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ORIGINAL PAPER

The Role of Mindfulness in Reactivity to Daily Stress in Urban Firefighters

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Abstract

Objectives The purpose of this study was to test the hypotheses that mindfulness would be related to reduced reactivity to daily stress in urban firefighters.

Methods Participants were 78 members from an urban fire department who completed an initial questionnaire and a 21-day daily diary. Mindfulness was assessed at baseline using the Mindful Attention and Awareness Scale. The daily diary included measures of stress (total stress, work stress, partner stress) and measures of negative affect, positive affect, and loneliness. Multilevel analyses adjusting for the dependent variable on the previous day were used to test the hypotheses.

Results Higher daily total, partner, and work stress were associated with increased negative affect. Higher daily, total, and partner stress were associated with increased loneliness and decreased positive affect. Mindfulness appeared to buffer against stress reactivity as higher baseline mindfulness was related to (a) less negative affect on days of greater total stress, (b) more positive affect on days of greater total, work, and partner stress, and (c) less loneliness on days of greater total, work, and partner stress.

Conclusions Mindfulness may improve the health and wellbeing of urban firefighters by reducing reactivity to daily stress, especially in relation to positive affect and loneliness. Future research should determine whether mindfulness-based interventions may be enhanced by focusing more closely on reducing reactivity to stress, especially in fire service populations.

Keywords Mindfulness · Firefighters · Stress reactivity · Affect · Loneliness

Mindfulness refers broadly to the ability to pay attention to, and be aware of, present-moment experience (Brown and Ryan 2003). Kabat-Zinn (1993) has defined mindfulness as "paying attention in a particular way, on purpose in the present moment, and nonjudgmentally" (p. 4). It is associated with several beneficial psychological processes, including cognitive flexibility, deeper experiencing of thoughts and emotions, and improved emotion regulation, particularly in the face of stressors (Coffey and Hartman 2008; Hill and Updegraff 2012; Shapiro et al. 2006). Nonreactivity (i.e., perceiving emotions and experiences without reacting to them) and mindful attention and awareness are key components of mindfulness hypothesized to reduce the impact of stress. Nonreactivity may help buffer against a stressor's impact on negative emotions by enabling a person to view the situation as a passing phenomenon (Hill and Updegraff 2012). Mindful attention and awareness may help buffer against a stressor's impact on positive emotions by broadening a person's awareness of the situation to reappraise it as less stressful and increase awareness of positive emotions (Jimenez et al. 2010). This acceptance of present-moment emotion and experience may prevent exaggerating the duration or consequences of distress (Kabat-Zinn 1990). A number of studies, both cross-sectional and longitudinal, have examined the benefits of dispositional mindfulness on buffering against the impact of daily stressors (Bullis et al. 2014; Calvete et al. 2018; Dixon and Overall 2016). These studies highlight the protective role of dispositional mindfulness, which likely increases emotion regulation, in reducing the impact of stress (Teper et al. 2013). The studies that have established this relationship between mindfulness and stress have examined populations experiencing more routine forms of daily stress.

Studying mindfulness in populations exposed to both stress from daily hassles as well as potentially traumatic events offers a unique opportunity to better understand the role of

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mindfulness in buffering against a wide range of stressors. Such research is important if mindfulness is to be incorporated successfully into models of treatment, coping, and resilience for particularly at-risk populations. Emergency responders, especially those in the fire service, are an ideal population for this inquiry for several reasons. First, they experience high occupational exposure to potentially traumatic stressors and the chronic stressor of being ready to respond to calls (Beaton et al. 1998; Mitani et al. 2006). Second, their work shifts (e.g., up to 72 h on and rotating shifts) and the tight-knit community that often forms as a result, can be a stressor to home life (Sanford et al. 2017). Third, because of these unique occupational circumstances, they are at elevated risk for a number of health problems including posttraumatic stress disorder (Corneil et al. 1999; Laposa and Alden 2003), depression (Kimbrel et al. 2011), substance use disorder (Gulliver et al. 2018), sleep disorders (Barger et al. 2015) and suicide (Henderson et al. 2016). Despite this elevated risk, the majority of fire service members are resilient in the face of potentially high occupational stressors (Kaplan et al. 2017).

Mindfulness may help mitigate the effects of stress on emotional wellbeing in the fire service. Its benefits on emotion regulation may help explain cross-sectional findings that suggest a relation between greater mindfulness and fewer trauma-related symptoms in firefighters (Setti and Argentero 2014; Smith et al. 2011). However, another understudied aspect of mindfulness that may help explain its relation to lower psychopathology symptoms in this population in particular is its potential to buffer against loneliness. Mounting evidence suggests that loneliness is harmful to physical and emotional health (Hawkley and Cacioppo 2010). In fire service populations, loneliness may be a risk factor for the morbidities noted previously, particularly PTSD. Fire service requires crews to work well together during calls and the time spent together often results in important and protective social bonds (Beaton and Murphy 1993; Beaton et al. 1998). Firefighters who feel alienated from others after exposure to trauma may be more likely to become depressed and develop PTSD (Regehr et al. 2000). Firefighters who feel alienated at work and strained in their relationships outside of work may therefore be at highest risk for poor mental health outcomes. Mindfulness may buffer against loneliness by improving communication about distressing emotions to others, lowering defensiveness, increasing attention to the needs of others, and increasing empathy – skills that may facilitate better relationships within and outside work (Block-Lerner et al. 2007; Stewart et al. 2018; Wachs and Cordova 2007). Given that mindfulness-based interventions (MBIs) are increasingly being used in occupational health settings (Creswell 2017; Dimidjian and Segal 2015), and are also being adopted to address the needs of at-risk populations, including those in the fire service (Kaplan et al. 2017), a greater understanding of how mindfulness alters reactivity to stress can better inform the tailoring of these interventions to the meet the unique needs of those in the fire service.

