



## The Combat Experience Log: A web-based system for the in theater assessment of war zone stress

Han-Joo Lee<sup>a</sup>, Katy Goudarzi<sup>b</sup>, Brian Baldwin<sup>c</sup>, David Rosenfield<sup>d</sup>, Michael J. Telch<sup>b,\*</sup>

<sup>a</sup> Department of Psychology, University of Wisconsin-Milwaukee, United States

<sup>b</sup> Department of Psychology, The University of Texas at Austin, 1 University Station, A8000, Austin, TX 78712, United States

<sup>c</sup> Institute for Advanced Technology, The University of Texas at Austin, United States

<sup>d</sup> Southern Methodist University, United States

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### ABSTRACT

This article presents preliminary data on the Combat Experience Log (CEL) – a web-based prospective data collection system for the in theater assessment of war zone stressors and stress reactions. 177 U.S. Army soldiers deployed to Iraq took part in the study. The overall response rate was 90.1% and the majority of CEL responders perceived the CEL system to be quite easy and convenient to use, and relevant to their war-zone experiences. Preliminary data on stress reactions, CEL utilization and soldier satisfaction are encouraging and suggest that the CEL assessment system offers a potentially useful assessment tool for enhancing our understanding of war-zone stress experiences and their contribution to PTSD and other combat stress disorders.

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Of the nearly two million military service members who have been deployed in Iraq and Afghanistan, most will return home from war without significant psychiatric morbidity. However data from recent prevalence studies indicate that a significant minority of returning veterans screen positive for one or more combat stress-related disorders including PTSD (Grieger et al., 2006; Hoge, Auchterlonie, & Milliken, 2006; Hoge et al., 2004; Kolkow, Spira, Morse, & Grieger, 2007; Lapierre, Schwegler, & LaBauve, 2007; Milliken, Auchterlonie, & Hoge, 2007; Seal, Bertenthal, Miner, Sen, & Marmar, 2007; Smith, Wingard, Ryan, Kritz-Silverstein, Slymen, & Sallis, 2008b; Vasterling et al., 2006), depression (Kolkow et al., 2007; Lapierre et al., 2007; Milliken et al., 2007; Seal et al., 2007) or probable TBI (Hoge et al., 2008; Vasterling et al., 2006). A telephone survey of 1965 Operation Iraqi Freedom (OIF)/Operation Enduring Freedom (OEF) veterans sampled from 24 geographic areas found that 14% screened positive for PTSD, 14% for major depression, and 19% for probable TBI in the past 30 days (Tanielian & Jaycox, 2008).

Research on the factors contributing to combat stress disorders among deployed military personnel has revealed a consistent relationship between soldiers' war zone experiences and risk for PTSD, depression, and other combat stress disorders (Grieger et al., 2006; Hoge et al., 2006; Hoge et al., 2004; Smith et al., 2008a). For

example, Hoge et al. (2004) found that compared to Afghanistan veterans, Iraqi veterans who reported greater rates of direct combat experiences with the enemy showed greater mental health problems (particularly PTSD) at the post-deployment assessment. Further, regardless of the two deployment locations, combat experiences (e.g., being shot at, killing enemy soldiers, handling corpses, or knowing someone who was killed, number of firefights) were strongly related to the prevalence of PTSD at post-deployment (Smith et al., 2008a). Taken together, the current literature provides compelling evidence that war-zone experiences are potent contributors to combat stress disorders such as PTSD and depression.

Until now the assessment of war zone stressors has relied on psychometric questionnaires administered to veterans after returning from the war zone environment. Two of the more well-known retrospective questionnaires for assessing war zone stressors are the War Zone Stressor Index developed by King, King, Gudanowski, and Vreven (1995) in the context of the National Vietnam Veterans Readjustment Study and the Deployment Risk and Resilience Inventory also developed by King et al. (King, King, Vogt, Knight, & Samper, 2006). The War-Zone Stressor Index consists of 72 items assessing one of the following four major areas: (a) traditional combat experience, (b) atrocities-abusive violence, (c) perceived threat, and (d) malevolent environment (King et al., 1995). The four sub-domains of the War-Zone Stressor Index showed Cronbach's alpha coefficients ranging from .83 to .94 (King

\* Corresponding author. Tel.: +1 512 560 4100; fax: +1 702 995 9347.  
E-mail address: telch@austin.utexas.edu (M.J. Telch).

et al., 1995), which indicates an adequate level of homogeneity and internal consistency within each domain. A later study found that the War-Zone Stressor Index significantly predicted the severity of PTSD symptoms at post-deployment, and was also associated with pre-deployment risk factors (e.g., family instability) and post-deployment resilience factors (e.g., hardiness and social support) (King, King, Foy, Keane, & Fairbank, 1999).

