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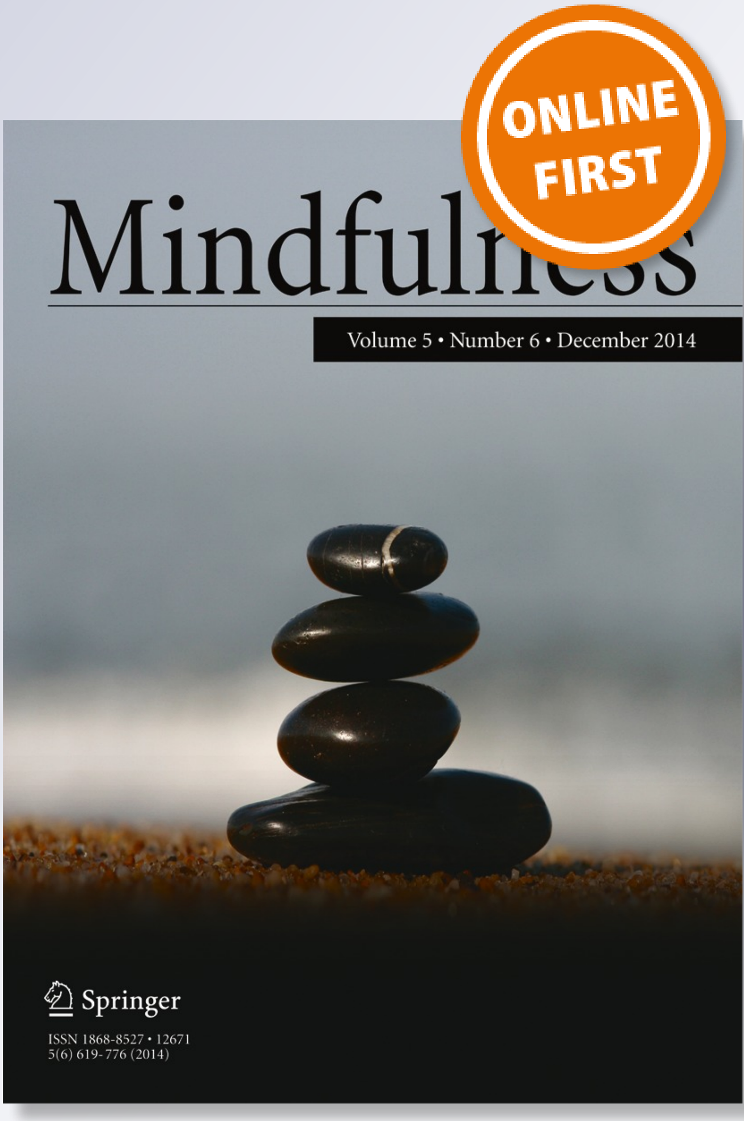

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ORIGINAL PAPER

Dispositional Mindfulness Moderates the Effect of a Brief Mindfulness Induction on Physiological Stress Responses

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Abstract This study investigated the effects of a brief mindfulness intervention on romantic partners' physiological responses to conflict stress moderated by trait mindfulness. Young adult couples (n=101 dyads) completed the Five Facet Mindfulness Questionnaire (FFMQ) to assess trait mindfulness approximately 1 week prior to a laboratory session involving a conflict discussion task. One third of partners were randomly assigned to a mindfulness induction condition before the conflict (remaining participants were assigned to a perspective taking or control condition). All participants gave five saliva samples over the course of the session to measure autonomic (salivary alpha-amylase, sAA) and neuroendocrine (cortisol) stress responses. There were no main effects of participation in the mindfulness condition, but analyses revealed differing intervention impacts for partners with high vs. low dispositional mindfulness. According to region of significance testing, partners with high FFMQ scores (top 23 % of men, 12 % of women) showed better stress regulation in the mindfulness condition, i.e., more dynamic sAA reactivity/recovery curves for men and quicker post-stress cortisol recovery for women, whereas those with low FFMQ scores (bottom 5 % of men, 11 % of women) showed poorer regulation, i.e., flatter sAA responses. Implications for using mindfulness to foster stress regulation are discussed.