The purpose of this study was to investigate the role of dispositional mindfulness in reducing reactivity to stress (total, work, and partner stress) in relation to negative affect, positive affect, and loneliness in urban firefighters through a daily diary design. This study extends prior literature on mindfulness in the fire service in several ways. First, it is one of the few longitudinal studies to test the relation between mindfulness and outcomes in this population (Kaplan et al. 2017). Second, it assesses not only work-related stress, but also partner-related stress, an understudied, but significant source of distress for many firefighters. Third, it focuses on negative affect, positive affect, and loneliness, distinct components that independently affect wellbeing. The daily diary design is an ideal way to understand how individual differences in dispositional mindfulness affect reactivity to daily stress in relation to affect because the temporal relationship between stress and affect can be examined in work and nonwork settings. Our overall hypotheses were that firefighters higher in dispositional mindfulness would have lower reactivity to daily stress as evidenced by smaller increases in negative affect, smaller decreases in positive affect, and smaller increases in loneliness on higher stress days compared to those lower in mindfulness.

Method

Participants

The participants for the current study were recruited from a Southwest city and metro area fire departments. Participants had to be fluent in English, working regular active-duty shifts, and willing to be contacted for a potential follow-up study within 2 years. The study was conducted in compliance with the Institutional Review Board at the University of New Mexico, and informed consent was obtained by research staff. Descriptive statistics are shown in Table 1. Participants included 78 fire service members (80% line firefighter, 4% alarm room/dispatch, 9% crisis response, 7% administration). Different fire service ranks were well represented in the sample with 59% firefighters, 10% fire engineer, 25% captains, and 6% battalion chief/chief. The majority of the sample was male (73%). Average age was 39.42 years (SD = 8.95). Of the sample, 18% was Hispanic, 69% was nonHispanic Caucasian, 3.6% was nonHispanic Black, 1.2% was Asian or Pacific Islander, 2.4% was Native American or Alaskan Native, and 4.8% was Mixed or Other. The most common range of income for the sample was between $60,000 and $89,999 annually. Forty percent of the sample fell in this range. Average education was 15.1 years (SD = 2.19 years). Average time in fire service was 11 years, 3 months (SD = 7 years, 6 months). Eighty-three percent of the

Table 1 Descriptive statistics for study variables

	Mean	SD	Range
Predictor variables			
Mindfulness	4.25	0.91	1.80–5.93
Total stress	3.12	1.52	1.00–7.00
Work stress	3.52	1.51	1.00–7.00
Partner stress	2.19	1.58	1.00–7.00
Dependent variables			
Positive affect	2.73	0.86	1.00–5.00
Negative affect	1.59	0.64	1.00–4.60
Loneliness	1.52	1.01	1.00–5.00
Demographic characteristics			
Age	39.42	8.95	23.00–62.00
Years education	15.1	2.19	12.00–24.00
Years fire service	11.25	7.6	0.26–31.05
Baseline negative affectivity			
Anxiety	6.14	4.13	0.00–20.00
Depression	4.60	4.61	0.00–17.00
PTSD symptoms	7.24	9.27	0.00–41.00

participants had a spouse or partner, with 55% being currently married and living with a partner. Participants completed an average of 18.5 days of the diary (1440 total) of which 8.0 were work days (626 total) and 10.5 were days off (814 total). The 78 firefighters who completed baseline data were included in the final analyses, and 88% of the daily diary entries were complete.

Procedures

The participants came to an informational meeting about the study held by research staff. They were informed about the nature of the study, shown the daily diary, and had the opportunity to ask questions. They were then given the opportunity to consent to the study and ask more questions after reading the consent form. Upon consent, participants were provided with the baseline questionnaires and completed them before being paid. They then received daily reminders with the online survey link. The third author monitored daily diary entries and contacted participants if they missed an entry. Participants received $40 for completing baseline measures and then $3 per day for every day they completed, plus $4 for every full week they completed, and an extra $6 if they completed all 21 days.

Measures

The measures were administered in an initial questionnaire and during the daily diary. The daily diary measures assessed affect, loneliness, stress, and work day, while the initial questionnaire assessed both dispositional mindfulness as well as several measures of psychopathology.

Daily Affect Positive affect and negative affect were measured using items from Larsen and Diener's (1992) 16-item Mood Adjective Checklist capturing all octants of mood pleasantness and mood arousal. Selected items represented each area of the emotion circumplex. Negative affect consisted the average of ratings for "anxious," "sad," "depressed," "nervous," and "angry" (Cronbach's alpha = .79). Positive affect consisted of average ratings for "cheerful," "energetic," "happy," "stimulated," "active," and "peppy" (Cronbach's alpha = .89). Participants rated their daily affect on a scale from 1 to 5 with the following anchors: *1 = not at all, 2 = a little, 3 = moderately, 4 = quite a bit,* and *5 = extremely.*

Daily Loneliness Loneliness was assessed using the item "lonely" asking participants "How much did you feel this way during the past day?" The participants responded on a five-point scale from 1 = "not at all" to 5 = "extremely."

