



Mind wandering and stress: When you don't like the present moment

Alexandra D. Crosswell¹, Michael Coccia¹, Elissa Epel¹

¹Department of Psychiatry, University of California, San Francisco

Abstract

Buddhist philosophy and existing empirical evidence suggest that being engaged in – and accepting – the present moment is associated with greater well-being. However, engaging with the present moment experience and ignoring unwanted thoughts is difficult given the nature of our minds and the competing demands for our attention. This may be especially true when experiencing stress, during which acceptance may be particularly difficult. This study examines inter- and intra-individual variability in how psychological stress influences daily mind states, and how mind states are related to affect. For 21 days, women (n=183; half chronically stressed, half low-stress controls) reported levels of mind wandering, engagement with and rejection of their current moment experience, positive and negative affect, and quality of connection to their spouse. Women under chronic stress reported more evening mind wandering, less engagement, and more rejection of the moment, compared to low stress controls. These mind states were in turn associated with worse evening mood. Daily contextual factors, specifically, objectively coded daily stress exposure and quality of connection with spouse (a known stress buffer), influenced evening mind states. Results provide evidence that psychological stress interferes with daily attention while positive social connection enhances attentional quality.

1. Introduction

The importance of the quality of daily consciousness for psychological well-being is a foundational component of many contemplative traditions and practices. One such quality that has received increased attention in academic research has been mindfulness.

Mindfulness is commonly defined as the state of being acutely attentive to and aware of what is taking place in the current moment, and experiencing clarity and vividness in that moment (Brown & Ryan, 2003). Dispositional mindfulness is thought to vary between people, and also within people at the daily level (Brown & Ryan, 2003).

Empirical research supports an association between higher self-reported dispositional mindfulness and many facets of well-being. Greater dispositional mindfulness is associated with lower rates of many major psychological disorders (Keng, Smoski, & Robins, 2011), higher levels of subjective well-being (i.e. higher positive affect and satisfaction with life; Brown & Ryan, 2003; Mrazek, Smallwood, & Schooler, 2012), and better physical health (e.g. Loucks et al., 2015, 2016). A stress-buffering hypothesis may explain some of the

benefits of trait mindfulness, such that being more mindful mitigates stress appraisals, reduces stress-reactivity, and speeds recovery from stress arousal (Creswell & Lindsay, 2014; Crosswell et al., 2017). Benefits of mindfulness may also operate by improving social relationships. For example, higher levels of dispositional mindfulness, as well as participating in mindfulness-based trainings, is beneficial for romantic relationship functioning (Barnes, Brown, Krusemark, Campbell, & Rogge, 2007).

Beyond the influence of trait level mindfulness, being in a mindful state more frequently in daily life is assumed to be associated with greater subjective well-being. However, this assumption has infrequently been tested, likely because it requires intensive daily level data collection. Variation in daily mind states – states such as mindfulness, focused attention, and an opposing construct, mind wandering can be captured through daily diary or ecological momentary assessment to examine how such states influence well-being. As an example of this methodology, when workers were paged multiple times throughout a working day and asked where their attention was, reporting active engagement in the present moment was associated with feeling more creative, free, active, alert and satisfied. This was even true if their current task was something they would not do if they had a choice (Csikszentmihalyi, 2014 p. 10). Felsman et al. (2017) also demonstrated the association between present moment engagement and increased daily well-being. In a study of undergraduates who reported on their mind states five times a day, being in a better mood at one assessment predicted more present focused attention at the next assessment. There have only been a handful of studies linking daily engagement in the moment and daily well-being indices, though a larger body of literature has examined the role of mind wandering on daily affect.

In a now classic study of daily mind wandering and mood, Killingsworth & Gilbert (2010) found that when participants were asked at random times throughout the day what they were thinking about in that moment, participants reported mind wandering nearly 50 percent of the time. When they were mind wandering, they reported greater negative affect, and lagged analyses showed that mind wandering prospectively predicted negative mood, while negative mood did not predict mind wandering. A series of studies have followed from this initial finding to explore the nuanced relationship between mind states and mood. One key finding from these additional studies is that the impact of mind wandering on mood depends on the content of the thoughts. For example, a 7-day daily diary study in a healthy community sample found that mind wandering predicted negative mood only when the content of the mind wandering was reported as ‘sad’ or ‘anxious’ mind wandering, but not for ‘happy’ or ‘calm’ mind wandering (Poerio, Totterdell, & Miles, 2013). Similarly, Ruby et al. (2013) found that mind wandering about past and other-oriented thoughts was associated with negative mood while mind wandering about future and self-oriented thoughts was associated with positive mood. This parallels a large body of acute stress research which demonstrates that ruminating about past experiences prolongs stress-related affective and physiological activation (Brosschot, Gerin, & Thayer, 2006), while thinking about the future may speed recovery from acute stress (Engert, Smallwood, & Singer, 2014). Further, future thinking may help facilitate the development of concrete personal goals (Medea et al., 2018). These results suggest that influence of specific mind states are more complex than a simple dichotomy between being actively engaged in the moment and having thoughts unrelated to the current moment experience (mind wandering). Examining how daily mind states

influences psychological well-being requires more nuanced measurement of these mind states, as we seek to do in the current study.

