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ORIGINAL ARTICLE

Daily Interpersonal and Noninterpersonal Stress Reactivity in Current and Remitted Depression

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Abstract

Background Major stressful life events are known to predict depression onset, but relatively few studies have examined the interplay of daily stress and negative affect, particularly in clinical samples. Preliminary research has been inconclusive whether only current depression is characterized by amplified emotional reactivity to stress, or whether these patterns are equally strong in those with any history of depression.

Methods Twenty-three participants with current major depression, 38 with remitted depression, and 43 with no history of depression completed 2 weeks of ecological momentary assessment to examine reactivity to perceived stress, negative daily events, and interpersonal versus noninterpersonal daily events.

Results Currently depressed individuals demonstrated greater reactivity (i.e. greater increases in negative affect) in response to daily perceived stress, relative to previously depressed and never depressed individuals. Furthermore, while previously and never depressed individuals exhibited equal reactivity to interpersonal and noninterpersonal stress, currently depressed participants were particularly sensitive to interpersonal negative events.

Conclusions These microlongitudinal results extend prior longitudinal evidence of the critical role of interpersonal stress in the course of major depression. The findings emphasize the importance of cognitive interventions that target negative interpretations of daily events.

Keywords Stress reactivity · Depression · Interpersonal stress · Daily events · Perceived stress · Ecological momentary assessment

Major depressive disorder (MDD) is a prevalent and debilitating mood disorder characterized by high levels of global negative affect (NA) and diminished positive affect (American Psychiatric Association 2013). Although emotional dysfunction is a core feature of MDD, the temporal dynamics of negative emotion during depressive episodes are not fully understood, nor are potential similarities or differences in these dynamics compared with those who have recovered from depression (Trull et al. 2015). Traditional assessments of NA, adopted within MDD research, have measured mood globally over days, weeks, or months. However, affective experiences are dynamic, rather than static, with emotions changing frequently across contexts and over time. Microlongitudinal studies, in which emotions are measured several times across the day, have confirmed, in fact, that depressed individuals have greater variability and instability in NA than healthy controls, despite depression being broadly characterized as persistent low mood (for review, see Houben et al. 2015). Presumably, much of this emotional variability is triggered by situational cues, but surprisingly few studies have examined reactivity to real-life daily events within depressed samples. Further investigations examining emotional experience, including reactivity to stress, are needed to gain insight into daily affective patterns that may contribute to the development and/or the persistence of MDD.

Microlongitudinal approaches can identify daily affective processes that may parallel, or may diverge from, findings based on macro-level, longitudinal measures of stress and depressive symptoms. A robust body of literature has

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established that stressful life events predict the onset of major depressive episodes (e.g., Kendler et al. 2000; Monroe and Harkness 2005). Given the strength and consistency of these findings, it is imperative to identify how this process plays out over finite periods of time. If distinct patterns of daily affective responses exist in those acutely vulnerable to depression, this may provide another target for intervention. As Wichers (2014) notes, "very subtle and small differences between individuals in affect and their interplay with daily life context may eventually explain macro-scale individual differences in the course of MDD" (p. 1352). New insights into whether individuals with depression or a history of depression display heightened sensitivity to daily stress will expand our understanding of the complex stress-depression relationship.

Preliminary ecological momentary assessment (EMA) studies have examined whether daily stress events and NA may be causally and differentially linked within depressed individuals (Bylsma et al. 2011; Myin-Germeys et al. 2003; Peeters et al. 2003; Thompson et al. 2012; Wichers et al. 2009a). Using EMA, researchers can capitalize on intensive measurement to examine the near immediate effects of daily stress on emotion, rather than only the cumulative effects of multiple days' or weeks' events. Additionally, recall bias for daily events and variable emotional experiences are minimized.

Stress reactivity refers to within-subject change in affect following a negative daily event or as event-related stress increases.[1] Most people demonstrate this basic affective pattern with daily stressors leading to increases in NA (e. g., Suls et al. 1998; van Eck et al. 1998). Individual differences exist, however. Some individuals are able to quickly regulate their emotional state back to a baseline level of affect, i.e. minimal reactivity. Others are more highly reactive displaying a steeper increase in NA following the occurrence of a daily stressor. What is less established is whether reactivity is a static characteristic or if reactivity varies when other aspects of psychological functioning, such as mental health, fluctuate. The present study investigated if stress reactivity is uniquely prominent during depressive episodes, or if stress reactivity is a more stable factor associated with depression, equally present in those with current or remitted depression.

Within recent EMA and daily diary research, there are two competing models of how current MDD may be associated with stress reactivity. Consistent with the cognitive-behavioral model, the negative potentiation model states that depressed individuals selectively attend to negative stimuli and therefore may be *more* reactive to negative daily events, relative to reactivity in healthy controls. Alternatively, the emotion context insensitivity (ECI) model posits that MDD is characterized by *blunted* reactivity, meaning smaller increases in NA in response to negative stimuli or contexts (Bylsma et al. 2008). Initial findings do not conclusively support one hypothesis over the other. Two EMA studies reported that currently depressed individuals experience greater NA as activity-related stress increases, relative to controls (Myin-Germeys et al. 2003; Wicherset al. 2009a). Conversely, Peeters et al. (2003) described blunted reactivity to daily events. Furthermore, two investigations found no differences in strength of reactivity to negative events between currently depressed individuals and controls (Bylsma et al. 2011; Thompson et al. 2012). The present study continues this research line, similarly comparing stress reactivity between currently depressed and never depressed individuals while also including a third group with remitted depression.

Findings regarding reactivity in remitted depression relative to healthy controls are also inconclusive. One study reported heightened stress reactivity in previously depressed participants, relative to controls (Husky et al. 2009); one study found no differences between the groups (Johnson et al. 2008). Similar reactivity in current and remitted depression could mark the affective pattern as a more stable vulnerability factor that precedes depression, or could indicate that heightened reactivity is a lingering consequence of depression. If reactivity is only heightened within currently depressed individuals, this would suggest that stress reactivity is a dynamic characteristic that emerges soon before or during a depressive episode and then normalizes in recovery. Only one study to date has examined whether NA reactivity to negative daily events differs between currently and previously depressed individuals, finding comparable patterns of reactivity (Lamers et al. 2018).

These inconsistencies in stress reactivity findings regarding current and remitted depression may partially be due to method variance. The two EMA studies that found that individuals with current MDD experience heightened stress reactivity operationalized stress via perceived stress ratings (Myin-Germeys et al. 2003; Wichers et al. 2009a), while the two studies that did not find differences between those with current MDD and those with no history of MDD operationalized stress as negative event occurrence. Similarly, when stress was assessed via perceived stressfulness ratings, previously depressed participants demonstrated greater stress reactivity (Husky et al. 2009); when stress was assessed as event negativity or negative event occurrence, no group differences were seen between those with remitted MDD and no history of MDD, nor between those with remitted MDD and current MDD (Johnson et al. 2008; Lamers et al. 2018). The present study addressed this method variance by analyzing both reactivity to subjective, perceived stress ratings

[1] The terms "stress reactivity" and "emotional reactivity" have been used similarly in previous literature. We adopt the term stress reactivity here to emphasize the study's focus on emotional responses to external daily stressors, negative events or other daily stress.

and reactivity to more objective, checklist items of recent negative events.