Daily Stress Stress was measured with four items designed to assess stress "during the past day" (Smith and Zautra 2002). Items assessed total stress ("How stressful was your day overall?"), work stress ("How stressful was your time at work overall?"), nonwork stress ("How stressful was your time away from work overall?"), and partner stress ("How stressful was your relations with your spouse or partner?"). Total stress and partner stress were assessed on all days and work stress was only assessed on days when the participant worked. The items were responded to on a seven-point scale from 1 = "not at all" to 7 = "extremely" and could mark "not applicable" to each source of daily stress.

Work Day Participants were asked whether they were working each day. Nonwork days were coded 0; work days were coded 1.

Mindfulness The Mindful Awareness Attention Scale (MAAS; Brown and Ryan 2003) assessed awareness of and attention to present-moment experience. The 15 items (e.g., "I find it difficult to stay focused on what's happening in the present", reverse scored) were responded to on a six-point scale from 1 = *almost never* to 6 = *almost always* (alpha = .91).

Anxiety Symptoms The 7-item anxiety subscale of the *Hospital Anxiety and Depression Scale* (HADS; Zigmond and Snaith 1983) was used to access anxiety symptoms. The items (e.g., "I felt tense or would up") were scored on a 4-point scale and added to form a summary score (alpha = .84).

Depressive Symptoms The revised version of the Beck Depression Inventory (BDI-II) (Beck et al. 1996) was used to assess depressive symptoms over the previous 2 weeks.

The 21 items were responded to on a 0–3 scale and added to form a summary score (alpha = .87).

PTSD Symptoms The Posttraumatic Diagnostic Scale (PDS; Foa et al. 1997) assessed past-month PTSD symptoms of re-experiencing, avoidance, and arousal with 17 items responded to on a 4-point scale (0 = *not at all or only one time* to 3 = *five or more times a week/almost always*). Firefighters responded to the items in reference to the experience on the job that bothered or disturbed them most in the past month. The scores on each item were added to form a summary score (alpha = .94).

Data Analyses

Multilevel modeling (e.g., hierarchical linear modeling) was used to analyze the relationship between mindfulness and daily measures. Multilevel modeling is useful for data that have a nested hierarchical structure. Daily data took a hierarchical form, with up to 21 daily observations nested within each of the participants. We used SPSS 23.0 mixed program for the multilevel analyses with model specifications based on the guidelines provided by Singer (1998). Maximum likelihood estimation was used in the multilevel analyses which enabled us to account for the missing daily diary entries.

The daily measures of negative affect, positive affect, and loneliness were the dependent measures and mindfulness and the stress measures (total stress, work stress, and partner stress) were the independent measures. Two basic types of prediction equations in the multilevel analyses were used: (a) a Level 1 equation, which examined the influence of within-person variables that were assessed every day on other within-person variables, and (b) a Level 2 equation, which examined the influence of between-person variables on within-person variables that we assessed every day.

Level 1 equations addressed questions about "when" rather than "who." For example, when a person has more stress, does he or she also report more negative emotion? Level 2 equations addressed questions regarding between-person differences. For example, do people who have different scores on a between-persons predictor (e.g., mindfulness) have different levels of the dependent variable (e.g., negative affect, positive affect, loneliness)? Level 1 equations were specified as follows:

$$\begin{aligned}\text{Level 1}: \quad & \text{daily negative affect} \\ &= \beta_0 + \beta_1 \text{total stress} \\ &\quad + \beta_2 \text{previous day negative affect} + \beta_3 \text{ workday} \\ &\quad + r\end{aligned}$$

yields an estimate of the average daily negative affect, β_1 provides slope estimates for total stress predicting daily negative affect, β_2 provides slope estimates for previous day negative affect, and β_3 provides slope estimates for work day (0 = day off, 1 = work day) predicting current day negative affect.

Individual differences in average daily variables were also explored through analyses at Level 2. For these analyses, the effects of individual differences in mindfulness were also examined. Mindfulness was used as a predictor of Level 1 daily measures of the three stress measures and of negative affect, positive affect, and loneliness. The Level 2 equations predicting Level 1 intercepts were specified as follows:

$$\text{Level 2}: \quad \beta_{0=\gamma 00} + \gamma_{01} \text{ mindfulness}_{+\mu 0.}$$

where γ_{00} corresponds with Level 2 intercept, γ_{01} provides slope estimates for mindfulness, and μ_0 reflects the residual intercept variance. Age, gender, education, income, months in the fire service, anxiety symptoms, depression symptoms, PTSD symptoms, and day in the study were also included as between-person control variables.

Cross-level interactions were examined through the effect of mindfulness variables on the relationship between stress and each dependent variable. The Level 2 equations predicting Level 1 slopes were specified as follows:

$$\text{Level 2}: \quad \beta_1 \text{total stress} = \quad \gamma_{10} + \gamma_{11} \text{mindfulness}_{+\mu 1.}$$

where γ_{10} corresponds with Level 2 slope, γ_{11} provides slope estimates for mindfulness and the cross-level interaction between mindfulness and stress, and μ_1 reflects the slope intercept variance.

We selected an unstructured variance-covariance matrix for the multilevel analyses based on the guidelines on selecting the best fitting model outlined in Singer (1998). The intercept was kept in the model as a random effects variable and the level 1 stress measures were included as random variables whenever their random effects were significant.

