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Everyday Emotional Experiences in Current and Remitted Major Depressive Disorder: An Experience-Sampling Study

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Abstract

The emotional experiences of people with major depressive disorder (MDD) are characterized by emotional disturbances. We examined whether these patterns characterize people with MDD in remission. Participants included individuals who had experienced at least two major depressive episodes (remitted-MDD group; $n = 80$), had current MDD (current-MDD group; $n = 48$), or were control participants ($n = 87$). Participants reported their momentary affect five times per day for 14 days, from which we computed the mean (i.e., intensity), standard deviation (i.e., variability), and autocorrelation (i.e., inertia). Negative affect (NA) intensity and variability, but not inertia, differed between groups; the current-MDD group had the highest levels, the control group had the lowest, and the remitted-MDD group fell in between. Differences in NA variability held after accounting for mean NA. The only significant group difference for positive affect (PA) was that PA intensity was lower in the current-MDD group compared with the other two groups. Emotional disturbances of participants with remitted MDD appear limited to NA.

Keywords

major depressive disorder, emotion, affect, instability, inertia

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Approximately 20% of Americans meet criteria for a depressive disorder over their lifetimes (e.g., Hasin et al., 2018). Major depressive disorder (MDD) is one of the leading causes of disability worldwide (Ferrari et al., 2013). This heavy disease burden is due in part to MDD's high recurrence rate, and 50% to 60% of people with MDD experience multiple depressive episodes over their lives (Hardeveld et al., 2010; Monroe & Harkness, 2011). Despite advances in psychological and psychopharmacological treatments, the prevalence of MDD has not decreased in the past 20 years (Jorm et al., 2017; Mojtabai & Jorm, 2015). One promising way to reduce the individual and societal burden of MDD is to decrease its recurrence rate, which is possible only by gaining a thorough understanding of the emotional risk factors of people with remitted MDD—specifically, those factors that distinguish remitted individuals from healthy, never-depressed individuals and that could make them vulnerable to future major depressive episodes (MDEs).

There is a rich history documenting the ways in which emotional experiences of people with current MDD vary from their nondepressed peers (for a review, see Houben et al., 2015). The emotional lives of individuals in remission from MDEs (periods of 2 weeks or longer during which individuals meet full criteria for MDD) have been less thoroughly explored, but they are important to understand in the context of recurrent MDD. In the present study, using experience-sampling methodology (ESM), we examined the emotional experiences of people in a current MDE as well as people whose MDD is in full remission (i.e., remitted MDD) with two goals in mind. First, we aimed to replicate existing findings that distinguish people with current MDD from control participants. Second, we aimed to identify viable emotion markers of remitted MDD—both in comparison

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with control participants and participants with current MDD. Characterizing the emotional architecture of people with remitted MDD and how it is similar or varies from the emotional architecture of these other two groups will inform future longitudinal research. For example, it will identify potential emotion markers that may make people with remitted MDD vulnerable to future depressive episodes, ultimately informing targets for secondary prevention efforts.

Emotional Experiences in Current MDD

Emotional intensity

Aberrant emotional experiences are central to the diagnosis of MDD: The two cardinal symptoms of an MDE are increased negative affect (NA) and decreased interest or pleasure, which includes diminished positive affect (PA; American Psychiatric Association, 2013). It is perhaps unsurprising, then, that an abundance of research shows people in a current MDE experience more intense (i.e., higher average) NA and less intense PA compared with their nondepressed peers. For example, adults with current MDD have reported higher NA intensity and lower PA intensity than did control participants in both cross-sectional studies (e.g., Watson et al., 1988) and ESM studies (e.g., Bylsma et al., 2011; Myin-Germeys et al., 2003).

Emotional variability

Emotional intensity has not been the only dimension of emotional experience used to understand the emotional architecture of people with current MDD. Much research has also focused on emotional variability (or what is sometimes referred to as instability), which captures the range or amplitude of an individual's emotional states across time (Houben et al., 2015). Using a clinical interview, Thompson et al. (2011) found that people with current MDD reported higher levels of emotional variability than those without MDD. Researchers have also used ESM—in which participants repeatedly report their momentary affect over a period of days or weeks—to assess emotional variability. In this approach, an index of variability, such as standard deviation or mean square successive difference (MSSD; Jahng et al., 2008), is directly computed according to the pattern of responses across surveys.[1] ESM research has generally found that people with current MDD experience greater variability of NA compared with control participants (e.g., Nelson et al., 2020; Peeters et al., 2006; Thompson et al., 2012). Note that these group differences remain significant even after controlling for people's average NA (Nelson et al., 2020; Thompson et al., 2012). There is some evidence for lower variability of PA in people with current MDD compared with control participants, but the effects are small (Houben et al., 2015).