Within stress reactivity, individuals may respond more strongly to some daily stress domains over others, with this pattern of response increasing risk for depression. *Interpersonal stress* traditionally refers to problems with romantic partners, peers, or family, while *noninterpersonal stress* refers to occupational, academic, or health difficulties. Two daily diary studies indicated that individuals who were reactive to daily interpersonal stressors later experienced greater depressive symptoms; reactivity to noninterpersonal stressors did not predict future depressive symptoms (O'Neill et al. 2004; Parrish et al. 2011). Likewise, longitudinal research indicates that interpersonal life events and interpersonal chronic stress are particularly predictive of the onset of depressive episodes when compared with noninterpersonal domains of stress (Sheets and Craighead 2014; Stroud et al. 2011; Vrshek-Schallhorn et al. 2014, 2015). While it is evident that exposure to interpersonal stress increases risk for depression, the means by which these stressors increase vulnerability relative to other stressors are not yet known. As noted by Vrshek-Schallhorn et al. (2015), one explanation may be that at-risk individuals are more emotionally sensitive to interpersonal than noninterpersonal stressors, with greater, swings of interpersonally-triggered NA cumulating into depressed mood over time. Thus, it may be useful to examine micro-level experience to gain this mechanistic knowledge (Wichers 2014). Few studies, however, have compared reactivity between daily stress domains, and none have examined differences in these patterns between groups with and without diagnosed depression. Evidence of a differential response to interpersonal daily stress, particularly in those with a history of depression, could help to explain the unique risks associated with interpersonal difficulties.

The primary aim of the present study was to examine differences in stress reactivity based on depression status. All participants were enrolled within a larger, longitudinal project on depression and stress during emerging adulthood. By this developmental phase, MDD is a leading cause of disability (Ferrari et al. 2013). Thus, it is imperative to understand how identifiable risk factors, such as stress reactivity, may relate to the course of MDD during this critical period of psychiatric vulnerability (Rohde et al. 2013). To our knowledge this is the first study to examine emotional reactivity to perceived stress and negative daily stress events in currently depressed, previously depressed, and never depressed individuals. Additionally, reactivity to interpersonal stress events and noninterpersonal stress events were compared between groups. Finally, appraisals of event expectedness, stressfulness, sense of control, and coping were examined as factors that may influence group differences in stress reactivity.

EMA was used to collect participants' emotional state and recent stress experiences four times per day for 14 consecutive days. The primary analyses examined models in which recent stress (e.g. over the past few hours) was expected to increase current NA, relative to periods in which less stress was experienced. Although several prior studies on stress reactivity have also examined positive affect as an outcome (Bylsma et al. 2011; Johnson et al. 2008; Myin-Germeys et al. 2003; Peeters et al. 2003; Thompson et al. 2012; Wichers et al. 2009a), the majority did not find group differences in change in positive affect; thus the current study focuses on NA. Consistent with prior EMA studies, we hypothesized that currently depressed participants would demonstrate an amplification of reactivity compared to never depressed controls, displaying a greater surge of NA following both recent perceived stress and the occurrence of negative events. Similarly, currently depressed participants were expected to demonstrate greater sensitivity to interpersonal versus noninterpersonal daily stress events. Due to the lack of prior research, hypotheses were not made regarding how previously depressed participants' stress reactivity patterns would compare to the currently depressed.

Method

Participants and Procedure

Participants were recruited by email announcements and fliers distributed at a college in the northeastern United States. Recruitment materials were aimed at first-year students who might currently be depressed or have previously been depressed, and were interested in joining a study on mood and stress. After contacting the first author by email, potential participants then received information about the larger project, a 3-year longitudinal study of emotion and stress, and were screened for depression status and history of bipolar disorder. Participants were compensated $30–35 for study session time and $1 for each survey completed within 30 min of an alert.

One hundred ten individuals attended the preliminary study session; participants provided informed consent and completed a laboratory task and questionnaires, including the Beck Depression Inventory-II (BDI) and Beck Anxiety Inventory (BAI). At the second study session, the mood episodes, psychotic screening, and anxiety disorders modules of the Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version (First et al. 2007) were administered by a licensed psychologist. Because the study aimed to compare current and remitted MDD with no history of depression, the inclusion criteria were broad. Exclusion criteria only included diagnosis of bipolar disorder or history of psychotic symptoms outside a mood episode. Participants

Table 1 Demographic and clinical characteristics

Characteristic	Current MDD ($n=23$)	Remitted MDD ($n=38$)	No MDD ($n=43$)
% Female	78.26%	71.05%	51.16%
% Caucasian	43.48%	73.68%	55.81%
Age in years (*SD*)	$18.74\ (0.69)_a$	$18.55\ (0.72)_a$	$18.42\ (0.76)_a$
BAI (*SD*)	$20.35\ (7.54)_a$	$15.42\ (8.27)_b$	$9.00\ (5.71)_c$
BDI-II (*SD*)	$23.17\ (6.95)_a$	$12.21\ (5.78)_b$	$8.07\ (5.69)_c$
Age of MDD onset (*SD*)	$14.00\ (3.50)_a$	$14.71\ (2.38)_a$	–
Estimated number of MDEs (*SD*)	$3.83\ (3.97)_a$	$1.92\ (1.92)_b$	–

Means with different subscripts differ at the $p=.05$ level

MDD major depressive disorder, *BDI-II* Beck Depression Inventory-II, *BAI* Beck Anxiety Inventory, *MDE* major depressive episode

categorized as current MDD met DSM-IV criteria for a current major depressive episode (MDE). Participants categorized with remitted MDD met DSM-IV criteria for at least one prior MDE but were not depressed when they enrolled in the project. Due to concerns about the quality of recall for mood experiences during childhood or early adolescence, MDD diagnosis focused on the high school years to present. Participants in partial remission, with 1 to 4 remaining MDE symptoms, were included in the remitted MDD group. Control participants had no history of MDD. One prospective participant chose not to return for the diagnostic interview session; one participant was excluded due to bipolar disorder. Thus, a total of 108 participants were enrolled in the study: 23 met criteria for current MDD, 42 met criteria for remitted MDD, and 43 had no history of MDD.[2]

Analyses comparing group differences in depression severity supported the diagnoses. A one-way ANOVA confirmed the expected differences in BDI, $F(2, 105) = 39.17$, $p < .001$. Participants with current MDD reported higher depressive scores than those with remitted MDD, who reported higher scores than controls, $ps < .001$. There were similar group differences in anxiety severity as measured by the BAI, $F(2, 105) = 19.98$, $p < .001$. Individuals with current MDD reported greater anxiety than those with remitted MDD, who reported greater anxiety than controls, $ps < .009$.

The majority of participants were female (65.7%). In the sample, 10.2% identified as African-American/Black, 15.7% as Asian, 60.2% as Caucasian, 2.8% as Latino/Latina/Hispanic, 9.3% as Multiracial, and 1.9% as Other. Income or socioeconomic status data were not collected. Because the larger project investigated depression in emerging adulthood, participants were 18.54 years old on average at enrollment (range 18–22). All participants were first-year college students at the time of study entry. Table 1 provides demographic and clinical characteristics of the diagnostic groups.

At the end of the second session, following the diagnostic interview, participants were trained in the EMA protocol. EMA data were collected on Samsung Blackjack II i617 phones, which did not have active cellular or Wi-Fi service, using the open source EMA tool MyExperience (Froehlich et al. 2007). Participants were given general instructions on operating the device. They then completed a practice survey as an opportunity to clarify each item and were provided with an instruction manual. As soon as the second session ended, the EMA protocol began.

Participants carried the devices for the following 14 days. The phones were programmed through MyExperience to alert participants randomly, four times per day, between 9:00 AM and 11:00 PM, for a total of 56 survey alerts (Johnson et al. 2008). Alerts were spaced apart 2 or more hours; participants were compensated for each survey completed within 30 min of an alert. In addition to this signal-contingent design, participants were instructed, both during the second study session and in the instruction manual, to initiate a survey when they felt "stressed or upset" (an event-contingent component). Participant-initiated surveys did not affect the signal-contingent sampling schedule. Each survey included the same primary questions in the same order. The 108 participants submitted a total of 3537 usable surveys ($M = 32.75$, $SD = 11.30$); 95 (2.94%) were event-contingent rather than signal-contingent surveys. On the 14th day of assessment, participants returned for the third session to return the device and complete additional questionnaires.

