Emotion

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The Role of Mindfulness in Attenuating the Adverse Effects of Daily Negative Events: An Experience Sampling Study

Yonatan Perelman, Niv Reggev, and Eran Bar-Kalifa
The Department of Psychology, Ben-Gurion University of the Negev

Mindfulness is robustly associated with psychological and physiological well-being. To date, studies have primarily focused on trait mindfulness while neglecting its state-level momentary regulatory effects on daily stress. This preregistered study investigated the effects of state mindfulness on participants' momentary mood and physiological arousal in cohorts sampled between 2021 and 2024. Using the experience sampling method, 100 cohabiting couples ($N = 200$) completed five daily surveys for 16 days, and reported on their experiences of stressors (adverse events), state mindfulness levels, positive mood, and negative mood, while wearing Fitbit devices to monitor their heart rate. The registered analyses mainly demonstrated main effects (but no buffering effects) for state mindfulness. Specifically, state mindfulness predicted higher positive mood and lower heart rate among women. No association was found with negative mood, and state mindfulness did not moderate the relationship between stressors and stress response (mood and heart rate). However, secondary registered analyses, using a State Mindfulness Scale with more items, showed support for the mindfulness buffering effect, and indicated that negative events were associated with men's heart rate when mindfulness was low. Overall, these results underscore the importance of studying state-level mindfulness and pave the way for future research on how momentary mindfulness can enhance emotion regulation, which in turn may help promote well-being in daily life.

Keywords: state-mindfulness, stress, experience-sampling method, heart rate, daily stressors

Supplemental materials: https://doi.org/10.1037/emo0001628.supp

Daily negative events such as conflicts and issues at work impact physical health and emotional well-being (Cohen et al., 2007; Glei & Weinstein, 2024; Tesser & Beach, 1998). Mindfulness has garnered significant empirical attention for its contribution to both physiological and psychological well-being, particularly through its role in emotion regulation (K. W. Brown & Ryan, 2003; Grossman et al., 2004; Nyklíček, 2011). Mindfulness is defined as the awareness that arises from attending to the present moment without reacting to internal or external stimuli (e.g., thoughts, feelings, bodily sensations, and others' reactions; Kabat-Zinn, 1991). However, most studies have focused on trait mindfulness (i.e., the extent to which one tends to be mindful across times and contexts, e.g., Carpenter et al., 2019; Lindsay et al., 2018). This contrasts with the theoretical emphasis on understanding the extent to which people are mindful at a given moment (i.e., state mindfulness; K. W. Brown & Ryan, 2003). The present study was designed to examine whether and to what extent state mindfulness can enhance emotion regulation by mitigating the associations between daily negative events and daily stress. It explicitly centered on physiological (i.e., heart rate; HR) and psychological (i.e., mood) stress indicators.

When in a state of mindfulness, individuals are attentive to the present moment and observe stimuli nonjudgmentally without assigning specific meanings to them (e.g., "bad," "pleasant"; Glomb et al., 2011). Numerous studies have documented the salubrious effects of mindfulness meditation training programs and mindfulness as a dispositional trait (i.e., personal tendency; Don & Algoe, 2020; Mesmer-Magnus et al., 2017). For example, different mindfulness interventions (mindfulness-based therapy; Khoury et al., 2013; mindfulness-based stress reduction; Kabat-Zinn, 1982) were found to be effective in mitigating psychological distress, including anxiety, depression, and pain (for a meta-analytic review, see Creswell, 2017). Relatedly, trait mindfulness has been linked to enhanced well-being, improved mood, lower stress levels, and better emotion regulation (K. W. Brown & Ryan, 2003).

Beyond its psychological benefits, mindfulness has been associated with enhanced physiological well-being (e.g., K. W. Brown et al., 2012). Specifically, a vast body of research has shown that mindfulness can lead to a range of adaptive physiological responses, including strengthening immune functioning, promoting brain activity in regions related to learning and memory, improving metabolic health, enhancing sleep quality, and reducing stress hormone levels (Caldwell et al., 2010; Carlson et al., 2003; Hölzel et al., 2011;

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Yonatan Perelman https://orcid.org/0000-0003-0407-3453
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Yonatan Perelman played a lead role in writing–original draft and an equal role in conceptualization, methodology, and software. Niv Reggev played a supporting role in conceptualization, supervision, and writing–review and editing. Eran Bar-Kalifa played a lead role in supervision, a supporting role in writing–review and editing, and an equal role in conceptualization, methodology, and software.

Correspondence concerning this article should be addressed to Yonatan Perelman, The Department of Psychology, Ben-Gurion University of the Negev, Ben-Gurion Boulevard 1, Beer-Sheva 8443944, Israel. Email: yonatanperelman@gmail.com

Matousek et al., 2010). These findings suggest that mindfulness, whether as a dispositional trait or cultivated through structured interventions, contributes to psychological resilience and physiological well-being.

One key way in which mindfulness fosters both mental and physical resilience is through its emotion-regulatory effect on stress responses (Hill & Updegraff, 2012; Roemer et al., 2015) at both the psychological (Creswell & Lindsay, 2014) and physiological (Guendelman et al., 2017; Hölzel et al., 2011) levels (though see Morton et al., 2020). Mindfulness supports emotion regulation by promoting nonreactive awareness of thoughts and emotions rather than impulsive or intense reactions to stressors (Kabat-Zinn, 1991). This detachment allows individuals to observe their experiences with greater acceptance and reduced judgment (Garland et al., 2011; Lindsay et al., 2018), ultimately fostering more adaptive responses to stressors.

Empirical findings support the role of mindfulness in stress regulation. Tang et al. (2007) found that brief mindfulness meditation training reduced autonomic arousal, as indicated by lower heart and respiratory rates during stressful situations. Similarly, mindfulness interventions have been linked to greater distress tolerance during a hyperventilation task (Carpenter et al., 2019) and reduced biological stress reactivity (i.e., lower cortisol and blood pressure levels) through increased acceptance (Lindsay et al., 2018).

To better understand how mindfulness exerts these beneficial effects, it is essential to consider the nature of the stress itself and the everyday challenges that give rise to it. Specifically, the literature on stress (Burton & Hinton, 2004; Kugelmass & Lynch, 2014; Lazarus & Folkman, 1984) differentiates between stressors (i.e., the objective challenges that can constitute a burden, such as a financial crisis, illness, or another negative event) and stress (i.e., the subjective response following such events/stressors). While stressors can sometimes be stable and chronic (Pearlin et al., 1981), they often vary on a daily basis. Daily stressors or negative events, such as traffic jams, car troubles, short-term illnesses, or looming work deadlines, frequently elevate stress levels, making some days more challenging (Kivimäki & Kawachi, 2015; Nelson & Bergeman, 2021; Serido et al., 2004; Shahar et al., 2015; Stawski et al., 2013). Although seemingly minor in isolation, due to their repeated nature and the tendency to minimize their importance (Tesser & Beach, 1998), these events can accumulate and lead to significant stress that can manifest in psychological (e.g., mood disturbances) and physiological (e.g., higher HR) responses (Almeida, 2005). Research indicates that frequent negative events can lead to chronic stress that negatively impact overall well-being (Cohen et al., 2007; Glei & Weinstein, 2024). This underscores the importance of using adaptive emotion regulation mechanisms when facing these momentary events.

