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**Does past military experience impact fear reactivity in active-duty firefighters?**

**Well, it is complicated.**

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**Abstract**

A significant proportion of military veterans successfully transition out of the military into civilian careers as first responders, such as firefighters. Like military service, being a firefighter is a high-risk profession involving exposure to aversive environments. Thus, it is possible that prior military experience may serve to buffer or exacerbate risk for negative psychological outcomes in firefighters. However, both occupations are associated with increased risk for psychopathology, such as posttraumatic stress disorder (PTSD), and little research has examined the effect of military service on processes that underlie stress in veterans serving as active-duty firefighters. *Objective:* The current study explored whether military service confers an adaptive advantage or additional risk. *Method:* Using a case-control design, we examined differences in fear reactivity through electrodermal activity (EDA) and recording of fearful facial expressions, between 32 firefighters with and 32 firefighters without military veteran status (MVS; all males). Participants completed a semi-structured, emotionally evocative interview with multiple contexts eliciting varying levels of emotion. *Results:* MVS firefighters had relatively elevated EDA across contexts. However, lower baseline levels indicated calmer resting state in MVS firefighters. There was greater incidence of lifetime PTSD in MVS compared to non-MVS firefighters (40.6% versus 15.6%). Overall, firefighters with past PTSD had less EDA reactivity. Finally, number of military deployments was associated with higher fear expressions throughout the interview. *Conclusions:* These findings highlight the need to consider interactions between military experience and psychiatric history in future investigations examining risk and resilience in first responders.

*Keywords:* Military, first responders, fear-reactivity, threat-response system, post-traumatic stress disorder

**Clinical Impact Statement**

A significant proportion of firefighters enter the profession with prior military experience. In a sample of firefighters from an urban district, those with prior military experience differed in aspects of fear-reactivity during a threatening interview task compared to firefighters without military experience. Specifically, firefighters with military experience had higher levels of sympathetic arousal across varying contexts, but their fearful facial activity showed greater flexibility. Additionally, PTSD was associated with blunted sympathetic arousal, independent of military veteran status. The results demonstrate the importance of considering military experience—an overlooked characteristic—and psychiatric history when assessing risk and resilience among first responders.

**Does past military experience impact fear reactivity in active-duty firefighters?**

**Well, it is complicated.**

The return to civilian life following military service comes with a significant adjustment period for many veterans (Romaniuk & Kidd, 2018), particularly for those who were deployed and experienced combat (Sayer et al., 2014). Military service is a particularly stressful career path in which exposure to trauma is common. Wisco and colleagues (2014) found that U.S. military veterans reported experiencing a mean of 3.4 potentially traumatizing events, with 87% having experienced at least one. Moreover, some veterans who experienced trauma are at heightened risk for developing post-traumatic stress disorder (PTSD) and other psychological and health-related problems (Smith, Wingard, & Ryan, 2009). Given the risk to psychological well-being military experience poses for many veterans, it is important to examine factors that may impact their ability to adjust to civilian life.

Adjustment to civilian life is likely impacted by career choices. For example, a significant proportion of military veterans enter civilian careers as first-responders, such as firefighters. Specifically, around 44 percent of firefighters enter the profession with prior military experience (Myer et al., 2012). Like the military, working as a firefighter is a stressful career path, as firefighters often work in highly aversive conditions. Over the course of firefighters’ careers, they are likely to experience repeated exposure to acute stressors, such as critical incidents—job-related potentially traumatic events (e.g., witnessing the serious injury or death of a victim or co-worker; Monnier et al., 2002). For some firefighters, this repeated exposure to stressful events has been positively associated with maladaptive outcomes such as alcohol abuse (Homish, Frazer, & Carey, 2012), impaired sleep (Coifman et al., 2021), and suicidality (Martin, Tran, & Buser, 2017). Indeed, firefighters are also at high risk for developing psychiatric disease, such as PTSD and depression (Carey et al., 2011; de Barros et al., 2013; Del Ben et al., 2006), and have high rates of suicide and suicidal ideation compared to the general population (Stanley et al., 2015).

Given that military veterans who become firefighters are choosing to transition from one high-stress career to another, it is important to investigate the psychological effects of military service on future vulnerability or adaptation. It remains unclear whether firefighters who first served in the military possess unique characteristics that foster adaptive emotional responding in the face of stress and adversity, or whether their military experience adds additional risk to an already high-risk profession. On one hand, the high-quality training received in the United States military might foster self-efficacy and adaptive emotion regulation in the face of stressful situations, creating an advantage for some veterans who choose to seek careers as first-responders (Bonanno et al., 2012; Whealin, Ruzek, & Southwick, 2008). On the other hand, military veterans are more likely to enter the profession with prior traumatic experiences. Given the essential role of first responders—as society relies on these personnel for safety and protection in everyday life—it is critical to determine the impact of military experience on processes that underly responses to stress, as such factors may have relevance for future functioning and ability to cope with the stress of the job (Smith et al., 2018).

One major factor related to stress processing that may be impacted by military experience is the threat-response system. This is an affective system involved in the detection and avoidance of acute threats in the environment, consisting of a fear response, which includes an increase in autonomic arousal, reallocation of cognitive resources (e.g., attention), and avoidant behavior (e.g., fleeing; Bradley et al., 2001; Cuthbert et al., 2003). Fear—a crucial component of the threat-response system—is generally thought to have evolved to both detect and to motivate avoidance of such threats, promoting survival (Cosmides & Tooby, 2008; Ohman & Mineka, 2001). Although fear is generally considered adaptive, prior research has demonstrated how exposure to potentially traumatic events is associated with alterations in fear-processing, including increased fear reactivity to threats, overgeneralization of fear (e.g., responding with fear in the absence of real threats), as well as impaired extinction of learned fear associations (Fani et al., 2012; Kida, 2019; Lin et al., 2020; Lis et al., 2019; Mckinnon, Gray, & Snowden, 2020; Zoellner et al., 2020). Indeed, these processes have been shown to occur in some military veterans with combat exposure (Hinrichs et al., 2019; McFall et al., 1990; Ranes et al., 2017).