[2] The difference in group sample size was due to the prevalence of current MDD, relative to remitted MDD or no history of MDD, within the larger project's specific window for study entry, the first year of college.

Measures

Diagnostic Interview

The Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version (SCID) is a commonly used semi-structured interview, which assesses current and lifetime diagnoses of Axis I disorders (First et al. 2007). The SCID was administered to determine study eligibility and depression status. Interrater reliability within our research team has been excellent for MDD diagnosis, $\kappa = 0.91$ for 25 SCID interviews.

Baseline Depression Severity

The Beck Depression Inventory-II (BDI-II; Beck et al. 1996) is a 21-item self-report measure designed to assess the severity of depression symptoms. Higher scores indicate greater depressive symptomatology. The scale had good internal consistency in this study (Cronbach's alpha = 0.88).

Baseline Anxiety Severity

The Beck Anxiety Inventory (BAI; Beck et al. 1988) is a 21-item self-report measure designed to assess anxiety severity. Higher scores indicate greater anxiety symptoms. The scale had good internal consistency in this study (Cronbach's alpha = 0.87).

Ecological Momentary Assessment

Each EMA survey began with participants' current context (location, activities, and persons present). Participants then reported their *current* emotional state, at the time of the survey, by rating affect words or phrases, adapted from the Positive and Negative Affect Schedule-Expanded Form (Watson and Clark 1999). Each item was rated from 1 ("not at all") to 5 ("extremely"). Current NA was calculated by summing the Sad, Alone, Angry with Self, Guilty, Lonely, and Hopeless items. Per Shrout and Lane (2012), the between-subject reliability for current NA was high at .97. As expected for momentary assessment, the within-subject NA ratings were more variable but still demonstrated adequate reliability at .78.

Subjective, general perceived stress was then rated. Participants indicated how "stressed or anxious" they had been since their last survey response from 1 ("not at all") to 5 ("extremely stressed"). Previous research has supported the validity of single-item measures of subjective stress (Littman et al. 2006).

"Negative stress events" were assessed through a series of dichotomous items, modeled after previous daily stressor checklists (O'Neill et al. 2004; Wenze et al. 2009). Participants were asked if, since their last response, they (1) had an argument/conflict/disagreement with anyone, (2) got a bad academic grade, (3) experienced a negative event related to your job, (4) were ignored or snubbed by someone, (5) were physically ill or injured, (6) were let down or disappointed by someone, or (7) experienced some other type of negative event. Participants typed in a brief description if "other" event was selected. An a priori distinction was made between interpersonal and noninterpersonal negative events. Conflicts/arguments, being ignored/snubbed, and being let down/disappointed were categorized as interpersonal, while negative experiences related to one's job, with academics, or being ill/injured were noninterpersonal, consistent with O'Neill et al. (2004). "Other" negative event descriptions, such as "having to interact with my ex" and "my laptop broke down again," were individually coded as interpersonal (N = 70) or noninterpersonal (N = 143) by the first author. As a reliability check, a research assistant also coded all "other" responses, which indicated high reliability in the coding scheme, $\kappa = 0.81$.

When a participant indicated that a negative event had occurred, the survey immediately branched into event appraisal questions. Participants rated how expected the event was from 1 ("completely unexpected") to 5 ("fully expected"). Stressfulness of the event was rated from 1("minor annoyance") to 5 ("extremely stressful"). Sense of control over the event was rated from 1 ("no control") to 5 ("complete control"). Finally, participants rated how well they coped with the event from 1 ("definitely not effective") to 5 ("definitely effective"). These appraisal items were selected to correspond with prior stress reactivity research (Bylsma et al. 2011; O'Neill et al. 2004).

Statistical Analyses

EMA data have a hierarchical structure in which repeated measures (Level 1) are clustered within individuals (Level 2). To account for this nonindependence of data, all hypotheses were tested using multilevel modeling with the SAS (version 9.3) MIXED procedure. Multilevel modeling provides estimates of both fixed effects (intercepts and slopes) and random effects (between-subjects differences in intercepts and slopes). Multilevel modeling also is robust to missing data, and therefore does not require that all participants provide an equal number of observations. Data were modeled with restricted maximum likelihood estimation and an unstructured covariance matrix. To account for time-related dependency in the outcome variables, the spatial power error structure was used. This approach, rather than the first-order autoregressive AR(1) error structure, is more appropriate with variable-interval designs, such as EMA (Bolger and Laurenceau 2013).

In order to rule out time effects, particularly reactivity to repeated measurement, as the link between predictor and outcome variables, time was included as a predictor in all models. Time was rescaled such that a 1-unit increase corresponded with the passage of 1 day, and was centered such that 0 was the middle of the 14-day assessment period.

In order to control for potential lingering effects of prior stress and stress events, two lagged variables with the prior assessment's perceived stress rating and dichotomous negative event value were created and then grand-mean centered. The final dataset contained only those observations (N = 3230) for which lagged variables represented data provided within the prior 24 h (average lag = 8.18 h, *SD* = 1.27). Four participants, all from the remitted depression group, had fewer than 5 observations in the final dataset and therefore were not included in analyses (Bolger and Laurenceau 2013), providing a final sample of 104 participants. We adopted a conservative approach in specifying degrees of freedom, in which they were based on the number of participants rather than the total number of observations.

Group Differences in NA, Perceived Stress, and Number of Stress Events

Initial models examined differences in average NA, average perceived stress ratings, and average number of negative stress events, with group (current depression, remitted depression, or no history of depression) entered as a class variable. Differences in the interpersonal and noninterpersonal stress events also were examined.

Stress Reactivity as a Function of Depression Status

Comparisons of individuals with current depression, remitted depression, and no history of depression were accomplished with two dummy codes, using current depression as the reference group. The primary analyses of interest examined models in which a recent stress event, or perceived stress level, was hypothesized to increase current NA. It was expected that frequency of stress events, and perceived stress ratings, would vary both between- and within-subjects. If raw event scores (whether or not an event happened since the last response) were analyzed as a predictor of NA, the resulting coefficient would be a weighted average of the between- and within-subjects relationships of events with NA (Allison 2009). Significant results could be artifacts of between-subjects differences in average stress, rather than evidence of group differences in stress reactivity. To address this, we followed the recommendations of Bolger and Laurenceau (2013), creating two orthogonal versions of each stress variable that separated the between- and within-subjects components. By separating these components, we obtained correct estimates of the effect of within-subjects variation in stress on NA, a primary coefficient of interest. As an example, *within-subjects perceived stress* was computed by subtracting the participant's average perceived stress from each raw perceived stress rating, thus reflecting the within-subjects deviation. *Between-subjects perceived stress* was computed by subtracting the grand mean of perceived stress ratings from the participant's average perceived stress. This Level 2 variable was the same within a participant across assessments, while within-subjects perceived stress varied from assessment to assessment. Similar variables were calculated to estimate within-subjects variation in negative events occurring or not (e.g. between- and within-subjects negative event), interpersonal negative events occurring or not, and noninterpersonal events occurring or not. Finally, between and within-subjects components were computed for an interpersonal versus noninterpersonal event occurring.

Separate models were estimated for reactivity to perceived stress since the last response and reactivity to any negative event since the last response. Separate models then examined reactivity to an interpersonal stress event and reactivity to a noninterpersonal stress event. A final, fifth model directly examined differences in level of NA following an interpersonal event versus level of NA following a noninterpersonal event. All intercepts and slopes were allowed to vary for Level 1 predictors.

To test for moderation by depression status, cross-level interactions between within-subjects stress (Level 1) and the depression dummy codes (Level 2) were examined. Based on the group coding scheme, a positive significant slope for the within-subjects stress variable indicated reactivity within the currently depressed group, while significant cross-level interactions indicated differences in strength of reactivity between groups. Figures depicting cross-level interactions were prepared using the interaction utilities by Preacher et al. (2006; see https://quantpsy.org/interact/index.html).