Mindfulness may protect against the effects of daily stressors by modifying how individuals perceive and respond to these stressors (Bishop et al., 2004; Garland et al., 2011). In a mindful state, individuals observe internal and external stimuli without immediately reacting or passing judgment. As a result, this heightened awareness can prevent the automatic or exaggerated emotional responses that may follow adverse events (Shapiro et al., 2006). For instance, instead of reacting with immediate anger or sadness to a conflict with one's child, an individual in a mindful state might recognize the arising emotions, understand their temporary nature, and choose a more measured response (Burke et al., 2020).

To target such transient and routine experiences, studies need to examine mindfulness as it unfolds in people's natural environment on a momentary basis. However, the literature to date has mainly focused on trait mindfulness (i.e., the extent to which people tend to be mindful across times and contexts) or mindfulness interventions (e.g., Brewer et al., 2009; Carpenter et al., 2019; Hoge et al., 2013; Lindsay et al., 2018). Nevertheless, many theories emphasize the importance of understanding the extent to which people are mindful in the present moment (i.e., state mindfulness); that is, are present without reactivity at a particular moment in time (K. W. Brown & Ryan, 2003). Since an individual's mindfulness can fluctuate over time, and this variability in momentary mindfulness may be linked to various emotional outcomes (see Friese & Hofmann, 2016; Pepping et al., 2015), it is crucial to examine the within-person associations between state mindfulness and daily stress.

Studies that have focused on the main effects of state mindfulness have reported associations with better self-regulated behaviors, higher levels of positive emotions, less rumination, and lower aggression (K. W. Brown & Ryan, 2003; Eisenlohr-Moul et al., 2016). State mindfulness has also been associated with more adaptive stress responses (Donald et al., 2016). In recent years, research on state mindfulness has expanded considerably, and has often utilized experience sampling (exprience sampling [ESM]) and diary-based methodologies (Blanke et al., 2018; Mahlo & Windsor, 2021; Naragon-Gainey et al., 2023; Tschacher & Lienhard, 2021; Zhou et al., 2020). Scavone et al. (2020), for example, found that higher state mindfulness was associated with lower sympathetic activation and greater reductions in physiological stress responses, suggesting a downregulating role of mindfulness in acute stress. Another study used a 14-day diary design and reported a reciprocal association between state mindfulness and meaning in life (Lian et al., 2024).

By contrast, there is much less literature on the stress-buffering effect of state mindfulness. One exception is a daily diary study showing that state mindfulness mitigated the subjective stress responses to COVID-19-related stressors (Perelman et al., 2022), thus pointing to its potential role in emotion regulation under real-world stress conditions. However, no similar moderation effect was found for general measures of affect (i.e., positive or negative mood). One crucial limitation of this study was that the daily assessment of mindfulness did not target the participants' momentary experience of mindfulness, but instead asked the participants to report their daily mindfulness experiences retrospectively. Hence, the analyses may have missed the in-moment aspect of the mindfulness phenomenon.

The ESM is designed to assess individuals' experiences and behaviors in real-time in their natural environments (Myin-Germeys et al., 2018). It thus has several advantages when studying state mindfulness. Specifically, sampling individuals' real-in-moment experiences allows for a more ecologically valid assessment (Shiffman et al., 2008). Targeting individuals' mindfulness experiences close to the moment of experiencing them minimizes recall bias (Shiffman & Stone, 1998). ESM also enables researchers to examine the temporal patterns of state mindfulness, such as whether mindfulness at particular moments prospectively predicts a better stress response.

The primary objective of the present study was to implement the ESM to investigate the associations between state mindfulness and daily stress, as well as the potential buffering role of state mindfulness. It considered both the psychological and physiological experience of stress. The ESM was used to assess mood (as an indicator of psychological stress; Denollet & De Vries, 2006) and the participants were asked to wear a Fitbit watch to assess their heart rate (a standard physiological indicator of stress; Wei et al., 2018; see Milstein & Gordon, 2020 for validation when using wearable devices). In doing so, the goal was to better understand how momentary mindfulness contributes to emotion regulation in response to everyday stressors, thereby providing insights into its psychological and physiological mechanisms.

Four preregistered hypotheses (see Figure 1) were tested using ESM data collected five times a day for 16 consecutive days from cohabiting couples. We predicted (Hypothesis1; H1) that state mindfulness would be associated with lower heart rate and (H2) better mood (i.e., lower negative and higher positive moods). We further predicted that state mindfulness would buffer the adverse effects of negative events on HR (H3) and mood (H4).

Method

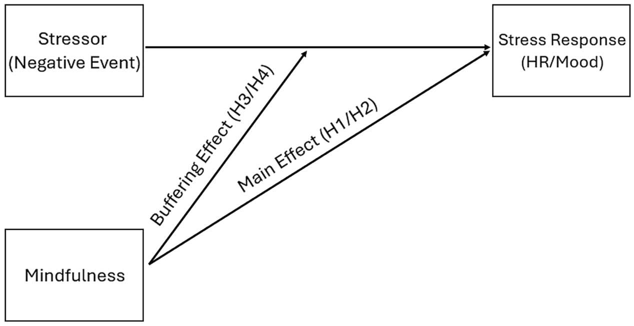
Participants

Between December 2021 and July 2024, 142 Israeli romantic couples who had lived together for at least 6 months were recruited for a multistage project. All the participants underwent a structured psychiatric interview (Mini-International Neuropsychiatric Interview; M.I.N.I.; Sheehan et al., 1997) and completed an initial background questionnaire. Then, in two lab sessions, the couples engaged in videotaped dyadic interactions where they discussed emotion-related experiences with each other (Session 1) and participated in goal-focused dyadic planning (Session 2). In addition, the participants completed five ESM questionnaires and an evening daily diary for 16 consecutive days. They also wore a Fitbit watch during this period. One month after the ESM period, the participants completed a follow-up assessment. The present study deals with the ESM questionnaires and the HR data collected on the Fitbit watches.

Of the 142 couples who completed the initial background questionnaire, 30 dropped out before the first lab session and the beginning of the ESM period. In addition, we excluded 11 other couples due to the low compliance rate of at least one partner during the ESM period (i.e., lower than the recommended threshold of 50%: 40 ESM prompts; Myin-Germeys & Kuppens, 2022). The HR data for one couple was unusable due to a technical issue with Fitbit equipment. Therefore, the final sample was composed of 100 couples who participated in the study in exchange for $110.

Figure 1

The Conceptual Framework Depicting the Potential Effects of Mindfulness



Note. HR = heart rate; H = Hypothesis.

Compliance with the ESM procedure ranged from 50% (*N* = 40 completed prompts) to 100% (*N* = 80), with an average of 75% (*N* = 60, *SD* = 11%; *N* = 8.8).

We recruited participants through advertisements posted in the community and on social media. Two couples self-identified as a same-sex (female–female) couple. Of the 200 participants in the study, 98 identified as male and 102 as women. The men's mean age was 25.9 years (*SD* = 2.13, range = 21–38), and the females' mean age was 25.0 years (*SD* = 1.92, range = 20–32). All participants had at least a high school education, and 34% had a college degree. Couples reported a mean relationship duration of 4.16 years (*SD* = 2.23 years, range = 1–10.75 years). Thirty-four percent of the couples were married.

