RESEARCH ARTICLE

Daily Affective Dynamics in Major Depressive Disorder: The Role of Daily Stressors and Positive Events

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Abstract
This study examined daily affective dynamic indices among individuals with a major depressive disorder (MDD) diagnosis in the past one year at the time of the interview, focusing on affective variability and change in affect in response to daily events (affective reactivity). Data were from the main survey and daily diary project of the Midlife in the United States (MIDUS) study. Participants ($N = 1,970$; $n_{MDD} = 202$; $n_{non\text{-}MDD} = 1,768$) completed structured clinical interviews on mental health and telephone interviews about their daily experiences spanning eight consecutive days. Multilevel models revealed that the MDD group experienced greater positive (PA) and negative affect (NA) variability than the non-MDD group. On days that at least one stressful event was reported, the MDD group experienced a greater decrease in PA and a greater increase in NA. On days that at least one positive event was reported, the MDD group experienced a greater increase in PA and a greater decrease in NA. Changes in affect to daily events, particularly the mood brightening effect, may be indicators of depression and potential targets for intervention. Limitations of the study include a community sample, reliance on self-reported measures of daily stressors and positive events, inclusion of remitted and current MDD participants, and the DSM-III-R based criteria for MDD diagnosis.

MDD and Affect

Depression is often conceptualized as increased negative affect (NA) and deficient positive affect (PA) that remains relatively unchanged over time during the depressed mood state (Dunn et al., 2020). Despite persistent disturbances in affect, research on daily affect for individuals diagnosed with major depressive disorder (MDD) is sparse (Bylsma et al., 2011). Affective dynamics, assessed using ecological momentary assessment (EMA) paradigms, provide a nuanced understanding of within-person fluctuations of negative affect (NA) and positive affect (PA) in daily life. Affective dynamics are indicators of psychological functioning

and well-being (Ong & Steptoe, 2020). Affective indices examined in intensive longitudinal design studies within the community population suggest, in general, NA varies over time while PA remains relatively stable (Scott et al., 2020). However, this may differ for individuals with MDD. Studies are unclear whether NA varies or remains stable in day-to-day life among patients with MDD compared to controls. Similarly, the variability of everyday PA remains unclear. The understanding of affective dynamics in depression has important treatment implications. For example, PA levels on stressful days predicted depression and anxiety disorders seven years later (Rackoff & Newman, 2020). Another predictive study (Panaite et al., 2020) showed that a greater number of daily positive events predicted better well-being in depressed individuals 10 years later.

Treatment of depression typically focuses on decreasing NA levels. Emerging evidence suggests, in contrast to NA, treatments need to also focus on increasing PA levels (Craske et al., 2019; Dunn et al., 2019). With the recent shift and focus of treatment on PA, the study of affective dynamics in depression has recently gained momentum in the scientific literature (Panaite et al., 2020). However, affective dynamic indices (e.g., affect levels, variability,

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reactivity) are not static states but dynamic processes that vary across time (*affective variability*) and change in response to external events, such as daily stressors and positive events (*affective reactivity*) (Almeida, 2005). Further investigation into the daily affective dynamics of MDD is warranted in order to get a better understanding of the pattern and differences in these indices compared to non-depressed individuals. This would allow for better targeted treatment interventions. In this study, we focus on examining differences in affective variability and affective reactivity between MDD and non-MDD individuals from a community sample.

Affective Variability and MDD

Daily affective variability (i.e., indexed as a within-person variability of affect within a person) captures the overall range of affect levels a person may experience across a particular time period (Ram & Gerstorf, 2009). Greater variability in affect may be associated with worse health outcomes. Studies support a cost linked to moving in and out of an affective "homeostasis" with higher fluctuations predicting poorer mental and physical health (Piazza et al., 2013). Temporal fluctuations in PA are associated with elevated mortality risk in older adults (Ong & Steptoe, 2020).

Affective variability has generally been found to be significantly higher in depressed individuals than in healthy controls (Bos et al., 2019). However, there are discrepancies in the literature on whether NA and PA are significantly variable in depressed individuals. One study showed individuals with more severe forms of depression demonstrated lower variability of PA. Another study, however, observed greater variability of PA in MDD (Heininga et al., 2017). Other studies on affective fluctuations showed that depressed patients had higher variability in NA (Peeters et al., 2006) and PA in comparison to controls (Gilbert, 2012; Gruber et al., 2013; Peeters et al., 2006). Patients with a current disorder of depression and/or anxiety disorders were found to have higher fluctuations of NA (Lamers et al., 2018) and PA than remitted patients and controls (Schoevers et al., 2021). Most studies have not included large samples affected by mood disorders, nor have they systematically investigated the comorbid role of anxiety disorders (Pfaltz et al., 2010). Such comparisons are essential for understanding how affective regulation differs between depression and comorbid anxiety disorder (O'Leary et al., 2017). This study focuses on affective variability in MDD by assessing day-to-day within-person fluctuations controlling for comorbid anxiety disorders. We also measure affective variability in a novel way by implementing multilevel heterogeneous variance models that simultaneously model level and variability in the same analyses.

Affective Reactivity and MDD

Our second focus in the study is the role of context (i.e., how affect changes in response to daily stressful or positive events). The change in affect due to daily context (i.e., a stressful event or a positive event) is termed affective reactivity (Charles et al., 2009). The role of context in the depression literature has focused primarily on negative events such as stress or major past adverse events. Previous studies examining affective reactivity following daily life events in MDD have yielded mixed results. One study reported increased NA in reaction to daily negative events among individuals with prior depression as compared with controls (Husky et al., 2009), while another study found smaller increases in NA in response to negative events in individuals with MDD (Peeters et al., 2003). The latter study also reported that decreases in PA following stressors were of significantly smaller magnitude in MDD compared with controls, while increases in PA following positive events were larger. A third study found no significant differences between participants with and without depression regarding changes in PA following either positive or negative events, or relative to increases in NA following negative events (Bylsma et al., 2011). The one relatively consistent yet surprising finding in examining affect reactivity in depression is the "mood brightening" effect. The mood brightening (MB) effect observed in ecological investigations of affective reactivity in depression is an unusual theoretical and empirical phenomenon in the depression literature. The MB effect refers to findings that individuals with MDD report larger decreases in negative affect (NA) in response to positive events in daily life compared to individuals with no history of MDD (Bylsma et al., 2011; Peeters et al., 2003; Thompson et al., 2012). Interestingly, these studies also observed that the MB effect was observed even after controlling for baseline mood, suggesting that this effect could not be accounted for by high levels of current NA among individuals with MDD. Another study observed a similar MB effect for depressed participants, but these individuals did not differ from controls concerning PA following positive events, or positive or negative affect following negative events (Khazanov et al., 2019). In summary, with the exception of the mood brightening effect that was observed across three investigations (Bylsma et al., 2011; Peeters et al., 2003; Thompson et al., 2012), the findings of previous EMA studies are inconsistent concerning differences in affective reactivity between individuals with and without depression. Such inconsistency may be explained by numerous factors including the presence of comorbidity, the nature of the event itself, and the clinical state of the participants at the time of the study (aan het Rot et al., 2012; Bylsma et al., 2011; Tan et al., 2012; Vrshek-Schallhorn et al., 2015).