Keywords Mindfulness · Cortisol · HPA · sAA · ANS · Stress · Couples

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Introduction

The way in which a person responds to stress has profound implications for physical and mental well-being (Cacioppo 1998; Dunkel Schetter and Dolbier 2011). In particular, the activation of stress-responsive autonomic and neuroendocrine systems impacts diverse health outcomes from immune function and inflammation to cognition and mood (e.g., Bizik et al. 2013; Juster et al. 2010; Marin et al. 2011). One approach to fostering a healthy stress response is the cultivation of mindfulness or intentional present-moment nonjudgmental awareness (Kabat-Zinn 1990). A substantial body of research supports the beneficial effects of mindfulness interventions on subjective and physiological stress (Epel et al. 2009; Keng et al. 2011); however, these effects are heterogeneous and do not appear in all studies (see Matousek et al. 2010). Further work is needed to define the conditions under which mindfulness influences stress.

Varying definitions of stress highlight the subjective or physiological aspects of an individual's response to threat or challenge, which may or may not coincide—in this investigation, we focus on the latter. The autonomic nervous system (ANS) and hypothalamic-pituitary-adrenal (HPA) axis represent complementary branches of the human stress response; whereas the ANS responds quickly to enable effortful "fight-or-flight" coping, the HPA axis responds more slowly to mobilize resources for surviving sustained threat (Sapolsky et al. 2000).

ANS activation in response to acute stress can be assessed indirectly by levels of alpha-amylase in saliva (sAA; Nater et al. 2006; Nater and Rohleder 2009). Variations in sAA response have implications for psychosocial adjustment; individuals with disruptive behavior, borderline personality disorder, elevated suicide risk, and depression have all been found to show lower sAA stress reactivity (de Vries-Bouw et al. 2012; McGirr et al. 2010; Nater et al. 2010). Much of this research deals with performance stress situations, but there is also evidence for adjustment-related differences in response to interpersonal stress. Couples' positive cognitions about and engagement in a conflict discussion have been related to increased sAA levels in response to the conflict paired with quicker reactivity/recovery dynamics overall (Ditzen et al. 2013; Laurent et al. 2013b). Together, this research suggests that autonomic regulation can be characterized by a robust, dynamic sAA response to stress.

The HPA axis, typically indexed through salivary cortisol, responds especially to stressors involving social-evaluative threat and/or uncontrollability (Dickerson and Kemeny 2004). Variability in HPA responses—both higher and lower cortisol levels, but more consistently delayed post-stress recovery—has also been implicated in mental health problems such as depression, anxiety, and post-traumatic stress (e.g., Burke et al. 2005; Jones and Moller 2011). In a couples stress context, destructive conflict behaviors—i.e., mutual negativity and demand-withdraw—related to flattened cortisol responses and slower recovery, particularly for women (Laurent et al. 2013c). Similarly to the ANS, then, HPA regulation can be characterized by a time-limited stress response followed by efficient recovery. Given the health implications of dysregulated responding, it is important to determine how to best promote such responses in real-world stress contexts.

Both dispositional mindfulness and mindfulness interventions have been associated with improved stress regulation, though such effects are not universal. People who endorse the core qualities of mindfulness—i.e., present-moment, nonjudgmental awareness, and the ability to observe and describe experience without getting caught up in emotional reactivity—have shown lower cortisol and negative affect in response to a standardized performance stressor (Brown et al. 2012). In the context of interpersonal stress, high dispositional mindfulness has also proven beneficial, predicting cortisol response patterns that in turn relate to superior mental health (i.e., less depression and greater well-being; Laurent et al. 2013a).

Stronger evidence for a causal role of mindfulness in stress responding comes from intervention studies, most involving assessments before and after an 8-week course such as Mindfulness-Based Stress Reduction (MBSR). Effects on stress physiology include reductions in autonomic arousal (heart rate, blood pressure, and sAA) and daily cortisol levels (e.g., Carlson et al. 2007; Lipschitz et al. 2013; Matchin et al. 2011). However, a number of these studies showed effects on one stress measure but not others, and other researchers have found no effects on stress physiology (Klatt et al. 2009; Robert McComb et al. 2004; Robinson et al. 2003). Studies of acute psychosocial stress response have demonstrated reductions in autonomic and inflammatory, but not cortisol, reactivity (Nyklíček et al. 2013; Rosenkranz et al. 2013). To our knowledge, no studies have explicitly examined effects on the dynamics of acute physiological stress reactivity/recovery.

Research on brief laboratory interventions to increase mindfulness has revealed effects on subjective stress reactivity. In particular, participating in a mindfulness induction has been shown to reduce negative emotion and/or increase positive emotion in response to negative mood induction or exposure to emotional pictures and film clips (Arch and Craske 2006; Broderick 2005; Erisman and Roemer 2010). Although the latter study included autonomic measures, no effects of brief mindfulness induction on physiological stress have been discovered. One possible explanation for null findings in this and some of the longer-term intervention studies reviewed above involves moderated effects; that is, mindfulness interventions (especially brief laboratory-based procedures with novice meditators) may only improve stress regulation for certain individuals.

