD risk in the literature are spotty, being older was associated with a greater PTSD risk in our study. Our finding is consistent with Shen et al. (2017), who also observed a positive association between age and PTSD. We had greater statistical power than previous studies of age and PTSD that had discrepant findings from ours. Wild et al. (2016), for example, observed only 32 people with

PTSD episodes in their study of 453 newly recruited paramedics. Another possible reason for the discrepancy could be differences in the average age of the sample. Participants in the Millennium Cohort Study (e.g., LeardMann et al., 2009; Smith et al., 2008), for example, tend to be much older than the participants in our study or the study by Shen et al. It may be that the associations between age and PTSD risk are strongest mostly within a younger age range. If this is so, the Army could consider taking a preventive approach and offering additional strengths-based training to its very youngest soldiers. Future research is certainly needed, however, to better understand the role of age in vulnerability to PTSD before any policy recommendations can be made.

Females tend to have higher PTSD risk than males in community samples, but findings in military samples have been far less consistent (Brewin et al., 2000). Some studies of the military, including a recent meta-analysis of 14 studies (primarily retrospective and cross-sectional studies), have linked being female to increased PTSD risk (e.g., Polusny et al., 2014; Xue et al., 2015). Other studies of the military, however, have not observed a statistically significant gender difference in PTSD risk (e.g., Luxton, Skopp, & Maguen, 2010; Maguen, Luxton, Skopp, & Madden, 2012; Rona, Fear, Hull, & Wessely, 2007) or have observed a decreased PTSD risk among females (e.g., Haskell et al., 2010). In our study, gender was not significantly associated with PTSD risk. These discrepancies may, in part, be because of the small proportion of females in the military (typically < 20%), and most studies of PTSD in the military include very small numbers of females (and female PTSD cases). Even though our large study, with 273 PTSD cases among females, found no effect of gender, future research should continue to examine whether and under what circumstances PTSD risk varies by gender.

We found that, consistent with the literature, soldiers who avoided using problem-solving strategies and perceived little social support were at greater risk of developing PTSD (Agaibi & Wilson, 2005; Brewin et al., 2000; Iversen et al., 2008; Pietrzak, Johnson, Goldstein, Malley, & Southwick, 2009; Shen et al., 2017; Taylor & Stanton, 2007; Wild et al., 2016). Like catastrophic thinking, there may be ways that the Army can increase social support, and Scales's (2016) important recommendations for strengthening defense at the basic unit of the squad is a good example.

Interestingly, we found that marriage was associated with a greater risk of being diagnosed with PTSD. Having a partner may encourage help-seeking behavior and so, paradoxically, increase the potential for detecting underlying mental problems (Waite, 1995). This association between marriage and a greater risk of a PTSD

diagnosis has received some support in the literature, particularly when comparing married individuals with single, as opposed to divorced, individuals (e.g., Shen et al., 2017; Smith et al., 2008). A few articles have, however, linked marriage to a decreased PTSD risk (e.g., Iversen et al., 2008). Future research should continue to examine the association between marriage and PTSD risk, as well as the mechanisms underlying this association.

Although we found that White soldiers were at greater risk for PTSD, associations between ethnicity and PTSD risk are not well supported in the literature. Previous research is mixed, with some studies finding an increased PTSD risk among Blacks relative to Whites yet no differences between Whites and other minorities (e.g., Shen et al., 2017) and other studies (particularly within the Millennium Cohort Study) finding no significant differences in PTSD risk between Blacks and Whites yet a significantly lower risk of PTSD among Whites relative to an "Other" minority group (e.g., LeardMann et al., 2009; Smith et al., 2008). Future research should continue to examine race-specific vulnerability and incorporate a more granular assessment of underlying cultural differences (Brewin et al., 2000; Kessler, Chiu, Demler, & Walters, 2005).

Estimating the PTSD rate in the Army

The PTSD incidence rate of 3.88% in this study, which was derived from medical chart diagnoses, is consistent with Army estimates of PTSD within the entire population of active duty soldiers (including soldiers who do not opt in to this and other research studies). According to the Health of the Force (United States Army, 2015), the PTSD rate among active duty Army soldiers ranged from 2.5% in 2009 to 3.3% in 2013 (i.e., over the study window). The PTSD rate in this study is also consistent with the PTSD rates typically found in other military research studies. In fact, one-third of the research studies included in a recent meta-analysis of combat-related PTSD among military personnel and veterans reported a PTSD rate below 5%, and nearly two-thirds of the studies reported a PTSD rate below 10% (Xue et al., 2015).

We emphasize caution here, however, because we are skeptical that the "true" incidence rate of PTSD (or of anxiety or depression) can ever be known in an actual military setting, and this is a limitation of our study and the entire literature. Higher PTSD rates than we found are generally observed in studies that examine treatment-seeking individuals, have smaller sample sizes (resulting in less precise estimates), rely on self-reports of symptoms, or apply less stringent cutoffs than an actual diagnosis (Bliese et al., 2008; Ramchand et al.,

2010). Differences in sample type (population-based or convenience), country of service, military status (service, component, and whether current or former soldiers), survey response rates, time since deployment, medical provider type (psychiatrist, psychologist, or social worker), and whether a screener or full inventory was administered may also inflate PTSD estimates (Bliese et al., 2008; Milliken, Auchterlonie, & Hoge, 2007; Ramchand et al., 2010; Wilk et al., 2016).