Results

The multilevel results for the fixed effects predicting the three kinds of stress (total stress, work stress, partner stress) are displayed in Tables 2, 3, and 4, respectively. There were nine separate analyses conducted for each of the three dependent variables (negative affect, loneliness, positive affect) with each of the three kinds of stress (total stress, work stress, partner stress). All models also adjusted for the previous day's score on the dependent variable. In addition, all models adjusted for baseline anxiety, depression, and PTSD symptoms as proxies for negative affectivity (e.g., neuroticism) and because they were each correlated with at least two of the three dependent variables. Finally, all models also adjusted for age,

Table 2 Mindfulness and daily stress predicting daily negative affect

Model	Parameter	Estimate	SE	*t*	*p*	CI LL	CI UL
Total stress	Intercept	0.20	0.06	3.57	< .001	0.09	0.31
	Negative affect lag	0.14	0.03	4.68	< .001	0.08	0.20
	Mindfulness	− 0.08	0.04	− 2.02	0.048	− 0.17	− 0.01
	Total stress	0.17	0.01	11.91	< .001	0.14	0.20
	Workday (0 = day off; 1 = workday)	− 0.11	0.02	− 4.68	< .001	− 0.15	− 0.06
	Mindfulness x total stress	− 0.04	0.02	− 2.35	0.022	− 0.07	− 0.01
	Workday x total stress	− 0.05	0.02	− 2.47	0.014	− 0.09	− 0.01
Work stress	Intercept	0.14	0.07	2	0.051	− 0.01	0.28
	Negative affect lag	0.19	0.05	3.68	0.001	0.09	0.30
	Mindfulness	− 0.06	0.05	− 1.13	0.262	− 0.16	0.04
	Work stress	0.08	0.02	3.95	< .001	0.04	0.11
	Mindfulness x work stress	− 0.02	0.02	− 1.26	0.21	− 0.06	0.01
Partner stress	Intercept	0.21	0.07	3.14	0.003	0.07	0.34
	Negative affect lag	0.20	0.04	5.37	< .001	0.12	0.27
	Mindfulness	− 0.09	0.05	− 1.65	0.105	− 0.20	0.02
	Partner stress	0.12	0.02	5.91	< .001	0.08	0.16
	Workday	0.02	0.03	0.77	0.443	− 0.03	0.07
	Mindfulness x partner stress	− 0.04	0.02	− 1.85	0.071	− 0.09	0.01
	Workday x partner stress	− 0.07	0.03	− 2.45	0.014	− 0.13	− 0.01

gender, education, income, months in the fire service, and day in the study because they were also related to the dependent variables. The tables do not display the control variables due to space considerations and as these were not central to primary aims of this paper. Workday and workday interactions with mindfulness and daily stress were included in the analyses and are displayed in the tables when they were significant.

Mindfulness, Daily Stress, and Work Day Predicting Negative Affect

Table 2 presents the results for the multilevel models with mindfulness, daily stress (total, work, and partner), and work days predicting daily negative affect, adjusting for the previous day's negative affect. Two significant interactions were

Table 3 Mindfulness and daily stress predicting positive affect

Model	Parameter	Estimate	SE	*t*	*p*	CI LL	CI UL
Total stress	Intercept	1.59	0.11	13.99	< .001	1.36	1.81
	Positive affect lag	0.27	0.03	10.1	< .001	0.22	0.32
	Mindfulness	0.02	0.07	0.33	0.744	− 0.12	0.17
	Total stress	− 0.08	0.01	− 6.53	< .001	− 0.11	− 0.06
	Workday	0.10	0.03	3.14	0.002	0.04	0.16
	Mindfulness x total stress	0.03	0.01	1.98	0.048	0.01	0.05
Work stress	Intercept	1.50	0.14	11.13	< .001	1.24	1.77
	Positive affect lag	0.31	0.04	8.17	< .001	0.23	0.38
	Mindfulness	0.03	0.08	0.37	0.713	− 0.13	0.19
	Work stress	− 0.02	0.02	− 0.90	0.371	− 0.06	0.02
	Mindfulness x work stress	0.04	0.02	2.03	0.043	0.01	0.08
Partner stress	Intercept	1.45	0.10	14.29	< .001	1.24	1.65
	Positive affect lag	0.31	0.04	7.73	< .001	0.23	0.39
	Mindfulness	0.13	0.07	1.77	0.081	− 0.02	0.27
	Partner stress	− 0.08	0.02	− 5.07	< .001	− 0.11	− 0.05
	Mindfulness x partner stress	0.03	0.02	1.96	0.050	− 0.01	0.06

Table 4 Mindfulness and daily stress predicting loneliness

Model	Parameter	Estimate	SE	*t*	*p*	CI LL	CI UL
Total stress	Intercept	0.20	0.15	1.38	0.177	−0.10	0.50
	Loneliness lag	0.11	0.04	2.67	0.011	0.03	0.20
	Mindfulness	−0.03	0.11	−0.31	0.758	−0.26	0.19
	Total stress	0.06	0.02	3.36	0.001	0.03	0.10
	Workday	−0.08	0.03	−2.23	0.026	−0.15	−0.01
	Mindfulness x total stress	−0.05	0.02	−2.25	0.028	−0.09	−0.01
Work stress	Intercept	0.15	0.17	0.91	0.365	−0.18	0.49
	Loneliness lag	0.26	0.07	3.56	0.001	0.11	0.41
	Mindfulness	0.05	0.12	0.44	0.662	−0.19	0.30
	Work stress	0.02	0.02	0.94	0.345	−0.02	0.07
	Mindfulness x work stress	−0.06	0.02	−2.57	0.011	−0.11	−0.01
Partner stress	Intercept	0.27	0.12	2.21	0.031	−0.03	0.50
	Loneliness lag	0.05	0.05	1.03	0.310	−0.05	0.14
	Mindfulness	−0.11	0.12	−0.92	0.365	−0.35	0.13
	Partner stress	0.07	0.03	2.90	0.005	0.02	0.12
	Workday	0.01	0.04	0.19	0.851	−0.06	0.08
	Mindfulness x partner stress	−0.07	0.03	−2.68	0.011	−0.13	−0.02

identified. First, there was an interaction between mindfulness and total stress such that individuals who were high in mindfulness had smaller increases in negative affect on high total stress days than those who were low in mindfulness (see Fig. 1a). In addition, there were smaller increases in negative affect on work days vs. days off and there was an interaction between workday and total stress. Second, there was an interaction between total stress and work day such that there were smaller increases in negative affect on high total stress workday days than there were on high total stress days off (see Fig. 1b).