One understudied daily mind state we explore in the current study is *rejecting the present moment*. Within Buddhist philosophy, being dissatisfied with what is, in other words, wanting things to be other than the way they are, is the source of suffering in life (Ekman, Davidson, Ricard, & Alan Wallace, 2005). This mind state of rejecting the moment is similar to the clinical construct of experiential avoidance (Hayes, Wilson, & Gifford, 1996). Experiential avoidance is the tendency to withdraw from uncomfortable inner experiences (e.g. thoughts, memories, bodily sensations) and takes steps to alter those experiences, regardless of whether those steps lead to better or worse outcomes. Experiential avoidance is associated with a wide range of clinical problems and lower quality of life (Hayes et al., 2004). Rejecting the present moment is the opposite of accepting and engaging with the present moment non-judgmentally (mindful state), and has yet to be explored empirically. In the current study we explore how rejecting the present may be associated with an unpleasant mood or other daily well-being indices.

What mind states are experienced and at what frequency in daily life is likely dependent on the context of one's life, though studies of mind wandering have tended to ignore how individual-level contextual factors influence daily mind states. One important contextual factor influencing daily mind states may be perception of daily demands. At the trait level, high subjective perceived stress (when environmental demands outweigh one's resources to cope adequately; Lazarus & Folkman, 1984) is associated with lower trait mindfulness (Bränström, Duncan, & Moskowitz, 2011) and higher trait mind-wandering (Mrazek, Phillips, Franklin, Broadway, & Schooler, 2013). Furthermore, decades of research from lab-based studies suggest that inducing states of acute stress immediately alters thoughts and emotions. For example, before an acute stress task (e.g. giving an impromptu speech), cognitions change to anticipatory thoughts (worries about the upcoming task), and after the task, they switch to ruminations about performance. Smallwood et al. (2009) has also shown that inducing negative mood states increases mind wandering. Despite evidence from observational and lab studies linking acute stress and alterations in thought patterns, it is unknown how being under chronic stress, or experiencing a daily stressor, alters daily mind states.

Because of the limited research examining the daily-level cognitive consequences of naturalistic stress states, the goal of the current study is to examine how chronic stress, daily stressors, and daily connection to one's partner (a stress buffer) influence daily mind states. The mind states we focus on are engagement in and rejection of the present moment, as well as experiences of mind wandering about neutral, pleasant, and unpleasant topics. We examine mind states in the context of the chronic stress of caregiving as a way to deconstruct how long term states of distress alter consciousness at the daily level. Examination of daily level data enables us to examine how fluctuations in day-to-day experiences within individuals (i.e. person-level daily fluctuation in level of stress and social connection) influence mind states that evening, independent of trait-level effects (i.e. controlling for the person's average across all days). Thus, we are more accurately able to capture the lived experienced of the interplay between the social world and our mind states.

This study examines the daily life of 183 mid-life women who were recruited as either high or low in chronic stress. Chronically stressed women were mothers of a child diagnosed with an autism spectrum disorder (ASD) and who reported above average levels of perceived psychological stress at the baseline assessment; low stress women were mothers of neurotypical children and who reported below average levels of perceived stress. Participants completed 21 days of daily reports (completed once a day, in the evening) on mind states, mood, stressful events, and connection with their spouse. Using this methodology, we are able to test (1) the between-person impact of chronic stress on evening mind states, (2) the within-person fluctuation of evening mind states on evening mood controlling for the person's average mind state, and (3) the within-person fluctuation of daily stress exposure and daily social connection on that evening's mind states.

We had three hypotheses. First, we expected that women under chronic stress (caregivers) would report lower levels of engagement in the moment, greater rejection of the moment, more mind wandering, as well as a greater number of high stressor days than women in the control group. Second, hypothesized that daily fluctuation in mind states from one's typical or average mind state would be associated with changes in that evening's mood, such that an increase in engagement, and decrease in rejection and mind wandering would be associated with more positive and less negative evening mood. Third, we tested whether the context of the day predicted mind states that night. We hypothesized that daily stressors and quality of daily connection with their partner would influence mind states that evening. Specifically, on days when participants reported experiencing an objectively coded stressful event ("stress days"), we expected participants to report less engagement, more rejection, and more mind wandering that evening; and, on days when participants reported more positive social connection with their partner, we expected participants to report greater engagement, less rejection, and less mind wandering.

2. Methods

2.1 Participants

Participants were 183 mothers from a prospective study that examined the impact of chronic caregiving stress on cellular aging. Ninety-two participants were mothers of children with autism spectrum disorder and 91 were age-matched low stress mothers of neurotypical children. These two groups were recruited to maximize differences in chronic stress. Eligibility included: a) age 20 to 50 years, b) at least one child between the ages of 2 and 16 years old, c) no current psychiatric conditions (including depression for the mothers of neurotypical children), and d) nonsmoker. For chronically stressed mothers, additional inclusion criteria were: caring for a child diagnosed with autism spectrum disorder, and Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983) score ≥ 13 . For control participants, additional inclusion criteria were: caring for a neurologically typical child, and Perceived Stress Scale score ≤ 19 . Recruitment took place in the San Francisco Bay Area, through mass mailings and advertisements in schools, local parenting publications, and direct recruitment in the University of California San Francisco (UCSF) Autism Clinic.