In summary, the study of affective dynamics in MDD is warranted given the mixed results in the literature and the

importance of affective dynamics in well-being. Implementing ecological sampling paradigms to advance the causes and maintenance of MDD and improve treatment interventions is supported (Telford et al., 2012). A meta-analysis has shown that overall, low psychological well-being co-occurs with more variable, unstable, and inert affect, with more pronounced results for negative compared to positive affect (Houben et al., 2015). The current study examines the distinctive nature of affective variability and affective reactivity, among MDD vs. non-MDD groups, particularly focusing on *positive affective reactivity* given the mood brightening effect observed in the literature.

The Role of Daily Diary Assessment of Daily Stressors and Positive Events

The experience of life event stressors has been linked with worse mental health outcomes (Charles et al., 2013). Earlier work on stress generally focuses on major life events, which are relatively rare, or generates chronic stress over long periods of time. Perceived stress has also gained attention as it captures the subjective experience of stress, but it is limited in that it is unable to disentangle subjective stress from the frequency of exposure to stressful events. One way we address this limitation in the current study to better focus on capturing the daily stress process is through the assessment of daily stressors. This paradigm focuses on small everyday stressful events rather than larger isolated events. Since we measure affect associated with daily stressors, this allows us to differentiate between perceived stress and the actual stressor. Everyday stressors such as a job interview, meeting a work deadline, and caring for children are also linked to health outcomes (Almeida et al., 2002). However, most of this evidence comes from cross-sectional or retrospective data on stress (Cohen et al., 2007; Pearlin & Bierman, 2013). The daily diary methodology allows individuals to report their experiences of events on the day they occurred, decreasing the likelihood of retrospective bias and increasing the accuracy of perception and occurrence of events.

How everyday stressors impact daily affective levels in depressed individuals and whether this differs from healthy individuals is unclear. Most studies have focused on temporal changes in affect with less emphasis on affective reactivity, or how affect changes in relation to daily events, whether stressful or positive. Investigating affective reactivity has several advantages. First, affective reactivity provides a better assessment of the impact of daily stressors on affective levels. Research has focused on overall stress and trauma with less focus on daily stressors (Grzywacz et al., 2004). Second, the focus on stress has usually taken a between-person approach based on the concept that some people experience more stress than others. This study centers on the within-person dynamic

characteristics of affect associated with exposure to stressors. Daily stressors usually lead to the stress response including an increase in negative affect (Almeida et al., 2020). This within-person approach to the stress process could help identify affective responses and changes associated with exposure to daily events. In other words, do depressed individuals experience similar levels of change in negative affect in response to a stressor or more compared to non-depressed individuals? Similarly, assessment of change in positive affect is also important, particularly given the consistent yet unusual mood brightening effect observed specifically in MDD. Further, stability of positive affect in the face of daily stressors is an indicator of robust psychological well-being (Ong & Steptoe, 2020). Recent research suggests that intra-individual variability or fluctuations in PA over time is a predictor of individual health outcomes; for example, greater fluctuations in PA were associated with greater mortality (Ong & Ram, 2017; Ong & Steptoe, 2020). We suspect that individuals with MDD have higher reactivity of both NA and PA associated with daily stressors.

Notably, earlier studies have recruited from clinics that may not generalize to the general population because of the increased severity and comorbidity of disorders reflected in clinical settings (Du Fort et al., 1993). Only two of the previously cited EMA investigations of affective dynamics have recruited participants from the general community (Bylsma et al., 2011; Thompson et al., 2012). Another gap in the literature is affective reactivity to positive events. There has been growing interest and recognition of the importance of PA but less focus on the *frequency* of positive event occurrence and affective reactivity to positive events (Ong & Ram, 2017; Ong & Steptoe, 2020; Rackoff & Newman, 2020; Sin et al., 2020). Studies have reported that daily positive events are associated with better health outcomes (e.g., lower inflammation) independent of positive affect levels (Sin et al., 2015). However, there is a lack of understanding of affective responses to these positive events. It is critical to assess whether the occurrence of a positive event produces affective changes in depressed individuals, as it suggests important treatment implications. We speculate that MDD participants would have higher PA and lower NA associated with daily positive events.

Hypotheses

The central purpose of the current study is to observe affective change indices, specifically, variability and reactivity, in the daily lives of individuals recently diagnosed with Major Depressive Disorder (MDD) based on daily telephone diary assessments and compare them to a non-MDD group. The present study tested two hypotheses. First, does the MDD group report higher negative and positive affect variability in a large national community sample? For PA,

we hypothesize that there would be lower mean PA levels and greater within-person affective variability in daily PA in the MDD group compared to the non-MDD group. For NA, we expect that there would be higher mean levels and greater within-person affective variability in daily NA in the MDD group compared to the non-MDD group. Second, we examine whether individuals with MDD exhibit higher affective reactivity to daily stressor and positive events. For negative affective reactivity, we expect that there would be a greater increase in NA in response to daily stressors and a greater decrease in NA in response to daily positive events in the MDD group compared to the non-MDD group. For positive affective reactivity, we expect a greater decrease in PA in response to daily stressors and a greater increase in PA in response to daily positive events in the MDD group compared to the non-MDD group.

Method

Participants and Procedure

The current study used data drawn from the second wave of the National Study of Daily Experiences (NSDE), the daily diary project of the Midlife in the United States (MIDUS) study (Ryff & Almeida, 2017; Ryff et al., 2018, 2021). The MIDUS study is a national survey examining health and well-being across middle and older adulthood. The original sample at the first wave of the study (MIDUS I) was recruited from 1995 to 1996 via a random-digit-dialing (RDD) procedure, resulting in 7,108 non-institutionalized and English-speaking adults aged between 25 and 74. In 2004 to 2006, a longitudinal follow-up was conducted (MIDUS II) which included 4,963 participants who completed the baseline phone interview (aged 35–86 years; 75.4% retention rate). Of those, 81% completed self-administered questionnaires (SAQs). Due to the lack of participants as racial minorities, especially those who identified as Black (90.1% white and 4.6% Black in MIDUS II vs. 75.1% white and 12.3% Black in the U.S. population), this sample was not fully representative of the U.S. population. To improve the diversity representation of the MIDUS II sample, a supplemental sample of 592 participants who mostly identified as Black (93.4%) were recruited from Milwaukee County, WI. The Milwaukee oversample completed the initial baseline interview (70.7%) and 67.2% of them also completed the SAQs. A random subsample of MIDUS II participants were invited to enroll in the daily diary study, and 2,022 participants completed the telephone interviews about their daily experiences on eight consecutive days (Almeida et al., 2009). Approximately 96% of participants completed at least six interview days, resulting in

92% of retention rate (i.e., 14,912 days out of a possible 16,176 days). Further data documentation is available at http://doi.org/10.3886/ICPSR26841.v2.

Of the 2,022 participants with 14,895 interview days, we included 1,970 participants with 12,225 interview days in the analyses who completed at least two consecutive interview days. The median time gap between the main survey and daily diary assessment for the current sample was 1.6 years (19 months), where about 50% had less than a 1-year gap and 70% had less than a 2-year gap. We used demographic variables drawn from the MIDUS II main survey, and participants who did not provide information on demographic characteristics ($n = 52$) were excluded in the analyses. The final sample of this study were aged 57 years on average and 57% were female. In addition, 85% of the sample identified their racial group as white, 11% Black, and 4% others (i.e., Asian, native American, native Hawaiian, or others), and 31% of the sample reported their highest level of education completed as high school or less.