Of these fear-related processes, fear reactivity is one of the most widely studied phenomena, with measures of sympathetic arousal being the one of the most common indicators. Within this literature, prolonged increases in sympathetic arousal have often been interpreted as evidence of risk for psychopathology. However, researchers have noted varying psychophysiological threat-response patterns in trauma-exposed samples. While elevated sympathetic arousal is common, some individuals tend to exhibit blunted physiological reactivity (e.g., low sympathetic arousal) in response to threatening stimuli (Cuthbert et al., 2003), particularly for individuals who experienced multiple trauma exposures (De’Andrea et al., 2013; McTeague et al., 2010). Therefore, the evidence of effects of trauma exposure on fear reactivity, particularly for measures of sympathetic arousal, remain unclear.

To add to the complexity of differing patterns of reactivity in trauma-exposed individuals, researchers have also demonstrated that repeated exposure to similar forms of trauma or frightening experiences facilitates increased coping ability through a variety of channels. Notably, there is evidence of adaptive buffering of fear reactivity and habituation to fear-relevant stimuli in prior trauma-exposed individuals (Aldwin, 2007; Walker et al., 2019). For example, emergency personnel who responded to the 1994 USAir Flight 427 crash (Dougall et al., 2000) demonstrated that prior exposure to dissimilar forms of stressors was associated with increased distress levels, whereas prior exposure to *similar* forms of stressors was not. In this case, prior exposure facilitates adaptive adjustment, which could manifest as enhanced sensitivity in emotional responses to a similar prior threat. In addition, Najstrom & Hogman (2003) showed that some military veterans with combat exposure are less reactive to negative stimuli than veterans without combat exposure, possibly due to adaptive habituation to fearful experiences in combat, and/or increased ability to regulate stress. While research has suggested this attenuated response may be a symptom of PTSD (e.g., Amdur et al., 2000), none of the combat veterans in the study by Najstrom & Hogman (2003) had PTSD, suggesting they may have developed a higher threshold for fear-reactivity to threats, which may be adaptive in a first responder scenario. Moreover, there is a large literature demonstrating that resilience is the most common outcome following a traumatic experience, and that psychological impairment, including PTSD, is typically the exception and not the rule (Bonanno, 2004; Bonanno et al., 2006). In fact, most military veterans have resilient, healthy outcomes, with a minority developing PTSD and other forms of psychopathology (Bonanno et al., 2012; Hotopf et al., 2006; Schlenger et al., 2012). Considering these findings, it is possible that military experience and/or combat exposure could confer some adaptive advantage when dealing with aversive situations typically confronted by firefighters. Thus, fear reactivity is an important, but complex factor to consider when examining the effects of military experience, requiring attention to the nuances of the threat-response system.

While some studies demonstrated that military veterans with trauma exposure show greater distress and sympathetic arousal when presented with threatening stimuli compared with military veterans without trauma exposure (Badour & Feldner, 2012; Liberzon et al., 1999; Wolfe et al., 2000), the heterogeneity of outcomes outlined above suggests that it is crucial to carefully consider the context in which these patterns of emotional responding occur. There is a large body of research showing that different patterns of in-vivo emotional reactivity, including self-reported affect, facial expressions, and psychophysiological responses, predict the development and course of psychological adjustment, including the development of emotion-related disorders such as depression and PTSD (Gross & Jazaieri, 2014; Marquardt et al., 2018; Rottenberg et al., 2002; Sperry, Walsh, & Kwapil, 2020; Spiller et al., 2019). Moreover, affective scientists emphasize the necessity to consider the contextual appropriateness of emotion expression (Coifman & Bonano, 2009; Rottenberg, Gross, & Gotlib, 2005). For example, elevated emotional reactivity should not be taken as de facto evidence for maladaptive emotional responding or psychopathology, as emotions are adaptive when engendered in the contexts in which they evolved. Rather, it is context *in*sensitive fear responses and psychophysiological arousal that are maladaptive. Indeed, research has shown that individuals with PTSD have context-*in*sensitive fear reactivity, demonstrating fear responses to even positive stimuli (Mckinnon et al., 2020). Moreover, elevated arousal at rest (in the absence of threats) has been shown to be an indicator and predictor of psychiatric and physical illness (Armstrong et al., 2019; Malpas, 2010; Smith et al., 2020; Ward, Doerr, Storrie, 1983). Thus, when studying fear-reactivity and the threat-response system, it is important to consider multiple contexts with varying levels of threat to better distinguish between context-sensitive fear-responding and patterns that might be indicative of risk (Coifman & Bonanno, 2009).

While there is a large literature demonstrating heterogeneous alterations of fear-responding in military and first responder samples respectively, few investigations to date have examined the influence of previous military experience on fear reactivity among civilians working in high-risk careers, such as firefighters. Most prior work has focused on identifying differences in risk-behaviors or psychological symptoms. For example, Barlett and colleagues (2018) tested differences between firefighters with and without “military veteran status” (MVS) on measures of alcohol use disorder, sleep quality, depression, suicidal behavior, and PTSD. They found MVS firefighters have slightly more, but likely negligible, self-reported sleep disturbances, depression symptoms, and PTSD symptoms than non-MVS firefighters. In addition, MVS firefighters who endorsed difficulties with emotion regulation had higher rates of PTSD symptoms (Barlett et al., 2019). While these studies present a good first step towards understanding risk within this much overlooked sub-population of MVS firefighters, the literature lacks investigations of differences in patterns of in-vivo fear reactivity between MVS and non-MVS firefighters. Investigating differences in in-vivo fear reactivity is essential for a more fine-tuned analysis of the psychological and physiological mechanisms that underly both risk and resilience.