2.2 Procedures

Participants came in to the research lab for a baseline assessment during which they completed demographic and psychosocial questionnaires, computer-based cognitive tasks, and blood draws. In addition, participants completed online daily reports in the morning and evening for 7 days. Evening reports included whether there was a stressful event that day, self-reported quality of their interactions with their partner, and mood and mind states within the last 30 minutes. This protocol was repeated 9, 18, and 24 months later. Because there was an intervention between the 18 and 24 month time point, analyses presented here do not include 24 month assessment data. For the daily level analyses, participants have up to 21 days of data (7 days of reporting over 3 data collection bursts). The UCSF institutional review board approved this research. Informed consent was obtained from all participants.

2.3 Measures

2.3.1 Mind states.

Engagement in and rejection of the moment. Engagement in the moment was captured with the item: “How often in the in the last 30 minutes have you felt totally focused and engaged in doing what you were doing at the moment?” Rejection of the moment was captured with the item: “How often in the last 30 minutes have you felt you didn’t want to be where you were or doing what you were doing at the moment?” The scale was a slider scale including anchors of not at all, somewhat, and a lot with scores ranging from 0 – 100. This variable was rescaled 0 – 5 to match the response scale of the mood outcome measure more closely.

Mind wandering. Frequency and emotional valence of wandering thoughts were captured in the evening with three items that asked about thoughts and attention within the last 30 minutes. Items were: “How often in the last 30 minutes, instead of thinking about what you were doing at that moment were you thinking about something else that was: a) pleasant, b) unpleasant, and c) neutral?” These items were adapted from a previous study on mind wandering (Killingsworth & Gilbert, 2010). The scale was a slider scale including anchors of not at all, somewhat, and a lot with scores ranging from 0 – 100, and was also rescaled 0–5.

2.3.2 Evening mood.—In the evening log, participants were asked to rate how much they felt a range of emotions that evening on a scale from 0 (not at all) to 4 (extremely; Fredrickson, Tugade, & Waugh, 2003). Twelve positive items (e.g. “I felt awe, wonder, amazement”) and twelve negative items (e.g. “I felt angry, irritated, frustrated”) were averaged in to positive and negative affect subscales. Alphas for these subscales were .87 for negative mood and .94 for positive mood.

2.3.3 Psychological stress.

Daily stress. In each evening log, participants wrote in detail about the event that caused them the most stress that day. Objective coders then reviewed the written text and assigned a severity score based on standard scoring (Almeida, Wethington, & Kessler, 2002). Rating categories were: 0 (no stressor occurred), 1 (low severity event), 2 (medium severity event),

3 (high severity event), and 4 (extreme severity event). Across the 21 days of data collection, participants reported experiencing low severity events just over half of the days (55% of the time) and medium severity events on one-third of the days (34% of the time). Days with no stress and severe stress were rare (2.5% and .8% respectively). A dichotomous variable was created by categorizing codes 0 and 1 as ‘no stress’ days, and codes 2, 3, and 4 as ‘stress days.’

Perceived stress.: General perceptions of stress were assessed with the 10-item Perceived Stress Scale (Cohen et al., 1983) completed at baseline, 9, and 18 months. Participants used a 5-point scale ranging from 0 (not at all) to 4 (almost all the time) to rate items such as “How often have you felt unable to control the important things in your life?” “How often have you felt nervous or stressed?” and “How often have you felt confident about your ability to handle personal problems?” (reverse coded).

2.3.4 Daily quality of social connection with marital partner.—In the evening log, participants reported on their sense of closeness with their marital partner that day. Three items captured positive aspects of interactions with the partner that day: “To what extent did you feel respected by your partner today?” “To what extent were you satisfied with your partner today?” “To what extent did you talk to your partner to get comfort, emotional support, or help with something that upset you?” The scale was a slider scale including anchors of not at all, somewhat, and a lot with scores ranging from 0 – 100, and was also rescaled 0 – 5. The three items were averaged within each day to create a daily ‘social connection’ score. The alpha for this scale was .65.

2.4 Analytic Method

Twenty-one days of daily diary data were captured in three 7-day increments during the baseline, 9 month, and 18 month study assessment points. The average number of days of diary reports completed was 18 (SD=5, range 1–21), meaning that the analysis dataset consisted of $183 \text{ (subjects)} \times 18 \text{ (days)} = 3,294$ evening reports.

We analyzed our data using a multilevel model that specified a within-subject process of daily variation in mood, mind states, and partner social connection following Bolger & Laurenceau (2013). Our predictor variables (i.e. engagement, rejection, daily stress, and daily positive partner connection) were decomposed into their within-subject state and between-subject trait components. Within-subject state variables were computed by subtracting each participant’s individual 21 day average from each of their daily scores. Between-subject trait variables were computed by subtracting the overall sample average from each participant’s individual 21 day average. Both the within-subject state and between-subject trait variables were included in the models, with the within-subject variables at Level 1 and the between-subject trait variables at Level 2. In this way we are able to test how daily fluctuation in our predictors, in relation to the person’s general level of that predictor (as captured with weekly average), are associated with our outcomes. The model equation is provided in the Online Supplemental Material.