Group Differences in Event Appraisals

Finally, to examine factors that might influence group differences in stress reactivity, a separate dataset was created containing only those assessments (N = 656) in which a negative event was reported. Differences in event appraisals (how expected was the event, how stressful, how much control did the participant have, and how well did he/she cope) were analyzed, with group examined as a class variable. All intercepts were allowed to vary.

Results

Compliance

Participants received an average of 48.97 (*SD* = 8.69) survey alerts over the 14-day period. An average of 31.44

Table 2 Average negative affect, perceived stress, and negative events by group

Variable	Current MDD ($n=23$)	Remitted MDD ($n=38$)	No MDD ($n=43$)
Negative affect (NA)	10.66 (0.48)[a]	8.94 (0.38)[b]	7.99 (0.35)[b]
Perceived stress since last response	2.46 (0.14)[a]	2.21 (0.11)[a]	1.90 (0.10)[b]
Negative events since last response	0.35 (0.05)[a]	0.24 (0.04)[a]	0.24 (0.04)[a]
Interpersonal negative events since last response	0.21 (0.03)[a]	0.14 (0.03)[a]	0.15 (0.02)[a]
Noninterpersonal negative events since last response	0.13 (0.02)[a]	0.09 (0.02)[a]	0.08 (0.01)[a]

Marginal means estimated using the SAS MIXED procedure, controlling for time. Standard errors are provided in parentheses. Means with different subscripts differ at the $p=.05$ level

MDD major depressive disorder

($SD=11.21$) surveys were completed within 30 min of an alert. The mean compliance rate of 63% ($SD=0.17$) is comparable to other studies (e.g. 65% in Bylsma et al. 2011) and is respectable given the 14-day EMA protocol. It was expected that timely responses would not always be possible, such as in a meeting or class, but the 30-min window was adopted following the recommendation of Scollon et al. (2003). Groups did not differ in number of surveys completed within 30 min or compliance rate, $ps>.30$.

Group Differences in NA, Perceived Stress, and Number of Stress Events

We analyzed whether currently depressed participants reported greater average NA and perceived stress (see Table 2). As expected, currently depressed participants reported greater NA than those with no history of depression, $t(103)=4.48$, $p<.001$, and those with remitted depression, $t(103)=2.82$, $p=.006$. Participants with remitted depression did not report greater NA than the never depressed. Currently depressed participants reported greater perceived stress than those with no history of depression, $t(103)=3.34$, $p=.001$. Participants with remitted depression also reported greater perceived stress than the never depressed, $t(103)=2.10$, $p=.038$. Participants with current versus remitted depression did not differ in perceived stress.

We also examined whether group status predicted the number of stress events reported and, more specifically, number of interpersonal or noninterpersonal stress events reported. There were no group differences in frequency of stress events, all $ps>.065$.

Stress Reactivity as a Function of Depression Status

First, the intraclass correlation (ICC) for NA was computed to describe the proportion of total variance at the between-subjects level. An ICC of 0.40 indicated that 40% of the observed variation in NA was due to differences between participants, thus 60% was attributable to within-person variation.

Stress reactivity was analyzed using multilevel models that separated between-subjects and within-subjects aspects of reactivity to stress in order to focus on the within-subjects causal process of greater stress predicting greater NA (Bolger and Laurenceau 2013). Stress was reported retrospectively, "since the last response," while NA was current emotions at the time of assessment. We predicted that within-subjects reactivity would be stronger for currently depressed participants, indicating that increases in daily stress led to greater surges of NA. Our hypotheses focused on fixed effects; random effects estimates indicated substantial between-subjects variability in the reactivity slopes, all $zs>2.64$, $ps<.005$.

All groups demonstrated within-subjects reactivity to recent perceived stress, or a positive within-subjects perceived stress slope, such that increases in perceived stress ratings predicted higher NA (all $ps<.001$). Importantly, depression status moderated reactivity, such that reactivity was greater for the currently depressed compared to the never depressed participants, $t(97)=2.78$, $p=.007$, and previously depressed participants, $t(97)=2.40$, $p=.018$; estimates and standard errors for the reactivity analyses are provided in Table 3. As perceived stress increased, currently depressed participants experienced greater intensification of NA, relative to the increases experienced by other participants. Previously and never depressed participants demonstrated similar reactivity to perceived stress, $t(97)=0.37$, $p=.709$. Figure 1 presents reactivity to perceived stress, moderated by depression status.[3] Because time in hours and lagged stress were included in the model, results were not due to temporal change or lingering effects of recent stress.

The significant slope for between-subjects stress indicated that currently depressed individuals with higher average

[3] Although gender differences were not a primary focus of the study, gender was examined as a possible moderator of stress reactivity. Gender did not moderate reactivity to negative events, interpersonal negative events, or noninterpersonal negative events, all $ps>.145$. Women did experience greater intensification of NA as perceived stress level increased, $t(100)=2.37$, $p=.020$.

Table 3 Summary of parameter estimates for multilevel models of negative affect (NA)s

Fixed effects (intercepts, slopes)	Perceived stress			Any negative event			IP negative event			NonIP negative event		
	Estimate	SE	p	Estimate	SE	p	Estimate	SE	p	Estimate	SE	p
Intercept	9.92	0.39	< .001	10.39	0.44	< .001	10.28	0.44	< .001	9.82	0.43	< .001
Remitted MDD	− 1.05	0.47	.028	− 1.20	0.55	.030	− 1.17	0.55	.034	− 0.93	0.53	.081
No MDD	− 1.37	0.47	.004	− 2.24	0.54	< .001	− 2.26	0.53	< .001	− 1.81	0.52	< .001
Within stress (for current MDD)	1.68	0.18	< .001	2.78	0.41	< .001	3.44	0.56	< .001	2.13	0.46	< .001
Within stress × remitted MDD	− 0.55	0.23	.018	− 0.82	0.52	.117	− 1.68	0.72	.022	0.02	0.59	.971
Within stress × no MDD	− 0.62	0.22	.007	− 1.08	0.51	.035	− 1.45	0.69	.040	− 0.79	0.59	.185
Between stress (for current MDD)	2.33	0.48	< .001	6.40	2.02	.002	7.08	2.13	.001	7.68	2.57	.004
Between stress × remitted MDD	− 1.00	0.62	.113	0.04	3.10	.989	2.13	3.43	.537	− 3.09	3.54	.385
Between stress × no MDD	− 0.44	0.64	.486	− 1.09	3.06	.724	− 3.11	3.59	.389	− 2.21	3.81	.563
Lagged stress	0.15	0.06	.013	0.44	0.15	.004	0.45	0.16	.005	0.27	0.13	.046
Time	0.03	0.02	.040	0.04	0.02	.063	0.04	0.02	.089	0.03	0.02	.131