**Current Investigation**

The aim of the current study was to apply a case-control design to evaluate differences in the threat-response system, as indexed by spontaneous fear reactivity (self-reported affect, facial expressivity, and sympathetic arousal), between MVS and non-MVS firefighters, before, and across an emotionally evocative interview with multiple contexts (intro, coping, fear eliciting, positive). Prior use of this interview paradigm has indicated that both the coping and fear-eliciting contexts can produce meaningful variability in emotion that is broadly associated with psychological health and functioning (Coifman et al, 2007; Coifman & Bonanno, 2010; Harvey et al, 2014). We explicitly considered the role of PTSD diagnosis in differences in fear reactivity, as it has previously been shown to play a prominent role in alterations of the threat-response system in both military and firefighter samples. Finally, we aimed to test whether military characteristics, including years of military service, number of deployments, and total months deployed had any meaningful associations with fear reactivity within MVS firefighters. To measure spontaneous fear-reactivity, we also included objective indicators of fear response not prone to the same biases as self-report indicators, including real-time recording of emotional facial expressions and sympathetic nervous system activity indexed throughout the interview.

Because prior research is largely mixed, we did not develop specific a-priori hypotheses, apart from anticipating the role of PTSD diagnosis. In general, we tested if MVS firefighters demonstrated differential fear reactivity (e.g., differing levels of sympathetic arousal, facial reactivity, and reported negative affect) from non-MVS firefighters. However, we explicitly tested to see if the MVS firefighters’ responses were more context sensitive than non-MVS firefighters, including at rest, suggesting some adaptive advantage. In contrast, if MVS firefighters demonstrate less context-sensitivity (e.g., greater fear reactivity during non-threatening contexts), military service might then be a risk factor to consider. As for PTSD, we predicted that it would be associated with blunted sympathetic arousal, along with elevated reported negative emotion, consistent with prior evidence across samples (De’Andrea et al., 2013; McTeague et el., 2009). No studies to date have tested whether PTSD is associated with greater fear expression (via objective measures of facial expression) during threatening tasks, and thus we also did not develop a specific hypothesis for this question.

**Methods**

**Participants**

Participants (n = 64) were male active-duty firefighters selected from a larger sample of firefighters from an urban, Midwest fire department. From the larger sample, 32 participants were selected for having reported previously served in the United States military, having military veteran status (MVS). An additional 32 participants without prior military experience were selected and matched with the MVS sub-sample. During the matching process, for each MVS firefighter, a non-MVS control was selected to match past psychiatric diagnosis (yes/no), approximate age, and number of years worked as a firefighter, then independent-samples t-tests were conducted to confirm equivalence of groups. The mean age was 34.16 (SD = 7.83), and of the 47 participants who indicated their race, 43 identified as Caucasian (91.49%). MVS and non-MVS firefighters did not differ in their demographic information, nor did they differ in current symptoms of PTSD as assessed in the clinical interview (see Measures section), t(61) = -0.91, p = .369 (See Table 1 for a full summary of the demographic characteristics; See Table S1 of the Supplemental Materials for frequencies of the various past psychiatric diagnoses). Within the MVS sub-sample, mean years served in the military was 5.73 (SD = 2.27), mean number of deployments was 1.81 (SD = 2.54), and mean months deployed was 12.69 (SD = 10.36); 40.60% (n = 13) served in the Army, 6.30% (n = 2) served in the Air Force, 34.40% (n = 11) served in the Marine Corps, 6.30% (n = 2) served in the Navy, and 12.50% (n = 4) served in the National Guard. See Table S2 of Supplemental Materials for additional information about the MVS sub-sample.

**Procedure**

Active-duty firefighters from an urban district were offered the opportunity to participate in a study examining “firefighter resilience”. Participants were recruited via flyers and announcements made during departmental meetings. Those who expressed interest were pulled from their shift to complete study activities in a private area at their department training facility. After providing written informed consent, participants completed questionnaires, a diagnostic interview administered by doctoral students in clinical psychology, and a semi-structured interview (SSI) designed to have specific emotionally evocative contexts (Coifman & Bonanno, 2010; Coifman, Flynn & Pinto, 2016). Following the initial study session, participants completed additional tasks not relevant to this investigation. Only data from the initial session (diagnostic interview and the SSI) were used for the current study. Participants were compensated with a $25 gift card and were entered into a lottery for a chance to win a $500 gift card at the end of data collection. The investigation was approved by the Kent State University Institutional Review Board, and participants provided written informed consent prior to study activities.

**Measures**

**Diagnostic Interview.** The Structured Clinical Interview for DSM-5 Research Version (SCID; First et al., 2015) was administered to assess current and past psychiatric diagnoses. For the current investigation, the following modules were administered: depression, bipolar, PTSD, panic disorder, agoraphobia, social phobia, generalized anxiety disorder, obsessive-compulsive disorder, psychosis, substance use, binge eating, and attention/hyperactive deficit disorder. Rater reliability was good at the diagnostic and symptom level, average Kappa=0.82 (range: .77 - .85). A variable for history of psychiatric disease (yes/no), and a continuous variable of current PTSD symptoms, was extracted from the SCID and was used as a matching variable for the selection of the military and non-military sub-samples. The two groups did not differ on these two variables. In addition, a lifetime PTSD variable (yes/no) was extracted and used as a covariate, as well as primary independent variable in a separate analysis. Participants with military experience had significantly higher rates of lifetime PTSD diagnosis than participants without military experience, χ2(1) = 4.63, p = .031, (40.63%, n = 13 vs. 15.63%, n = 5, respectively). However, MVS and non-MVS participants did not differ in current PTSD symptoms, t(61) = -0.91, p = .369 (M = 1.38, SD = 1.98 versus M = 0.97, SD = 1.56, respectively).