Measurements

State Mindfulness

We used the State Mindfulness Questionnaire developed by Van der Gucht et al. (2019), which examines two facets of mindfulness: (a) being present in the moment and attentive/aware and (b) nonjudgmental acceptance. The respondents ranked three items for each facet on a scale ranging from 1 (*not at all*) to 7 (*to a great extent*; note that the original continuous scale ranged from 0 to 100). The last two items focus on stressful/negative experiences (i.e., "Were you able to observe stressful thoughts or images without getting caught in them?" and "Were you trying to let negative thoughts and feelings be without suppressing them?"); for these items, the respondents could click "irrelevant" for the assessment times when there were no stressful or negative thoughts to report. In the primary preregistered analysis, we only used the four items that were applicable regardless of the experience of stressful/negative thoughts or feelings. We calculated the mean of these four items to index the participants' state mindfulness, which exhibited high within-subject reliability (for the four items: *Rc (Reliability of Change)* = .82; for the six items: *Rc* = .78; Cranford et al., 2006; Shrout & Lane, 2012). The secondary (preregistered) analysis incorporated the two additional items. In 52% of the ESM prompts on which participants rated their state mindfulness level, they indicated "irrelevant" for these two items.

Measurement of the Occurrence of Negative Events

To assess the occurrence of adverse events, the participants were asked to respond to the following item:

> Please briefly describe a negative event or experience that occurred within the last two hours (excluding instances involving your romantic partner or your relationship). The event or experience can be minor or major. The critical thing is that you perceived it as negative. If there were multiple events, please select the most important one and describe it below. If you have not experienced any negative events in the last two hours, please indicate "irrelevant."

Based on participants' responses, we created a dummy-coded variable with two levels: "1" for prompts in which a negative event was reported and "0" for prompts in which no event was reported.

Mood

To assess positive/negative mood, the participants rated two items ("At this moment, to what extent do you feel positive/negative emotions?"), on a scale ranging from 1 (*not at all*) to 7 (*to a great extent*). Before running the primary analysis, we estimated the correlation between positive and negative moods; since the correlation was below $r = .6$ (in terms of absolute values; $r = -.359$, $p < .001$), as preregistered, we used each mood item as a separate outcome.

HR and Step Count

The participants wore a smartwatch ("Fitbit Charge 4"; for validation studies, see Chevance et al., 2022; Nissen2022) that monitored their HR minute-by-minute during the sampling period (16 days) and counted their steps. We asked the participants to wear the watch constantly, except when it needed to be charged. The device's battery life is approximately 1 week, so participants were instructed to charge it every 5 days to prevent automatic shutdown. After the participants were assigned their Fitbit watches, we generated a unique token number for each. We extracted the Fitbit-related data using RStudio Team (2024) by accessing the data stored for each unique token on the Fitbit website. We downloaded the participants' data every minute (i.e., HR level and step count). The participants' mean heart rate and total number of steps were calculated for the 1-hr periods before and after each ESM prompt, creating two separate time windows. In 5% of the completed ESM prompts, no heart rate or step data were available during the 1 hr before/after the prompt. On average, participants wore the Fitbit for 55.2 min during the hours of interest, for a compliance rate of 92%. In 26% of the completed prompts, the HR and step data were available but incomplete (i.e., the participants did not wear the Fitbit watch for the entire hour before/after the prompt). In these instances, the length of time the participants wore Fitbit was 54 min (90%; $SD = 5.4$, Range = 2–58) on average. The Supplemental Materials report the sensitivity analysis, excluding instances where the participants wore the Fitbit for less than 30 min. The pattern of results remained essentially the same (for the complete results, see Supplemental Table S3).

Procedure

As noted above (see the Participants section), the present study utilized data from a larger, multistage project. The components of the multistage project related to the present study are described below. The participants first completed a background questionnaire to assess demographics. Then, for 16 days, the partners were sent the ESM questionnaires five times a day. Each questionnaire assessed state-level mindfulness, the occurrence of adverse events, and the participants' mood. Specifically, the participants received a text message with the questionnaire link five times a day at random times within five fixed time windows, interspersed throughout the day (9:00 a.m.–8:00 p.m.). The intervals between the two prompts ranged from 90 min to 3 hrs. The link expired 1 hr after its sending time. Throughout this entire period, the Fitbit watches monitored their heart rate and steps (with the exceptions described above).

Data Analysis

Analytic Strategy

To accommodate the nested structure of the data (i.e., observations were nested within participants), the data were analyzed using multilevel dynamic structural equation modeling (DSEM; Sadikaj et al., 2021), implemented in Mplus (Version 8.10; Muthén & Muthén, 2017). We took the partners' nonindependence into account by estimating the within-couple covariances between the partners' estimates. DSEM enables the breakdown of variability into the between- and within-person variance components. The between-person variance reflects individual differences in mean responses, whereas the within-person variance reflects fluctuations around the mean outcome over time. DSEM also allows for the examination of lagged effects by integrating an estimation of lagged within-person variables. DSEM can also handle unequal spacing between measurement points by rescaling continuous time values to integer time values, thereby satisfying the time-series modeling assumption that participants are observed at equivalent intervals (see Asparouhov et al., 2018, for full details). In the present study, we rescaled the continuous time variables into windows of 132 min (using TINTERVAL (Time Interval) = 2.2, reflecting 2.2 hr; see McNeish & Hamaker, 2020). This time was equivalent to the duration of one ESM measurement window in the study (out of the five possible time windows during the day). Multilevel DSEM also allows for the assessment of both fixed and random effects. A fixed effect refers to the mean association between two within-person variables (e.g., the within-person association between state mindfulness and HR). Random effects are defined as the between-person variance in the magnitude of these associations. We estimated all within-person regression paths as random slopes.

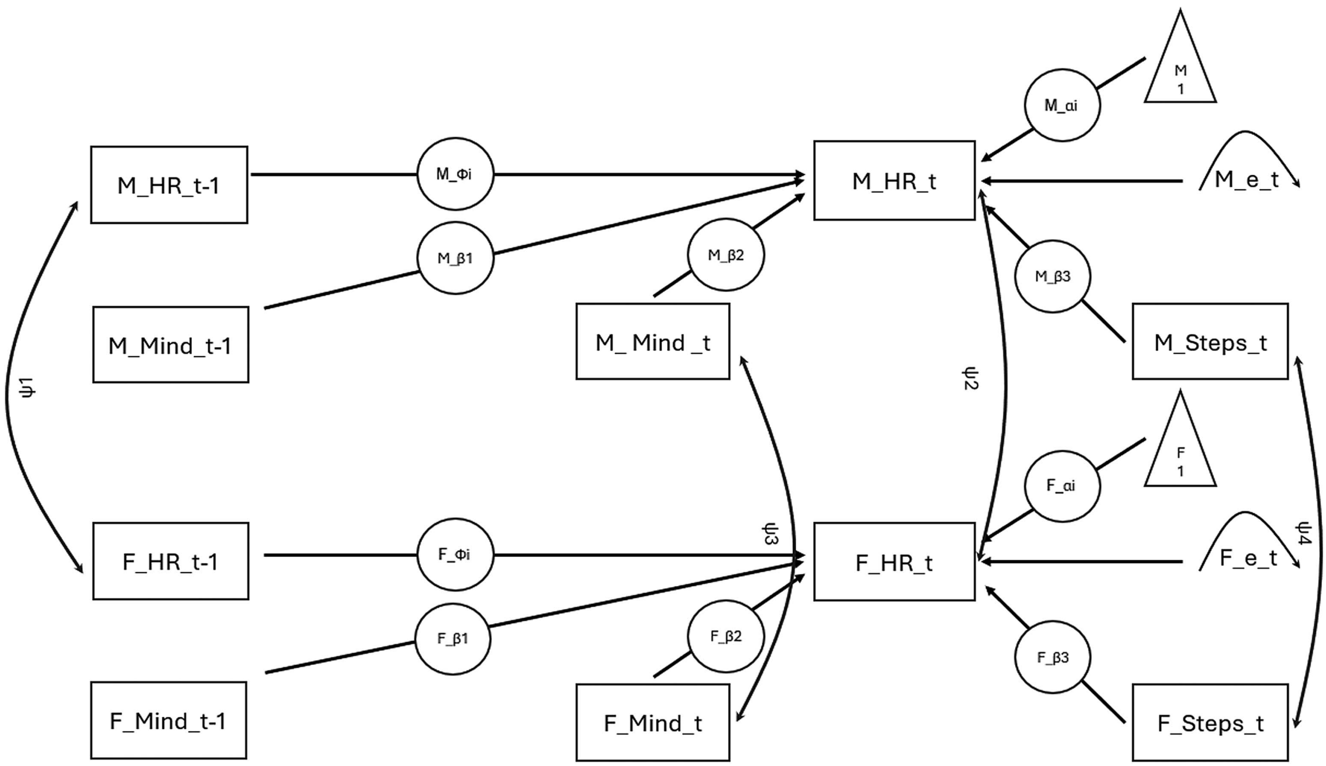
We used Bayesian model estimation, which relies on Markov chain Monte Carlo methods to estimate the posterior parameter distributions. We utilized two chains with a minimum of 5,000 steps, and used the first 50% of the steps for "burn-in." Default noninformative priors were applied to all model parameters (Muthén & Muthén, 2017). The sample size was sufficiently powered to detect a medium effect size at the within-person level (the moderation effect of state mindfulness on the association between the occurrence of adverse events and mood/hr; $\beta = 0.14$; Bodner, 2017). As a sensitivity test, we also conducted all the analyses while considering potential time effects. The pattern of results remained essentially the same (for the complete results, see Supplemental Tables S4 and S5).