To confirm there was enough within-subject daily variation in each variable to run these models, we ran empty models for each outcome and found that the estimates of the intercept

was substantially larger than its standard error, indicating that there appears to be significant variation in the daily level outcomes. Approximately 43–51% of the variance in all our predictor and outcome variables was within-subject, indicating that while there was (as expected), between-subject variation in amount of daily mind wandering, social connection, and mood, much of the daily variation took place within individuals. Our analyses primarily focused on understanding these intra-individual daily variations in order to test our hypotheses about the relationship between daily mind states and daily well-being indices.

We chose to use 21 days of data when the data was collected in three distinct collection bursts (at baseline, 9 months, and 18 months) for several reasons. Twenty-one days of data captures a more reliable average of the person's normal functioning than one week of data, and provides enough opportunity for variation in our variables of interest (e.g. stress day) in order to test our hypotheses. To account for the fact that the data was collected at different time points, we included a time point indicator to control for assessment week in our models. We are also modeling the time-dependence (adjacent observations are more similar than distant ones) via autocorrelations of our residuals.

2.5 Hypothesis Testing

To describe our sample and test our first hypothesis, we compared mothers under chronic stress to low stress mothers on average psychosocial characteristics, including weekly averages of our daily level predictors and outcomes, using *t*-tests. Pearson correlations were used to examine associations between weekly average mind states, mind wandering, and global perceived stress across the sample as a whole. To test our second hypothesis, we examined how daily fluctuation in mind states influenced evening positive and negative mood using multilevel models as described above. To test our third hypothesis, we examined how fluctuation in daily stress and daily social connection influenced daily mind states using multilevel models.

3. Results

3.1 Participant Characteristics

Participants ($n=183$) were on average 44 years old, Caucasian (77.5%), married (86%), and had a household income above \$100,000 (76.4%)¹. By design, mothers of a child with an autism spectrum disorder reported significantly higher levels of global perceived stress at baseline (mean=21.9, $SD=4.7$) than low stress mothers (mean=15.7, $SD=4.4$), $p<.001$.

3.2 Chronic Stress and Daily Life

Chronic stress was associated with differences in daily mind states and mind wandering. As presented in Table 1, across the 21 days of daily data, chronically stressed mothers reported lower levels of engagement, greater rejection, and more unpleasant and neutral mind wandering. The two groups did not differ significantly in the amount of pleasant mind wandering or in daily social connection with partner. The mothers under chronic stress also reported a greater proportion of stress days compared to no-stress days.

¹This is not a particularly high household income for San Francisco, where the 2016 median household income was \$84,160.

Greater global perceived stress averaged across all assessment time points was negatively correlated with engagement in the present moment ($r=-.45$), and positively correlated with rejection of the present moment ($r=.48$), unpleasant mind wandering ($r=.23$), and neutral mind wandering ($r=.57$). Perceived stress was not associated with pleasant mind wandering ($r=.01$). Figure 1 demonstrates the robust association between global perceived stress and neutral mind wandering.

3.3 Mind States and Mood

When examining frequency of evening mind wandering and mind states across the sample as a whole averaged across the 21 days of data collection, participants reported being present and engaged in the moment more often than (mean = 3.2, SD=.7) they reported rejecting the moment (mean=1.4, SD=.8) or mind wandering (pleasant mean=1.8, SD=.8; unpleasant mean=2.0, SD=.9; neutral mean=1.5, SD=.8).

On evenings when engagement in the present moment was higher than the person's average daily engagement score, they reported greater positive mood ($B=.158$, $SE=.01$, $p<.001$) and lower negative mood ($B=-.086$, $SE=.01$, $p<.001$). Conversely, on evenings when participants' reported rejecting the moment more than their own daily average, they also reported lower positive mood ($B=-.149$, $SE=.01$, $p<.001$) and greater negative mood ($B=.091$, $SE=.01$, $p<.001$).

For mind wandering, an increase in pleasant mind wandering was associated with higher positive mood ($B=.099$, $SE=.01$, $p<.001$) and lower negative mood ($B=-.042$, $SE=.01$, $p<.001$). An increase in neutral mind wandering was associated with lower positive mood ($B=-.17$, $SE=.01$, $p<.001$) and higher negative mood ($B=.142$, $SE=.01$, $p<.001$). An increase in unpleasant mind wandering was marginally associated with lower evening positive mood, $p=.057$, and not associated with evening negative mood, $p=.451$. However, as expected, greater levels of trait (21 day average) unpleasant mind wandering was associated with lower positive ($p=.028$) and greater negative mood each evening ($p=.009$). This means that the inter-individual variability in unpleasant mind wandering was related to evening mood, but intra-individual changes were not.

3.4 Daily Stress Exposure and Mind States

Across the 21 days of data collection, participants reported an average of 10 days during which a moderate stressor happened ('stress days'; $SD=5$, range=0–21; 48% of days). Chronically stressed mothers reported a greater proportion of stress days vs non-stress days compared to the low stress mothers (proportion for chronic stress group=.51, $SD=.23$ versus the low stress group=.42, $SD=.19$; $t(181)=2.74$, $p<.007$; which equates to 11 stress days out of 21 total days in the chronically stressed group and 9 stress days in the low stress group).

