



Differential impact of post-deployment stress and PTSD on neural reactivity to emotional stimuli in Iraq and Afghanistan veterans



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ABSTRACT

For many veterans returning from combat in Iraq and Afghanistan, the transition from military to civilian life is complicated by an array of postdeployment stressors. In addition to significant stress associated with reintegration after deployment, many returning veterans also contend with the added burden conferred by PTSD symptoms. While the relationship between PTSD symptoms and the neurobiological substrates of emotion dysregulation has begun to be studied, even less is known about the effects of postdeployment stress on neural function. In order to assess the relationship among a neural measure of attention to emotion (i.e. the late positive potential; LPP), PTSD symptoms and postdeployment stressors, EEG was recorded and examined in a linear mixed model of 81 OEF/OIF/OND veterans. Results revealed a main effect for postdeployment stressors such that increased postdeployment stress was associated with a relatively *enhanced* LPP across all emotion types. There was also a main effect for PTSD symptoms such that greater symptoms were related to a relatively *blunted* LPP across all emotion types. Findings may have important implications for understanding how both current stress and PTSD symptoms affect motivated attention as measured by the LPP. Moreover, this work highlights the need to consider the effects of current stress, in addition to PTSD symptoms, on the functioning of returning veterans.

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1. Introduction

As our men and women in uniform return from the wars in Iraq and Afghanistan, many encounter significant life stress as they transition back to civilian life. For example, many returning veterans of Operations Enduring Freedom, Iraqi Freedom and/or New Dawn (OEF/OIF/OND) struggle with impairments in family, financial, educational, occupational and social functioning (Spelman et al., 2012). Veterans may be especially sensitive to these types of post-deployment challenges because war-related stressors are known to increase vulnerability to subsequent stress, a process

termed stress sensitization (Antelman et al., 1980; Post and Weiss, 1998). Thus, it is possible that post-deployment stressors are particularly salient for veterans as they work to reintegrate into their families, jobs, and communities.

In addition to contending with significant stress associated with the transition from military to civilian life, many returning veterans also contend with the added burden of posttraumatic stress disorder (PTSD). Of the more than 2 million U.S. soldiers that have been deployed to Afghanistan and Iraq, 23% have developed PTSD (Fulton et al., 2015). In addition to the study of PTSD as a discrete diagnostic category, recent work has also begun to highlight the strain created by subthreshold PTSD symptoms. For example, growing evidence has demonstrated that even subthreshold PTSD confers profound clinical and functional hardship, including heightened suicide risk and greater health problems (Eekhout et al., 2016; Jakupcak et al., 2011; Pietrzak et al., 2009).

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While substantial work from functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) has begun to elucidate the biological correlates of PTSD (e.g. Hughes and Shin, 2011; Lobo et al., 2015), few attempts have been made to examine the neural underpinnings of post-deployment stress. One method for elucidating the neurobiological correlates of post-deployment stressors is through the use of an event-related potential (ERP) component, known as the late positive potential (LPP). The LPP is a centro-parietal, positive-going ERP component that appears approximately 400 ms after stimulus onset and is larger for emotional (e.g., threatening) stimuli than neutral stimuli (Dolcos and Cabeza, 2002; Foti et al., 2009; Schupp et al., 2000). Because of its relation to emotional processing and motivated attention, the LPP has been examined in disorders of affect dysregulation, such as PTSD (Lobo et al., 2015). Specifically, earlier research examining a cohort of combat veterans with and without PTSD suggests that the diagnosis of PTSD is related to blunting of the LPP during processing of emotional faces (MacNamara et al., 2013).

Far fewer studies, however, have examined the LPP in the context of recent stress (as opposed to psychopathology). The LPP may be a particularly useful ERP component to examine current stress because it is fundamentally understood as a means of tracking motivated attention toward emotionally salient information (Hajcak et al., 2013). As stress is known to disrupt attentional focus by increasing emotional vigilance at the cost of decreased attention toward non-emotional stimuli (Alomari et al., 2015), the LPP may be a strong neural marker to examine motivated attention. Although the LPP may be a useful measure to examine how stressors influence reactivity and regulation at the neural level, very few studies have examined the LPP in conjunction with current stress—and these studies have been focused on acute, provoked stress trials (e.g., response to physically uncomfortable stimulus) as opposed to the daily, routinized stressors with which returning veterans must contend (e.g., marital problems, financial stress). In one study, Weymar and colleagues (Weymar et al., 2011) performed a stress trial on healthy volunteers in which they showed participants unpleasant images. In some trials, the images were preceded by a stressor (i.e., cold pressor test) and in other trials there was no preceding stressor. Results indicated viewing of unpleasant images evoked an enhanced LPP when participants were exposed to prior acute stress as compared to when they were not. Another study found that stress-related olfactory cues increased the salience of neutral and ambiguous faces in healthy adults as indicated by an enhanced LPP response (Rubin et al., 2012). Taken together, these prior studies suggest that stress enhances the LPP. Notably, however, no studies have examined how day-to-day psychosocial stressors, such as those during post-deployment, may be related to the LPP in veterans. Moreover, no study has examined the effect that current stressors and PTSD symptoms may be same or different on neural function; consequently, their unique and potentially interactive effects remain unknown.