A good candidate moderator for mindfulness induction effects is dispositional mindfulness. Consistent with this proposal, MBSR participants with higher pre-intervention mindfulness scores have shown more dramatic improvements in a number of subjective stress measures, including perceived stress and well-being (Shapiro et al. 2011). People who already possess a certain level of qualities cultivated in mindfulness training may be more able to benefit from such training because they can apply mindfulness skills in a less effortful and/or more focused way. For example, neuroimaging research has shown that expert meditators respond to emotional stimuli in a less resource-intensive manner than novices (Taylor et al. 2011), and novice meditators high in dispositional mindfulness recruit attention networks more strongly during focused breathing (Dickenson et al. 2013). To our knowledge, no research has yet addressed dispositional mindfulness × mindfulness induction effects on physiological stress responses.

The current study was designed to address several gaps in understanding when and how mindfulness intervention aids in physiological stress regulation. In particular, we aimed to determine the effects of a brief mindfulness induction on autonomic and HPA stress responses and whether these effects would depend on participants' trait mindfulness. We approached these questions in a sample of adult romantic partners exposed to a common real-life stressor: a discussion of interpersonal conflict. Pre- and post-stress salivary measures of both sAA and cortisol allowed assessment of not only activation levels but also reactivity/recovery dynamics across stress systems. Previous investigation in this sample found sex-specific effects of dispositional mindfulness facets and an indirect effect of total mindfulness on cortisol responses, but did not address mindfulness induction effects or sAA responses (Hertz et al. 2014; Laurent et al. 2013a). Because the main effect of the mindfulness induction (compared to other experimental conditions) was not significant and the focus of this prior work was the main effects of dispositional mindfulness, experimental conditions were not reported; however, the possibility of moderated effects remained and became the focus of the present investigation. Based on the basic stress research and mindfulness literature reviewed above, we hypothesized that mindfulness induction would predict higher sAA levels and more dynamic sAA and cortisol reactivity/recovery curves, and that these effects would be strengthened by partners' dispositional mindfulness.

Method

Participants

Heterosexual couples (n=114) were recruited through an online student research participant pool and community flyers to participate in a two-part study of romantic relationships. To be eligible, participants had to be at least 18 years old (M=21.31, SD=6.12, range 18–69) and in a romantic relationship for at least 2 months (M=26.7 months, range 2 months–47 years). The majority of couples (93 %) reported that they were in an exclusive committed relationship. Reflective of the region from which the sample was drawn, the majority of participants (83 %) were Caucasian. The current study is based on the subset of participants (n=101 couples) who participated in both sessions and completed all of the measures described below. A comparison of these participants with those not included in the final sample revealed no significant differences on demographics and variables used in the current study.

Procedures

All procedures were approved by the University of Wyoming Institutional Review Board, including standard informed consent and voluntary participation guidelines. Except for the interactive conflict task, partners were always in separate rooms. Couples completed questionnaire measures of trait or trait-like constructs (including dispositional mindfulness) during an initial hour-long laboratory session. During the second session, scheduled approximately 1 week later and lasting 1.75 h, couples participated in a conflict discussion task and gave saliva samples to assess physiological stress. Sessions began at 4:00 p.m. to control for diurnal variability in sAA and cortisol. To minimize extraneous sources of salivary cortisol variability, participants were instructed not to consume more than one alcoholic drink within 24 h of the session, not to smoke or use non-prescription drugs the day of the session, not to exercise vigorously or brush teeth within 3 h of the session, and not to eat or drink within 1 h of the session. Following a set of initial questions to determine compliance with these conditions, the first saliva sample was collected (entry sample). This and all subsequent samples were collected via passive drool.

Next, participants were given a vivid description of the conflict task—prior to this, participants only knew they would engage in a recorded interaction, not that the interaction would involve conflict—and were individually asked to nominate a topic of unresolved conflict in the relationship. One of the conflict topics (i.e., the one nominated by the male or the female partner) was selected by coin toss for later discussion. Twenty minutes after receiving the conflict task description, the second saliva sample was collected (anticipatory stress sample).