There was a main effect (across the sample as a whole) of daily stress on engagement and rejection of the moment. On stress days, participants reported being less engaged in the moment ($B=-.192$, $SE=.04$, $p<.001$), rejecting the moment more ($B=.23$, $SE=.05$, $p<.001$), and doing less pleasant mind wandering ($B=-.129$, $SE=.04$, $p=.003$) and more neutral mind wandering ($B=.33$, $SE=.04$, $p<.001$) than they did on non-stress days. Stress day did not

impact amount of unpleasant mind wandering ($p=.196$). These results are illustrated in Figure 2.

3.5 Daily Connection with Partner and Mind States

The intra-individual variability in daily connection with marital partner was also associated with mind states. Specifically, on days when a participant felt more connected to their partner than their daily average, participants also reported greater engagement in the moment ($B=.155$, $SE=.03$, $p<.001$), lower rejection of the moment ($B=-.137$, $SE=.03$, $p<.001$), more pleasant mind wandering ($B=.12$, $SE=.03$, $p<.001$), and less neutral mind wandering ($B=-.087$, $SE=.03$, $p=.003$). Daily fluctuations in partner social connection was not associated with amount of unpleasant mind wandering ($p=.388$).

We also tested whether these effects were moderated by chronic stress status and found a marginally significant ($B=.12$, $SE=.06$, $p=.061$) interaction of caregiver group and daily partner social connection for pleasant mind wandering, such that for caregivers, there was a stronger association between daily social connection and pleasant mind wandering. Caregiver group did not moderate the effect of daily social connection on other mind states.

4. Discussion

Mind wandering vs. engagement in the moment are frequent states of mind that may offer important clues or even serve as determinants of one's daily mental health and happiness. The findings presented here provide the first empirical evidence that experiencing psychological stress shapes these mind states at the daily level. We found that being under chronic stress was associated with more daily mind wandering and importantly, less engagement in – and more rejection of – the present moment. Greater evening mind wandering and less presence in turn, was associated with lower positive and higher negative evening mood. Furthermore, the context of the day influenced one's mind states; experiencing a moderately stressful event earlier in the day made it less likely for someone to feel engaged in their present experience that evening. Conversely, an increase in perceived partner social connection during the day (an increase from one's average sense of social connection) made it more likely that the person would report being present that evening. While being under chronic stress is associated with more daily stressful events, and lower social connection on average, the daily changes in these factors predict changes in mind states for our whole sample, regardless of chronic stress status (whether they are a caregiver or not).

Our results support our first hypothesis; women under chronic stress reported lower average levels of engagement and higher levels of rejecting the moment in comparison to an age-matched control group over a 21 day period of evening reporting. These results add to our group's previous finding that trait-level reports of engagement and rejection were associated with depressive symptoms, perceived stress, rumination, life satisfaction, and the stress-related biomarker of aging, telomere length (Epel et al., 2013). The current study looked at these constructs in a more granular way by asking participants to report on their mind states in the past 30 minutes, compared to the previous study in which participants reported at a single time point. Further, we demonstrated that these mind states differ by chronic stress

status. Taken with our previous results, this work suggests that mind states offer a window in to the inner workings of those under chronic stress.

We also found that women under chronic stress experience more evening neutral and unpleasant mind wandering compare to age-matched controls. This is in line with evidence from Jha et al. (2015) demonstrating that a time-limited chronic stressor (8 weeks pre-deployment for military personnel) was associated with a deterioration in attention and increases in mind wandering measured by a laboratory cognitive task. Our study adds to this research by comparing daily mind wandering reports in a sample specifically recruited because of their levels of perceived stress in addition to objective stressor exposure. Being under chronic stress may lead to increases in mind wandering because the demands of the chronic stressor depletes psychological and physiological resources that are needed to regulate attention.

The increase in neutral mind wandering for those under chronic stress is interesting since it is unclear why it is more frequent, and what those mind wandering thoughts are about. It could indicate that those under chronic stress use mind wandering as a tool to take them out of the present moment, to 'zone out' and not engage with a difficult reality or emotion in the moment. Indeed, across the sample as a whole, neutral mind wandering was strongly correlated with global subjective stress (assessed with the PSS, $r=.57$). Neutral mind wandering may also be indicative of more time spent future planning, as many self-generated thoughts during mind wandering are future oriented (Smallwood & Schooler, 2015), and mothers of children with an autism spectrum disorder may need to do more planning to coordinate caregiving activities compared to control mothers. Interestingly, neutral mind wandering did not appear benign, as it was associated with higher evening negative mood, as described next.

A more nuanced examination of the content of mind wandering thoughts in chronically stressed samples would shed further light onto this initial finding. In addition to valence and time-orientation (future versus past) of mind wandering thoughts, other aspects of mind wandering that may be important to capture include the cognitive orientation (i.e. self-related or goal-directed; Baird, Smallwood, & Schooler, 2011) and intentionality of the thought (Seli, Risko, Smilek, & Schacter, 2016). The consequences of mind wandering likely depend on these aspects of the self-generated thoughts since the differences in cognitive architecture create differences in experience they create (Smallwood & Andrews-Hanna, 2013; Wang et al., 2018). Future research should continue to explore these various aspects of mind states in chronically stressed samples (and on high stress days) to continue to understand the daily cognitive consequences of stress states, including whether there are types of mind states that support resilience to stress states.