N = 104 participants, 3230 observations

IP interpersonal, *MDD* major depressive disorder

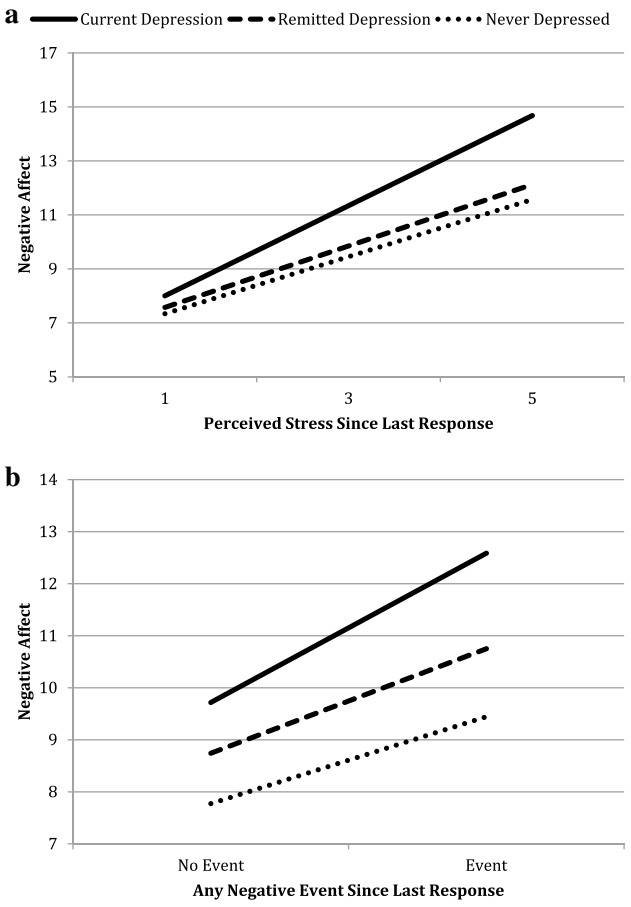

Fig. 1 Negative affect as a function of perceived stress and depression status (**a**) and negative daily events and depression status (**b**)

stress reported higher NA, $t(97) = 4.84$, $p < .001$; this effect was not moderated by depression status. Between-subjects slopes are reported in Table 3 but were not a primary focus for the study.

After demonstrating that depression status moderated reactivity to subjective stress, the remaining analyses focused on response to negative events, arguably a more objective measure of daily stress. Similar to perceived stress, all groups experienced greater NA following a negative event than following periods in which a negative event had not occurred (i.e. a positive slope, all $ps < .001$). Reactivity again was moderated by depression status with currently depressed participants demonstrating a stronger response to negative events than those without a history of depression, $t(97) = 2.14$, $p = .035$. There was not a significant difference in reactivity between participants with remitted depression and those with current depression, $t(97) = -1.58$, $p = .117$, or those with no history of depression, $t(97) = 0.59$, $p = .557$; see Fig. 1.

Analyses then focused more specifically on reactivity to interpersonal negative events relative to periods when an interpersonal event had not happened. All groups reported greater NA following an interpersonal negative event (all $ps < .001$). Currently depressed participants continued to demonstrate greater sensitivity than both the never depressed, $t(97) = 2.09$, $p = .040$, and previously depressed participants, $t(97) = 2.34$, $p = .022$. Previously and never depressed participants demonstrated similar reactivity to interpersonal events, $t(97) = 0.38$, $p = .703$. While each group also demonstrated within-subjects reactivity to non-interpersonal events (all $ps < .001$), depression status did not moderate non-interpersonal reactivity, all $ps > .13$. Figure 2

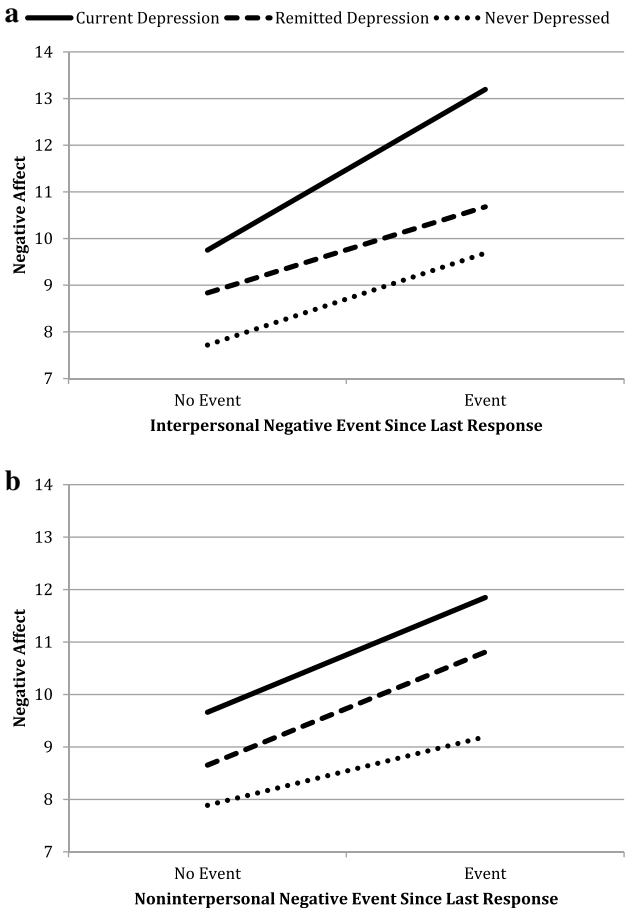

Fig. 2 Negative affect as a function of interpersonal negative events and depression status (**a**) and noninterpersonal negative events and depression status (**b**)

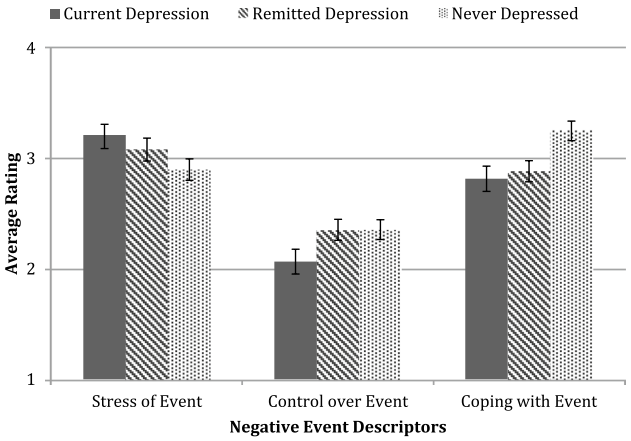

Fig. 3 Event appraisals by depression status, indicating average event-related stress, sense of control over the event, and subjective coping. Error bars represent standard errors

presents reactivity to interpersonal and noninterpersonal negative events.

A final model compared response to interpersonal negative events versus non-interpersonal negative events. Instead of examining level of NA when negative events did versus did not happen, this analysis compared NA following the two types of events. Only assessments that included one but not both types of events were included in this follow-up analysis (N = 605). A positive slope would indicate stronger affective response to interpersonal than non-interpersonal negative events. Only the currently depressed group demonstrated stronger response to interpersonal versus non-interpersonal events, B = 1.98, $p < .001$. Slopes for the previously depressed, B = − 0.11, $p = .863$, and never depressed, B = 0.33, $p = .555$, were not significant. Depression status moderated interpersonal versus non-interpersonal response, with currently depressed individuals showing greater sensitivity to interpersonal events than those with no history of depression, $t(97) = 2.05$, $p = .043$, or remitted depression, $t(97) = 2.41$, $p = .018$.[4]

Group Differences in Event Appraisals

To explore whether group differences in reactivity might partially be explained by differences in event appraisals, we examined whether group status predicted four subjective event descriptors: how expected was the event, how stressful was the event, how much control did the participant have over the event, and how well did they cope. In order to include all event data, average ratings for any negative event (rather than interpersonal only or noninterpersonal only) were analyzed. Multilevel models revealed no group differences in anticipation, or how expected events were. However, currently depressed participants rated events as more stressful, on average, than those with no history of depression, $t(103) = 2.01$, $p = .048$. Participants with remitted depression did not differ from either group in average event-related stress. Currently depressed participants also reported less sense of control over events than the never depressed, $t(103) = -2.02$, $p = .046$. Participants with remitted depression did not differ from either group in sense of control. Finally, currently depressed participants reported poorer coping with negative events than those without a history of depression, $t(103) = -2.99$, $p = .004$, as did

[4] All stress reactivity models were re-analyzed to control for gender and baseline anxiety symptoms. There were no changes in the statistical significance of group differences in reactivity to perceived stress, to all negative events, to interpersonal events, or to noninterpersonal events. The only change in moderation results was that, compared with those with no history of depression, participants with current depression were no longer significantly more reactive to interpersonal versus noninterpersonal events, $t(97) = 1.86$, $p = .067$.

previously depressed participants, $t(103) = -2.81$, $p = .006$. Participants with current versus remitted depression did not differ in subjective coping. Marginal means for event appraisals are depicted in Fig. 3.