**Semi-Structured Interview (SSI).** The SSI consisted of a one-on-one, five-question interview. The interview structure and questions were developed in prior investigations of spontaneous emotion processing in high-risk populations and shown to evoke strong emotion, within discrete contexts (e.g., Coifman & Bonanno, 2010; Coifman et al, 2007; Harvey, et al, 2014). Participants were positioned in a comfortable chair in a small, private room sitting across from the interviewer. With the participants’ consent, a high-resolution video camera was set up to record the participants’ facial expressions throughout the interview. In addition, Electrodermal Activity (EDA), an index of sympathetic nervous system activity, was recorded throughout the interview with the Affectiva Q-Sensor (Affdex, Boston, MA; Sano, Picard, & Stickgold, 2014), and participants provided affect ratings following their responses to each question. Prior to the start, the participant was left to sit quietly in the room for three minutes to record a resting baseline. Following the resting baseline, the interviewer entered the room and read detailed instructions for the interview.

During the interview, the experimenter provided five prompts, corresponding to each of the 5 contexts, and the participants had three minutes to respond to each prompt. The participants’ responses were open-ended, and they were able to respond to each prompt as they saw fit, with very little comment or interruption by the experimenter (other than by using standardized prompts to encourage more responding, e.g., “Can you please tell me more about that?”). The prompts included an initial active baseline (a neutral question in which the participant was asked to simply list what they did during the previous day, from the moment they woke up, until the moment they went to sleep). The active baseline prompt was followed by four prompts asking about their experiences as firefighters, including: 1) *Intro Prompt*: “Please tell me what is it like to be a firefighter”; 2) *Coping* Prompt: “How have you coped with the hard work that you do as a firefighter?”; 3) *Fear* Eliciting Prompt: “Please tell me about a particularly scary or frightening event that you experienced while on duty as a firefighter”, and 4) *Positive* Prompt: “Please tell me about a very positive event that you have experienced while on duty as a firefighter”. See Supplemental materials, Figure S1, for a visual schematic of the SSI.

**Self-Reported Negative Affect.** Immediately following each SSI response, participants provided ratings for 8 negative emotion words commonly used in emotion research, including sadness, shame, fear, embarrassment, distress, guilt, anger, and disgust (e.g., Seah & Coifman, 2021). Each emotion word was rated on a Likert scale from 1 (none) to 7 (strong). Negative affect scores were indexed for each SSI response by taking the mean of all negative emotions, resulting in 5 negative affect scores (α = .79-.92). However, due to an overwhelming number of 1’s (none) reported for Negative Affect (Active baseline, M = 1.14, SD = 0.32; *Intro*, M = 1.13, SD = 0.37; *Coping*, M = 1.17, SD = 0.46; *Fear*, M = 1.36, SD = 0.70; *Positive*, M = 1.10, SD = 0.24), the variables were significantly skewed (e.g., skew > 2.0 and kurtosis > 7.0), and were not amenable to data transformations. Moreover, mean self-reported negative affect during the SSI was substantially lower for our sample than for previous samples utilizing a similar interview (e.g., Coifman & Bonanno, 2010, M = 2.72, SD = 1.53). Thus, we opted to exclude Negative Affect from our analyses, concluding that it was not a valid indicator of self-reported negative emotion, as participants underreported, a phenomenon consistent with other comparable samples (Britt, 2006; Thunholm, 2001).

**Fear Facial Expressions.** Digital video recordings of the participants’ facial expressions throughout the interview were scored using Noldus FacereaderTM (Loijens et al., 2014), an automated facial coding software derived from the standard Facial Action Coding System (Ekman & Friesen, 1978). The software uses 3D modeling and Deep Learning algorithms to detect changes in facial muscle contractions associated with the expressions for basic emotions (e.g., fear), assigning each emotion a score between 0 and 1 at a rate of 30 frames per second. Scores for fear expression were derived as an aggregate across each three-minute SSI response, yielding a total of five scores. Six participants had missing data, and one participant did not consent to be video recorded. Thus, for analyses involving facial expressions, the MVS sample included n = 30, and the non-MVS sample included n = 25.

**Autonomic Activity.** Electrodermal Activity (EDA) was used as an index of sympathetic arousal. EDA is the measurement of variation in the electrical conductance of the skin resulting from sweat excretion. Because sweating is controlled by the sympathetic nervous system, EDA provides an estimate of sympathetic arousal, and is often interpreted as a threat response (Esteves et al., 1994; Wood et al., 2015). EDA was measured using an Affectiva Q-Sensor (Affdex, Boston, MA; Sano, Picard, & Stickgold, 2014) with 1-cm diameter Ag-AgCl dry electrodes, worn by the participant on their ventral forearm. EDA was measured in microsiemens (µS) and skin surface temperature was logged at 32 Hz. The data were cleaned using customized software and visual inspection, deriving a mean EDA score for each question during the SSI. Mean EDA scores were indexed for the resting baseline period and the five SSI prompts, resulting in 6 EDA variables. Ten participants had missing EDA data (1 due to a corrupted data file, 8 due to technical errors in recording, and 1 due to a participant not consenting to wear the sensor); thus, for analyses that included EDA, the MVS sample consisted of n = 27 and the non-MVS sample n = 25.

**Data Analytic Strategy**

First, we conducted preliminary analyses by testing whether the SSI prompts varied as expected in their elicitation of emotion for the sample, regardless of group membership. Paired-samples t-tests were conducted comparing EDA for each prompt with EDA at active baseline. Next, to compare EDA during each SSI context, reactivity scores were calculated by taking the difference of EDA at each prompt and active baseline EDA (SSI Prompt – active baseline) to correct for individual differences in baseline EDA. Then paired-samples t-tests were conducted using the EDA reactivity scores, pairing each adjacent SSI prompt (*Intro* Prompt with *Coping* Prompt, *Coping* Prompt with *Fear* Prompt, and *Fear* Prompt with *Positive* Prompt). The same analyses were conducted to compare levels of Fear Expression across the task, although because Fear Expression has a true zero score, we used raw scores.