For the primary analysis, we estimated four preregistered models (see Figures 2–5). Note that all the analyses included the two same sex couples. To account for these couples, we randomly assigned one partner to the "man" role and then conducted a sensitivity analysis by assigning the other partner to the "man" role. The results remained consistent across all models.

Transparency and Openness

In the Method section, we report how we determined the sample size, all data exclusions, and all measures in this study. All the study data and analysis codes are available on the Open Science Framework (https://osf.io/vb3s5/?view_only=55bb7025aa5b4fcebbfba0d8defca467). The data were analyzed using Mplus (Version 8.10; Muthén & Muthén, 2017). The hypotheses and their analyses were preregistered (see https://osf.io/jt9yc/?view_only=4f010b54fd1946fbb2f1a6626ee2b82c). These data have not been used in previously published or in-press articles.

Figure 2
Model 1a (Model 1 in the Preregistration); the Main Effect of State Mindfulness on HR



Note. Four within-person paths were estimated separately for men and women; path labels beginning with "M" refer to men; path labels beginning with "F" refer to women; "Mind" represents state mindfulness; Φ represents the autoregressive effect: the association between HR_{t-1} (the mean HR in the hour before the ESM prompt) and HR_t (the mean HR in the hour after the ESM prompt); β1 represents the cross-lagged effect: the association between $mindfulness_{t-1}$ and $HR_{t.}$; β2 represents the concurrent effect: the association between $mindfulness_t$ and $HR_{t.}$; α represents the association between participants' random intercepts and the HR; *e* represents the residual variance. To account for the dyadic nature of the data, we controlled for the nonindependence of romantic partners by estimating the within-couple covariation in partners' variables (see Bolger & Laurenceau, 2013). Ψ1−Ψ4 represent these covariances. Participants' step counts were included as a covariate to account for changes in HR associated with physical activity. β3 represents the steps effect. HR = heart rate.

Results

Descriptive Statistics

Table 1 presents the descriptive statistics for the primary variables (means, standard deviations, correlations, and intraclass correlation coefficient; ICC). Table 1 shows that the participants reported moderate levels of mindfulness. As expected (see Prabhavathi et al., 2014), women's HR was lower than men's. The participants reported high levels of positive mood and low levels of negative mood, and in, approximately, 50% of the prompts, they noted the occurrence of a negative event.

State mindfulness was positively associated with positive mood and negatively correlated with negative mood. The occurrence of negative events was positively associated with negative mood and negatively related to positive mood. For additional plots illustrating HR and the step data throughout the day, see Supplemental Figures A and B. We present the main results for each model below, starting with the registered analyses. For the complete results, including the autoregressive paths, the covariate effects, and covariances, see Supplemental Tables S1 and S2.

Primary Analysis

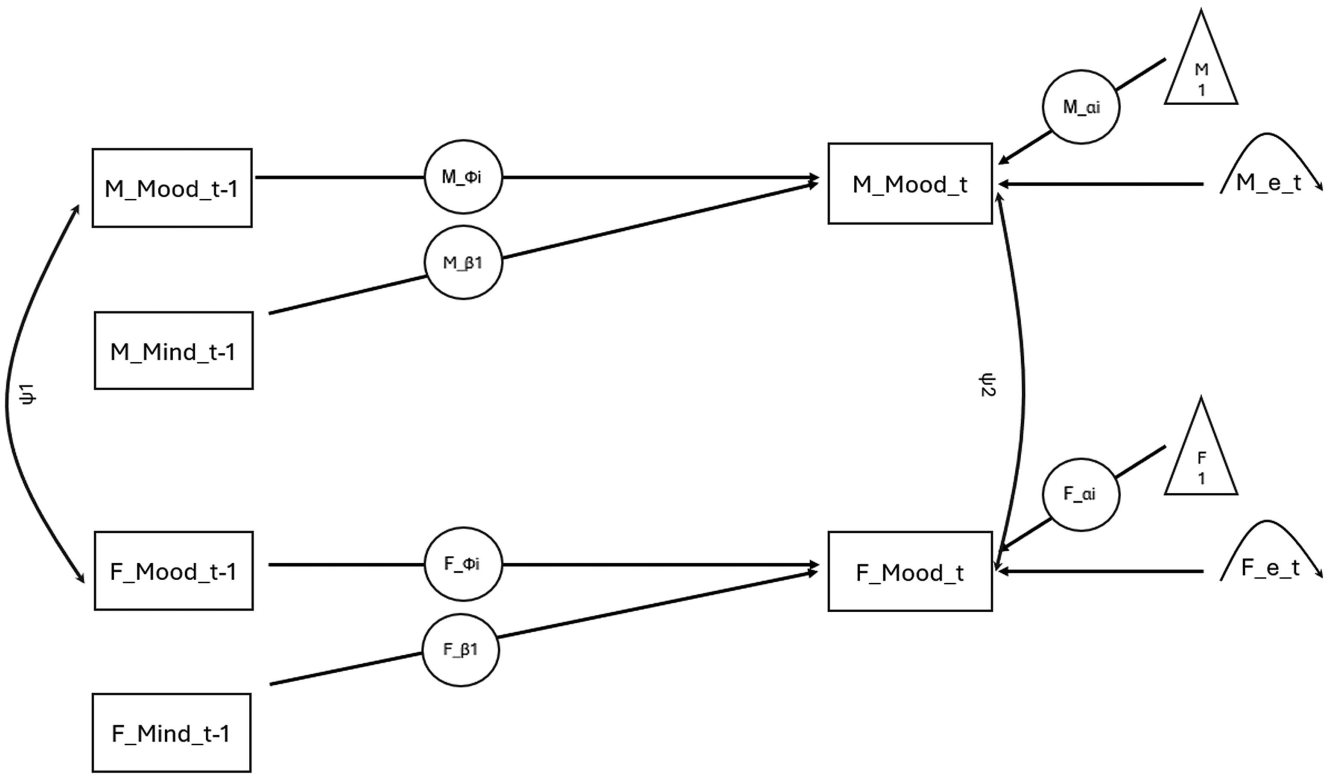
Model 1a; The Main Effect of State Mindfulness on HR

Consistent with H1 (see Figure 1 for the conceptual model and Figure 2 for the tested model along with the effect notations), we found a negative association between mindfulness at time $t-1$ and HR at time t for women ($F\_\beta1 = -.019$; 95% CI [−0.038, 0.000]); however, no such lagged association was found for men ($M\_\beta1 = -.009$; 95% CI [−0.026, 0.007]). Interestingly, state mindfulness at time t was positively associated with HR at time t, for both men ($M\_\beta2 = .167$; 95% CI [0.132, 0.189]) and women ($F\_\beta2 = .172$; 95% CI [0.143, 0.199]). See Supplemental Table S1 for complete results.