Measures

Daily Affect

Daily affect was measured using scales developed by MIDUS (Mroczek & Kolarz, 1998; Watson et al., 1988). Participants reported how much of the time they experienced 13 positive and 14 negative emotions using a 5-point scale ranging from 0 (*none of the time*) to 4 (*all of the time*). Negative affect items included feeling restless or fidgety, nervous, worthless, so sad nothing could cheer you up, hopeless, irritable, lonely, upset, everything was an effort, jittery, ashamed, angry, frustrated, and afraid ($\alpha_{within-person} = .84$, $\alpha_{between-person} = .75$; Hox et al., 2017). Positive affect items included feeling in good spirits, extremely happy, calm and peaceful, cheerful, full of life, enthusiastic, proud, active, like you belong, satisfied, attentive, close to others, and confident ($\alpha_{within-person} = .91$, $\alpha_{between-person} = .96$; Hox et al., 2017). Daily negative and positive affect were calculated using average scores of affect items, respectively.

Daily Stressors

Daily stressors were measured using the Daily Inventory of Stressful Events (DISE; (Almeida et al., 2002). The DISE asks about the occurrence in the past 24 h of seven events that most people commonly find stressful. These events included an argument or disagreement, avoidance of an argument, a stressor at work/school, a stressor at home, discrimination, stressful events experienced by a close friend or relative (i.e., a network stressor), and any other stressor. We used a binary variable representing whether participants experience any of stressors on a given day ($1 = yes$, $0 = no$).

Daily Positive Events

Participants reported whether each of the following five positive events had occurred in the past 24 h during the telephone interviews: a positive social interaction, a positive experience at work/school/volunteer position, a positive experience at home, a positive event experienced by a close friend or relative (i.e., a network positive event), and any other positive event (Sin & Almeida, 2018). A binary variable indicating whether participants experienced any positive event on a given day ($1 = yes$, $0 = no$) was used for the analyses.

Major Depressive Disorder (MDD)

Recent MDD was diagnosed during the MIDUS II main survey using the Comprehensive International Diagnostic Interview-Short Form (Kessler et al., 1998) which aligned with the *Diagnostic and Statistical Manual–Third Edition-Revised* (DSM-III-R; American Psychiatric Association, 1987) criteria. During the telephone interview, the CIDI-SF assessed whether participants experienced depressed mood or anhedonia in the past 12 months, and associated symptoms including problems with eating, sleeping, concentration, energy, feelings of self-worth, and suicidal ideations or actions. A criterion for a diagnosis of MDD required the concurrent presence of at least two weeks of either depressed affect or anhedonia for most of the day/nearly every day, and at least of four associated symptoms. Studies have shown that the CIDI-SF has a strong inter-rater reliability, diagnostic sensitivity, and diagnostic specificity compared to the full CIDI (Kessler et al., 1998). Bipolar Disorder was not assessed within this group, only MDD.

Covariates

Sociodemographic covariates included age, gender (male vs. female), race (white vs. Black), highest education level (high school graduate or less vs. more than high school graduate), and marital status (married vs. non-married). A diagnosis of an anxiety disorder (i.e., generalized anxiety disorder and panic disorder), assessed using CIDI-SF, was also included as a covariate, as MDD and anxiety disorders are highly comorbid (Kessler et al., 2007). We also included a weekday vs. weekend variable as a covariate indicating whether the interview day was on a weekday or weekend, and previous-day positive and negative affect (i.e., lagged outcome variable) to strictly evaluate the day-level association. In addition, we included person-means of daily stressors and positive events as covariates (i.e., the proportion of days on which the stressors/positive events had occurred across interview days).

Data Analysis

Multilevel models were estimated to examine our hypotheses on differences in daily affective variability and affective reactivity to daily events between MDD and non-MDD groups. Affective variability was operationalized as a within-person variability of daily affect across eight study days, and affective reactivity was operationalized as the degree of change in affect in response to daily events compared to days without any events. For the analyses, level-1 continuous predictors were person-mean centered and level-2 continuous predictors were grand-mean centered to interpret estimated parameters as deviations from person-mean and grand-mean, respectively. First, to examine whether MDD has a greater daily affective variability, we tested multilevel models with heterogeneous within-person variance. This approach is powerful and parsimonious in that it allows modeling for within-person fluctuation in daily affect while controlling for all within- and between-person covariates (Liu et al., 2018). Level 1 residuals of daily affect estimated from these models represent within-person variability of daily affect. For example, equations for a model with within-person heterogeneous variance estimating daily negative affect are as follows:

Level 1 (day-level):

$$Daily\ Negative\ Affect_{di} = \beta_{0i} + e_{di}, e_{di} \sim N(0, R)$$
$$R = \begin{bmatrix} \sigma^2_{eg=0} & 0 \\ 0 & \sigma^2_{eg=1} \end{bmatrix}$$

Level 2 (person-level):

$$\beta_{0i} = \gamma_{00} + \gamma_{01}(Major\ Depression\ Disorder)_i + u_{0i}, u_{0i} \sim N(0, G)$$

At level 1, β_{0i} represents the intercept which indicates the person i's average amount of negative affect and e_{di} is a residual error representing leftover level-1 variance in negative affect for person i. At level 2, γ_{00} represents the sample mean of negative affect, γ_{01} represents the effect of MDD on the person-specific intercept β_{0i}, and u_{0i} represents a deviation of person i's mean from the sample mean of negative affect. R matrix indicates the variance–covariance matrix of level-1 (i.e., within-person) residuals, where σ^2_{eg} differs across two groups (i.e., MDD and non-MDD groups). The models with heterogeneous within-variance were compared with common variance model based on Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), of which lower values indicate a better-fitting-model.

To examine differences in affective reactivity to daily events among MDD and non-MDD groups, we estimated multilevel models with cross-level interaction terms between daily events and MDD. For example, equations for a model

examining interaction between daily events and MDD on daily negative affect are as follows:

Level 1 (day-level):

$$Daily\ Negative\ Affect_{di} =$$
$$\beta_{0i} + \beta_{1i}(Daily\ Stressor)_{di} + \beta_{2i}(Daily\ Positive\ Event)_{di} + e_{di}$$

Level 2 (person-level):

$$\beta_{0i} = \gamma_{00} + \gamma_{01}(MDD)_i + u_{0i}$$
$$\beta_{1i} = \gamma_{10} + \gamma_{11}(MDD)_i + u_{1i}$$
$$\beta_{2i} = \gamma_{20} + \gamma_{21}(MDD)_i + u_{2i}$$

At level 1, β_{1i} and β_{2i} are the slopes representing a change in person i's daily negative affect on stressor days and positive event days, respectively. At level 2, γ_{11} and γ_{21} capture the interaction effects between daily events (i.e., daily stressors and daily positive events) and MDD. u_{1i} and u_{2i} represent leftover level-2 variance in the regression coefficients, β_{1i} and β_{2i}, respectively, that is not explained by MDD. Random effects (i.e., random slopes) were included in the estimation for daily stressors and daily positive events, which allows changes in daily affect in response to daily events to differ across individuals. The aforementioned covariates were also included in the analyses.