For our primary analyses, we began by conducting an independent-samples t-test to test for differences in resting baseline EDA between the MVS and non-MVS firefighters, as differences in resting levels of sympathetic arousal could be clinically meaningful. Next, to test our primary question—which is whether there are group differences in fear reactivity between MVS and non-MVS firefighter across the SSI—we conducted two separate 2 (Group [MVS vs. non-MVS]) x 4 (Time [SSI Prompts]) repeated-measures analysis of variance (ANOVAs) for EDA and fear facial expression, with active baseline EDA and past PTSD as covariates (we did not control for active baseline for the Fear Expression analyses). Tests of between-subjects effects indicated whether there were mean-level group differences, and post-hoc comparisons were conducted to determine at which SSI prompts(s) there were group differences. We decided that if PTSD status entered significantly into the model, we would re-run the analysis with PTSD status (yes/no) included as a moderator. Then we examined the within-subjects tests to determine whether trends in EDA and Fear Expression varied by group or PTSD status. Specifically, we looked for 2-way interactions between time (SSI question) and group status (MVS vs non-MVS) and 2-way interactions between time and PTSD status. Finally, we examine 3-way interactions between time, group, and PTSD status.

Finally, in post-hoc analyses, we tested whether—within the MVS sub-sample—military service characteristics (years served, number of deployments, and total months spent on deployment) were associated with higher fear reactivity (EDA and Fear Expression) across the SSI task. To test this, we conducted partial correlations by segment, controlling for past PTSD diagnosis.

**Results**

**Preliminary Analyses**

Paired-samples t-tests indicated that EDA at each SSI prompt was significantly higher than EDA at active baseline (p < .001 for all analyses), suggesting that participants were responding to the interview as intended. When correcting for active baseline EDA using reactivity scores, paired-samples t-tests indicated that EDA generally continued to rise throughout the SSI. Specifically, EDA at *Coping* Prompt (M=1.33, SD=2.10) was significantly higher than EDA at the *Intro* Prompt (M=0.90, SD=1.33), t(52) = 2.87, p = .006. EDA at the *Fear* Prompt (M=1.28, SD=1.96) did not significantly differ from EDA at the *Coping* Prompt, t(52) = 0.62, p = .539. Finally, EDA at *Positive* Prompt (M=1.53, SD=2.04) was significantly higher than EDA at the *Fear* Prompt, t(52) = 2.25, p = .029.

Next, paired-samples t-tests indicated that fear facial expressions were elevated during the *Fear* prompt. Fear Expression at active baseline (M = 0.05, SD = 0.04) did not significantly differ from the *Intro* prompt (M = 0.05, SD = 0.05), t(55) = -1.07, p = .291. Fear Expression did not significantly differ between the *Intro* and *Coping* Prompts (M = 0.06, SD = 0.05), t(55) = -0.79, p = .431, d = -0.11. Fear Expression during the *Fear* Prompt (M = 0.06, SD = 0.05) was significantly higher than during the *Coping* Prompt, t(55) = 2.08, p = .042, d = 0.28. However, Fear Expression did not significantly differ between the *Positive* (M = 0.06, SD = 0.05) and *Fear* Prompts, t(55) = 1.10, p = .277, d = 0.15, indicating considerable variability in regulating fear responses during the positive context.

**Primary Analyses: Comparing MVS v. non-MVS Responses**

**EDA Differences at Resting Baseline*.*** We tested whether MVS and non-MVS firefighters differed in resting (tonic) EDA. An independent-samples t-test was conducted. Levene’s Test of Equality of Variance was significant, and equality of variance was not assumed. Results suggested a marginal difference in tonic EDA, t(44.58) = 1.97, p = .055, 95% CI [-0.02, 1.86], d = 0.53, such that MVS firefighters (M = 1.22, SD = 1.35) had lower resting sympathetic arousal than non-MVS firefighter (M = 2.14, SD = 2.04),

**EDA*.*** Using a 2 (Group [MVS vs non-MVS]) x 4 (Time [SSI prompts]) repeated measures ANOVA, we first tested the following question: *are there group differences in EDA between MVS and non-MVS firefighters across contexts*? Tests of between-subjects effects showed mean-level differences in EDA, F(1,48) = 6.94, p = .011, partial η2 = .13, such that MVS firefighters (M = 3.84, SE = 0.33) had significantly higher mean-levels of sympathetic arousal during the SSI task than non-MVS firefighters (M = 2.59, SE = 0.34). PTSD entered significantly into the model, indicating it was an important covariate, F(1,48) = 5.65, p = .022, partial η2 = 0.11. Next, we conducted post-hoc comparisons to determine at which SSI Question(s) MVS firefighters’ EDA was significantly higher. Parameter estimates indicated that MVS firefighters had significantly higher levels of EDA across all four prompts: *Intro*, t(52) = -2.05, p = .045, 95% CI [-1.48, -0.02]; *Coping*, t(52) = -2.34, p = .023, 95% CI [-2.49, -0.19]; *Fear*, t(52) = -2.60, p = .012, 95% CI [-2.43, -0.31]; and *Positive*, t(52) = -2.92, p = .005, 95% CI [-2.62, -0.48].

Next, we examined the within-subjects effects to determine whether trends in EDA across the SSI varied by group or by PTSD. There was a significant time x group interaction, such that the mean-level increases in EDA across the task depended on military status, F(2.26,108.33) = 3.20, p = .039, partial η2 = 0.06. In addition, PTSD status continued to be a significant predictor F(2.26,108.33) = 3.47, p = .029, partial η2 = .07. Results of these analyses of between- and within-subjects effects indicated that MVS firefighters demonstrated higher levels of sympathetic arousal throughout the SSI, with a greater overall increase over time (See Figure 1a).