The Deployment Risk and Resilience Inventory (King et al., 2006) is a suite of scales assessing a wide variety of psychosocial risk and resilience factors, as well as war-zone stress experiences, among individuals deployed to a combat zone or other hazardous environment. The DRRI includes 2 predeployment factors (prior stressors and childhood family environment), 10 deployment factors (combat experiences, perceived threat, aftermath of battle, difficult living and working environment, sense of preparedness, nuclear, biological, and chemical exposures, concerns about life and family disruptions, deployment social support, sexual harassment, and general harassment), and 2 post-deployment factors (post-deployment social support and post-deployment stressors). Psychometric studies of the reliability and validity of the DRRI have been favorable (Fikretoglu, Brunet, Poundja, Guay, & Pedlar, 2006; Vogt, Proctor, King, King, & Vasterling, 2008). Moreover, the DRRI has been found to significantly predict several indices of mental and physical health outcomes at post-deployment (King et al., 2006; Vogt et al., 2008).

Although retrospective assessment scales of war-zone stress experiences are easy to administer and have provided important contributions to our understanding of combat-related stress disorders, they are also vulnerable to a host of problems (King et al., 1995). These include: (a) mood congruent memory bias (Bower, 1981; Watkins, Vache, Verney, & Mathews, 1996); (b) stress-induced retrieval difficulty (Burke, Heuer, & Reisberg, 1992; Loftus & Burns, 1982); (c) unintentional reconstruction bias (Metts, Sprecher, & Cupach, 1991); and (d) intentional reporting biases that can take the form of under or over-reporting traumatic events (Carlson, 1997; McNally, 2007). Moreover, as noted by King et al. (1995), the accuracy of retrospective self-reports of war zone traumatic experiences is questionable given that the inability to recall aspects of the trauma is one of the avoidance symptoms for meeting a DSM-IV diagnosis of PTSD.

One promising approach to assessing war-zone stress experiences while circumventing the numerous problems associated with the retrospective mode of assessment is to utilize a web-based assessment system. Enabling soldiers to report their ongoing war zone stress experiences using a web-based assessment was expected to significantly enhance the reliability of self-reports by (a) minimizing the time passage from stress exposure to assessment, (b) minimizing the demand on retrospection by assessing stress reactions in the current month, (c) maintaining the environmental and emotional contexts of stress exposure and assessment to be proximal, and (d) conducting repeated prospective assessments in the war zone, which is less likely to result in incentive-driven self-reports, relative to post-deployment retrospective assessment. Thus, we expect the web-based prospective assessment strategy to contribute to significantly reducing most of the methodological problems that may arise from retrospective assessment of war-zone stress experiences, including memory biases, retrieval failures, and reporting biases.

The principal aim of this article is to describe the development and implementation of the Combat Experience Log (CEL) – a web-based assessment system for the measurement of war zone stressors and war zone stress reactions in theater. Unlike retrospective rating scales such as the DRRI, which assess war zone experiences at a single time point after returning from the war zone, the CEL assessment system provides repeated in-the-

ater assessments of soldiers' war zone experiences and several relevant domains of stress reactions (i.e., PTSD, depression and general stress/anxiety symptoms) over the soldiers' full deployment period. Preliminary data are presented on: (a) soldiers' utilization of the CEL system; (b) soldiers' satisfaction with the CEL system; and (c) growth curve analyses of soldiers' stress reactions over an 18-month deployment period.

## 1. Method

### 1.1. Participants and recruitment procedures

The sample was drawn from U.S. Army soldiers stationed at Ford Hood who participated in the Texas Combat Stress Risk Study, a prospective investigation of genetic, neuroimaging, psychosocial, and cognitive risk factors predicting soldiers' combat stress reactions while deployed in Iraq between August 2007 and August 2009. Participants ( $N=177$ ) were recruited through announcements to unit leaders from four combat units, one combat support unit, and four combat service support units. The PI and the Project Director conducted group study briefing meetings for potential soldier volunteers from each of the nine Fort Hood Units. To reduce the potential for soldiers to feel coerced to participate, unit leaders were not present at the briefing meetings, and an U.S. Army ombudsman, not connected to the study, was present during all recruitment sessions. Of the 223 soldiers attending the group orientation sessions, 184 soldiers (82%) provided informed consent and completed an extensive 8-h pre-deployment assessment at the Imaging Research Center at the University of Texas at Austin. Our study sample represented the 9 participating units fairly evenly – the mean number of participants across the 9 units was 20.4 with a standard deviation of 4.88 (range = 12–25). Of the 184 soldiers completing the pre-deployment assessment, 6 soldiers were not deployed and one deployed soldier actively withdrew from the study after consenting.