For the model with work stress, negative affect during the previous day and work stress were related to increases in negative affect. Mindfulness was not related to negative affect and there was no interaction between mindfulness and work stress predicting negative affect.

For the model with partner stress, there was a trend for an interaction between mindfulness and partner stress. In addition, there was an interaction between workday and partner stress. The interaction was such that there were smaller increases in negative affect on high partner stress workday days than there were on high partner stress days off (see Fig. 1c).

Mindfulness, Daily Stress, and Work Day Predicting Positive Affect

Table 3 presents the results for the multilevel models with mindfulness and daily stress predicting positive affect, adjusting for the previous day's positive affect. For the model with total stress, there was an interaction between mindfulness and total stress such that individuals who were high in mindfulness had smaller decreases in positive affect on high total stress days than those who were low in mindfulness (see Fig. 2a). Work days were associated with increases in positive affect. For the model with work stress, there was an interaction between mindfulness and work stress such that individuals who were low in mindfulness had decreases in positive affect on high work stress days (Fig. 2b). For the model with partner stress, there was a trend for an interaction between mindfulness and partner stress such that individuals who were high in mindfulness had smaller decreases in positive affect on high partner stress days than those who were low in mindfulness (see Fig. 2c).

Mindfulness and Daily Stress Predicting Loneliness

Table 4 presents the results for the multilevel models with mindfulness and daily stress predicting loneliness, adjusting for the previous day's loneliness. For the model with total stress, there was an interaction between mindfulness and total stress such that individuals who were high in mindfulness had smaller increases in loneliness on high total stress days than those who were low in mindfulness (see Fig. 3a). In addition, there were smaller increases in loneliness on work days vs. days off.

For the model with work stress, there was an interaction between mindfulness and work stress such that individuals high in mindfulness had a decrease in loneliness on high work stress days and those low in mindfulness had an increase in loneliness on high work stress days. However, individuals who were high in mindfulness had more loneliness on days of low work stress than those with low levels of mindfulness (Fig. 3b).