Model 1b; The Main Effect of State Mindfulness on Positive and Negative Mood

In line with H2 (see Figures 1 and 3), state mindfulness at time $t-1$ was positively associated with positive mood at time t for both men ($M\_\beta1 = .099$; 95% CI [0.063, 0.132]) and women ($F\_\beta1 = .056$;

Figure 3
Model 1b (Model 3 in the Preregistration); the Main Effect of State Mindfulness on Mood



Note. The analysis treated positive/negative mood as separate outcomes. Two within-person paths were estimated separately for men and women. "M," "F," and "Mind" represent the same parameters as described in the legend for Figure 2; Φ represents the autoregressive effect: the association between Mood_{t-1} (the lagged mood was estimated using the Mplus lagging procedure TINTERVAL option with windows of size 2.2 hr; see McNeish & Hamaker, 2020, for more details) and Mood_t. Since the Mplus lagging procedure does not allow for predicting the lagged variable, we did not estimate the concurrent effect (i.e., the association between Mindfulness_{t-1} and Mood_{t-1}). β1 represents the cross-lagged effect: the association between Mindfulness_{t-1} and Mood_{t}.; α, e and Ψ1–Ψ2 represent the same parameters as described in the legend for Figure 2. HR = heart rate.

95% CI [0.019, 0.083]). Disconfirming H2, state mindfulness at time $t-1$ was not associated with negative mood at time t for men ($M\_\beta1 = -.272$; 95% CI [−0.874, 0.057]) or women ($F\_\beta1 = -.061$; 95% CI [−0.554, 0.516]). See Supplemental Table S1 for complete results.

Model 2a; The Moderation Effect of State Mindfulness With HR as an Outcome

Contrary to H3 (see Figures 1 and 4), mindfulness at time $t-1$ did not moderate the effect of the occurrence of negative events at $t-1$ on HR at time t for men ($M\_\beta3 = -.022$; 95% CI [−0.044, 0.001) and women ($F\_\beta3 = -.002$; 95% CI [−0.026, 0.019]). Notably, the main effect of a negative event at time $t-1$ did not predict HR at time t for men ($M\_\beta1 = -.003$; 95% CI [−0.018, 0.018]) and women ($F\_\beta1 = -.001$; 95% CI [−0.021, 0.016]). See Supplemental Table S2 for complete results.

Model 2b; The Moderation Effect of State Mindfulness With Mood as an Outcome

Disconfirming H4 (see Figures 1 and 5), mindfulness did not moderate the effect of the occurrence of a negative event on participants' positive (for men; $M\_\beta3 = .023$; 95% CI [−0.013, 0.061], and women; $F\_\beta3 = .020$; 95% CI [−.016, .057]) or negative (for men; $M\_\beta3 = -.012$; 95% CI [−.053, .021], and women; $F\_\beta3 = .041$; 95% CI [−0.007, 0.082]) mood. Interestingly, no main effects were found between the occurrence of a negative event and positive (for men; $M\_\beta1 = -.027$; 95% CI [−0.065, 0.006], and women; $F\_\beta1 = -.025$; 95% CI [−0.055, 0.007]) and negative (for men; $M\_\beta1 = .000$; 95% CI [−0.042, 0.018], and women; $F\_\beta1 = -.016$; 95% CI [−0.019, 0.037]) mood. See Supplemental Table S2 for complete results.

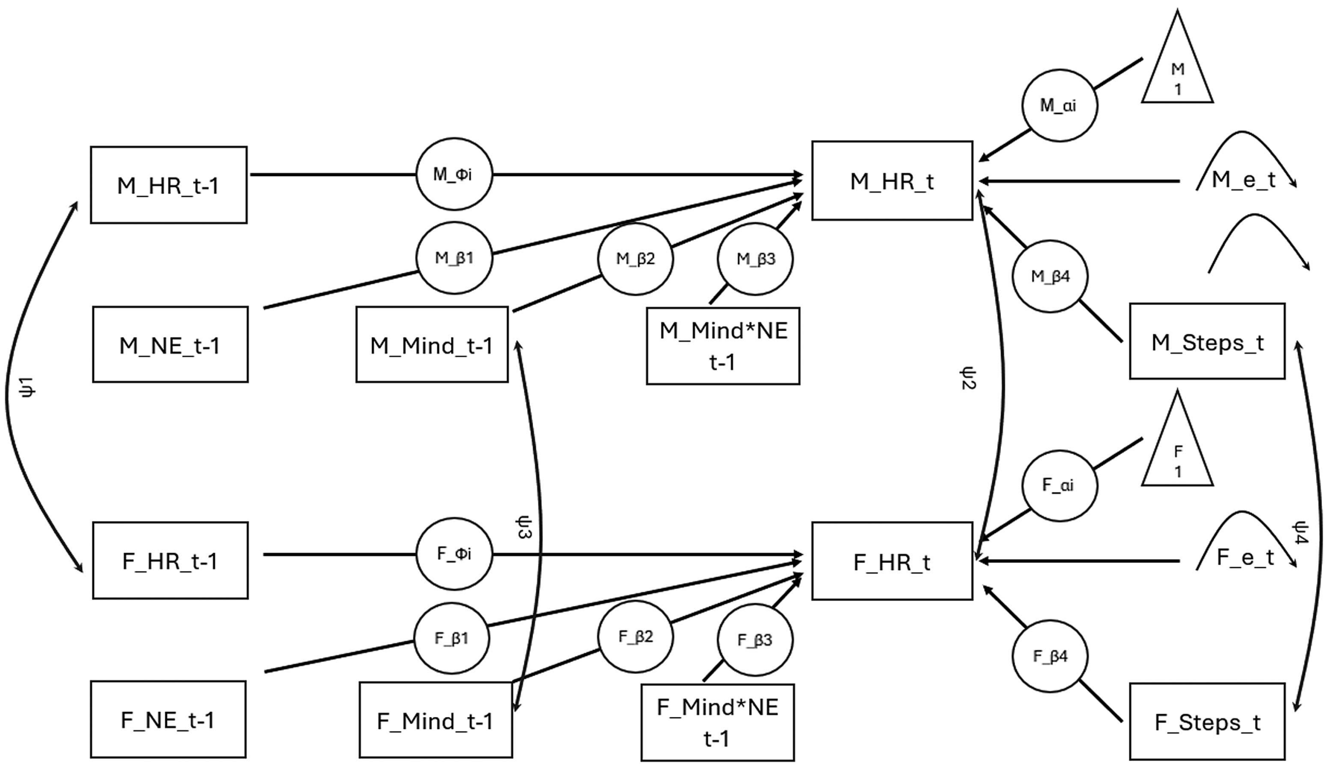
Secondary Registered Analyses

Models Analyses, Using the Six-Item State Mindfulness Scale

We ran a set of preregistered secondary models, using the full State Mindfulness Scale (six items, rather than just the first four as in the primary analysis). The two additional items were applicable only when a negative experience was reported; thus, in these analyses, we used the mean of the six items when they were available (48% of entries) and the average of the four items when they were not.