Before the conflict discussion, participants were instructed using both written material and an audio-guided exercise to approach the conflict task in one of three ways: by attending mindfully to whatever arose (mindfulness condition), by taking the perspective of their partner (PT condition), or by focusing on their own thoughts and feelings about the issue (control condition). Couples were sequentially assigned to conditions, i.e., couple 1 to mindfulness, couple 2 to PT, and couple 3 to control. These conditions were selected to compare two different stress regulation strategies recommended for interpersonal conflict—i.e., perspective taking and mindfulness—against the immersive (not observational) and judgmental self-focus that typically fuels destructive conflict. The mindfulness condition instructions were the same as those used by Erisman and Roemer (2010) to experimentally induce mindfulness in a laboratory setting. Instruction condition varied between couples, but not within couples, such that both partners of a given couple received the same instructions.

Partners were then brought together, informed which topic had been chosen, and given 15 min to discuss and attempt to resolve the chosen issue. This interpersonal stress paradigm has been used in many studies to elicit physiological stress responses and has shown individual differences related to adjustment (e.g., Heffner et al. 2004; Kiecolt-Glaser et al. 1998; Laurent and Powers 2007; Powers et al. 2006a, b). Following the discussion, partners were again escorted to separate rooms to complete questionnaires. Ten minutes after the discussion had concluded, the third saliva sample was collected (conflict stress sample). The fourth and fifth samples were collected 15 and 30 min after the conflict stress sample to index recovery. All samples were immediately frozen (−20 °C) until shipment on dry ice to the Johns Hopkins Center for Interdisciplinary Salivary Bioscience.

Measures

FFMQ (Baer et al. 2006). The 39-item Five Facet Mindfulness Questionnaire (FFMQ) assesses trait mindfulness through questions such as "I do jobs or tasks automatically without being aware of what I'm doing" (reverse-scored) and "I watch my feelings without getting lost in them."

Respondents rate each item on a five-point Likert-type scale indicating how often each item is true for them (1=never or very rarely true, 5=very often or always true). Although the FFMQ can yield five individual subscale scores, these scores are often combined to give a total mindfulness score, as in the current investigation (α=.86). Standardized scores are used in analyses.

sAA Samples 1–4 were assayed for sAA in singlet using commercially available kinetic reaction assays (Salimetrics, State College, PA). The assay employs a chromagenic substrate, 2-chloro-4-nitrophenol, linked to maltotriose. The enzymatic action of sAA on this substrate yields 2-chloro-*p*-nitrophenol, which can be spectrophotometrically measured at 405 nm using a standard laboratory plate reader. The amount of sAA activity present in the sample is directly proportional to the increase (over a 2-min period) in absorbance at 405 nm. Results are computed in units per milliliter of sAA. Intra-assay variation computed for the mean of 30 replicate tests was <7.5 %. Inter-assay variation computed for the mean of average duplicates for 16 separate runs was <6 %.

Cortisol All saliva samples were analyzed with the HS Salivary Cortisol Diagnostic Enzyme Immunoassay (Salimetrics product no. 1–3002). The correlation between cortisol in the saliva and serum cortisol for this procedure is strong, r (47)=0.91, $p<.0001$. The minimal concentration of cortisol required for detection is <0.003 μg/dL. The intra-assay precision coefficient of variation was 3.35–3.65 %. The inter-assay precision coefficient of variation was 3.75–6.41 % (Johns Hopkins Center for Interdisciplinary Salivary Bioscience).

Analytic Strategy

Growth curve modeling in HLM was used to test the effects on men's and women's sAA and cortisol trajectories. This approach separates variability into within- and between-couple levels while accounting for the dependency of repeated physiology measures within partners. Level 1 modeled partner-specific sAA or cortisol trajectories, and level 2 modeled between-couple differences in these trajectories as a function of predictive variables (i.e., participation in mindfulness condition, dispositional mindfulness, and their interaction). Three stress physiology parameters were estimated: (1) an intercept corresponding to the estimated sAA or cortisol level at the conflict stress sample, (2) a linear term depicting slope of the sAA or cortisol trajectory at that sample, and (3) a quadratic term describing the steepness of the entire response trajectory (with a negative coefficient/deceleration indicating expected reactivity followed by recovery and a positive coefficient/acceleration indicating an atypical decrease followed by an increase). Whereas the intercept reflects a partner's level of physiological stress, the linear and quadratic terms reflect the dynamics of his/her response trajectory. For illustration, the two-level equation testing trait mindfulness-moderated effects of the laboratory mindfulness induction on men's sAA is shown below:

Level 1: Male Partner sAA $=\beta_0+\beta_1(\text{time})+\beta_2(\text{time}^2)+\text{error}$

Level 2: $\beta_0=\gamma_{00}+\gamma_{01}(\text{mindfulness condition})+\gamma_{02}(\text{FFM score})+\gamma_{03}(\text{mindfulness condition}\times\text{FFM})+\text{error}$

(similar equations used to predict β_1-β_2)

A threshold of $p<.05$ was used to determine significance of hypothesized effects in model testing. Significant interactions were probed using region of significance calculations (i.e., to determine at what levels of dispositional mindfulness significant mindfulness condition-based differences emerged). Estimates of effect size ranges (Z statistics and conversions to d based on sample size) are provided for condition-based differences at the bounds of significance and at the limits of sample data.