Discussion

Although MDD is characterized by high global NA, depressed individuals experience greater variability and instability in NA than healthy controls (Houben et al. 2015). Surprisingly few studies, however, have examined the situational cues that trigger this emotional variability. An ecological momentary assessment approach allows for fine-grained analysis of this temporal relationship. The present study was novel in its use of 14 days of EMA to compare reactivity to daily stress in those diagnosed with MDD, those with remitted MDD, and never depressed controls. To our knowledge, this is the first study to compare stress reactivity in all three groups. Reactivity to both subjective, perceived stress ratings and reactivity to more objective, checklist items of recent negative events were examined, as was differential response to interpersonal versus non-interpersonal stressors. Additionally, differences in event appraisals that may partially explain the observed patterns of stress reactivity were examined. As noted by Wichers (2014), subtle, recurring alterations in affective experiences, such as greater NA reactivity to daily stress, may mediate other risk factors known to impact psychopathology.

Our primary hypotheses were supported with currently depressed participants generally demonstrating heightened stress reactivity relative to previously depressed and never depressed participants. While all groups demonstrated emotional responses to stress, reactivity was amplified for those with current MDD. Importantly, the between- and within-subjects components of stress were separated in these multilevel models, so the results cannot be an artifact of between-subjects differences in average stress. Additionally, because time in hours and lagged stress were included in the model, results were not due to temporal change or lingering effects of recent stress. As subjective, perceived stress increased, currently depressed individuals experienced significantly greater intensification of NA, relative to the increases in NA experienced by other participants. Similarly, currently depressed participants reported greater NA following negative daily events than healthy controls. We believe this is the first study to find evidence of greater reactivity to negative daily events in those with current MDD.

Research on stress reactivity in individuals with a history of MDD has been inconclusive to date, but these findings replicate two EMA studies reporting heightened reactivity to perceived stress in currently depressed individuals, compared with healthy controls (Myin-Germeys et al. 2003; Wichers et al. 2009c), and one study reporting no differences in previously depressed individuals and healthy controls (Johnson et al. 2008). Evidence that reactivity both to perceived stress and to interpersonal negative events was heightened in currently depressed individuals, relative to those with remitted depression, suggests that stress reactivity is a dynamic characteristic that emerges soon before or during a depressive episode and then normalizes in recovery. Larger-scale research, with microlongitudinal assessment of the same participants both in and out of depressive episodes, is needed to confirm this pattern. It would be particularly useful to know whether stress reactivity re-emerges before the onset of a new MDE. Evidence that stress sensitivity precedes full MDE onset would mark this as an important target for depression prevention.

Knowing that appraisals are an important link between stress and affect, group differences in event appraisals were examined. Currently depressed participants reported less of a sense of control over events, rated negative daily events as more stressful, and indicated poorer coping than those with no history of depression; this extends prior evidence of heightened stress appraisals within current MDD (Bylsma et al. 2011; Myin-Germeys et al. 2003; Peeters et al. 2003). Taken together, the reactivity and appraisal results suggest that cognitive vulnerabilities to stress and NA at the daily level are partially state-dependent, being most prominent during a MDE rather than being consistently present in both current and remitted depression.

The stress reactivity pattern revealed in the present study is a real-life process in need of intervention. Evidence of greater stress reactivity in individuals with current MDD diverges from research suggesting that MDD may be characterized by blunted emotional response to negative events, or emotion context insensitivity (Rottenberg 2005). Instead, these findings support cognitive models showing that greater global NA during a depressive episode facilitates interpretation biases and the activation of dysfunctional cognitions (e.g. Beck et al. 1979). Increased activation of negative cognitions may lead to heightened emotional reactivity to daily stressors. Supporting this, prior research indicated that those who ruminated following a daily stressor experienced a greater elevation of NA, and MDD symptoms in the moment (Connolly and Alloy 2017; Ruscio et al. 2015). Additionally, rumination mediated the association between appraised stressfulness and NA; this mediation was stronger among individuals with MDD than healthy controls (Ruscio et al. 2015). The present results support cognitive therapy approaches that target immediate, automatic interpretations of stressors; cognitive therapy has been shown to reduce daily stress reactivity, along with daily reactivity to negative thoughts (Parrish et al. 2009). Given that heightened

NA is a core feature of major depression, improvement in event appraisal and stress reactivity may facilitate recovery from MDD.

Beyond establishing general sensitivity to stress among those currently depressed, the present study also identified a differential response to interpersonal versus noninterpersonal stressors. Individuals in the midst of depression were particularly sensitive to interpersonal negative events, demonstrating greater increases in NA, while previously and never depressed individuals responded similarly to events regardless of the stressor domain. Nezlek and Gable (2001) suggested that depressed individuals' compromised sense of self-worth may make them more sensitive to negative (and positive) daily events. During depressive episodes, self-esteem may become highly contingent on environmental events, leaving depressed individuals more affected by daily stressors. The feelings of loss, humiliation, or rejection associated with interpersonal stress may particularly diminish one's sense of self-worth. This study's results suggest that interpersonal events may influence self-worth more than noninterpersonal events, consequently heightening NA. However, further EMA research is needed to elucidate the role of diminished self-worth, and other negative cognitions, in amplifying interpersonal stress reactivity during depression.

To date, interpersonal sensitivity primarily has been conceptualized as a static characteristic associated with depression vulnerability, such as work examining sociotropy, rejection sensitivity, or neuroticism more broadly (Beck 1983; Downey and Feldman 1996; Kendler et al. 2004). This research posits that when interpersonally sensitive individuals experience interpersonal stress, they struggle to regulate the resulting NA, which makes them particularly vulnerable to depression (Parrish et al. 2011). The distinct reactivity patterns in currently versus previously depressed individuals seen in the present study suggests that interpersonal stress reactivity is a dynamic phenomenon that varies within individuals, becoming more pronounced with pathological changes in mood. Traits such as neuroticism may moderate level of reactivity, but general, and particularly interpersonal, reactivity appear to be unique, dynamic processes that are independently related to depressive symptoms (O'Neill et al. 2004; Suls et al. 1998).

Strengths and Limitations

The methodological design of the present study has several strengths. The EMA approach allowed for analysis of within-person variation in stress and affect, while other longitudinal approaches rely more heavily on between-person variability in stress experiences. Additionally, retrospective recall bias was decreased while the assessment of real-life stressors rather than a laboratory paradigm improved ecological validity. Fourteen days of assessment allowed for more robust assessment of daily stress and resulting NA across a range of contexts. Finally, the inclusion of both subjective ratings of recent perceived stress and more objective, checklist items of recent negative events allowed for broader assessment of stress experiences.

Several limitations should also be noted. First, current emotional state and recent stress events were assessed simultaneously. While current emotional state cannot influence the occurrence of prior events, it may impact the recall and reporting of events. EMA stress assessments are dependent on self-report, as there are no feasible means to verify stress events several times per day. Similarly, an unavoidable limitation of EMA research is that context-based ratings of stress events, used in traditional longitudinal research, are not practicable. It is possible that participants with current MDD experienced qualitatively different, more challenging daily events, which contributed to heightened stress reactivity. In microlongitudinal projects with multiple assessments per day, it is not feasible to collect enough detail about a specific event to fully understand and code its unique context. However, future stress reactivity research could incorporate a baseline interview of participants' ongoing stress conditions, such as chronic family conflict, limited social connections, or financial challenges. This would allow researchers to examine whether having to endure more stressful ongoing conditions partially accounts for heightened reactivity to daily stress.