Figure 4

Model 2a (Model 2 in the Preregistration); the Association Between the Occurrence of Negative Events and HR and the Moderation Effect of State Mindfulness



Note. Five within-person paths were estimated separately for men and women; "M," "F," "Mind," Φ, α, e, and Ψ1–Ψ4 represent the same parameters as described in the legend for Figure 2; "NE" represents negative event, and "Mind*NE" represents the interaction between Mindfulness_{t-1} and Negative Event_{t-1}. β1 represents the association between Negative Event_{t-1} and HR_t; β2 represents the association between Mindfulness_{t-1} and HR_t; β3 represents the interaction path in predicting HR*t*; β4 represents the steps effect. HR = heart rate.

The Main Effect of State Mindfulness on HR and Mood (See Supplemental Models A1–A3). Unlike the model with the four mindfulness items, consistent with Hypothesis 2, a significant negative effect of mindfulness at time $t-1$ in predicting negative mood at time t was found for men (β = −.037; 95% CI [−0.065, −0.001]). As in the original analysis, this effect was not found for women (β = −.011; 95% CI [−0.033, 0.0123]). The remaining results regarding the prediction of positive mood and HR were identical to the original results (see Supplemental Table S6).

The Moderation Effect of State Mindfulness on the Association Between Negative Event and HR/Mood (See Supplemental Models A4–A6). Unlike the model with the four mindfulness items, consistent with H3, there was a significant interaction between a negative event and mindfulness at time $t-1$ in predicting HR at time t for men (β = −.023; 95% CI [−0.046, −0.003]). To further investigate this interaction, we employed a region of significance (ROS) analysis. ROS pinpoints the specific values at which the interaction becomes significant, thus providing a more fine-grained understanding of the conditional effects within the interaction analysis (Preacher et al., 2003). The ROS analysis indicated that the effect of negative events on men's HR was significant only when mindfulness levels were very low. Specifically, the effect was significant when mindfulness was nearly two standard deviations below the mean (b = 0.251; 95% CI [0.001, 1.180]). While technically the analysis also identified a significant effect of negative events on men's HR at extremely high mindfulness levels (eight standard deviations above the mean; b = −0.772; 95% CI [−7.242, −0.001]), such values are far beyond the realistic (or observed) range and therefore may have no practical meaning. In practice, this means that negative events only predicted increases in HR for men when mindfulness levels were low.

The interaction effect between negative events and mindfulness in predicting women's HR was not significant (β = −.005; 95% CI [−0.027, 0.017]). No interaction effect was found for men or women in terms of predicting negative and positive mood (see Supplemental Table S7).

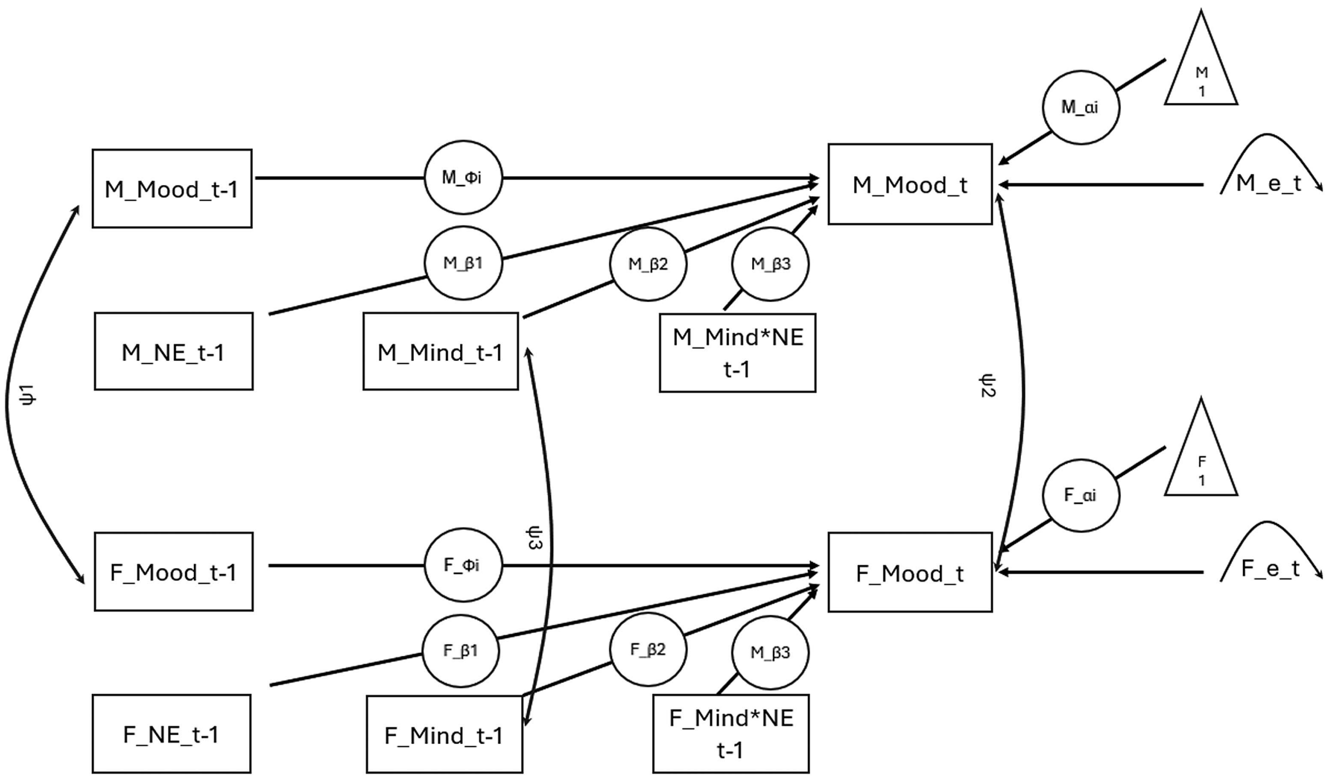
Exploratory Nonregistered Analyses

Gender-Aggregated Analysis (Supplemental Models B1–B6)

In the primary preregistered analysis, we compared the paths for men and women for each model. None of the models showed a significant difference between any of the hypothesized paths (see Supplemental Tables S8 and S9). Therefore, to increase statistical power, we conducted analyses across the entire sample without separating the effects of men and women (see Supplemental Tables S10 and S11). Consistent with

Figure 5

Model 2b (Model 4 in the Preregistration);Tthe Association Between the Occurrence of Negative Events and Mood and the Moderation Effect of State Mindfulness



Note. The analysis treated positive/negative mood as separate outcomes. Four within-person paths were estimated separately for men and women. "M," "F," "Mind," "NE," "Mind*NE," α, *e*, and Ψ1–Ψ3 represent the same parameters as described in the legend for Figure 4; Φ represents the autoregressive effect as described in Figure 3; β1 represents the association between Negative Event_{t-1} and Mood_t.; β2 represents the association between Mindfulness_{t-1} and Mood_t.; β3 represents the interaction between Mindfulness_{t-1} and Negative Event_{t-1} in predicting Mood_t.