Results

Descriptive Statistics and Correlations

Participants' sociodemographic characteristics and descriptive statistics for daily experiences are presented in Table 1. Among the sample of 1,970 participants, 202 participants (10.3%) were diagnosed with MDD in the past 12 months and 1,768 participants (89.7%) were not diagnosed with MDD. MDD participants were more likely to be younger ($M = 52.2$ vs. 57.2) and female (72.3% vs. 55.5%) than non-MDD participants, and 35% of MDD participants had an anxiety disorder compared to 5% among non-MDD participants. On 76.9% of interview days, both MDD and non-MDD participants reported at least one stressor or positive event. Stressors occurred on 44% of interview days among MDD participants and 35% of days among non-MDD participants. Positive events occurred on 63% of interview days among MDD participants and 69% of days among non-MDD participants.

Table 2 shows patterns of associations among the daily diary variables (i.e., within-person and between-person correlation coefficients). The intraclass coefficients indicate that between-person differences account for 77% of variance in daily positive affect, 53% in daily negative affect, 25% in daily stressors, and 41% in daily positive events. At the between-person level, the correlation coefficients between MDD status and daily events were moderate to weak, indicating that MDD participants were more likely to report higher NA, lower daily PA, higher stressor exposure, and lower positive event exposure. At both between-person and within-person levels, the correlation matrix indicates that higher daily PA was correlated with lower daily NA, having fewer stressors, and more positive events. In addition, lower daily NA and reports of positive events were correlated with having stressors, respectively, at both between-person and within-person levels.

Daily Affective Variability

Table 3 shows the results from multilevel models with heterogeneous within-person variance. The fixed-effect

Table 1 Descriptive statistics

Variable	MDD ($n = 202$; $Obs = 1,186$) Mean (SD) or n (%)	Non-MDD ($n = 1,768$; $Obs = 11,039$) Mean (SD) or n (%)	Total ($N = 1,970$; $Obs = 12,225$) Mean (SD) or n (%)
Sociodemographic and anxiety disorder			
Age, years	52.21 (10.93)	57.22 (12.23)	56.74 (12.19)
Sex, Male	56 (27.7%)	786 (44.5%)	842 (42.7%)
Race, White	172 (85.2%)	1,502 (85.0%)	1,674 (85.0%)
Education, high school graduate or	70 (34.7%)	538 (30.4%)	608 (30.9%)
less	114 (56.4%)	1,246 (70.5%)	1,360 (69.0%)
Marital status, Married	70 (34.7%)	90 (5.1%)	160 (8.1%)
Anxiety disorder			
Daily diary variables			
Positive affect	2.26 (0.88)	2.81 (0.67)	2.75 (0.72)
Negative affect	0.39 (0.45)	0.15 (0.21)	0.18 (0.25)
Stressors (% of days)	44.4%	34.7%	35.7%
Positive events (% of days)	62.7%	68.5%	67.9%
Weekday (vs. weekend)	72.1%	72.4%	72.4%

Note: MDD Major Depressive Disorder

Table 2 Intraclass Correlation (ICC) and within- and between-person correlations

Variable	MDD	Positive affect	Negative affect	Stressors	Positive events
MDD					
Positive affect	−.24***	**.77**	−.49***	−.21***	.10***
Negative affect	.31***	−.56***	**.53**	.35***	−.02*
Stressors	.12***	−.31***	.41***	**.25**	.11***
Positive events	−.06***	.12***	−.03***	.29***	**.41**

Note: N = 1,970; Observations = 12,225; MDD = Major Depressive Disorder; Diagonals (bold) represent intraclass correlation (ICC; between-person level variance divided by total variance) for the variables. Numbers above diagonals show within-person correlation coefficients, and below diagonals are between-person correlation coefficients. * $p < .05$, *** $p < .001$

estimates for association between MDD and daily affect indicate that MDD group reported higher average levels of NA (est. = 0.182, *SE* = 0.019, $p < .001$) and lower average levels of PA (est. = -0.423, *SE* = 0.055, $p < .001$). For within-person variance components, MDD group reported greater variability in both NA (0.131 vs. 0.037) and daily PA (0.244 vs. 0.133; See Fig. 1).

Affective Reactivity to Daily Events

Table 4 displays the results from multilevel models for affective reactivity to daily stressors and positive events. For positive affective reactivity, the interaction between daily positive events and MDD was significant (Est. = 0.181, *SE* = 0.038, $p < .001$). Figure 2a shows that there was a greater increase in PA on days with any positive events in MDD participants (simple slope: est. = 0.253, *SE* = 0.037, $p < .001$) than non-MDD participants (simple slope: est. = 0.072, *SE* = 0.010, $p < .001$). The interaction between daily stressors and MDD on PA was marginally significant (est. = -0.068, *SE* = 0.035, $p = .054$). Although the result did not reach statistical significance level of 0.05, we conducted simple slope analyses to examine the difference between positive affective reactivity to daily stressors in MDD vs. non-MDD groups (Fig. 2b). Simple slope analyses revealed that there was a decrease in PA on stressor days in both MDD participants (Est. = -0.199, *SE* = 0.034, $p < .001$) and non-MDD participants (Est. = -0.131, *SE* = 0.009, $p < .001$).

For negative affective reactivity, the interaction between MDD and daily positive events (est. = -0.103,

Table 3 Parameter estimates for multilevel models with within-person heterogeneous variance

	Daily positive affect Estimate (*SE*)	Daily negative affect Estimate (*SE*)
Fixed effect		
Intercept	2.838 (0.047)***	.174 (0.015)***
MDD	−.423 (0.055)***	.182 (0.019)***
Age	.010 (0.001)***	−.002 (0.000)***
Male (vs. female)	−.039 (0.032)	−.011 (0.010)
Less than high-school graduate	.064 (0.034)†	−.002 (0.010)
White (vs. others)	−.045 (0.044)	−.032 (0.014)*
Married (vs. not-married)	.063 (0.035)†	−.028 (0.011)**
Anxiety disorder	−.270 (0.060)***	.154 (0.019)***
Previous-day affect	.010 (0.010)	.031 (0.010)***
Weekday (vs. weekend)	−0.049 (0.010)***	0.038 (0.004)***
Random effect		
VAR (Intercept)	0.437	0.036
Residual	0.133	0.037
Heterogeneous within-person variance component		
MDD	0.244	0.131
Non-MDD	0.133	0.037

Note: N = 1,970; Observations = 12,225; MDD = Major Depressive Disorder; Model-fit indices indicate heterogenous within-person variance models (PA: AIC = 16672.29, BIC = 16768.63; NA: AIC = -356.66, BIC = -260.33)fit better than the common variance models (PA: AIC = 16858.66, BIC = 16947.58; NA: AIC = 458.16, BIC = 547.09) for both positive and negative affect