***PTSD as Moderator.***Given the importance of PTSD status in the previous model, we re-ran the analysis, including PTSD as a moderator, per the data analytic plan. Our aim was to test for group differences in EDA between firefighters with and without a lifetime diagnosis of PTSD, and whether these differences interacted with military status. Tests of between-subjects effects showed significant group differences, F(1,47) = 6.26, p = .016, partial η2 = 0.12, such that firefighters with a lifetime diagnosis of PTSD (M = 2.23, SE = 0.46) had significantly lower mean-levels of EDA than firefighters without PTSD (M = 3.56, SE = 0.28); however, these differences were only significant at the mean-level, as post-hoc tests did not identify any significant group differences on any of the four SSI questions, specifically. In addition, there was no significant MVS x PTSD interaction, F(1,47) = 0.76, p = .389, partial η2 = .02. See Figure 1b for visual depiction of differences in EDA by PTSD status.

**Fear Facial Expression.**Next, using a 2 (Group [MVS vs non-MVS]) x 4 (Time [SSI Prompts]) x past PTSD (yes/no) we tested the following question: *Are there group differences in Fear Expression between MVS and non-MVS firefighters across contexts*? Tests of between-subjects effects showed no significant mean-level group differences in Fear Expression, F(1,51) = 2.59, p = .114, partial η2 = 0.05. There was a time by group interaction suggesting a quadratic response in the MVS group relative to the non-MVS group, F(1,52) = 6.02, p=.018, partial η2 = 0.11 depicted in Figure 2. There were no significant differences by PTSD status. Post-hoc contrast tests revealed a significant difference to the *Positive* Prompt in MVS versus non-MVS participants, F(1, 51) = 4.66, p = .036, partial η2 = .019, indicative of a context-sensitive response. This context-sensitive fear response for MVS firefighters is visually depicted in Figure 2.

**Post-hoc Analyses**

Finally, we explored the following question: *are any of the military service characteristics—including years of military service, number of deployments, and total months deployed—associated with EDA or Fear Expression during the SSI*? To test this, we ran partial correlations (n = 30) between the military characteristics and EDA and Fear Expression at all four SSI prompts, controlling for past PTSD. Results indicated that number of deployments was positively associated with Fear Expression at all four SSI prompts (r=.47, r=.55, r=.38, and r=.53, respectively), whereas years served was only associated with Fear Expression at the *intro* (r = .43) and *coping* (r = .37) prompts, and total time deployed was also only associated with Fear Expression at the *intro* (r = .60) and *coping* (r = .52) prompts. See Table S2 in Supplemental Materials for all partial correlations.

**Discussion**

It is well-documented that a significant proportion of firefighters enter the profession with prior military experience but less is known whether it may confer an adaptive advantage or risk. Therefore, the current study aimed to address this question by evaluating differences in the threat-response system, as indexed by spontaneous fear-reactivity, during an emotionally evocative interview task between MVS and non-MVS firefighters. To test for such differences, we measured fear facial expressions and sympathetic arousal (EDA) when providing idiographic responses to shifting emotional contexts while also considering lifetime diagnosis of PTSD. Results indicated that MVS (vs. non-MVS) firefighters demonstrated some differences in fear reactivity. Specifically, MVS firefighters had lower resting sympathetic arousal at baseline but consistently higher arousal throughout the SSI, regardless of context, compared to non-MVS firefighters. In contrast, no overall mean-level group differences were observed for fear facial expressions but there was a significant time by group interaction with a quadratic pattern. Post-hoc contrasts showed greater reductions in fear expression between the *Fear* and *Positive* prompts, indicative of greater context-sensitive fear facial responses for MVS firefighters.

A key factor in our analyses was the consideration of prior diagnosis of PTSD. While the sub-samples did not differ in current PTSD symptoms, the MVS sample had significantly higher levels of past PTSD, indicating its potential importance. In particular, when past PTSD was included as a between-subjects factor—testing differences in EDA between firefighters with and without a lifetime PTSD diagnosis—it was apparent that regardless of MVS, firefighters with history of PTSD had significantly blunted EDA compared to firefighters without PTSD. This finding was surprising because: 1) the MVS sub-sample had a significantly higher incidence of past PTSD diagnosis, and 2) the MVS sub-sample had overall higher EDA than non-MVS sub-sample. However, importantly the samples were matched on overall psychopathology. This finding suggests that both military experience and past PTSD had unique, and interactive, effects on EDA. However, given the relatively small, matched samples, replication in a larger sample is needed to grow confidence in this finding.

Results also indicated that within the MVS sub-sample, years of service, number of deployments, and total time on deployment were associated with higher fear expression, even when controlling for past PTSD. More specifically, years served, and total months deployed were associated with fear-expression during the SSI responses to the *Intro* and *Coping* prompts, which were less explicitly threatening contexts. In addition, number of deployments was associated with higher fear expression for *all four* SSI responses. This suggest that the number of times transitioning in and out of deployment might have greater implications for alterations in the threat-response system than overall length of military service or time spent on deployment. This could be due to experiencing stressful events in multiple contexts or locations and a general pattern of influence on the threat-response system.

Given the results of the current study, and the differences in fear-reactivity observed between MVS and non-MVS firefighters, the following question remains: Does military experience confer some form of adaptive advantage (e.g., increased fear flexibility), or is it associated with additional risk? The results from this investigation highlight the complexity of testing such a question. On the one hand, MVS firefighters had lower sympathetic arousal at rest, suggesting a potentially calmer disposition when not engaged with anything that could be perceived as threatening. For example, lower resting sympathetic arousal is positively associated with physical and psychological health (Armstrong et al., 2019; Malpas, 2010; Smith et al., 2020; Ward, Doerr, Storrie, 1983). On the other hand, MVS firefighters had *elevated* sympathetic arousal throughout the entire SSI, even during less-explicitly threatening segments. It is possible that military personnel tend to become more psychophysiologically prepared to respond to potential threats as a result of training and/or aversive experiences while deployed, which may be adaptive (by responding more swiftly in the presence of threat) or maladaptive (by resulting in burnout over time). Importantly, however, because we relied on expressions of emotion, we were able to detect a quadratic pattern of MVS firefighters in fear expressions across the interview, indicative of emotion-context sensitivity and greater flexibility in fear-specific responses, a phenomenon with clear associations to psychological health (Coifman & Summers, 2019). This level of precision is not always evident for EDA, as it reflects general sympathetic activation, which is not as precise (Yiend, 2009).