H1, the combined analysis revealed a significant negative association between mindfulness at time *t*−1 and HR at time *t* (i.e., the lagged effect of mindfulness; β = −.018; 95% CI [−0.034, −0.006]). Further, consistent with H3, the combined analysis revealed a significant interaction between mindfulness and negative events at time *t*−1 in predicting HR at time *t* (β = −.029; 95% CI [−0.048, −0.007]). The ROS follow-up analysis indicated that the effect of negative events on HR was only significant when mindfulness was −0.33 standard deviations below the mean (*b* = 0.561; 95% CI [0.002, 0.866]). While technically the analysis also identified a significant effect of negative events on HR at extremely high mindfulness levels (nearly five standard deviations above the mean; *b* = −1.211; 95% CI [−3.799, −0.002]), such values are beyond the realistic (or observed) range and therefore may have no practical meaning. In practice, this means that negative events only predicted increases in HR when mindfulness levels were low.

The Moderation Effect of State Mindfulness on the Concurrent Associations Between State Mindfulness and the Study Outcomes (Supplemental Models C1–C3)

The preregistered models examining the moderating effect of state mindfulness (Models 2a and 2b) only assessed the lagged effects of mindfulness, negative events, and their interaction on each of the study outcomes. To examine whether state mindfulness moderation effect may unfold within a shorter timeframe, we used three nonregistered models (see Supplemental Tables S12 for the full results), that tested the associations between Mindfulness_t, Negative_Event_t, and the interaction between Negative_Event_t and Mindfulness_t in predicting Outcome_t separately for men and women. The remainder of the models was identical to Models 2a and 2b in the primary analysis. Only results that differed meaningfully from those already presented in the preregistered analyses are reported here. First, mindfulness at time *t* was negatively associated with negative mood at time *t* for both men (β = −0.060; 95% CI [−0.086, −0.025]) and women (β = −0.065; 95% CI [−0.099, −0.028]). Second, there was a significant interaction between negative event and mindfulness at time *t* in predicting positive mood at time *t* for women (β = −0.063; 95% CI [−0.100, −0.030]), but not for men (β = 0.012; 95% CI [−0.023;0.061]). A simple slopes analysis revealed a significant negative association between negative events and positive mood when mindfulness was low (−1 *SD*: *b* = −0.390; 95% CI [−0.387, −0.126]), average (*b* = −0.515; 95% CI [−0.470, −0.291]) and high (+1 *SD; b* = −0.640; 95% CI [−0.619, −0.392]).

Table 1
Means, Standard Deviations, ICC, and Correlations With Confidence Intervals

Variables	Woman *M* (*SD*) ICC	Man *M* (*SD*) ICC	1	2	3	4	5	6
1. Mind	4.43 (1.41) .583	4.14 (1.47) .661	.11** .17 .05**	−.09**	.10**	−.15**	.37**	.01
2. NE	0.54 (0.50) .233	0.47 (0.50) .234	−.03*	.16** .51** .04**	.01	.35**	−.13**	−.00
3. HR	85.33 (11.74) .461	78.56 (11.72) .332	.04**	.07**	.2** .13 .23**	−.05*	.10**	.56**
4. NM	2.55 (1.47) .309	2.33 (1.36) .347	−.12**	.36**	.02	.16** .18 .14**	−.33**	.00
5. PM	4.38 (1.37) .290	4.32 (1.49) .427	.31**	−.14**	.09**	−.39**	.16** .12 .16**	.06**
6. Steps	491.66 (639.85) .073	577.40 (707.38) .068	.05**	.03*	.46**	−.02	.06**	.35** .31* .35**

Note. The diagonal, from top to bottom within each cell, shows the total, between-couple, and within-couple correlations. Values above/below show the correlations for men and women, respectively; M = man; W = woman; Mind = mindfulness; NE = negative event; HR = heart rate; NM = negative mood; PM = positive mood; ICC = intraclass correlation coefficient.
$^{*}p < .05$. $^{**}p < .01$.

Discussion

The present study aimed to contribute to the growing literature on mindfulness by providing more granular insights into its state-level temporal effects and its potential regulatory role on daily stressors. Specifically, it examined the beneficial effects of state mindfulness on daily stress responses, both at the psychological (i.e., mood) and physiological (i.e., HR) levels, as well as the role of state mindfulness in buffering the effects of daily negative events on these outcomes. We utilized ESM self-reports and Fitbit watches to capture fluctuations in state mindfulness and stress responses in real-time within a naturalistic context.

The findings partially supported the hypothesis that state mindfulness would be associated with improved stress outcomes. In line with the preregistered hypothesis, lagged state mindfulness predicted greater positive mood reports and, among women, lower HR. Interestingly, a positive association was found between state mindfulness and concurrent HR. In addition, contrary to the hypothesis, no association was found between lagged state mindfulness and negative mood. In addition, no interaction effects were found between negative event occurrence and state mindfulness in predicting mood and HR.

The additional set of nonregistered analyses revealed a more complex and mixed picture of the findings. Since the effects for men and women were not significantly different, we re-ran the analyses by pooling the men's and women's data. The gender-aggregated analysis replicated the negative association between lagged state mindfulness and HR. Using gender-aggregated data, we also found evidence for a stress-buffering effect; specifically, there was an interaction between state mindfulness and a stressor (i.e., the occurrence of a negative event) when predicting HR. We probed this interaction and found that negative events were only associated with elevated heart rate levels when mindfulness levels were low. This secondary analysis suggests that the model, which considered men and women separately, lacked sufficient statistical power to detect an interaction effect, which typically requires a larger sample. Follow-up studies should aim to replicate this finding with a larger sample.

In addition, in the primary analysis, we focused on the four state mindfulness items that were applicable regardless of the presence of negative thoughts or emotions. However, in a secondary registered analysis, we used the full State Mindfulness Scale that included the two additional items tapping participants' mindful experience when encountering negative thoughts/emotions. When using this more comprehensive measure, the interaction between stressors and state mindfulness in predicting HR emerged once again. There was also a negative association between lagged state mindfulness and negative mood for men. Hence, omitting these two items could have impeded the capture of the more fine-grained effects of negative thoughts/sensations, thus potentially limiting the detection of both the main and buffering effects of state mindfulness. Notably, the two additional items may have captured a somewhat different psychological process. Rather than indexing momentary attentional presence per se, these items may have reflected the active use of mindfulness-based coping strategies in response to distress, such as allowing or accepting negative internal experiences. This distinction aligns with monitoring and acceptance theory (Lindsay & Creswell, 2017), which distinguishes between the roles of awareness and acceptance in regulating stress responses.

There was also an intriguing contradictory finding related to the positive association between state mindfulness and concurrent HR and the negative association between state mindfulness and prospective HR. Mindfulness, by fostering present-moment awareness, may initially heighten physiological arousal (i.e., increased HR). However, fully experiencing emotions with acceptance and without suppression can promote later relaxation, as reflected in a subsequent

HR decrease. This aligns with emotion regulation models (Gross, 2015), which suggest that adaptive regulation involves engaging with emotions before modulating their intensity. Similar two-stage processes have been observed in emotion-focused coping, where initial emotional engagement was reported to precede resolution (Aldao et al., 2010; Luciano et al., 2010). These dynamics also resonate with monitoring and acceptance theory (Lindsay & Creswell, 2017), which posits that mindful awareness may initially increase sensitivity to emotional or stressful stimuli, thus potentially amplifying physiological reactivity, especially in the absence of acceptance. However, when coupled with a nonjudgmental, accepting stance, this heightened awareness can facilitate more adaptive responses and reduce stress reactivity over time. This framework may help reconcile the seemingly contradictory associations observed here between mindfulness and HR across time points. The psychotherapy literature also highlights the critical role of emotional engagement. Specifically, various therapeutic approaches emphasize accepting and experiencing painful emotions rather than avoiding them, thus pointing to their role in enhancing emotional regulation and well-being over time (Greenberg & Watson, 2006; Hayes et al., 2006; Linehan, 1993).