Study inclusion/exclusion criteria included: (a) current Army soldier scheduled to deploy to Iraq within three months, (b) no prior deployment to a war zone, and (c) age 18 or over. The final sample was predominantly male (88.7%) with a mean age of 24.41 ( $SD=6.12$ ) and the following race/ethnicity breakdown: Caucasian (72.3%), Hispanic (17.5%), African American (9.0%), American Indian or Alaska Native (10.7%), Asian, Native Hawaiian or Other Pacific Islander (4.6%), and multi-ethnic (3.4%). Educational status of the sample was as follows: some high school education (53.1%), some college (37.9%), undergraduate degree (5.1%), and master's degree or higher (3.9%). With respect to marital status, 57.6% had never been married, 31.6% were married, 7.9% were divorced or separated, and 2.8% were living with a partner.

### 1.2. Combat Experience Log (CEL)

The CEL is a web-based in theater assessment system developed to provide repeated measures of combat-related stressors and stress reactions among military personnel deployed to a war zone. Noteworthy features of the CEL system include: (a) user-friendly self-administered repeated assessment of several core facets of war-zone stress experiences, (b) is accessible from any computers in the world with an Internet connection, (c) can be completed within 10 min, and (d) can be efficiently managed by research staff members. To this end, we conducted a thorough literature review and also worked closely with our military advisors to identify important war-zone stress factors. The CEL consists of two primary sections – one devoted to the assessment of combat-related stressors and the other devoted to the assessment of war zone stress reactions.

### 1.2.1. Section I: Assessment of combat-related stressors

This section presents a list of 18 war-zone stressors modeled after a modified version (Vasterling et al., 2006) of the DRRI Section I – Combat Experiences (see Table 1). Soldiers were instructed to carefully review the list of 18 stressors and check those experienced during the past 30 days. Soldiers were also provided the opportunity to record two additional war zone stressors that were not captured by any of the 18 war zone stressor items. Next, soldiers were instructed to indicate the one stressor that caused them the most distress in the past 30 days.

### 1.2.2. Section II: Assessment of war-zone stress reactions

This section assesses war-zone stress reactions in the following four domains: (a) PTSD, (b) depression, (c) traumatic brain injury (TBI), and (d) general emotional distress.

**1.2.2.1. CEL – PTSD.** The CEL includes two well-validated instruments that have demonstrated high sensitivity and specificity for assessing symptoms of PTSD: the Short PTSD Interview (SPRINT; Connor & Davidson, 2001) and the brief version of the PTSD Checklist (PLC-Short; Bliese et al., 2008). The SPRINT is a brief 10-item PTSD scale, tapping each of the three symptom clusters contained in the DSM-IV PTSD diagnostic criteria (i.e., re-experiencing, avoidance, and hyperarousal). The SPRINT has demonstrated sound psychometric properties and a total score of 14–17 among victims of trauma has shown 96% PTSD diagnostic accuracy (Connor & Davidson, 2001; Vaishnavi, Payne, Connor, & Davidson, 2006). For the current sample, internal consistency computed from the first entry of the CEL-SPRINT was .88.

PTSD symptoms were also assessed using the PCL-Short – a 4-item version of the original 17-item PCL (Weathers et al., 1993), which has undergone extensive psychometric evaluation (Andrykowski, Cordova, Studts, & Miller, 1998; Blanchard, Jones-Alexander, Buckley, & Forneris, 1996; Dobie et al., 2002; Lang & Stein, 2005). The PCL-Short includes each of the three PTSD symptom clusters: re-experiencing (2 items), avoidance (1 item), and increased arousal (1 item). A recent validation study indicated that the PCL-short has a diagnostic accuracy estimate equivalent to that of the full PCL, with a value of 7 as a reasonable cutoff score (Bliese et al., 2008). For the current sample, internal consistency coefficient computed from the first entry of the CEL-PCL-Short was .79.