The second aim of the study was to examine whether daily fluctuations in mind states are associated with fluctuations in mood on the same evening, controlling for the individual's average level of that mind state. We found that on evenings when women reported being more engaged in the moment (an increase from their daily average), or doing more pleasant mind wandering, they also reported being in a better mood. Conversely, on evenings when women reported rejecting the moment more and doing more neutral mind wandering, they

also reported being in a worse mood. This aligns with previous work by Killingsworth & Gilbert (2010) in a community sample showing that mind wandering episodes prospectively predicted worse mood, using multiple reports over the course of a single day. Participants in their study completed an average of 8 in-the-moment-reports of mood and/or mind wandering across several days of data collection. Our study does not allow for temporal inferences because participants only completed the assessments once a day, but our participants provided nearly twice as many samples over a greater period of their life—three data collection bursts of seven days over 18 months, leading to an average of 18 evening reports per person. A greater number of days of data for each participant enhances the statistical power to detect an effect. However, our study does not allow for temporal inferences since the predictors and outcomes we focused on were captured at the same time, eliminating the ability to test causality. Our study is also limited in that participants only reported on their mind states in the evenings, and thus our results are constrained to inferences about relationships between evening mind states and mood.

Our study also extends previous work by examining how daily fluctuations in the affective valence of the mind wandering – whether it was pleasant, unpleasant, or neutral to the participant – are related to daily social and emotional states. Previous research has demonstrated that whether mind wandering is harmful or helpful for well-being likely depends on the content of thoughts during the mind wandering episode (e.g. Franklin et al., 2013; Poerio et al., 2013; Ruby et al., 2013; Wang et al., 2018). This idea helps clarify the seemingly contradictory literature which shows that mind wandering episodes are associated with negative cognitive outcomes such as cognitive tasks performance deficits, and also positive cognitive outcomes such as creative problem solving and future planning (Mooneyham & Schooler, 2013). It may be that pleasant wandering thoughts are associated with positive well-being outcomes while unpleasant wandering thoughts are associated with worse well-being. Indeed, our analyses of daily-level mind wandering valence data show that mind wandering labeled by the participant as pleasant was associated with greater positive mood that same evening, whereas neutral mind wandering was associated with lower levels of positive mood that evening. This suggests that mind wandering about something pleasant (or that gives one a pleasant feeling) may be beneficial for that evening's mood. Future studies should capture more information about the mind wandering thoughts in order to fully explore when mind wandering leads to increases in subjective well-being, versus decreases.

The third aim was to contribute to our understanding of the environmental conditions that influence evening mind states by testing the influence of two daily contextual factors: moderate stress exposure and perceived quality of connection with partner. As hypothesized, we found that on days when a moderate stressor occurred, participants were less present that evening. On 'stress days' participants reported less engagement and more rejection of the moment, and less pleasant and more neutral mind wandering. Surprisingly, participants did not report more unpleasant mind wandering on stress days. Daily fluctuation in unpleasant mind wandering may be influenced by daily contextual factors not examined here such as physiological states of sleep deprivation or hunger, or personality traits such as neuroticism. Since we know from previous research that the majority of wandering thoughts are focused on the past or future, these unpleasant thoughts might not be resulting from that day's events

but rather the common perseverative cognition characterized by rumination over past events and worry about events that have not happened. It is also possible that positive and neutral mind wandering are more influenced by the current day's events.

We also found that naturally occurring daily fluctuations in connection with partner influenced evening mind states. On evenings that participants reported feeling positively connected to their partner (controlling for average level of partner connection), participants also reported greater engagement in the moment and less mind wandering. This is the first study to our knowledge to look at how daily changes in quality of partner connection influences engagement with the present moment. Previous studies have demonstrated a positive association between stable indices of partner connection such as relationship satisfaction and dispositional mindfulness (Barnes et al., 2007). Our results suggest that small daily changes in relationship quality are associated with a present oriented focus that evening. This is an important finding as positive interactions and connection with marital partner is something that can be prioritized and fostered each day. Interestingly, a study by Poerio et al. (2016) suggests that social connectedness can be fostered through social daydreaming exercises, and that this exercise may be beneficial when experiencing distressing feelings like loneliness.

The tendency to mind wander and to experience different states of consciousness exists both as a trait tendency, and as a myriad of fluctuations in a person's day that is influenced by contextual factors. We know little about the factors that predict greater mind wandering in naturalistic settings. We do know from both daily diary and experimental studies that negative moods lead to greater mind wandering (Killingsworth & Gilbert, 2010; Smallwood, Fitzgerald, Miles, & Phillips, 2009), that older adults tend to report less mind wandering than do younger adults (Jackson & Balota, 2012), and people tend to mind wander more during an easy than a difficult task (Forster & Lavie, 2009). Our results identify new contextual factors, namely chronic stress, exposure to daily stressful events, and daily quality of partner connection, that also influence one's ability to engage with the present moment, and frequency of mind wandering.