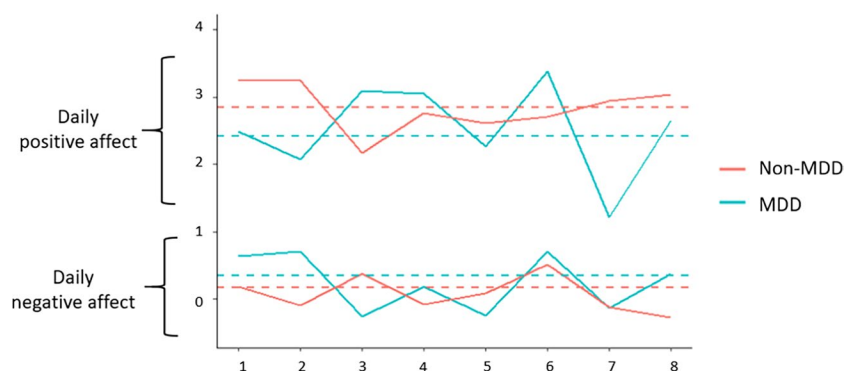† $p = < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Fig. 1 Daily affective reactivity to daily events. Dotted lines represent average levels of daily affect across 8 days and solid lines represent variability in daily affect. The values used are estimated values from the heterogeneous variance multilevel model without daily events components. An average level of positive affect was lower in MDD ($b=2.415$) than non-MDD ($b=2.838$), and that of negative affect was higher in MDD ($b=0.356$) than non-MDD ($b=0.174$). Variances in both daily positive affect (PA) and negative affect (NA) were higher in MDD (PA = 0.244; NA = 0.133) than non-MDD (PA = 0.131; NA = 0.037)

$SE=0.024$, $p<.001$) and between MDD and daily stressors (est. = 0.114, $SE=0.026$, $p<.001$) were significantly associated with NA. Figure 2c indicates that there was a greater

decrease in NA on a positive-event day among MDD participants (simple slope: est. = -0.087, $SE=0.015$, $p<.001$) than non-MDD participants (simple slope: est. = 0.002,

Table 4 Parameter estimates for multilevel models examining affective reactivity to daily events

	Daily positive affect Estimate (*SE*)	Daily negative affect Estimate (*SE*)
Fixed effect		
Intercept	2.836 (0.045)***	.125 (0.011)***
MDD	−.433 (0.062)***	.189 (0.023)***
Daily stressors	−.131 (0.009)***	.149 (0.006)***
Daily positive events	.072 (0.010)***	.001 (0.005)
Daily stressors X MDD	−.068 (0.035)†	.114 (0.026)***
Daily positive events X MDD	.181 (0.038)***	−.103 (0.024)***
Age	.005 (0.001)***	.000 (0.000)
Male (vs. female)	−.056 (0.030)†	.009 (0.007)
Less than high-school graduate	.032 (0.033)	.020 (0.007)*
White (vs. others)	−.058 (0.042)	−.036 (0.001)***
Married (vs. not-married)	.067 (0.031)*	−.031 (0.007)***
Previous-day affect	.005 (0.010)	.009 (0.009)
Weekday (vs. weekend)	−.038 (0.008)***	.026 (0.004)***
Average daily stressor days	−.701 (0.061)***	.194 (0.015)***
Average daily positive-event days	.411 (0.059)***	−.060 (0.014)***
Random effect		
VAR (Intercept)	.448	.030
VAR (Stressor slope)	.018	.024
VAR (Positive event slope)	.022	.006
CORR (Int, Stressor slope)	−.137	.343
CORR (Int, Positive event slope)	−.459	−.844
CORR (Stressor slope, Positive event slope)	−.427	.168
Residual	.123	.035
Heterogeneous within-person variance component		
MDD	.213	.117
Non-MDD	.123	.030

$N=1,970$; Observations = 12,225; *MDD* Major Depressive Disorder

† $p<.10.$, * $p<.05$, *** $p<.001$

$SE = 0.006$, $p = .70$). In addition, as depicted in Fig. 2d, there was a greater increase in NA on stressor-days among MDD participants (simple slope: est. $= 0.263$, $SE = 0.025$, $p < .001$) compared to non-MDD participants (simple slope: est. $= 0.149$, $SE = 0.006$, $p < .001$).

Discussion

This study investigated whether individuals diagnosed with MDD in the past one year experienced higher affective variability and reactivity to daily events compared to non-depressed individuals using a large U.S. national sample. Our first hypothesis was supported in that depressed individuals experienced higher levels of both NA and PA variability over an 8-day period. Our second goal was to determine whether depressed individuals experienced higher affective reactivity to daily events, including both stressful and positive events. This hypothesis was also supported as we found that depressed individuals experienced significantly higher levels of negative affect reactivity (i.e., an increase in NA) to daily stressors and lower levels of negative affect reactivity (i.e., a decrease in NA) to daily positive events, in alignment with the mood brightening effect consistently detected in previous studies. Depressed individuals also experienced a greater increase in levels of positive affect in response to positive events, also corresponding to the mood brightening effect. We only found marginally significant effects of daily stressors on positive affect. Thus, as expected, in

addition to mean level affect differences, we found differences in affective variability and reactivity in the MDD group.

Affective Variability

The higher levels of NA and lower levels of PA in depressed individuals is unsurprising and expected. However, despite the belief of a stable depressed mood and affect state, depressed individuals still experience higher levels of affective variability for both negative and positive affect. We found that, overall, the MDD group experienced 3.5 times higher levels of negative affective variability and close to twice as much higher levels of positive affective variability compared to the non-MDD group. The higher NA variability is supported by the literature (Koval et al., 2013; Panaite et al., 2020), although similar studies did not find significant variability in PA (Panaite et al., 2020). Positive affective dynamic indices have increasingly gained importance as a marker for well-being and positive mental health. Given that the MDD group was experiencing such higher variability levels for both negative and positive affect, interventions targeting the decrease in affective variability may be warranted, focusing on positive affective variability.

Affective Reactivity to Daily Events

Earlier work by Almeida and colleagues has emphasized the importance of affective dynamics indices as a predictor of both physical and mental health outcomes (Almeida, 2005;
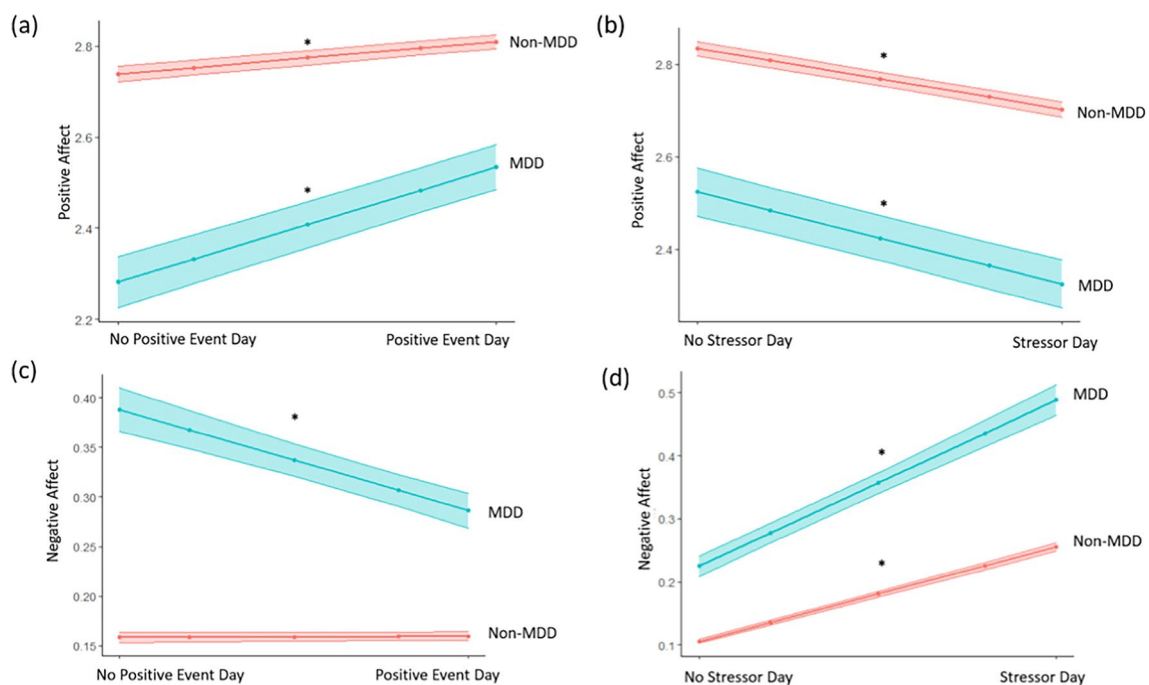