Thus, this study sought to expand the current literature on the relation between current stress and PTSD symptoms. Specifically, in an independent cohort from that reported by MacNamara et al. (2013), we sought to examine the unique and interactive effects of post-deployment stressors and PTSD symptoms in OEF/OIF/OND veterans on neural reactivity as measured by the LPP. We examined all variables as continuous predictors in order to extend our understanding of the role of individual differences in the relationship between PTSD symptoms, stress, and LPP reactivity. Because LPP reactivity can be measured in various time windows, we examined neural reactivity in our sample in an early (i.e., 500–1500 ms) and late (i.e., 1500–3000 ms) time window. Analysis of two time windows was used to enrich understanding of the relationship

between stress and PTSD symptoms on sustained, initial or late neural reactivity.

We hypothesized that both PTSD symptoms and post-deployment stressors would be related to emotional reactivity as measured by the LPP response to angry, fearful and happy faces. While we hypothesized that both PTSD would be related to blunting of the LPP based on prior research (DiGangi et al., 2017; MacNamara et al., 2013), we made no directional hypothesis for post-deployment stressors, given that no prior work has examined post-deployment stress in veterans with a range of psychiatric symptoms. Similarly, in terms of the interaction between stress and PTSD symptoms, no directional hypotheses were made because of the exploratory nature of this hypothesis.

2. Methods

This study was approved by the Institutional Review Boards at Jesse Brown VA Medical Center, Chicago IL and its university affiliate, the University of Illinois at Chicago. Research was conducted in accordance with the Helsinki Declaration.

2.1. Participants

Eighty-one participants with LPP data from EEG were included from a larger sample of OEF/OIF/OND veterans recruited at the Jesse Brown VA Medical Center and the University of Illinois Chicago. After completing informed consent procedures, participants completed the ERP task, a clinical assessment, and self-report measures. Exclusionary criteria for participants included: presence of a clinically significant medical or neurological condition, presence of an organic mental syndrome and/or psychotic disorder, intellectual disability or pervasive developmental disorder, and current substance abuse or suicidal ideation at a level that would interfere with the study protocol. Ages ranged from 21 to 53 years (mean: 33.99 SD: ± 7.2); 80.2% of the sample was male. Average HAM-D score was 8.59 (SD: ± 5.7 ; see Measures). Of the 81 participants, 4.8% ($n = 4$) had a primary diagnosis of an anxiety disorder that was not PTSD (e.g., Panic Disorder), 31% ($n = 26$) had a primary diagnosis of mood disorder and 9.5% ($n = 8$) had a current or past substance use disorder. At the time of enrollment, 41.7% of the sample was prescribed psychiatric medications (see Table 1).

2.2. Measures

All clinical measures were administered by a psychologist or a master's level research assistant under the supervision of a licensed psychologist. Post-deployment stressors were assessed through self-report, using the Post-Deployment Stressors (PDS) subscale of the Deployment Risk and Resilience Inventory-2 (DRRI-2) (Vogt et al., 2013). The PDS subscale is scored on a dichotomous (i.e., yes/no) scale and includes stressors that have occurred post-deployment (e.g., I lost my job or had serious trouble finding a

Table 1
Demographic and clinical characteristics.

	n = 81	AGE	CAPS	HAM-D	DRRI/PDS	
					Mean (+/- SD)	
		33.99 (7.2)	40.37 (31.4)	8.59 (5.7)	4.05 (2.9)	
					n	%
Gender	Male				65	80.2
	Female				16	19.8
Primary Dx	Other Anxiety Disorder (not PTSD)				4	4.8
	Mood Disorder				26	31
	Substance Use Disorder				8	9.5
Current Psych Med Use					35	41.7

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