There are several strengths and limitations of this study. Using nightly reports on consecutive days, and stretching these sampling periods out into three intervals over one and a half years, offers a more stable way to assess intra-individual differences in daily experience, regardless of the changes in life circumstances that occur over time. However, because mind state data was only collected in the evenings, and both mood and unwanted thoughts are influenced by time of day (May & Hasher, 1998; Stone, Smyth, Pickering, & Schwartz, 1996), the inferences made about mind state findings are constrained to evenings only. Sampling at multiple unpredictable times throughout the day would improve the ability to examine temporal sequence. Each evening, participants reported earlier daytime stressful experiences and their perceived partner connection across that entire day. These reports are likely influenced by their current mood, and the relationships between them are bi-directional (e.g. Poerio et al., 2013). Further, the measures of mind states, while they preceded the measures of nightly mood, were taken during the same reporting session. Therefore, they are correlational and it is difficult to infer if mind states more influenced mood or whether mood was influencing mind states. Indeed, lab-based mood induction

studies have demonstrated that inducing an unpleasant mood can lead to mind wandering about past events (Smallwood & O'Connor, 2011). Future studies will need to sample mood and mind states more frequently during the day to examine temporal effects. There are many remaining questions about psychological stress and mind states for future studies to examine. For example, it is unknown whether chronic and/or acute stress interferes with one's ability to notice mind wandering episodes (meta-awareness), how the contents of the self-generated thoughts during mind wandering differs under states of stress, and whether mind wandering is used as a regulatory tool to decrease stress-related emotional or physiologic arousal.

Among the limitations is that the chronic stress group all had children with autism, leaving open the possibility of genetic differences between the mothers. While some of the genetics in autism are due to de novo mutations, not passed on by the parents (Sanders et al., 2012), and there is a large heterogeneity among the condition, there is also evidence of heritability found in both population-based and twin studies (Colvert et al., 2015; Sandin et al., 2014). Studies examining autism-related symptoms in parents are mixed, with some studies finding statistically worse functioning on social communication in parents (Bishop et al., 2004; Bora, Aydın, Saraç, Kadak, & Köse, 2017), which may or may not be due to genetic risk. In the current study, it is possible but unlikely that the stress related differences in caregiver mind states are due to small differences in social communication skills. It will be important to replicate these findings in other chronically stressed groups like parental caregivers of other conditions that are not neurodevelopmental or psychiatric.

Our results replicate previous evidence linking daily mind wandering about neutral topics and worse mood, and extend this work to include other states of consciousness, and by demonstrating that chronic stress and daily contextual factors (stress exposure and partner connection) influence mind states. We did not replicate previous findings (e.g. Killingsworth & Gilbert, 2010) that link both pleasant and unpleasant mind wandering to worse mood. In fact, our results demonstrated that pleasant mind wandering was associated with better mood, as was engagement in the present moment. Further, our results provide evidence that the relationship between mind states and mood shift within people based on their daily experiences. The specific mind states studied here – and rejection of the moment in particular, which is understudied – may serve as targets for well-being interventions, especially in high stress groups. These targets may be particularly affected by psychological and/or contemplative interventions such as ones that incorporate acceptance-based strategies of accepting one's current psychological experiences, including unwanted or negative emotions.

5. Conclusion

A fundamental Buddhist principle is that acceptance of the current moment experience without rejecting the reality of the situation is essential to happiness and to avoiding suffering. Rejecting the present moment may be at the core of what is experienced by those under chronic, ongoing stress. And, regardless of experiencing chronic stress, exposure to daily stressors leads us to mind states associated with decreases in well-being. Using contemplative traditions to inform research about how different types of life challenges,

chronic and acute, influence well-being can help us understand what is toxic about stress, and may provide specific psychological constructs to target with intervention. Furthermore, contemplative practices may be used to inform the refinement of existing psychological interventions to target these specific mechanisms. The integration of wisdom traditions with contemporary psychology, and the utilization of newer data collection and statistical techniques, provides an opportunity for a deeper understanding of a well-lived life, at the daily level.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding

Research reported in this publication was supported by the National Institute on Aging of the National Institutes of Health; K01AG057859; R01AG030424, R24AG048024). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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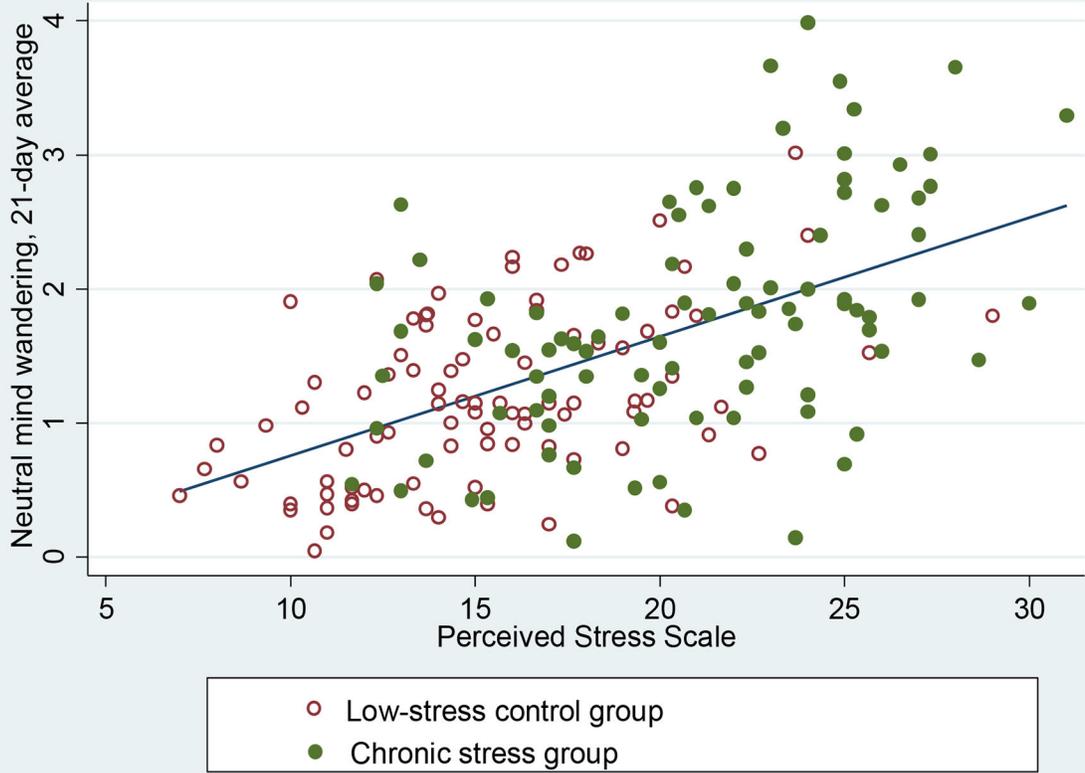