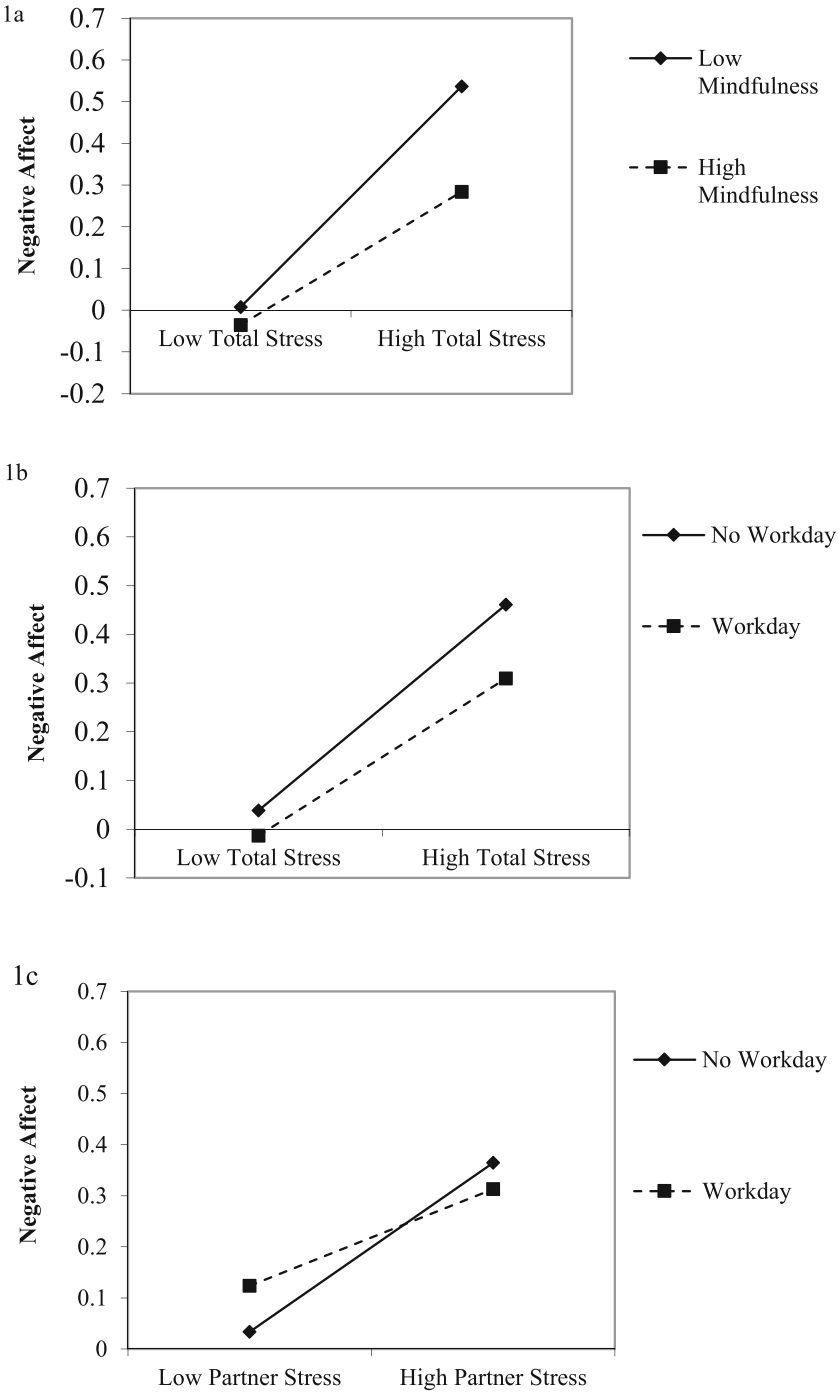

Fig. 1 Interaction plots for mindfulness and total stress, and work days and stress (total and partner) predicting negative affect. For mindfulness, the dotted lines are for individuals 1 sd above the mean in mindfulness and the solid lines are for individuals 1 sd below the mean in mindfulness

For the model with partner stress, partner stress was related to increases in loneliness but mindfulness and loneliness during the previous day were not related to loneliness. There was a 2-way interaction between mindfulness and partner stress. The interaction was such that individuals who were high in mindfulness had smaller increases in loneliness on high partner stress days than those who were low in mindfulness (see Fig. 3c).

Discussion

Firefighters experience multiple sources of stress that may impact psychological wellbeing, including stress related to work and partner stress. Mindfulness may support resilience in this population, but prior to this study, had not been examined in relation to important, diverse sources of stress (e.g., partner stress) or in conjunction with contextual variables such

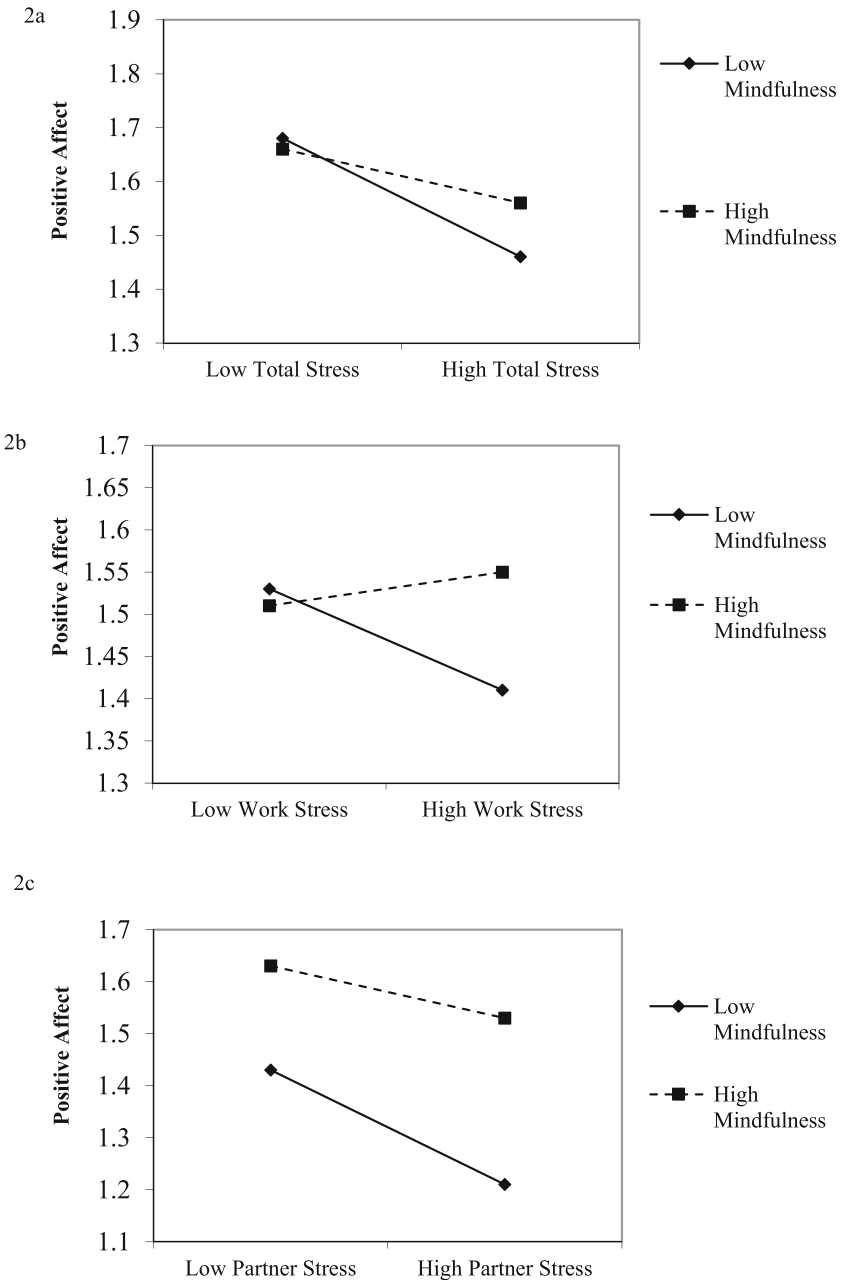

Fig. 2 Interaction plots for mindfulness and stress (total, work, and partner) predicting positive affect. The dotted lines are for individuals 1 sd above the mean in mindfulness and the solid lines are for individuals 1 sd below the mean in mindfulness

the impact of work days. The purpose of this study was to test the hypotheses that mindfulness would be related to reduced reactivity to daily stress in urban firefighters as indicated by daily negative affect, positive affect, and loneliness, and to examine the effect of work days on affect. Overall, our results suggest that mindfulness may be a protective factor against the effects of multiple sources of daily stress on affect. Our results also highlight the importance of attending to work days when studying stress and resilience in this population.