Fig. 2 Daily affective reactivity to daily events between MDD and Non-MDD adults. Interaction effects of "Daily Events x MDD status" for daily positive affect and negative affect, controlling for all the covariates

Almeida et al., 2020; Charles et al., 2013; Piazza et al., 2013; Sin et al., 2020). In our study, MDD participants experienced not only higher negative affect and lower daily positive affect but also higher stressor exposure (9% more reported stressors) and lower positive event exposure (6% less reported positive events) compared to non-MDD participants. This implies that, within this sample, the MDD group experiences at least one extra stressor event per week and at least one less positive event per week. On a yearly basis, that translates to 52 extra stressors and 52 fewer positive events for the MDD group compared to the non-MDD group. This finding is in line with the stress generation hypothesis (Hammen, 1991, 2006), where depressed individuals are more likely to experience stressful life events than non-depressed ones because they behave in ways contributing to stressful environments influenced by their beliefs, expectations, and personal characteristics (Alloy et al., 2010). With the caveat that the 8-day sample might not be representative of the participants' year, this reflects how the MDD group navigates and perceives their daily lives, highlighting the importance of context and external events that happen on a daily basis.

The investigation of how affect is impacted by the occurrence of both stressors and positive events in depressed individuals was a novel aspect of this study. Here too, we found that the MDD group's NA increased and PA decreased significantly in response to a stressful event compared to the non-MDD group. Thus, the already elevated levels of NA are further exacerbated in the event of a daily stressor in depressed individuals. Similarly, the PA levels which were lower than those of non-depressed individuals prior to the stressor also decreased significantly when the daily stressor occurred. The impact of event-related affective changes on daily functioning is a promising research area that warrants further investigation. Research has demonstrated that reduced PA in the event of a daily stressor is likely to maintain and even predict future depression relapse (Rackoff & Newman, 2020).

In accordance with the mood brightening theory, depressed individuals experienced an increase in PA and decrease in NA significantly more than the non-depressed group in response to positive events. Thus, the MDD group appears to experience a greater advantage or gain from positive events than the non-MDD group, at least in terms of the magnitude of change in NA and PA following daily positive events (Panaite et al., 2018). This challenges the theoretical view of depression as involving intractable and high levels of NA (Koval et al., 2013). The findings also contradict most lab-based studies which generally detect an association of blunted affect irrespective of context in MDD (Rottenberg, 2005). From a therapeutic standpoint, the findings on affective reactivity to positive events were both informative and promising. The caveat, however, is that non-depressed individuals have significantly higher levels of PA and lower levels of NA to begin with

and thus there is limited room for change. On the other hand, depressed individuals have room for change, and introducing coping mechanisms to not only heighten these affect changes but also to maintain them is a vital research area that requires further investigation. Recent innovative interventions are now targeting increases in positive affect, not just decreases in negative affect, to improve transdiagnostic symptoms of depression, anhedonia, and anxiety in mental health patients (Craske et al., 2019; Dunn et al., 2019).

Limitations

Several limitations of this study should be noted. First, our study is based on a community population; therefore, generalization to mental health populations needs to be cautious warranting replication in a clinical population of MDD patients. Second, other comorbid psychiatric symptoms, including bipolar disorder, were not controlled other than generalized anxiety disorder and panic disorder. Importantly, bipolar disorder shares overlapping diagnostic criteria with MDD and is well known to be sensitive to positive affect. Due to the lack of information on bipolar disorder, we could not rule out whether some individuals within the MDD group actually had bipolar disorder, which in turn could account for some of the positive affect findings (Painter et al., 2019). Future studies could address whether other mental disorders have similar impacts on daily affective dynamics and reactivity. Third, the timeline for diagnosis of MDD was not fully known due to the time gaps between the diagnostic interview and daily diary assessments. Therefore, it is unclear how many of the MDD group were symptomatic and fulfilled diagnostic criteria at the time of completing the daily diary interviews, limiting generalization of the results to clinical samples. Further, the cross-sectional observational design of the current study does not inform about causal relationships (i.e., is the higher affective variability and reactivity in MDD caused by the development of MDD symptoms or vice versa?). Future studies using longitudinal or experimental design and multiple assessments could help to examine the directionality of the associations. Additionally, our measures on daily affect and daily events are based on subjective self-reported questionnaires which might produce reporting biases. Studies that utilize objective indicators of daily events and well-being could inform how these biases created by self-reported measures may impact the results. Next, DSM III R criteria was the basis for MDD diagnosis at the time of the study. The major difference between DSM III R and DSM 5 criteria would be the absence of the following criterion for MDD diagnosis in the DSM 5: "The symptoms are not better accounted for by bereavement (i.e., after the loss of a loved one, the symptoms persist for longer than 2 months or are characterized by marked functional impairment, morbid preoccupation with worthlessness, suicidal ideation, psychotic symptoms, or psychomotor retardation)." Thus, the DSM III

R excludes individuals from MDD who are experiencing symptoms of grief/sadness related to bereavement while the DSM 5 criteria do not. Finally, marginally significant interaction effects of daily stressor and MDD status on positive affect might indicate that the result did not produce statistically meaningful results. However, we found that there was a difference in simple slopes, which indicates that there might be meaningful difference in positive affective reactivity to daily stressors between two groups. Nevertheless, these results need to be interpreted with caution and replicated in different samples in future investigations. Future studies should measure cumulative stressors rather than relying on a binary measure of stressors.

Future Directions

Despite these limitations, our study has important implications for future investigation. Our study could warrant future studies in two areas: intervention-focused and symptom-trajectory-focused. Intervention-focused studies would benefit from investigating the impact of increasing affective stability with a particular focus on increasing PA. This may be achieved through interventions directed at increasing positive experiences in the lives of people with MDD. The second area of investigation focuses on the trajectory of changes in depressive symptoms based on longitudinal studies examining the link between the emergence of depressive symptoms, their maintenance, and the remission of symptoms based on changes in affective dynamics. This would provide clues on the stability of the mental health diagnosis over time and the factors associated with it (Keyes et al., 2010). The robustness, scope, and relative specificity of the brightening effect highlights the need to resolve conflicting findings across laboratory and ecological studies to advance the understanding of affective dynamic indices in MDD (Khazanov et al., 2019).

Additional Information

Data Availability The datasets generated during and analyzed during the current study are publicly available in the National Archive of Computerized Data on Aging (NACDA) repository https://www.icpsr.umich.edu/web/NACDA/studies/26841/versions/V2 (Ryff & Almeida, 2017; Ryff et al., 2018, 2021).