Results

Baseline Models

Baseline models with no predictors were examined to confirm the shape of partners' sAA and cortisol trajectories and to determine whether there was significant variability to merit further explanatory model testing. Both outcome measures were log-transformed to correct for positive skew. As described further below, stress physiology trajectories were best captured by quadratic models, which included an intercept (representing the partner's sAA or cortisol level immediately after the conflict task), linear slope (the instantaneous rate of reactivity or recovery following the task), and quadratic term (the steepness of the overall response curve across the session, with more negative coefficients reflecting more dynamic reactivity/recovery). None of the possible covariates tested (i.e., medication use, sleep, age, BMI, relationship length, and status) altered primary model effects reported below.

Nonsignificant sAA linear terms suggested partners tended to reach a peak close to the conflict task (men's $b=-.006$, $p=.70$; women's $b=.012$, $p=.52$). Although average sAA quadratic terms did not reach significance (men's $b=-.013$, $p=.29$; women's $b=-.021$, $p=.14$), removing these parameters resulted in significantly poorer model fit as indexed by change in the deviance statistic, $\chi^2(4)=12.93$, $p<.05$ for men and $\chi^2(4)=35.16$, $p<.001$ for women. On average, partners showed cortisol recovery post-conflict (men's linear $b=-.078$, $p<.001$; women's linear $b=-.084$, $p<.001$), and negative cortisol quadratic terms were consistent with the expected pattern of reactivity followed by recovery (men's $b=-.051$, $p<.001$; women's $b=-.029$, $p=.001$). Again, removing quadratic terms resulted in significantly poorer model fit for men, $\chi^2(4)=95.60$, $p<.001$, and for women, $\chi^2(4)=84.26$, $p<.001$. As in previous couples research using a similar sample and stress paradigm (Laurent and Powers 2007; Laurent et al. 2013b), on average, men showed a more dynamic (quickly reacting and recovering) cortisol response curve and a less dynamic sAA response curve compared to women. There was significant between-couple variability in all model terms for both sAA and cortisol, $\chi^2(100)=140.23$–1774.34, all p's$<.01$. This suggested that partners varied in the degree to which they showed reactivity/recovery curves and that adding person-level predictors (i.e., study condition and/or dispositional mindfulness) could help to explain this variability.

Explanatory Models

Preliminary models tested main effects of study condition on partners' sAA and cortisol trajectories; these were all nonsignificant. To test the primary study hypothesis that dispositional mindfulness would moderate the effect of a mindfulness induction on stress physiology, each partner's participation in the mindfulness condition, total Five Facet Mindfulness (FFM) score, and the condition×FFM interaction was entered as a predictor of his/her cortisol or sAA trajectory terms. First, models contrasted the mindfulness condition separately against both (a) control and (b) perspective-taking conditions. However, the same pattern of significant effects was found in each comparison, and no differences between control and perspective-taking conditions were found. Because of this, we combined these two comparison conditions, and all further tests contrasted mindfulness against non-mindfulness conditions.

For men, the mindfulness condition×FFM interaction predicted the sAA quadratic term (see Table 1, top panel). This means the effect of the mindfulness induction on the steepness of sAA response curves varied by men's dispositional mindfulness. To better interpret the interaction, a region of significance calculator (Preacher et al. 2006) was used to determine at which ranges of men's FFM scores the mindfulness condition had a significant effect. Whereas at high levels of dispositional mindfulness (top 23 %), the mindfulness induction predicted a more dynamic sAA response (zs for the difference between conditions ranged from −1.96 to −2.46; ds ranged from −.40 to −.50); at low levels (bottom 5 %), the induction predicted a flatter response curve (zs from 1.96 to 2.06; ds from .40 to .42). Examining predicted trajectories in the middle of these regions of significance showed that participating in the mindfulness condition meant a shift from marginally significant sAA deceleration to nonsignificant acceleration for men with low FFM scores, and a shift from nonsignificant sAA acceleration to significant deceleration for those with high FFM scores. Figure 1 depicts mindfulness induction effects at upper and lower significance bounds of men's FFM. In this model controlling for the interaction, a significant main effect of the mindfulness induction on men's sAA linear term (quicker recovery) and a marginally significant effect on the sAA intercept (higher levels) emerged. There were no significant effects on men's cortisol trajectories.