**1.2.2.2. CEL – perceived threat.** Perceived threat during deployment is assessed using the Deployment Concerns subscale of the DRRI (DRRI-DC). The DRRI-DC includes 15-items (e.g., “I thought I would never survive,” “I felt that I was in great danger of being killed or wounded,” “I was afraid I would encounter a mine or booby trap”) each rated on a 5-point scale (1: Strongly Disagree ~ 5: Strongly Agree). The decision to include this scale was based on prior research implicating perceived threat as a significant contributor to the development of PTSD in response to war zone stressors (King, King, & Foy, 1996; Kolkow et al., 2007). For the current sample, internal consistency computed from the first entry of the CEL-Perceived Threat scale was .90.

**1.2.2.3. CEL – depression.** Depression during deployment is assessed in the CEL system using the 10-item short version of the Center for Epidemiologic Studies Depression (CES-D) Scale (Andresen, Malmgren, Carter, & Patrick, 1994). This brief version of the CES-D has shown adequate psychometric properties and corresponds closely to the original 20-item scale ( $\kappa = .97, p < .001$ ; Andresen et al., 1994). For the current sample, internal consistency computed from the first entry of the CES-D 10 was .72.

**1.2.2.4. CEL – TBI.** The CEL system also includes a 10-item measure that assesses symptoms of TBI: headache, dizziness, irritability,

memory problems, difficulty concentrating, fatigue, visual disturbance, aggravation by noise, judgment problems, and anxiety (Hoge et al., 2008; Kushner, 1998; Nampiaparampil, 2008). The occurrence of head injury or loss of consciousness is assessed as part of war-zone stressors in Section I of the CEL system (i.e., “injured your head” and “became unconscious”). Thus, the CEL enables an assessment of the occurrence of head injury and loss of consciousness and a varying degree of subsequent TBI symptoms on a monthly basis. For the current sample, internal consistency computed from the first entry of the CEL-TBI index was .86.

**1.2.2.5. CEL – general emotional distress.** The CEL also provides an assessment of a wide array of psychological and somatic stress reactions reflecting general depression and anxiety symptoms. Soldiers were instructed to indicate the extent to which they experienced each of 31 symptoms (e.g., feeling sad, loss of energy, sleep disturbance, loss of appetite, sudden feeling of panic) during the past 30 days using a 5-point scale (1 = not at all to 5 = extremely). For the current sample, internal consistency coefficients were .86 and .92 for the General Depression and General Anxiety scales, respectively.

## 1.3. CEL administration and procedures

The CEL system and its database reside in a secure ColdFusion server at the University of Texas at Austin. During their pre-deployment assessment, all participants were assisted in creating a password-protected personal CEL user account. A set of built-in administrative utilities allows staff to monitor each soldier's CEL response data (i.e., exact date and time of each CEL entry) as well as notification status (i.e., how many email reminders have been sent to each soldier for any given month and when the last reminder was sent out). The CEL management section also has an automated notification system that makes it very easy for staff to send out email reminders individually tailored to each soldier's CEL response schedule. Soldiers were instructed to complete a CEL entry every 30 days starting from one month after their deployment date.

Upon receiving their monthly email reminder, soldiers access the CEL login page by simply clicking the link embedded within the email message. The first reminder was sent to soldiers 6 days prior to every 30th day from their deployment date. If the soldier failed to complete the CEL entry within 7 days of the first reminder, another reminder was automatically sent to the soldier. In the event that soldiers for whatever reason (e.g., no access to the internet) were not able to complete a CEL entry in response to these two email reminders, they were sent a reminder again in the following monthly cycle. However, soldiers were allowed to access and complete the CEL entry in between these monthly reminding periods.

## 1.4. CEL experience survey (CELES)

We also developed an 18-item online survey to assess soldiers' experiences and attitudes toward the CEL assessment system. Items (e.g., the CEL was easy to use) were rated on a 6-point scale (1 = Strongly Disagree to 6 = Strongly Agree). To minimize the burden of ongoing web-based assessment in the war zone, the CELES was administered to study participants at their post-deployment assessment.