Firefighters who were higher in dispositional mindfulness generally experienced less reactivity in terms of negative affect, positive affect, and loneliness to daily stress than those who were lower in mindfulness, although there were some important nuances depending on the type of stress. For example, mindfulness appeared to buffer against the effect of higher total stress—but not work or partner stress—on daily negative affect. Most studies of mindfulness have examined its impact on managing overall and not specific aspects of stress in relation to negative affect whereas ours examined mindfulness in relation to work and partner stress in the fire service. Therefore, although our results might suggest that it is more difficult to use mindfulness to mitigate the effects of work and partner stress on negative affect in this population, the estimates for the interaction terms were in the expected direction (and there was a trend for mindfulness and partner

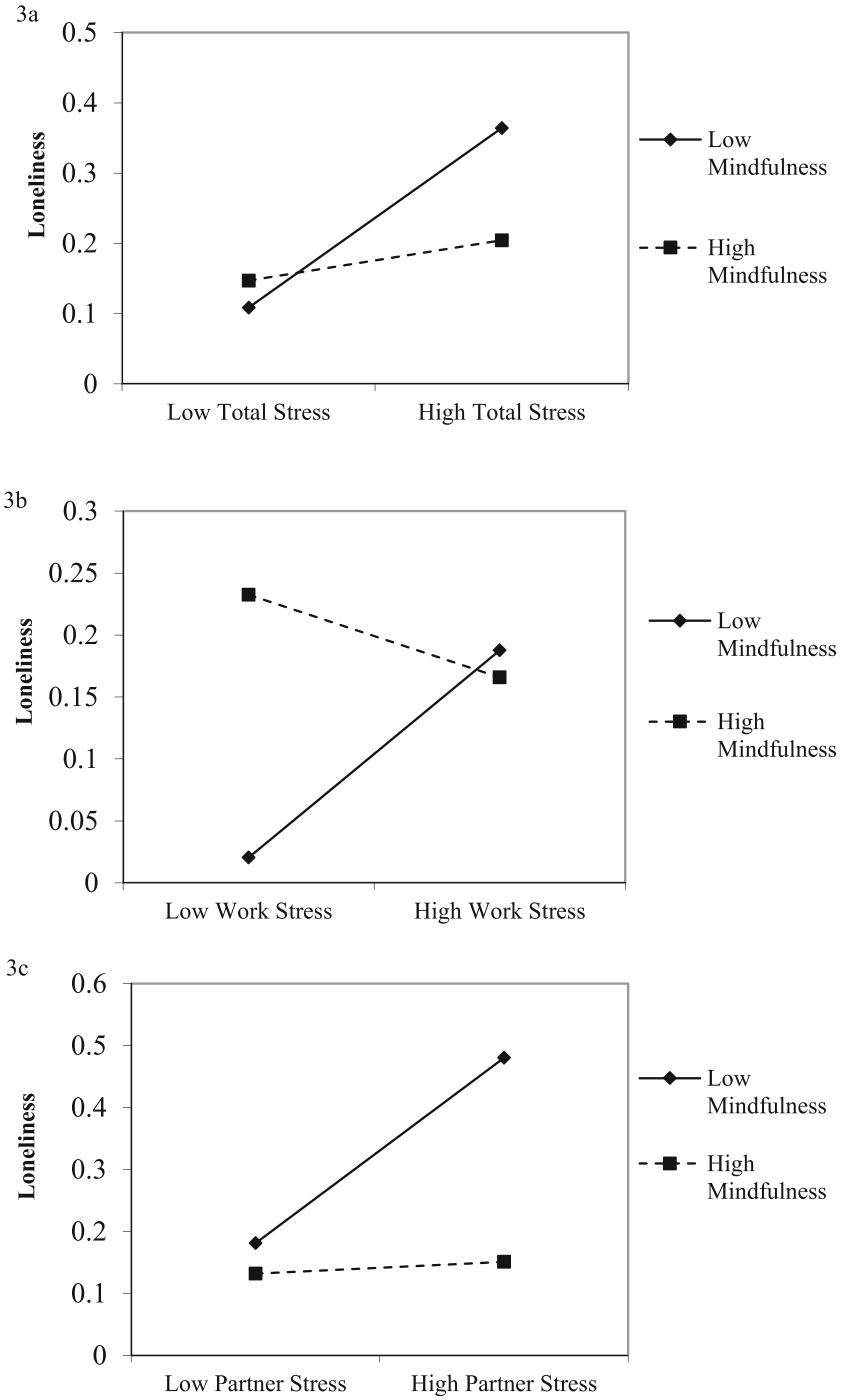

Fig. 3 Interaction plots for mindfulness and stress (total, work, and partner) predicting loneliness. The dotted lines are for individuals 1 sd above the mean in mindfulness and the solid lines are for individuals 1 sd below the mean in mindfulness

stress), suggesting a larger sample might yield the expected effects of mindfulness.