Code Availability Not applicable.

Author Contribution Not applicable.

Ethical Approval The study was approved by the IRB of the institution responsible for data collection and all respondents consented to their participation.

Consent to Participate Not applicable.

Consent for Publication Not applicable.

References

aan het Rot, M., Hogenelst, K., & Schoevers, R. A. (2012). Mood disorders in everyday life: A systematic review of experience sampling and ecological momentary assessment studies. *Clinical Psychology Review, 32*(6), 510–523.

Alloy, L. B., Liu, R. T., & Bender, R. E. (2010). Stress generation research in depression: A commentary. *International Journal of Cognitive Therapy, 3*(4), 380–388.

Almeida, D. M. (2005). Resilience and vulnerability to daily stressors assessed via diary methods. *Current Directions in Psychological Science, 14*(2), 64–68.

Almeida, D. M., Wethington, E., & Kessler, R. C. (2002). The daily inventory of stressful events: An interview-based approach for measuring daily stressors. *Assessment, 9*(1), 41–55. https://doi.org/10.1177/1073191102091006

Almeida, D. M., McGonagle, K., & King, H. (2009). Assessing daily stress processes in social surveys by combining stressor exposure and salivary cortisol. *Biodemography and Social Biology, 55*(2), 219–237.

Almeida, D. M., Marcusson-Clavertz, D., Conroy, D. E., Kim, J., Zawadzki, M. J., Sliwinski, M. J., & Smyth, J. M. (2020). Everyday stress components and physical activity: Examining reactivity, recovery and pileup. *Journal of Behavioral Medicine, 43*(1), 108–120.

American Psychiatric Association. (1987). *Diagnostic and statistical manual of mental disorders* ((3rd ed., rev.)). Author.

Bos, E. H., de Jonge, P., & Cox, R. F. (2019). Affective variability in depression: Revisiting the inertia–instability paradox. *British Journal of Psychology, 110*(4), 814–827.

Bylsma, L. M., Taylor-Clift, A., & Rottenberg, J. (2011). Emotional reactivity to daily events in major and minor depression. *Journal of Abnormal Psychology, 120*(1), 155.

Charles, S. T., Piazza, J. R., Luong, G., & Almeida, D. M. (2009). Now you see it, now you don't: Age differences in affective reactivity to social tensions. *Psychology and Aging, 24*(3), 645.

Charles, S. T., Piazza, J. R., Mogle, J., Sliwinski, M. J., & Almeida, D. M. (2013). The wear and tear of daily stressors on mental health. *Psychological Science, 24*(5), 733–741. https://doi.org/10.1177/0956797612462222

Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *Jama, 298*(14), 1685–1687.

Craske, M. G., Meuret, A. E., Ritz, T., Treanor, M., Dour, H., & Rosenfield, D. (2019). Positive affect treatment for depression and anxiety: A randomized clinical trial for a core feature of anhedonia. *Journal of Consulting and Clinical Psychology, 87*(5), 457.

Du Fort, G. G., Newman, S. C., & Bland, R. C. (1993). Psychiatric comorbidity and treatment seeking: Sources of selection bias in the study of clinical populations. *The Journal of Nervous and Mental Disease, 181*(8), 467–474.

Dunn, B. D., Widnall, E., Reed, N., Owens, C., Campbell, J., & Kuyken, W. (2019). Bringing light into darkness: A multiple baseline mixed methods case series evaluation of Augmented Depression Therapy (ADepT). *Behaviour Research and Therapy, 120*, 103418.

Dunn, B. D., German, R. E., Khazanov, G., Xu, C., Hollon, S. D., & DeRubeis, R. J. (2020). Changes in positive and negative affect during pharmacological treatment and cognitive therapy for major depressive disorder: A secondary analysis of two randomized controlled trials. *Clinical Psychological Science, 8*(1), 36–51.

Gilbert, K. E. (2012). The neglected role of positive emotion in adolescent psychopathology. *Clinical Psychology Review, 32*(6), 467–481.

Gruber, J., Kogan, A., Mennin, D., & Murray, G. (2013). Real-world emotion? An experience-sampling approach to emotion experience and regulation in bipolar I disorder. *Journal of Abnormal Psychology, 122*(4), 971.

Grzywacz, J. G., Almeida, D. M., Neupert, S. D., & Ettner, S. L. (2004). Socioeconomic status and health: A micro-level analysis of exposure and vulnerability to daily stressors. *Journal of Health and Social Behavior, 45*(1), 1–16.

Hammen, C. (1991). Generation of stress in the course of unipolar depression. *Journal of Abnormal Psychology, 100*(4), 555.

Hammen, C. (2006). Stress generation in depression: Reflections on origins, research, and future directions. *Journal of Clinical Psychology, 62*(9), 1065–1082.

Heininga, V. E., Van Roekel, E., Ahles, J. J., Oldehinkel, A. J., & Mezulis, A. H. (2017). Positive affective functioning in anhedonic individuals' daily life: Anything but flat and blunted. *Journal of Affective Disorders, 218*, 437–445.

Houben, M., Van Den Noortgate, W., & Kuppens, P. (2015). The relation between short-term emotion dynamics and psychological well-being: A meta-analysis. *Psychological Bulletin, 141*(4), 901.

Hox, J. J., Moerbeek, M., & Van de Schoot, R. (2017). *Multilevel analysis: Techniques and applications*. Routledge.

Husky, M. M., Mazure, C. M., Maciejewski, P. K., & Swendsen, J. D. (2009). Past depression and gender interact to influence emotional reactivity to daily life stress. *Cognitive Therapy and Research, 33*(3), 264–271.

Kessler, R. C., Andrews, G., Mroczek, D., Ustun, B., & Wittchen, H. U. (1998). The World Health Organization composite international diagnostic interview short-form (CIDI-SF). *International Journal of Methods in Psychiatric Research, 7*(4), 171–185.

Kessler, R. C., Merikangas, K. R., & Wang, P. S. (2007). Prevalence, comorbidity, and service utilization for mood disorders in the United States at the beginning of the twenty-first century. *Annual Review of Clinical Psychology, 3*, 137–158.

Keyes, C. L., Dhingra, S. S., & Simoes, E. J. (2010). Change in level of positive mental health as a predictor of future risk of mental illness. *American Journal of Public Health, 100*(12), 2366–2371. https://doi.org/10.2105/ajph.2010.192245

Khazanov, G. K., Ruscio, A. M., & Swendsen, J. (2019). The "brightening" effect: Reactions to positive events in the daily lives of individuals with major depressive disorder and generalized anxiety disorder. *Behavior Therapy, 50*(2), 270–284.

Koval, P., Pe, M. L., Meers, K., & Kuppens, P. (2013). Affect dynamics in relation to depressive symptoms: Variable, unstable or inert? *Emotion, 13*(6), 1132.

Lamers, F., Swendsen, J., Cui, L., Husky, M., Johns, J., Zipunnikov, V., & Merikangas, K. R. (2018). Mood reactivity and affective dynamics in mood and anxiety disorders. *Journal of Abnormal Psychology, 127*(7), 659.