## 2. Results

### 2.1. Current deployment status of the study sample

All 177 soldier participants returned to the US and 90.4% ( $n = 160$ ) completed the post-deployment assessment. For the 177

**Table 1**  
War-zone stressors reported by soldiers using the CEL system.

	% Soldiers reported the event	% Soldiers reported the event as most distressing
1. Gone on a combat patrol/mission	58.4	24.8
2. Moved from one region of Iraq to another	63.4	28.0
3. Received hostile incoming small arms-type fire	39.8	11.2
4. Witnessed Americans/allies (that you did not know) seriously wounded or killed	31.7	13.0
5. Witnessed Americans/allies (that you knew well) seriously wounded or killed	13.0	7.5
6. Witnessed enemy combatants being seriously wounded or killed	12.4	2.5
7. Received hostile incoming fire	67.1	32.9
8. Participated in a combat mission.	47.8	6.8
9. Seen people begging for food	62.1	11.2
10. Been wounded or injured in combat	3.7	.0
11. Observed homes or villages being destroyed	11.2	.6
12. Seen Americans or allies after they had been seriously wounded or disfigured in combat	28.6	8.7
13. Exposed to a chemical or biological weapon	3.7	.0
14. Experienced significant conflict(s) with other soldiers	37.3	15.5
15. Injured your head	10.6	2.5
16. Became unconscious	3.7	.6
17. Received bad news from home	52.8	28.6
18. Became physically sick	34.8	14.9
19. Other – unique stressor	28.6	25.5

returned soldiers, the average duration of deployment was 420 days (=14 months; SD = 221.15 days; range = 33–772 days).

## 2.2. CEL usage data

Of the 177 study participants, 161 (90.1%) completed the CEL diary at least once during their deployment. Among the 161 CEL responders, 40 soldiers (24.8%) completed one CEL entry, 32 soldiers (19.9%) completed 2–3 entries, 26 soldiers (16.1%) completed 4–6 entries, 14 soldiers (8.7%) completed 7–9 entries, and 49 soldiers (30.4%) completed 10 entries or more. On the average, our CEL responders provided 6.46 entries during their deployment (SD = 5.47, range = 1–18).

## 2.3. Predictors of CEL usage

Predictors of CEL use were examined using multiple regression analyses. Soldiers' gender, age, education, marital status, ethnicity and race were entered together as predictors in the model and CEL use as indexed by the number of diary entries completed served as the dependent variable. Categorical variables with more than two levels were dummy-coded. This analysis was confined to the main effects of each demographic variable because there was no strong theoretical rationale to test interaction effects among these demographic characteristics in predicting CEL response rates.

The overall regression model explained 40% of the variance in the number of CEL entries,  $F(11,165) = 9.81$ ,  $p < .001$ . Although a number of predictors were included in the regression model, tolerance (all  $> .20$ ) and Variance Inflation Factor (VIF; all  $< 4.0$ ) statistics indicated that the results were not affected by multicollinearity. Three variables emerged as significant predictors of the total number of CEL entries: gender ( $B = -3.99$ ,  $t = -3.44$ ,  $p < .005$ ), age ( $B = .46$ ,  $t = 6.74$ ,  $p < .001$ ), and education level ( $B = 4.30$ ,  $t = 2.36$ ,  $p < .05$ ). With respect to gender, females completed more entries than their male counterparts (9.70 vs. 5.39). With respect to age, older soldiers completed more entries than younger soldiers. Finally, with respect to education level, soldiers who had completed a bachelor's degree provided more CEL entries compared to those who did not complete high school (10.33 vs. 3.80).

One of the 9 deployed units experienced significant network and computer access problems in Iraq. In fact, 9 of the 15 CEL non-responders (56%) were members of this unit, which on average provided 4.68 less CEL entries than the other 8 units ( $B = -4.68$ ,  $t = -4.00$ ,  $p < .001$ ).

## 2.4. In theater reports of war-zone stressors and stress reactions obtained from the CEL

Data on soldiers' in theater self-reported war-zone stressors obtained from Section I of the CEL are presented in Table 1. Overall, soldiers reported an average of 3.34 stressors (SD = 2.83) each month from the 18 war-zone experiences included in the CEL system. Of the 161 responders, 46 (28.6%) recorded at least one unique war-zone stressor in addition to their responses to the 18 stress events in Section I. Close inspection of the content of these individualized responses revealed that they were indeed specific instances of stress events that were already covered by the 18 CEL items, e.g., receiving bad news from home such as the death of a family member, seeing injured people, relationship problems with peers or family members, physical illnesses, etc.

Of the 18 war-zone stressors assessed in Section I of the CEL, the five most frequently experienced stressors recorded at least once during deployment were: (1) received hostile incoming fire (67.1%); (2) moved from one region of Iraq to another (63.4%); (3) saw people begging for food (62.1%); (4) went on a combat patrol/mission (58.4%); and (5) received bad news from home (52.8%).