Table 1 Mindfulness condition×dispositional mindfulness effects on men's and women's stress physiology trajectories

Predictor	Intercept		Slope		Quadratic	
	Coeff.	*p*	Coeff.	*p*	Coeff.	*p*
Men						
sAA outcome						
Mindfulness condition	.29	.078	−.077	.035	−.012	.634
FFM score	−.076	.378	.030	.099	.031	.066
Mindfulness condition×FFM	.18	.258	−.048	.263	−.070	.016
Women						
sAA outcome						
Mindfulness condition	−.006	.969	−.025	.506	.008	.741
FFM score	−.022	.781	.008	.707	.016	.213
Mindfulness condition×FFM	.022	.877	−.025	.410	−.042	.025
Cortisol outcome						
Mindfulness condition	.089	.430	−.019	.503	−.002	.906
FFM score	.10	.247	.004	.761	−.006	.512
Mindfulness condition×FFM	−.15	.243	−.043	.038	−.004	.825

Women displayed a similar mindfulness condition×FFM interaction effect on the sAA quadratic term (see Table 1, lower panel). The region of significance testing showed that as for men, women with low levels of dispositional

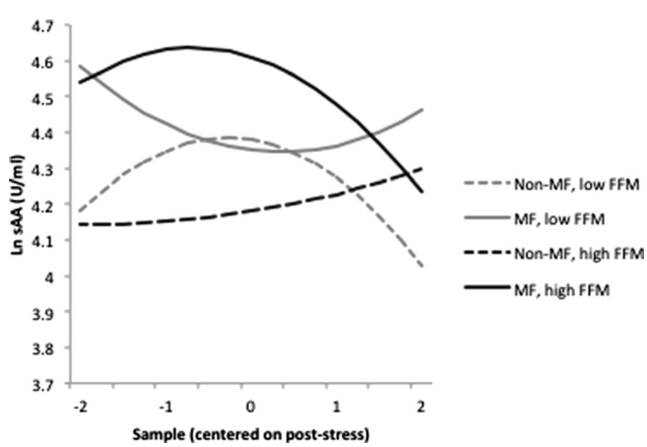

Fig. 1 Men's dispositional mindfulness moderates the effect of laboratory mindfulness induction on sAA (shown at *upper and lower bounds* of region of significance). *Non-MF* participation in control or perspective-taking condition, *MF* participation in mindfulness condition, *FFM* Five Facet Mindfulness score

mindfulness (bottom 11 %) had flatter sAA curves in response to the mindfulness induction (*z*s from 1.96 to 2.39; *d*s from .40 to .49); the high FFM level at which the induction would predict a steeper response was out of range for the sample. Calculating expected trajectories in the middle of the region of significance showed that for women with low FFM scores, participating in the mindfulness condition meant a shift from significant sAA deceleration to nonsignificant acceleration. Figure 2 shows mindfulness induction effects for women's sAA at the FFM lower bound.

The mindfulness condition×FFM interaction also predicted women's cortisol linear term (see Table 1, lower panel). Region of significance testing revealed that for women high in dispositional mindfulness (top 12 %), the mindfulness induction predicted quicker post-conflict cortisol recovery (*z*s from −1.96 to −2.24; *d*s from −.40 to −.46); the low FFM level at which the induction would predict slower recovery was out of the range of possible scores (i.e., <0). Examining trajectories in the middle of the region of significance showed that for women with high FFM scores, participating in the mindfulness condition more than doubled their (significant) cortisol recovery rate. Figure 3 shows mindfulness induction effects for women's cortisol at the FFM upper bound.

Several follow-up tests were conducted to offer further context for these findings. First, to gauge the specificity of the above effects, perspective taking and control condition× FFM interactions were also tested. These were all nonsignificant. Second, within-couple differences in FFM scores were examined to determine whether levels of dispositional mindfulness *relative to one's partner* predicted stress responses. For men only, within-couple FFM discrepancy moderated the effect of condition such that for men with higher dispositional mindfulness than their partner, the mindfulness induction predicted a higher and more dynamic (negative linear, quadratic) sAA response. Finally, analyses with specific FFMQ facets revealed that the describing scale moderated mindfulness induction effects on men's and women's sAA, whereas the nonjudging scale moderated effects on women's cortisol.