While the clinical significance of the differences in fear-reactivity are difficult to interpret, it should be noted that the MVS sub-sample had significantly higher levels of past PTSD than the non-MVS sub-sample. This result alone could be interpreted as evidence for increased risk among MVS firefighters, as there are likely MVS firefighters who are at greater risk (e.g., those who have a history of PTSD symptoms), as well as those who are highly resilient and benefited from their experiences in the military, as demonstrated by greater context sensitivity/flexibility to shifting emotional contexts. Future research will require larger samples to tap into such variability. Taken together, the results provide preliminary evidence for meaningful differences in reactivity between MVS and non-MVS firefighters, but their clinical significance remains unclear. Thus, the findings of the current study may have implications for the recruitment of military veterans into first responder careers. Given that many firefighters enter the career with prior military experience, it will be important to assess for psychological impairment, particularly for those who have been deployed multiple times, or have unmanaged PTSD symptoms. However, if MVS firefighters without symptoms of PTSD and other psychopathology have more adaptive fear reactivity due to their training and experiences in the military, there may be a rationale for preferential hiring of such military veterans. This would need to be explored in future research. Finally, future research should investigate whether such observed differences have any practical effects on job performance, as this will have implications for recruitment.

The current study had both strengths and limitations worthy of consideration. As for strengths, objective measures of fear-reactivity were used, measuring multiple aspects of the fear response. Facial expressions are considered the most objective and precise measures of basic emotion (Ekman & Rosenberg, 1999; Skiendziel, Rösch, & Schultheiss, 2019). EDA is also one of the most widely used indicators of sympathetic arousal and is commonly used as a measure of fear-related psychophysiology in fear-conditioning paradigms and other forms of laboratory fear-elicitation (Esteves, Dimberg, & Ohman, 1994; Marin et al., 2017; Vervliet et al., 2004). In addition, an SSI with several contexts, including neutral, threatening, and positive, was used to elicit emotional responses. Idiographic methods have been shown to elicit strong emotions (Coifman & Bonanno, 2010; Coifman et al, 2016; Harvey, et al, 2014; Kuo et al., 2014), and the SSI was designed to draw out emotions in relation to experiences personally relevant to each individual. Finally, the matched case-control design allowed for direct comparison between MVS and non-MVS firefighters. While this method did not allow for causal inferences, MVS is a clear and easily distinguishable attribute for direct comparison of outcomes. This design allows us to establish the temporal precedence of military experience, as MVS firefighters served in the military *prior* to enlisting as firefighters. We can therefore assume that the MVS subsample had unique experiences going into the profession that non-MVS firefighters did not have. Our results suggest that MVS is uniquely associated with different patterns of fear reactivity, particularly EDA.

The findings of the current study should also be considered in light of key limitations. First, the sample sizes were relatively small, and some analyses could be underpowered. Analyses with larger sample sizes may reveal more nuanced differences and would provide essential replication. Thus, future research will need to aim for larger sample sizes with enough power to better delineate the clinical implications of the differences observed. Another limitation was the underreporting of negative affect that resulted in the exclusion of negative affect as a variable. Negative affect is an important indicator of the subjective experience of negative emotion and is particularly useful for examining conscious appraisal of emotionally evocative tasks. However, underreporting of negative affect is not uncommon in samples such as first-responders and military personnel (Britt, 2006; Thunholm, 2001) as there is often significant pressure to conceal emotional expressiveness. Thus, reliance on objective measures is also essential, which we did do here. Additionally, future research would benefit from the inclusion of self-report measures of PTSD alongside diagnostic interviews. Finally, our sample only contained male (majority white) firefighters, and therefore the results may not generalize to female and gender diverse firefighters. While women are underrepresented in the firefighter and military professions (around 8% and 20%, respectively; NFPA, 2020; CFR, 2020), there is a substantive literature demonstrating sex difference in fear processing (Inslicht et al., 2013; Kelly et al., 2008; Velasco et al., 2019), and therefore military and/or combat exposure may have a different effect on female firefighters. Moreover, while racial and ethnic minorities are well-represented in the military in most cases (CFR, 2020), they are often underrepresented in the firefighter profession (NFPA, 2020), and therefore may have unique experiences not captured by the current investigation. Future research should seek samples with greater gender and racial/ethnic diversity to maximize the generalizability of the findings.

**Conclusion**

The current investigation represents a first step towards understanding the effects of prior military experience on fear-reactivity in active-duty firefighters. Military service is a high risk, high stress occupation, and yet many veterans successfully transitioning out of the military into careers as first responders, such as firefighters. Although around 40% of firefighters enter the profession with prior military experience, limited research has examined the effects of military experience on processes involved in the processing of stress in MVS firefighters. The current study was the first to investigate differences in fear-reactivity between MVS and non-MVS firefighters. Overall, MVS firefighters had lower resting sympathetic arousal, but higher arousal during an emotionally evocative SSI, compared to non-MVS firefighters. In contrast, firefighters with past PTSD had significantly blunted sympathetic arousal compared to firefighters without PTSD. While there were no mean-level differences in fear expression during the task, MVS firefighters showed significantly greater evidence of adaptive fear context-sensitivity, resulting in greater recovery following the fear-eliciting interview prompt. Finally, number of military deployments was associated with higher fear-expression throughout the SSI. These results indicate that the intersection of military experience and psychiatric history should be a topic of further clinical research within active-duty firefighters, as well as other first responders.