Of these same 18 war-zone stressors, the five rated by soldiers as most distressing were: (1) received hostile incoming fire (32.9%); (2) received bad news from home (28.6%); (3) moved from one region of Iraq to another (28.0%); (4) gone on a combat patrol/mission (24.8%); and (5) experienced significant conflict(s) with other soldiers (15.5%).

## 2.5. Growth curve analyses of war zone stress reactions over time

Table 2 presents overall means and standard deviations of stress reaction indicators from Section II of the CEL system. To

**Table 2**  
Means and standard deviations of overall stress reactions in theater.

Measure	M (SD)
PCL-4	5.29 (1.96)
SPRINT	4.08 (5.36)
Perceived threat	26.33 (10.26)
CESD	7.11 (3.80)
General distress-DEP	19.07 (7.00)
General distress-ANX	9.88 (8.66)

PCL-4: Brief PTSD Symptom Checklist; SPRINT: Short PTSD Interview; CESD: 10-item Center for Epidemiologic Studies Depression Scale; General distress-DEP: General Depression Symptoms; General distress-ANX: General Anxiety Symptoms.

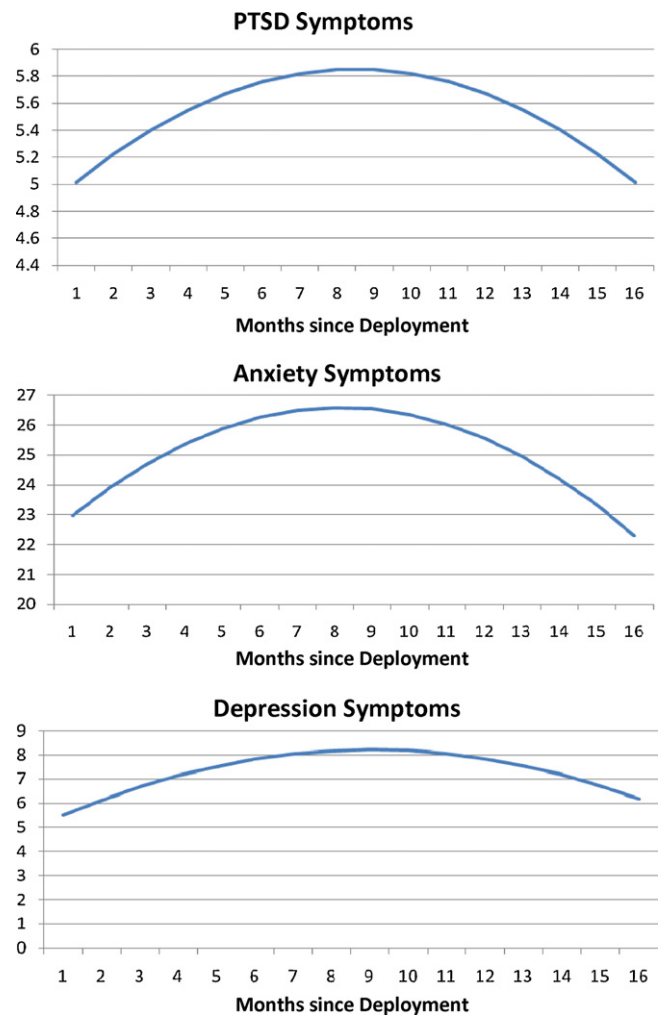
examine the pattern of war zone stress over the course of deployment, mixed-effects regression models (MRMs) were used to construct separate growth curves for PTSD symptoms, depression symptoms, and general stress/anxiety symptoms using data obtained in theater from the CEL. For each growth curve model, both linear and quadratic terms of mean-centered Time (days since deployment) and Time<sup>2</sup> were entered along with level of war zone stress exposure. This enabled us to examine the overall change in symptoms over time (i.e., linear component of the growth curve) and non-linear change in symptoms over time (i.e., quadratic component of the growth curve) after controlling for level of war zone stressors. The linear trend was significant only for depressive symptoms,  $b = .09$ ,  $t(97) = 1.98$ ,  $p = .05$ . In contrast, the quadratic trend over time was significant across all three war zone stress indices, namely, PTSD symptoms;  $b = -.015$ ,  $t(96) = 4.47$ ,  $p < .001$ ; general stress/anxiety symptoms  $b = -.07$ ,  $t(100) = 3.97$ ,  $p < .001$ ; and depression symptoms as measured by the CES-D 10,  $b = -.04$ ,  $t(97) = 5.44$ ,  $p < .001$ . Contrary to expectation, stress reactions increased over time during the first half of deployment and peaked at around month 8, and then gradually returned to their initial levels by month 16 (see Fig. 1).