An important strength of this study was our attention to the relation between mindfulness and daily positive affect, which, independent of negative affect is an important contributor to overall psychological and physical health (Pressman and Cohen 2005). Our results suggest mindfulness may be a consistent buffer against the effects of stress—total, work, and partner—on daily positive affect in this population. Mindfulness appears to have made it more possible for the firefighters in our sample to maintain high levels of positive affect during times of stress. This is consistent with Zautra's Dynamic Model of Affect (Zautra et al. 2001) which holds that people who are more resilient may be better able to differentiate positive and negative affect in the context of stress. Being more mindful may have helped firefighters positively reappraise situations and sustain positive emotions during times of

stress (Garland et al. 2009, 2010). Indeed, because the stress of being a firefighter is often associated with the rewards of making a difference and serving others (Cowman et al. 2004), mindfulness may have made it possible for some firefighters to better focus on the positive and rewarding aspects of firefighting during times of stress.

A unique aspect of this study was our assessment of the relation between mindfulness and daily loneliness. Loneliness is a distinct experience of negative affect with insidious effects on wellbeing (Adams et al. 2017). In fire service, experiences of loneliness may be particularly problematic (Beaton et al. 1998). Our results suggest mindfulness may be protective against loneliness on days of high total and partner stress. Further, firefighters appeared to experience a decrease in loneliness on days of high work stress. However, firefighters with higher dispositional mindfulness actually reported higher loneliness on low work stress days. This finding was unexpected, but may be explained in part by the potential for increased social connection in fire service on days of high work stress. The nature of fire service calls for working closely together in one's assigned unit (Beaton and Murphy 1993; Beaton et al. 1998). If high stress work days were days on which firefighters had emergency calls, there may have been more opportunity to feel connected and work as a team (Block-Lerner et al. 2007; Wachs and Cordova 2007). Mindfulness may have helped firefighters attend to that social connectedness and therefore resulted in lower loneliness. In contrast, if days of low work stress were days on which fire fighters were not responding to calls and instead had more time to themselves, they may have lacked some of the opportunity for social connectedness with their team and mindfulness may have functioned negatively, perhaps enabling fire fighters to attend more to dissatisfying aspects of social relationships at work.

Overall, it appears that mindfulness was associated with less reactivity to stress with regard to aspects of both the emotional and social experience of firefighters. How might the ability to pay attention to and be aware of the present moment have reduced reactivity in these important domains? First, the ability to focus on the present may have enabled firefighters to pause and not immediately react to internal and external stimuli that could be considered stressful (Chambers et al. 2009; Hill and Updegraff 2012). Second, the ability to focus on any emotional reaction that they did have could have enabled them to learn that these responses would pass rather than escalate by exaggerating or prolonging their thoughts and feelings about their initial responses (Kabat-Zinn 1993; Kornfield 1993). Third, the ability to pause and focus on their emotional experience may have enabled them to better differentiate positive and negative stimuli and better maintain positive emotions (Zautra et al. 2001). Fourth, the ability to focus on the stressful situation at hand may have made it more likely for them to cope in an effective manner that would result in less distress and more positive emotion about having effectively coped (Brown et al. 2007). Finally, the ability to focus and pause and the resultant decrease in distress could have made them more able to remain attuned and engaged with others in a way that may have improved their social connections and decreased their sense of loneliness (Block-Lerner et al. 2007; Wachs and Cordova 2007).

Limitations and Suggestions for Future Research

This study has several important limitations. First, the participants were professional urban firefighters. The results may not generalize as well to volunteer firefighters. Volunteer firefighters, who report greater psychological distress and less access to mental health resources compared to professional colleagues, may experience stress differently (Stanley et al. 2017). For example, they may be similarly exposed to potentially traumatic stressors, but lack the potential tight-knit social support system of career firefighters. Second, although we assessed a theoretically and logically sound central component of dispositional mindfulness, acting with awareness, the MAAS measure does not capture all of the components that have been associated with mindfulness and therefore does not allow for examination of multiple mechanisms of action (Baer et al. 2006; Coffey and Hartman 2008). Third, the measures of daily stress and loneliness were limited to one item, reducing their reliability. Fourth, although two of the three daily stress measures focused on specific domains of stress, they did not focus on discrete events which would make it less likely that the responses would be influenced by personality biases.

These findings regarding the role of mindfulness in reactivity to stress have strong theoretical and research implications. This study adds to the recent evidence that the beneficial effects of mindfulness in first-responders may be explained in part through increases in nonreactivity to experiences, perhaps especially through reduced reactivity to stress (Bolger and Zuckerman 1995; Kalill et al. 2014; Kaplan et al. 2017). This study suggests that longitudinal measurement of stressors in first-responder populations may be an especially fruitful direction in which to examine the temporal relationship of changes in nonreactivity and stress in MBIs. Above, we suggested some potential ways that nonreactivity may lead to reductions in stress but these and other reputed mechanisms need to be more directly measured and experimentally manipulated to test them. Future studies should also further assess the relation between mindfulness, work stress, and loneliness, as our assessment of work stress precluded assessment of which aspects of work stress were most stressful (e.g., going on calls, relationships

with other crew members, etc.). Delineating these aspects of work stress may help clarify the relation between mindfulness and loneliness in the context of work stress.

Author Contributions BWS: Designed the study, analyzed the data, and led manuscript development and writing. CGF: Assisted with the literature review, interpreting and writing results, and collaborated in the writing and editing of the final manuscript and submission process. LES: Collaborated on study design, executed the study, and collaborated on writing the manuscript. All authors approved the final version of the manuscript for submission.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest.

Ethical Approval The study was approved by the UNM Main Campus Institutional Review Board. There were no adverse events reported All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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