Figure 1. Correlation between neutral mind wandering and perceived stress, by chronic stress group.

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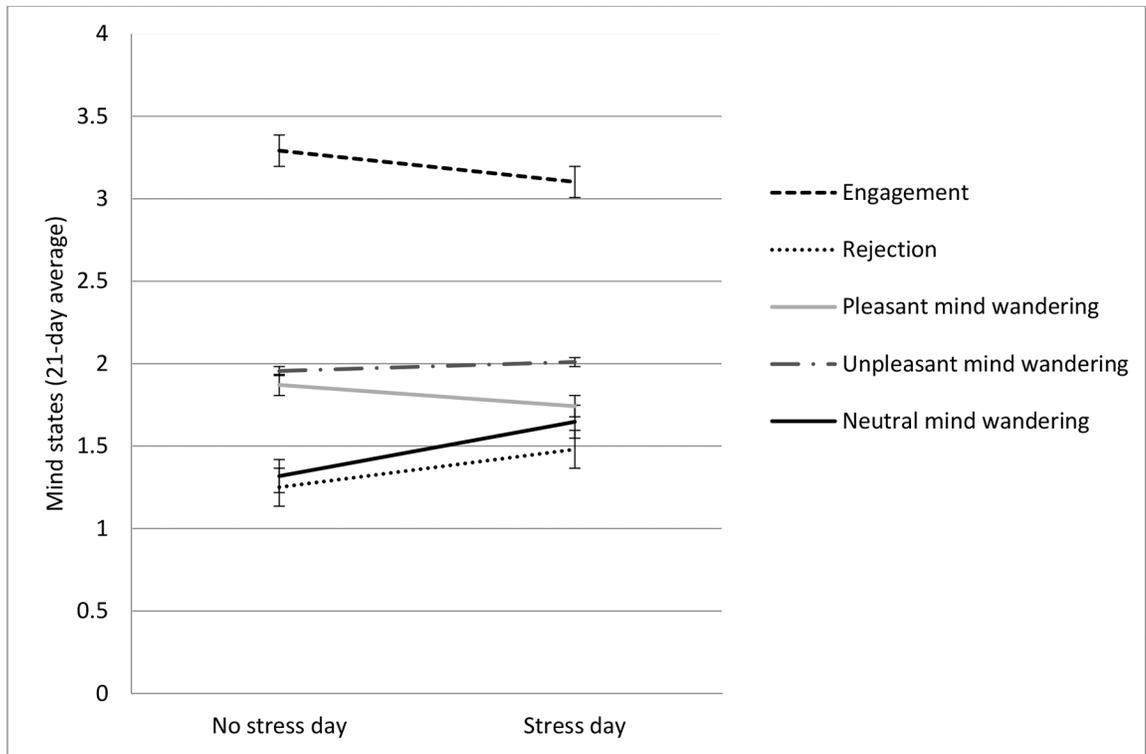


Figure 2. Average mind state scores across the sample on no stress day vs. stress day.

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Table 1

Daily averages of key variables across 21-days of data by chronic stress group

Daily level variable	Chronically stress mothers (n=91)		Low stress mothers (n=90)		Group difference P value	Correlation with PSS ^d r
	Mean (SD)		Mean (SD)			
Focus of attention (last 30 mins)						
Engagement in the moment	2.96 (.69)		3.42 (.62)		<.001	-.45 ^{***}
Rejecting the moment	1.55 (.86)		1.18 (.65)		.001	.48 ^{***}
Mind wandering frequency (last 30 mins)						
Pleasant mind wandering	1.83 (.78)		1.79 (.81)		.725	.05
Unpleasant mind wandering	2.12 (.82)		1.87 (.9)		.052	.23 [*]
Neutral mind wandering	1.78 (.86)		1.19 (.63)		<.001	-.57 ^{***}
Connection with marital partner (over the course of the day)	2.9 (.77)		3.1 (.53)		.104	-.29 ^{***}
Proportion of a days a moderate or severe stressor occurred	.51 (.21)		.41 (.17)		<.001	.32 ^{***}

* $p < .01$,*** $p < .001$ ^d Values are averaged across baseline, 9, and 18 month visits to create an average trait-level estimate.