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| --- | --- | --- | --- | --- | --- | --- |
| **Table 1**  *Sample characteristics for military and non-military sub-samples.* | | | | | | |
|  | *n* | *M* | *SD* | Percent of Sub-Sample | *t* | χ2 |
| *Military Sub-Sample* | 32 |  |  |  |  |  |
| Age | 32 | 34 | 7.64 |  | 0.16 |  |
| Firefighter Experience (Years) | 32 | 6.40 | 8.12 |  | 0.58 |  |
| Past Psychiatric Diagnosis | 20/32 |  |  | 62.50% |  | 0 |
| Current PTSD Symptoms | 32 | 1.38 | 1.98 |  | 0.91 |  |
| Past PTSD Diagnosis | 13/32 |  |  | 40.60% |  | 4.63\* |
| American Indian/Alaska Native | 2 |  |  | 6.30% |  | 0.51 |
| Black/African American | 1 |  |  | 3.10% |  | 0.01 |
| White/Caucasian | 20 |  |  | 62.50% |  | 0.02 |
| Asian/Pacific Islander | 0 |  |  | 0% |  | 0 |
| Hispanic/Latino | 0 |  |  | 0% |  | 0 |
| *Non-Military Sub-Sample* |  |  |  |  |  |  |
| Age | 31 | 34.32 | 8.15 |  |  |  |
| Firefighter Experience (Years) | 32 | 7.51 | 6.98 |  |  |  |
| Past Psychiatric Diagnosis | 20/32 |  |  | 62.50% |  |  |
| Current PTSD Symptoms | 31 | 0.97 | 1.56 |  |  |  |
| Past PTSD Diagnosis | 5/31 |  |  | 15.60% |  |  |
| American Indian/Alaska Native | 1 |  |  | 3.10% |  |  |
| Black/African American | 1 |  |  | 3.10% |  |  |
| White/Caucasian | 23 |  |  | 71.90% |  |  |
| Asian/Pacific Islander | 0 |  |  | 0% |  |  |
| Hispanic/Latino | 0 |  |  | 0% |  |  |

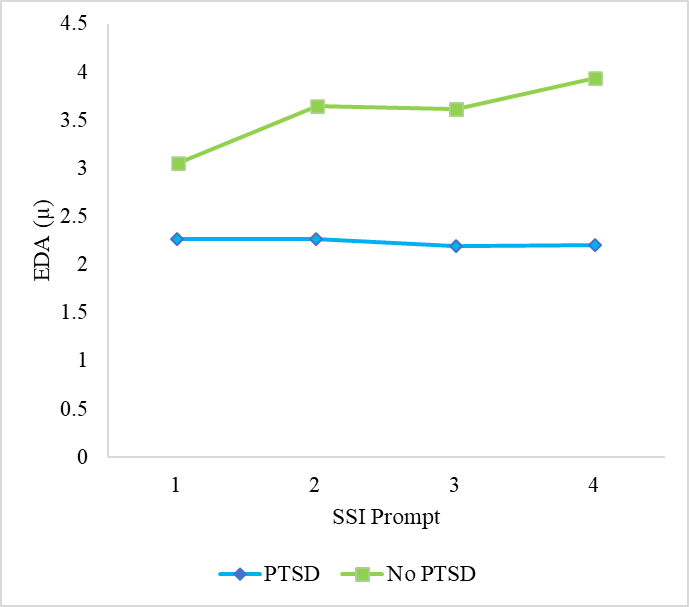
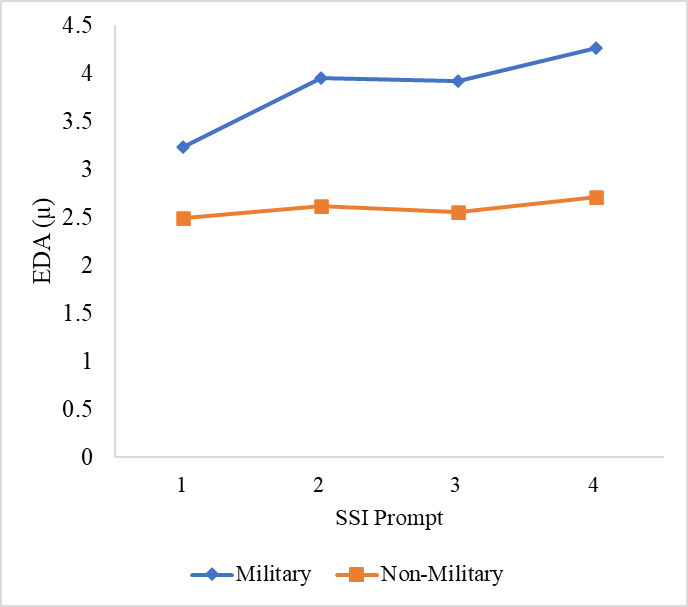
*Note:* n = sample size; M = mean; SD = standard deviation; t = t-test statistic; χ2 = chi-squared statistic. \* denotes that p < .05 for the t-test and chi squared tests.

Figure 1b

*Differences in EDA Between Firefighters with and without Past PTSD*

Figure 1a

*Differences in EDA Between MVS and Non-MVS Firefighters*



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*Note: MVS =* Military Veteran Status; *SSI* = Semi-Structured Interview; EDA = Electrodermal Activity; µS = Microsiemens. On the x-axis, 1 denotes *Intro* prompt, 2 denotes *Coping* prompt, 3 denotes *Fear* prompt, and 4 denotes *Positive* prompt. (\* p < .05, \*\* p < .01)

Figure 2  *Plotted Time x Group Interaction Showing Greater Reduction in Fear Expression Between the Fear and Positive* SSI Prompts.

*Notes:* On the x-axis, 1 denotes *Intro* prompt, 2 denotes *Coping* prompt, 3 denotes *Fear* prompt, and 4 denotes *Positive* prompt. (\* p < .05)

\*

F(1,52) = 6.02, p=.018, partial η2 = 0.11