There were also weak associations between HR and mood (see Table 1). Studies have found that physiological patterns and psychological processes do not always match (C. L. Brown et al., 2021; Qaiser et al., 2023). This may explain why state mindfulness was associated with HR but not with self-reported negative mood. Since the current findings identified discrepancies between physiological responses and subjective experiences, future studies targeting specific contexts or samples could further probe this inconsistency and its potential relationship to state mindfulness. For example, empirical studies have shown that individual differences in interoceptive ability, brain activity in specific regions related to cardiac sensation processing, or even weight can explain the physiological self-report inconsistency (Garfinkel et al., 2015; Herbert & Pollatos, 2014; Siepe et al., 2025). Hence, future research should examine factors, such as heightened interoceptive awareness, that may moderate the relationship between HR and emotional self-reports.

Relatedly, the association between positive and negative mood was moderate, which may explain the different patterns of results for these outcomes. Lagged state mindfulness consistently predicted positive mood but only predicted negative mood for men and only in the analysis that included the six-item mindfulness measure. This may have been due to the relatively low levels of negative mood reported in the current sample (see Table 1). Hence, future studies should sample more distressed participants (e.g., see mindfulness effects on clinical samples involving participants dealing with (Post-Traumatic Stress DIsorder (PTSD), social anxiety, and substance use; Bowen & Enkema, 2014; Call et al., 2015) or target a more stressful context (e.g., during a health crisis; Guillaume et al., 2016 ; Toniolo-Barrios & Pitt, 2021). Nevertheless, the findings for positive mood are meaningful, given the role of positive mood in physical and mental well-being (Pressman & Cohen, 2005; Steptoe et al., 2008) and are consistent with the literature that has reported a positive association between mindfulness and positive mood (Jislin-Goldberg et al., 2012).

Another explanation for the discrepancies between the results for positive and negative moods could be related to the timing of the lagged effects. The Broaden-and-Build Theory of positive emotions (Fredrickson, 2004) suggests that positive emotions expand individuals' thinking and behaviors, thus fostering creativity and resource-building. Over time, positive emotions can create a reinforcing cycle that generates additional positive emotions and extend the overall positive experience, which is less likely to occur with the more transient nature of negative emotions, particularly when they are at low levels, as observed in the present study. As a result, the analysis may have revealed a delayed relationship between mindfulness and positive mood, whereas the negative experiences, because they were short-lived, did not show a similar pattern. This explanation was supported by the secondary analysis (see Supplemental Tables S12), which found an association between state mindfulness and negative mood when measured concurrently.

The fact that we examined lagged effects may also explain why the preregistered analyses showed no interaction effect, since the lagged main effect of negative events on mood was nonsignificant. By contrast, when examining them simultaneously, a significant association emerged (see Supplemental Tables S12). However, even in this secondary analysis, an interaction was only found for women's positive mood. Future work should consider using a more intensive ESM schedule to capture lagged but short-lived effects, such as the observed interaction and the concurrent association between state mindfulness and negative mood (Hektner et al., 2007).

Although one of the main goals of this study was to examine the regulatory buffering effect of mindfulness, the findings for its main effect were more robust. The main and buffering effects are two alternative paths that may account for how personal/relational resources can protect against stressors. This idea has been extensively studied with respect to social support, where main effects are more consistently observed, while the buffering effect is less reliably replicated (Lakey et al., 2010). Relational Regulation Theory argues that psychological resources do not mitigate the impact of stressors but instead create a competing path. In line with this idea, the current findings suggest that mindfulness, as a personal regulatory resource, may primarily benefit individuals by directly promoting better emotional and physiological outcomes, rather than by moderating the association between stressors and outcomes. This interpretation is consistent with models of psychological resilience, which propose that certain regulatory processes, such as mindfulness, exert their protective effects by enhancing general emotional resilience rather than by buffering acute responses (Troy et al., 2013). Future studies should examine in which cases mindfulness acts as a main effect and when as a moderator. For example, Perelman et al. (2022) found that state mindfulness only buffered the impact of stressors on the subjective experience of stress directly related to the stressor and not on other personal or relational outcomes.

Constraints on Generality

Several limitations of the present study are worth mentioning. First, the sample consisted of nonclinical participants who were likely able to cope with minor daily stressors adaptively. Since the study was designed to examine the regulatory effect of mindfulness on stress responses, these characteristics may have limited the statistical power (e.g., due to lack of variability). Second, the present study focused on two specific measures of stress (i.e., self-reported mood and HR), which may only reflect part of the broader stress-mindfulness picture. Hence, future studies should examine the effects of state mindfulness on other physiological (e.g., hormonal responses) and psychological (e.g., mental fatigue, behavioral responses, and worries) stress measures (Arsalan et al., 2022; Dogan et al., 2022). The third limitation concerns the study's focus on negative events that did not involve the participants' romantic partners. This decision aimed to align with the objective of the broader project investigate the effects of partners' interpersonal emotion regulation of external stressors (as reported in a night diary, which was not part of the present study). We therefore focused on stressors stemming from events in which the partners were not directly involved. However, the exclusion of relationship-related stressors limits the generalizability of the findings, since relational tension (e.g., conflict) is often a significant source of daily stress for romantic partners (e.g., Rafaeli et al., 2008).

Furthermore, although the present study employed an intensive ESM, no conclusions as to causal inferences can be drawn. This differs from just-in-time interventions (see Klasnja et al., 2015; Nahum-Shani et al., 2016) that involve delivering interventions when individuals are most likely to benefit from them. These interventions can help establish causal relationships by manipulating variables in naturalistic settings while maintaining ecological validity. By embedding experimental controls within everyday experiences, researchers can better assess the temporal dynamics of psychological processes and strengthen causal inferences.

Another limitation pertains to how mindfulness was measured in the present study. The State Mindfulness Scale addresses two key aspects of mindfulness (i.e., attention-awareness and nonjudgment); however, mindfulness involves several other features (Baer et al., 2008), including nonreactivity, observing, describing, attention-awareness, and nonjudgment. Using comprehensive measures in ESM studies can be challenging, since it is critical not to burden participants. However, future empirical efforts should focus on developing more comprehensive state-level measures of mindfulness to advance the field.

Summary

This study contributes to a better understanding of state mindfulness as a potential mechanism for enhancing emotion regulation by enhancing responses to stress at both the psychological and physiological levels. The findings revealed a complex relationship, where state mindfulness consistently predicted positive mood across various models but showed mixed effects on HR and negative mood. These results underscore the importance of contextual factors, such as gender and measurement timing, in understanding the impact of mindfulness. Clinically, the findings suggest that fostering state mindfulness, whether through naturalistic practices or targeted interventions, may help individuals regulate stress by promoting positive mood and potentially modulating physiological arousal over time. Future research should further explore these dynamics in emotionally intense contexts and in more diverse and distressed populations by utilizing more fine-grained mindfulness measurements and intensive sampling methodologies to capture short-term processes and causal relationships.

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