Our concerns regarding the validity of the chart diagnoses of PTSD, depression, and anxiety in our study, which were derived from many different diagnosticians across the Army, are comparable with our concerns regarding the self-report methods of prior studies. A structured diagnostic interview that is uniform across diagnosticians would be better, but that is not a practical possibility in a theater-wide military study under combat conditions involving hundreds of diagnosticians.

But the real limitation on finding the true incidence of PTSD, anxiety, or depression is bias. Because mental illness remains highly stigmatized in the Army (Kim, Britt, Klocko, Riviere, & Adler, 2011), soldiers may underreport PTSD symptoms or refrain from seeking treatment to avoid rejection from their peers and protect their military careers. For similar reasons, providers may use less stigmatizing diagnoses even when PTSD, depression, or anxiety is clinically indicated. This would lead chart diagnoses to underestimate the true PTSD incidence. On the other hand, some soldiers may exaggerate their symptoms to evade combat or gain reimbursement. This would lead chart diagnoses to overestimate the true PTSD incidence.

Additional study limitations

Although unprecedented in size, completeness, and scope, our study has several additional limitations. For example, we only examined active duty soldiers, and the incidence of PTSD may be somewhat higher among Army Reserve and National Guard soldiers who deployed to Iraq or Afghanistan (Milliken et al., 2007). Whether there are different vulnerabilities in these occupational components warrants further empirical scrutiny. In addition, social support was assessed by a single item: the “number of people you can count on if you have a serious problem.” Inclusion of a more comprehensive measure of social support could help disentangle which aspects of social support (e.g., instrumental or emotional support) relate most strongly to PTSD risk (DiMatteo, 2004). This study also did not consider other types of traumatic events (e.g., car accidents, sexual assault, or other violent crimes), prior combat stress (Grieger et al., 2006), or other aspects of deployment (e.g., uncertain redeployment date, lack of

privacy, being separated from family, and other relationship problems) that may increase PTSD risk (Castro & Adler, 2000; MHAT 9, 2013). Long separation from family and lack of crucial social support systems, for example, place additional strain on deployed soldiers, which can exacerbate catastrophic thinking.

Conclusion

In summary, high catastrophic thinking predicts increased PTSD risk among deployed soldiers, whereas low catastrophic thinking predicts lower PTSD risk. This remains true even after adjusting for established PTSD risk factors, such as combat intensity and baseline depression. Although these data are correlational and could reflect the possibility that the tendency to think catastrophically merely marks risk for PTSD, they also are wholly consistent with the notion that catastrophic thinking plays a causal role in generating risk (when high) or conferring protection (when low). The best way to determine whether catastrophic thinking is truly causal is to enhance current resilience interventions to equip soldiers with appropriate strategies that can help them better deal with traumatic events and to see if this reduces PTSD risk. We suggest that when possible, military leadership avoid exposing high catastrophizers to intense combat and encourage the deployment of low catastrophizers to intense combat. This has the potential to reduce casualties, improve general well-being, and enhance combat outcomes, along with lowering health care costs. With gratitude, we emphasize that all of our findings relied on the new, authoritative Person-Event Data Environment, and so we hope that civilian and military researchers will make wide use of the PDE to better understand the influence of psychological assets and deficits on illness and health.

Action Editor

Stefan G. Hofmann served as action editor for this article.

Author Contributions

M. E. P. Seligman and R. Cornum developed the study concept. M. E. P. Seligman, A. R. Allen, L. L. Vie, T. E. Ho, and L. M. Scheier contributed to the study design. A. R. Allen and T. E. Ho performed the data analysis, and all authors contributed to interpretation of the results. All authors also contributed to the drafting of this manuscript. All the authors approved the final manuscript for submission.

Acknowledgments

We acknowledge the significant support provided to this project by the men and women of the Office of the Deputy Under Secretary of the Army, the Army Analytics Group, and the Research Facilitation Laboratory. We also thank Drs. Les

McFarling and Kristin Saboe from the Army Resiliency Directorate for assisting us with acquiring Global Assessment Tool data, Dr. Doug Bonett for statistical guidance, and Drs. David Clark, Terry Keane, Steven Hollon, and Ayelet Ruscio for comments on the manuscript. T. E. Ho is now at Northrop Grumman Technology Services, Seaside, California. L. M. Scheier is now at LARS Research Institute, Inc., Scottsdale, Arizona. The U.S. Department of Defense (DOD) does not exercise any editorial, security, or other control over the information in this article. The authors assume responsibility for the veracity, accuracy, and source documentation of the material, including no use of classified material and conformity to copyright and usage permissions.

Declaration of Conflicting Interests

The University of Pennsylvania has a proprietary interest in the Master Resilience Training, which is the backbone of the Comprehensive Soldier Fitness program of the U.S. Army. The University of Pennsylvania licenses such resilience training programs and positive psychology training programs to private companies. M. E. P. Seligman receives a nominal fee from the university for some of these. M. E. P. Seligman is often paid to give speeches that occasionally mention the material in this article. The remaining author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article. The remaining author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

Funding

This publication stems from a military-civilian collaboration, supported in part by the Robert Wood Johnson Foundation through a grant to the Positive Psychology Center of the University of Pennsylvania (M. E. P. Seligman, Principal Investigator and R. Cornum, Co-Principal Investigator).

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