## 2.6. Effects of war zone stressors on stress reactions in-theater

The relationship between level of war zone stressors and PTSD, depression, and general stress/anxiety symptoms assessed in theater by the CEL were examined using MRM analyses. Results revealed a significant main effect of level of exposure to war zone stressors as assessed by Section I of the CEL and war zone stress symptoms. Specifically, soldiers who reported higher average war zone stressors had higher levels of PTSD symptoms,  $b = .30$ ,  $t(92) = 3.28$ ,  $p < .005$  and general anxiety/stress symptoms,  $b = 1.85$ ,  $t(96) = 3.15$ ,  $p < .005$ . Similarly, monthly variations around a soldier's average war zone stressors were also related to PTSD symptoms and general stress/anxiety symptoms over time. Specifically, increases (decreases) in war zone stressors over time were associated with increases (decreases) in PTSD symptoms,  $b = .15$ ,  $t(95) = 3.25$ ,  $p < .005$ , and general stress/anxiety symptoms;  $b = 1.16$ ,  $t(99) = 4.32$ ,  $p < .001$ .

## 2.7. Soldiers perceptions of the CEL assessment system

Anonymous data on soldiers' perceptions of their CEL experience were obtained from a subset of participants ( $n = 125$ ) at the post-deployment assessment. Of the 125 returned soldiers assessed at post-deployment, 79.2% ( $n = 99$ ) reported completing at least one CEL entry while deployed. From this group, 88.9% of the survey responders agreed or strongly agreed that the CEL system was easy to use. Similarly, 88.9% of the survey responders agreed or strongly agreed with the statement that CEL items were easy to understand. Moreover, only 16.1% of survey responders reported that the CEL



**Fig. 1.** Growth curves of war zone stress reactions over time.

was time-consuming and 10.1% endorsed the statement that the CEL was a waste of time.

Regarding the perceived relevance of CEL items, 80.8% of survey responders agreed or strongly agreed with the statement that the CEL questions were relevant to their war-zone situation. Relatedly, 75.7% agreed or strongly agreed with the statement that results from the CEL diary may help future soldiers.

We also surveyed participants about their emotional reactions to completing the CEL. Only 8% of those surveyed agreed with the statement that completing the CEL was emotionally upsetting; whereas 20.2% reported that the completing the survey made them feel better, and the biggest proportion (58.6%) reported having no emotional reaction (good or bad) in connection with using the CEL. However, about one-fourth of the soldiers surveyed (27.3%) indicated that they found the CEL email reminders annoying.

Reasons given for not completing the CEL assessment system were collected from the subsample of soldiers ( $N = 86$ ) who failed to complete one or more monthly CEL entries. The foremost reason for non-response was limited access to the Internet (80.2%). Other reasons included, (a) I was too busy (60.5%), (b) the CEL questions were not relevant to my situation (15.1%), (c) I did not believe the Stress Logs were important (7.0%), (d) other soldiers advised me not to complete it (2.3%), and (e) I was concerned that other soldiers would criticize me for completing them (2.3%).

### 3. Discussion

To our knowledge, the CEL is the first fully operational web-based system for the in theater assessment of war zone stressors and war zone stress reactions. Preliminary data from this convenience sample of OIF military personnel suggests that despite the demands of the war zone environment, most soldiers – barring problems with computer access – will take the time to complete the CEL. In fact, most participants reported favorable reactions to the CEL system in terms of its ease of use and relevance to their war-zone experiences. Data on soldiers' emotional reactions to completing the CEL in the war zone environment suggest that it does not lead to undesirable emotional reactions in the large majority of soldiers. Rather, participants' emotional reactions were primarily neutral in nature, with a significant minority reporting that completing the CEL made them feel better.

Our findings showing an ongoing positive relationship between level of war-zone stressors and war zone stress reactions tapping PTSD, depression, and general emotional distress symptoms assessed in theater are consistent with previous reports using retrospective assessments of war zone stress obtained from soldiers after returning from deployment (Grieger et al., 2006; Hoge et al., 2006; Hoge et al., 2004; Smith et al., 2008b). Moreover, data on the most frequently reported stressors and the most distressing stressors in the war zone suggest that both direct combat-related events (e.g., hostile incoming fire, combat/patrol mission) and non combat-related environmental factors (e.g., relocation in the war-zone, conflicts with other soldiers, bad news from home) may cause significant stress. These findings are consonant with the existing multi-dimensional approaches that revealed the significant impact of both direct combat-related events and malevolent war-zone environments on the level of PTSD symptoms assessed at post-deployment (King et al., 1995; King et al., 2006).