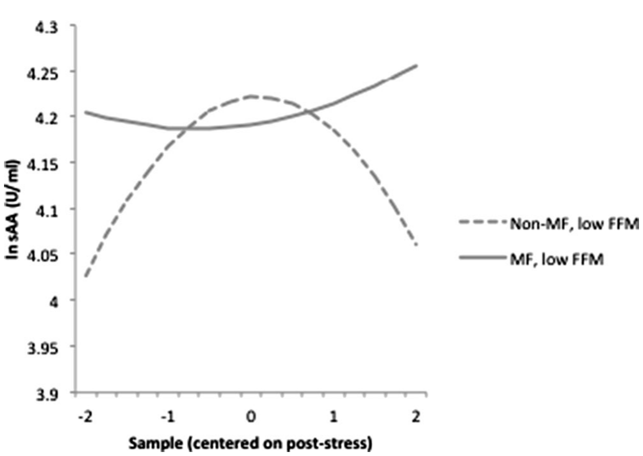

Fig. 2 Women's dispositional mindfulness moderates the effect of laboratory mindfulness induction on sAA (shown at *lower bound* of region of significance). *Non-MF* participation in control or perspective-taking condition, *MF* participation in mindfulness condition, *FFM* five facet mindfulness score

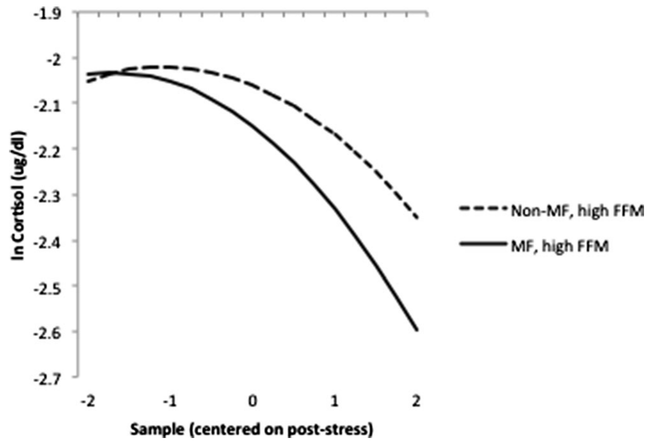

Fig. 3 Women's dispositional mindfulness moderates the effect of laboratory mindfulness induction on cortisol (shown at *upper bound* of region of significance). *Non-MF* participation in control or perspective-taking condition, *MF* participation in mindfulness condition, *FFM* five facet mindfulness score

Overall, the above model results suggest that the benefits of a brief mindfulness induction—in the sense of a more dynamic physiological stress response with rapid recovery—are only evident for people with high levels of dispositional mindfulness. For those low in dispositional mindfulness, such an induction may have the opposite effect.

Discussion

In this study, we found that the effect of a brief experimental mindfulness induction on romantic partners' physiological stress responses depended on partners' levels of dispositional mindfulness. Specifically, for partners reporting moderate levels of trait mindfulness, the induction had no effect on sAA (autonomic) or cortisol (neuroendocrine) responses, whereas for partners reporting especially high or low levels of trait mindfulness, the induction had effects in opposite directions. This finding helps to illuminate the possible basis for null effects in other mindfulness research and has important implications for mindfulness interventions aimed at stress reduction.

By investigating not only levels of stress physiology but also dynamics of reactivity and recovery across the ANS and HPA systems, we were able to discern (moderated) effects of a laboratory mindfulness induction undetected in previous research. Both men and women who rated themselves low in mindfulness qualities actually showed poorer sAA regulation in the mindfulness condition—i.e., flatter response trajectories—whereas men with relatively high mindfulness qualities (top quartile) appeared to benefit from the intervention. The latter showed higher, more dynamic sAA responses to romantic conflict that have been associated with positive conflict-related cognitions and with psychosocial adjustment more broadly. Women who rated themselves high in mindfulness also appeared to benefit from the mindfulness induction, showing quicker post-conflict cortisol recovery profiles previously related to constructive conflict behaviors and to mental health.

Overall, there were no significant differences in stress response profiles by experimental condition; it was only when considering the effects of dispositional mindfulness as a moderator that effects emerged. This finding may be important for interpreting laboratory experimental research using relatively brief, low-intensity interventions to induce complex regulatory strategies such as mindfulness (and perspective taking). In particular, a lack of main effects does not rule out meaningful effects that hold for some, but not all, participants. Not surprisingly, given the current study's focus on dispositional mindfulness, moderated effects only emerged for the mindfulness condition. Future research should probe individual differences that alter the impact of other strategies such as perspective taking.