Noninterpersonal negative events were less frequent than interpersonal events; the limited number of noninterpersonal events experienced over the 14-day period may have impacted the reactivity results. Future studies could expand the types of noninterpersonal daily events that are assessed. Another study limitation is that the depression groups were not of equal size. With 23 participants in the current MDD group, it will be important to replicate these findings in a larger overall sample. Finally, this study focused on depression during emerging adulthood, a critical period for MDD onset and recurrence (Rohde et al. 2013). It is possible that the observed patterns of stress reactivity could differ among older individuals with more experience coping with daily stressors.

Future Directions

The project points to several paths for future research. Future projects with complex microlongitudinal and prospective designs are needed to determine whether heightened reactivity, and particularly sensitivity to interpersonal stress, is causally linked to MDE onset or emerges within episodes. Traditional longitudinal approaches consistently

indicate that major interpersonal life events and interpersonal chronic stress are unique predictors of MDE onset (Sheets and Craighead 2014; Stroud et al. 2011; Vrshek-Schallhorn et al. 2014, 2015). Furthermore, in a daily diary study, individuals who were more reactive to daily interpersonal stressors went on to experience greater depressive symptoms two months later; reactivity to noninterpersonal stressors did not predict future depressive symptoms (O'Neill et al. 2004). Reactivity to interpersonal stressors again predicted depressive symptoms in a follow-up study, but greater baseline depressive symptoms did not predict later reactivity, suggesting that the relationship between interpersonal stress reactivity and depressive severity is unidirectional (Parrish et al. 2011). Similarly, baseline stress sensitivity assessed via EMA predicted increases in depressive symptoms as well as the onset of new depressive episodes in women without a history of depression (Wichers et al. 2009b). The present study's findings suggest that sensitivity to interpersonal stressors may not be stable across long periods of time. Future projects with multiple intensive phases of microlongitudinal assessment are needed to confirm whether heightened interpersonal sensitivity is prodromal to a full MDE or whether reactivity follows the emergence of a new episode.

Additionally, further investigation of the association of stress reactivity with more distal predictors of MDD risk, such as childhood adversity, is needed. Preliminary evidence indicates that individuals who experience childhood trauma before age 10 demonstrate increased reactivity to daily stresses in adulthood (Glaser et al. 2006). Of note, childhood adversity did not increase subjective perceptions of daily event stress but did predict greater NA following the same level of stressfulness. Wichers et al. (2009c) similarly reported that childhood adversity predicted greater NA reactivity to daily stressors; the authors suggest that amplified stress reactivity in adulthood may be the result of sensitization processes initiated by early exposure to adversity. Further research is needed to determine how childhood adversity may amplify stress reactivity.

In conclusion, the present study demonstrated that currently depressed individuals experience greater increases in NA in response to daily stress, particularly subsequent to negative interpersonal rather than noninterpersonal events. Findings from this study emphasize the importance of cognitive interventions that target negative interpretations of daily events. Future studies examining alterations in stress reactivity over time will deepen our understanding of its role in the course and maintenance of major depression.

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Compliance with Ethical Standards

Conflict of Interest Erin S. Sheets and Michael F. Armey declare that they have no conflicts of interest.

Ethical Approval This study was conducted in accordance with the ethical standards of the Colby College Institutional Review Board and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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

Animal Rights This article does not contain any studies with animals performed by any of the authors.

References

Allison, P. (2009). *Fixed effects regression models*. Thousand Oaks: Sage Publications.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Philadelphia: American Psychiatric Association.

Beck, A. T. (1983). Cognitive therapy of depression: New perspectives. In P. J. Clayton & J. E. Barrett (Eds.), *Treatment of depression: Old controversies and new approaches* (pp. 265–290). New York: Raven Press.

Beck, A. T., Epstein, N., Brown, G., & Steer, R. A. (1988). An inventory for measuring clinical anxiety: Psychometric properties. *Journal of Consulting and Clinical Psychology, 56*, 893–897. https://doi.org/10.1037/0022-006X.56.6.893.

Beck, A. T., Rush, J., Shaw, B. F., & Emery, G. (1979). *Cognitive therapy of depression*. New York: Guilford Press.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Beck Depression Inventory* (2nd ed.). San Antonio: The Psychological Corporation.

Bolger, N., & Laurenceau, J.-P. (2013). *Intensive longitudinal methods: An introduction to diary and experience sampling research*. New York: Guilford Press.

Bylsma, L. M., Morris, B. H., & Rottenberg, J. (2008). A meta-analysis of emotional reactivity in major depressive disorder. *Clinical Psychology Review, 28*(4), 676–691. https://doi.org/10.1016/j.cpr.2007.10.001.

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), 155–167. https://doi.org/10.1037/a0021662.

Connolly, S. L., & Alloy, L. B. (2017). Rumination interacts with life stress to predict depressive symptoms: An ecological momentary assessment study. *Behaviour Research and Therapy, 97*, 86–95. https://doi.org/10.1016/j.brat.2017.07.006.

Downey, G., & Feldman, S. I. (1996). Implications of rejection sensitivity for intimate relationships. *Journal of Personality and Social Psychology, 70*(6), 1327–1343. https://doi.org/10.1037/0022-3514.70.6.1327.

Ferrari, A. J., Charlson, F. J., Norman, R. E., Patten, S. B., Freedman, G., Murray, C. J. L., et al. (2013). Burden of depressive disorders by country, sex, age, and year: Findings from the Global Burden of Disease Study 2010. *PLOS Medicine, 10*(11), e1001547. https://doi.org/10.1371/journal.pmed.1001547.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (2007). *Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Patient Edition. (SCID-I/P)*. Biometrics Research, New York State Psychiatric Institute.

Froehlich, J., Chen, M. Y., Consolvo, S., Harrison, B., & Landay, J. A. (2007). *MyExperience: A system for in situ tracing and capturing of user feedback on mobile phones*. Paper presented at the ACM.

Glaser, J.-P., van Os, J., Portegijsc, P. J. M., & Myin-Germeys, I. (2006). Childhood trauma and emotional reactivity to daily life stress in adult frequent attenders of general practitioners. *Journal of Psychosomatic Research, 61*, 229–236. https://doi.org/10.1016/j.jpsychores.2006.04.014.

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), 901–930. https://doi.org/10.1037/a0038822.

Husky, M. M., Mazure, C. M., Maciejewski, P. K., & Swendsen, J. (2009). Past depression and gender interact to influence emotional reactivity to daily life stress. *Cognitive Therapy and Research, 33*, 264–271. https://doi.org/10.1007/s10608-008-9212-z.

Johnson, E. I., Husky, M., Grondin, O., Mazure, C. M., Doron, J., & Swendsen, J. (2008). Mood trajectories following daily life events. *Motivation and Emotion, 32*, 251–259. https://doi.org/10.1007/s11031-008-9106-0.

Kendler, K. S., Kuhn, J., & Prescott, C. A. (2004). The interrelationship of neuroticism, sex, and stressful life events in the prediction of episodes of major depression. *American Journal of Psychiatry, 161*(4), 631–636. https://doi.org/10.1176/appi.ajp.161.4.631.

Kendler, K. S., Thornton, L. M., & Gardner, C. O. (2000). Stressful life events and previous episodes in the etiology of major depression in women: An evaluation of the 'Kindling' hypothesis. *American Journal of Psychiatry, 157*(8), 1243–1251. https://doi.org/10.1176/appi.ajp.157.8.1243.

Lamers, F., Swendsen, J., Cui, L., Husky, M., Johns, J., Zipunnikov, V., et al. (2018). Mood reactivity and affective dynamics in mood and anxiety disorders. *Journal of Abnormal Psychology, 127*(7), 659–669. https://doi.org/10.1037/abn0000378.