Contrary to expectation, the pattern of war zone stress reactions over the period of deployment was more complex than expected by earlier reports showing that length of deployment predicts PTSD and other combat stress reactions among Navy sailors deployed (Shen, Arkes, & Pilgrim, 2009). Only depressive reactions showed a significant linear increase over the period of deployment. In contrast, PTSD symptoms, depression symptoms, and general stress/anxiety symptoms showed a significant inverted U-pattern in their respective growth curves indicating that these stress reactions increased over time during the first half of deployment (i.e., approximately eight months), but then decreased over the final eight months of deployment. These findings clearly highlight the potential advantage of repeated prospective assessment in better capturing the pattern of combat stress reactions over time, relative to a single retrospective assessment at post-deployment.

We can only speculate as to the factors contributing to the observed inverted U growth curve pattern of war zone stress reactions. One possibility is that the observed reduction in war zone symptoms over the latter stage of deployment may reflect resilience factors that enable soldiers to cope more effectively as they became accustomed to repeated exposure to similar stressors over prolonged deployment to the war zone. Alternatively, the varying intensity of war may also have contributed to the inverted U-pattern growth curves such that the impact of deployment length on stress reactions was attenuated as the intensity of war wound down over time. Consistent with this possibility, annual tallies of coalition military fatalities since 2003 show that the casualties peaked in May 2007 and started to decline rapidly (<http://icasualties.org/iraq/index.aspx>; Coalition military fatalities by year – 2003 = 580, 2004 = 906, 2005 = 897, 2006 = 872, 2007 = 961, 2008 = 322, 2009 = 150, 2010 = 60). Further investiga-

tion is needed to elucidate the change in war zone stress reactions over time.

The CEL assessment system yields several analytic advantages over retrospective post-deployment assessment of war zone stress experiences. First, the repeated assessment of war zone experiences offered by the CEL provides the opportunity to construct growth curve models to better understand the interplay between ongoing war-zone stress exposure and subsequent stress reactions. Moreover, advanced growth curve analyses have now been used to examine pre-deployment risk and resilience factors and their interaction with war zone stressors in predicting soldiers' combat stress symptoms as they develop in the war zone (Beevers, Lee, Wells, Ellis, & Telch, *in press*; Telch, Rosenfield, Lee, & York, 2011). Second, the CEL assessment system provides the opportunity to examine the linkage between war zone stress experiences assessed in theater vs. war zone stress experiences assessed retrospectively in order to help shed light on the influence of various memory biases and reconstrual effects (Metts et al., 1991) on soldiers' reports of war zone stress reactions.

Some limitations of the current study and considerations for future research should be noted. First, the CEL assessment system inevitably generates varying assessment time points with an irregular pattern of missing data entries. However, advanced analytic strategies such as multilevel modeling approaches effectively handle missing values and irregular assessment timing in a longitudinal research design. Second, despite the overall high response rate, the average number of CEL entries for each individual was approximately once every two months as opposed to the scheduled monthly assessment. The foremost reason for non-response was limited access to the Internet, which is especially problematic for military personnel who deploy to small combat outposts. Advances in Internet technologies that are not affected by geographical features or locations (e.g., satellite internet access) will likely yield improved availability and stability of web-based systems for assessing war zone stressors in theater.

Finally, it is still unclear how repeated web-based assessments of war zone experiences affect soldiers' pattern of responding as well as their emotional well-being. Although web-based methods have been shown equivalent to traditional paper-and-pencil methods (e.g., Gosling, Vazire, Srivastava, & John, 2004) and are widely used in many areas of psychological research, it remains unclear how web-based reporting of war zone experiences differ from those obtained via paper-and-pencil surveys. With respect to the emotional/psychological consequences of having soldiers self-monitor their war zone experiences, our preliminary data collected at the post-deployment assessment suggest that the large majority of soldiers reported no emotional reaction – good or bad – from the repeated assessment of war zone stressors or their reactions to them. Moreover, the few that did were more likely to report that completing the CEL made them feel better as opposed to made them feel worse. Studies, which experimentally manipulate soldiers' utilization of the CEL in the war zone are likely to yield important information concerning the benefits and adverse effects of the CEL assessment system.

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