Liu, Y., Bangerter, L. R., Rovine, M. J., Zarit, S. H., & Almeida, D. M. (2018). Intrinsic emotional fluctuation in daily negative affect across adulthood. *The Journals of Gerontology: Series B, 73*(1), 100–112. https://doi.org/10.1093/geronb/gbw159

Mroczek, D. K., & Kolarz, C. M. (1998). The effect of age on positive and negative affect: A developmental perspective on happiness. *Journal of Personality and Social Psychology, 75*(5), 1333–1349. https://doi.org/10.1037//0022-3514.75.5.1333

O'Leary, K., Bylsma, L. M., & Rottenberg, J. (2017). Why might poor sleep quality lead to depression? A role for emotion regulation. *Cognition and Emotion, 31*(8), 1698–1706.

Ong, A. D., & Ram, N. (2017). Fragile and enduring positive affect: Implications for adaptive aging. *Gerontology, 63*(3), 263–269.

Ong, A. D., & Steptoe, A. (2020). Association of positive affect instability with all-cause mortality in older adults in England. *JAMA Network Open, 3*(7), e207725–e207725. https://doi.org/10.1001/jamanetworkopen.2020.7725

Painter, J. M., Mote, J., Peckham, A. D., Lee, E. H., Campellone, T. R., Pearlstein, J. G., Moskowitz, J. T. (2019). A positive emotion regulation intervention for bipolar I disorder: Treatment development and initial outcomes. *General Hospital Psychiatry*, *61*, 96–103.

Panaite, V., Rottenberg, J., & Bylsma, L. M. (2020). Daily affective dynamics predict depression symptom trajectories among adults with major and minor depression. *Affective Science, 1*(3), 186–198.

Panaite, V., Koval, K., Dejonckheere, E., & Kuppens, P. (2018). Emotion regulation and mood brightening in daily life vary with depressive symptom levels. *Cognition and Emotion, 33*(6), 1291–1301. https://doi.org/10.1080/02699931.2018.1543180

Pearlin, L. I., & Bierman, A. (2013). Current issues and future directions in research into the stress process. In C. S. Aneshensel, J. C. Phelan, & A. Bierman (Eds.), *Handbook of the sociology of mental health*. Springer, Dordrecht: Handbooks of Sociology and Social Research. https://doi.org/10.1007/978-94-007-4276-5_16

Peeters, F., Nicolson, N. A., Berkhof, J., Delespaul, P., & deVries, M. (2003). Effects of daily events on mood states in major depressive disorder. *Journal of Abnormal Psychology, 112*(2), 203.

Peeters, F., Berkhof, J., Delespaul, P., Rottenberg, J., & Nicolson, N. A. (2006). Diurnal mood variation in major depressive disorder. *Emotion, 6*(3), 383.

Pfaltz, M. C., Michael, T., Grossman, P., Margraf, J., & Wilhelm, F. H. (2010). Instability of physical anxiety symptoms in daily life of patients with panic disorder and patients with posttraumatic stress disorder. *Journal of Anxiety Disorders, 24*(7), 792–798.

Piazza, J. R., Charles, S. T., Sliwinski, M. J., Mogle, J., & Almeida, D. M. (2013). Affective reactivity to daily stressors and long-term risk of reporting a chronic physical health condition. *Annals of Behavioral Medicine : A Publication of the Society of Behavioral Medicine, 45*(1), 110–120.

Rackoff, G. N., & Newman, M. G. (2020). Reduced positive affect on days with stress exposure predicts depression, anxiety disorders, and low trait positive affect 7 years later. *Journal of Abnormal Psychology, 129*(8), 799–809. https://doi.org/10.1037/abn0000639

Ram, N., & Gerstorf, D. (2009). Time-structured and net intraindividual variability: Tools for examining the development of dynamic characteristics and processes. *Psychology and Aging, 24*(4), 778–791. https://doi.org/10.1037/a0017915

Rottenberg, J. (2005). Mood and emotion in major depression. *Current Directions in Psychological Science, 14*(3), 167–170.

Ryff, C. D., & Almeida, D. M. (2017). *Midlife in the United States (MIDUS 2): Daily Stress Project, 2004-2009* Inter-university Consortium for Political and Social Research [distributor]. https://doi.org/10.3886/ICPSR26841.v2

Ryff, C., Almeida, D., Ayanian, J., Carr, D. S., Cleary, P. D., Coe, C., Williams, D. (2018). *Midlife in the United States (MIDUS 2): Milwaukee African American Sample, 2005-2006* Inter-university Consortium for Political and Social Research [distributor]. https://doi.org/10.3886/ICPSR22840.v5

Ryff, C. D., Almeida, D. M., Ayanian, J. Z., Carr, D. S., Cleary, P. D., Coe, C., Williams, D. R. (2021). *Midlife in the United States (MIDUS 2), 2004-2006* Inter-university Consortium for Political and Social Research [distributor]. https://doi.org/10.3886/ICPSR04652.v8

Schoevers, R., Van Borkulo, C., Lamers, F., Servaas, M., Bastiaansen, J., Beekman, A., Riese, H. (2021). Affect fluctuations examined with ecological momentary assessment in patients with current or remitted depression and anxiety disorders. *Psychological Medicine*, *51*(11), 1906–1915.

Scott, S. B., Sliwinski, M. J., Zawadzki, M., Stawski, R. S., Kim, J., Marcusson-Clavertz, D., Almeida, D. M. (2020). A coordinated analysis of variance in affect in daily life. *Assessment*, *27*(8), 1683–1698.

Sin, N. L., Graham-Engeland, J. E., & Almeida, D. M. (2015). Daily positive events and inflammation: Findings from the National Study of Daily Experiences. *Brain, Behavior, and Immunity, 43*, 130–138.

Sin, N. L., & Almeida, D. M. (2018). Daily positive experiences and health: Biobehavioral pathways and resilience to daily stress. In Carol D. Ryff & Robert F. Krueger (Eds.), *The Oxford handbook of integrative health science*. Oxford Library of Psychology.

Sin, N. L., Wen, J. H., Klaiber, P., Buxton, O. M., & Almeida, D. M. (2020). Sleep duration and affective reactivity to stressors and positive events in daily life. *Health Psychology, 39*, 1078–1088.

Tan, P. Z., Forbes, E. E., Dahl, R. E., Ryan, N. D., Siegle, G. J., Ladouceur, C. D., & Silk, J. S. (2012). Emotional reactivity and regulation in anxious and nonanxious youth: A cell-phone ecological momentary assessment study. *Journal of Child Psychology and Psychiatry, 53*(2), 197–206.

Telford, C., McCarthy-Jones, S., Corcoran, R., & Rowse, G. (2012). Experience sampling methodology studies of depression: The state of the art. *Psychological Medicine, 42*(6), 1119–1129.

Thompson, R. J., Mata, J., Jaeggi, S. M., Buschkuehl, M., Jonides, J., & Gotlib, I. H. (2012). The everyday emotional experience of adults with major depressive disorder: Examining emotional instability, inertia, and reactivity. *Journal of Abnormal Psychology, 121*(4), 819.

Vrshek-Schallhorn, S., Stroud, C. B., Mineka, S., Hammen, C., Zinbarg, R. E., Wolitzky-Taylor, K., & Craske, M. G. (2015). Chronic and episodic interpersonal stress as statistically unique predictors of depression in two samples of emerging adults. *Journal of Abnormal Psychology, 124*(4), 918.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063.