Littman, A. J., White, E., Satia, J. A., Bowen, D. J., & Kristal, A. R. (2006). Reliability and validity of 2 single-item measures of psychosocial stress. *Epidemiology, 17*, 398–403. https://doi.org/10.1097/01.ede.0000219721.89552.51.

Monroe, S. M., & Harkness, K. L. (2005). Life stress, the "kindling" hypothesis, and the recurrence of depression: Considerations from a life stress perspective. *Psychological Review, 112*, 417–445. https://doi.org/10.1037/0033-295X.112.2.417.

Myin-Germeys, I., Peeters, F., Havermans, R., Nicolson, N. A., deVries, M. W., Delespaul, P., et al. (2003). Emotional reactivity to daily life stress in psychosis and affective disorder: An experience sampling study. *Acta Psychiatrica Scandinavica, 107*, 124–131. https://doi.org/10.1034/j.1600-0447.2003.02025.x.

Nezlek, J. B., & Gable, S. L. (2001). Depression as a moderator of relationships between positive daily events and day-to-day psychological adjustment. *Personality and Social Psychology Bulletin, 27*, 1692–1704. https://doi.org/10.1177/01461672012712012.

O'Neill, S. C., Cohen, L. H., Tolpin, L. H., & Gunthert, K. C. (2004). Affective reactivity to daily interpersonal stressors as a prospective predictor of depressive symptoms. *Journal of Social and Clinical Psychology, 23*, 172–194. https://doi.org/10.1521/jscp.23.2.172.31015.

Parrish, B. P., Cohen, L. H., Gunthert, K. C., Butler, A. C., Laurenceau, J.-P., & Beck, J. S. (2009). Effects of cognitive therapy for depression on daily stress-related variables. *Behaviour Reserach and Therapy, 47*, 444–448. https://doi.org/10.1016/j.brat.2009.02.005.

Parrish, B. P., Cohen, L. H., & Laurenceau, J.-P. (2011). Prospective relationship between negative affective reactivity to daily stress and depressive symptoms. *Journal of Social and Clinical Psychology, 30*(3), 270–296. https://doi.org/10.1521/jscp.2011.30.3.270.

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), 203–211. https://doi.org/10.1037/0021-843X.112.2.203.

Preacher, K. J., Curran, P. J., & Bauer, D. J. (2006). Computational tools for probing interaction effects in multiple linear regression, multilevel modeling, and latent curve analysis. *Journal of Educational and Behavioral Statistics, 31*, 437–448. https://doi.org/10.3102/10769986031004437.

Rohde, P., Lewinsohn, P. M., Klein, D. N., Seeley, J. R., & Gau, J. M. (2013). Key characteristics of major depressive disorder occurring in childhood, adolescence, emerging adulthood, and adulthood. *Clinical Psychological Science, 1*(1), 41–53. https://doi.org/10.1177/2167702612457599.

Rottenberg, J. (2005). Mood and emotion in major depression. *Current Directions in Psychological Science, 14*, 167–170. https://doi.org/10.1111/j.0963-7214.2005.00354.x.

Ruscio, A. M., Gentes, E. L., Jones, J. D., Hallion, L. S., Coleman, E. S., & Swendsen, J. (2015). Rumination predicts heightened responding to stressful life events in Major Depressive Disorder and Generalized Anxiety Disorder. *Journal of Abnormal Psychology, 124*(1), 17–26. https://doi.org/10.1037/abn0000025.

Scollon, C. N., Kim-Prieto, C., & Diener, E. (2003). Experience sampling: Promises, pitfalls, strengths, and weaknesses. *Jounal of Happiness Studies, 4*, 5–34. https://doi.org/10.1023/a:1023605205115.

Sheets, E. S., & Craighead, W. E. (2014). Comparing chronic interpersonal and noninterpersonal stress domains as predictors of depression recurrence in emerging adults. *Behaviour Research and Therapy, 63*, 36–42. https://doi.org/10.1016/j.brat.2014.09.001.

Shrout, P. E., & Lane, S. P. (2012). Psychometrics. In M. R. Mehl & T. A. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 302–320). New York: Guilford Press.

Stroud, C. B., Davila, J., Hammen, C., & Vrshek-Schallhorn, S. (2011). Severe and nonsevere events in first onsets versus recurrences of depression: Evidence for stress sensitization. *Journal of Abnormal Psychology, 120*(1), 142–154. https://doi.org/10.1037/a0021659.

Suls, J., Green, P., & Hillis, S. (1998). Emotional reactivity to everyday problems, affective inertia, and neuroticism. *Personality and Social Psychology Bulletin, 24*, 127–136. https://doi.org/10.1177/0146167298242002.

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), 819–829. https://doi.org/10.1037/a0027978.

Trull, T. J., Lane, S. P., Koval, P., & Ebner-Priemer, U. W. (2015). Affective dynamics in psychopathology. *Emotion Review, 7*(4), 355–361. https://doi.org/10.1177/1754073915590617.

van Eck, M., Nicolson, N. A., & Berkhof, J. (1998). Effects of stressful daily events on mood states: Relationship to global perceived stress. *Journal of Personality and Social Psychology, 75*(6), 1572–1585. https://doi.org/10.1037/0022-3514.75.6.1572.

Vrshek-Schallhorn, S., Mineka, S., Zinbarg, R. E., Craske, M. G., Griffith, J. W., Sutton, J., et al. (2014). Refining the candidate environment: Interpersonal stress, the serotonin transporter polymorphism, and gene-environment interactions in major depression. *Clinical Psychological Science, 2*(3), 235–248. https://doi.org/10.1177/2167702613499329.

Vrshek-Schallhorn, S., Stroud, C. B., Mineka, S., Hammen, C., Zinbarg, R. E., Wolitzky-Taylor, K., et al. (2015). Chronic and episodic interpesonal stress as statistically unique predictors of depression in two samples of emerging adults. *Journal of Abnormal Psychology, 124*(4), 918–932. https://doi.org/10.1037/abn0000088.

Watson, D., & Clark, L. A. (1999). The PANAS-X: Manual for the positive and negative affect schedule—expanded form. Retrieved from https://www.psychology.uiowa.edu/Faculty/Watson/PANAS-X.pdf.

Wenze, S. J., Gunthert, K. C., Forand, N. R., & Laurenceau, J.-P. (2009). The influence of dysphoria on reactivity to naturalistic fluctuations in anger. *Journal of Personality, 77*(3), 795–824. https://doi.org/10.1111/j.1467-6494.2009.00565.x.

Wichers, M. (2014). The dynamic nature of depression: A new micro-level perspective of mental disorder that meets current challenges. *Psychological Medicine, 44*, 1349–1360. https://doi.org/10.1017/S0033291713001979.

Wichers, M. C., Barge-Schaapveld, D. Q. C. M., Nicolson, N. A., Peeters, F., deVries, M., Mengelers, R., et al. (2009a). Reduced stress-sensitivity or increased reward experience: The psychological mechanism of response to antidepressant medication. *Neuropsychopharmacology, 34*, 923–931. https://doi.org/10.1038/npp.2008.66.

Wichers, M., Geschwind, N., Jacobs, N., Kenis, G., Peeters, F., Derom, C., et al. (2009b). Transition from stress sensitivity to a depressive state: Longitudinal twin study. *The British Journal of Psychiatry, 195*, 498–503. https://doi.org/10.1192/bjp.bp.108.056853.

Wichers, M., Schrijvers, D., Geschwind, N., Jacobs, N., Myin-Germeys, I., Thiery, E., et al. (2009c). Mechanisms of gene–environment interactions in depression: Evidence that genes potentiate multiple sources of adversity. *Psychological Medicine, 39*, 1077–1086. https://doi.org/10.1017/S0033291708004388.