It may be that for partners who possess very little of the attentional and attitudinal qualities of mindfulness to begin with, being asked to step back and simply notice what is happening during conflict is so effortful and/or threatening that it takes away from active coping represented by the sAA response. Conversely, for those who already embody these mindfulness qualities to some extent, the instructions may simply cue skills already used to successfully regulate responses to interpersonal stress, highlighting their importance for navigating the current task. Much as for expert (vs. novice) meditators, a certain threshold of trait mindfulness may make the process of using mindfulness to approach stress less effortful, enabling a stronger coping response (represented by the ANS) and/or more efficient recovery (especially of the HPA). Further work will be needed to discern the paths by which mindfulness impacts physiological stress in this context, but possibilities include both direct effects on autonomic engagement during emotion provocation and indirect effects via enhanced cognitive reappraisal of the conflict (see Garland et al. 2013; Hanley and Garland 2014). In addition, previous couples research points to specific cognitions (positive vs. negative expectations of conflict, rumination) and behaviors (negative escalation and demand-withdraw exchanges) surrounding the conflict that could transmit effects of mindfulness on partners' stress physiology (Laurent et al. 2013b, c).

For men, it was not simply a higher absolute level of mindfulness, but higher mindfulness relative to one's partner, that optimized the effect of the mindfulness induction. Perhaps in relationships characterized by a mindfulness imbalance (male partner higher), being cued to take a mindful approach had a particularly strong effect as men attempted to compensate for their partner's (less mindful) stance in the conflict. Similar effects for women may not have emerged because females are more typically cast in a caretaking role in romantic relationships, regardless of mindfulness qualities. Another distinction that arose was in the particular dimension of dispositional mindfulness underlying effects on men's and women's sAA (i.e., describing) versus women's cortisol (i.e., nonjudging). The ability to articulate what one is experiencing may especially support constructive engagement with interpersonal conflict, whereas a nonjudgmental stance toward experience may be more relevant for releasing negative affect once the conflict is over. Prior work in this sample similarly highlighted the role of describing internal events and an accepting attitude toward those events in men's and women's stress regulation respectively (Laurent et al. 2013a). As proposed in the previous paper, these facets may matter because they represent an antidote to emotion regulation difficulties more common in men (i.e., alexithymia) versus women (i.e., rumination). Of course, these ideas regarding gender differences in mindfulness effects are preliminary and will require further testing to assess their generalizability.

The current results suggest that not everyone is likely to benefit to the same extent (if at all) from a brief mindfulness induction, which may help to guide screening and education for mindfulness interventions more generally. If people low in dispositional mindfulness are not as likely to realize immediate gains in stress regulation (at least, at the physiological level), it may be advisable to emphasize up front the time it takes to experience benefits of mindfulness intervention and the fact that this process unfolds on different time scales for different people. That is, intervention participants may need to build up a foundation of mindfulness qualities before practice effects become apparent and attempts to apply mindfulness during stressful situations may result in feeling worse early in training before improving outcomes with further practice. Another possible implication is that mindfulness approaches should not be suggested as a first-line strategy for people at the low end of dispositional mindfulness. In these cases, alternative empirically supported stress regulation approaches that do not rely on nonjudgmental acceptance of thoughts and feelings—e.g., cognitive behavioral therapy and relaxation training—should be offered. Conversely, these results suggest that mindfulness training could especially benefit people scoring at the high end of dispositional mindfulness, and efforts should be made to make mindfulness-based interventions more available to this group.

This study contributes to understanding how and when mindfulness inductions are likely to aid in stress regulation. At the same time, limitations of the current design suggest points to be addressed in future research. Effects of a brief laboratory induction may or may not map onto more intensive mindfulness training; a natural next step would be to test trait mindfulness as a moderator of effects of a standard 8-week mindfulness intervention on physiological stress, much as has been done for subjective stress outcomes (Shapiro et al. 2011). It would also be advisable to test effects on responses to different stressors, including performance tasks and more intense/prolonged stress, to determine whether the effects we detected for interpersonal conflict stress apply equally to different types and degrees of psychosocial stress. Finally, dispositional mindfulness held up as a moderator of mindfulness intervention effects, consistent with existing research, but it is probably not the only moderator. Further studies should investigate other individual differences (i.e., personality traits and motivational style) and contextual factors that make mindfulness induction more or less helpful for stress regulation. It is our hope that the present study supports the ongoing evolution of mindfulness research as we move from the basic question of "Does mindfulness help?" to the critical questions "How does it help?" and "For whom?"

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