Emotional inertia

Another dimension of emotional experience that has been implicated in current MDD is emotional inertia, or the extent to which a person's level of affect resists changing over time (Suls et al., 1998). Higher levels of inertia reflect slower change. Inertia is often assessed using an autoregressive slope between a person's intensity of affect at one point in time and a subsequent point in time in a multilevel model (e.g., Koval & Kuppens, 2012). Note that one can have highly variable affect that is also highly inert (i.e., affect that fluctuates greatly but changes slowly; for further discussion, see Kuppens et al., 2010). A meta-analysis found that MDD diagnosis is associated with greater NA inertia (Houben et al., 2015). That is, negative emotions experienced in the course of MDD are particularly resistant to change. Current MDD is also related to PA inertia but to a lesser extent than it is to NA inertia (Houben et al., 2015).

Emotional Experiences in Remitted MDD

There is preliminary evidence that these alterations in emotion that characterize individuals with current MDD also characterize people with depressive disorders that are in remission. A few ESM studies have shown that individuals with remitted MDD continue to experience more intense levels of NA, but not PA, compared with control participants (Barge-Schaapveld & Nicolson, 2002; Knowles et al., 2007; Wichers et al., 2012). There is some research that examined whether emotional variability differs among people with and without remitted depressive disorders. Knowles et al. (2007) found that people with remitted MDD do not show greater variability in NA or PA compared with control participants; however, neither group had more than 19 people, so the study may have been underpowered. Thompson et al. (2011) found that people with MDD in remission had greater emotional variability than people with no history of MDD but did not assess variability by valence. In analyses in which participants who had only anxiety disorder diagnoses were excluded, Schoevers et al. (2020) found that people with remitted depressive disorders had (a) greater variability of NA and PA than people with no history of depressive disorders and (b) lower variability of NA but similar variability of PA to people with current depressive disorders. No studies have examined emotional inertia in remitted MDD.[2] Research is needed to more thoroughly assess emotional

variability and inertia among people whose MDD is in remission.

The Present Study

In the present study, we examined intensity, variability, and inertia of NA and PA among three groups: control participants, people with recurrent MDD that is in full remission, and people with current MDD. We used an ESM design, which offers good ecological validity and allows for the direct measurement of various emotion dynamics (e.g., variability, inertia). Self-reports of affect are more valid the more closely they assess momentary emotional experience (Mauss & Robinson, 2009). Furthermore, compared with momentary assessments, global or trait assessments are more likely to tap people's beliefs about themselves (e.g., Robinson & Clore, 2002), which is particularly problematic in samples with MDD, who are characterized by a variety of negative cognitive biases (Gotlib & Joorman, 2010). Another strength of using an ESM design is that emotional variability is computed across the sampling period on the basis of repeated reports of momentary NA and PA instead of being assessed at a single time point on the basis of participants' perceptions of their emotional variability.

Consistent with the extant literature, we expected that people with current MDD will experience elevated NA intensity, diminished PA intensity, greater variability of NA, and greater NA inertia compared with the control group. We also hypothesized that alterations in the emotional architecture that characterize people with current MDD will characterize people whose MDD is in full remission, albeit at lesser levels. More specifically, we hypothesized that the remitted MDD group's NA intensity, PA intensity, NA variability, and NA inertia will fall between those of the control group and current-MDD group. If we found group differences in emotional variability or inertia, we ran additional analyses controlling for mean affect to demonstrate relations between these dimensions of emotional experience and MDD that are not better accounted for by mean affect (for further discussion, see Dejonckheere et al., 2019; Russell et al., 2007).

Method

Participants and procedure

A total of 215 individuals participated in the present study, having originally been recruited for a large-scale study on emotion and depression. Participants were recruited largely through online advertisements (e.g., Craigslist) and through a medical school participant registry. The mean age of the sample was 44.3 years (SD = 16.1, range = 18–77) and was composed of 66.0% women. Racial/ethnic composition of the sample was 69.8% White, 19.5% Black, 2.8% Asian, 0.5% Native American, and 7.0% other or multiracial (0.5% did not report); 1.4% of the sample also reported that they were Hispanic. The highest level of education attained by most participants was a bachelor's degree (32.6%), followed by a graduate or professional degree (31.6%), some college (24.2%), or a high school diploma (9.3%). Participants' employment status was as follows: 19.1% were employed part-time, 40.9% were employed full-time, 14.4% were retired, and 10.7% were unemployed; others were receiving disability payments (2.8%), were stay-at-home spouses/parents (1.9%), were seasonally employed (1.9%) or temporarily unemployed (0.5%), or did not report (1.9%). Participants reported their relationship status as follows: 30.2% had never married, 28.8% were married, 12.6% were living with a romantic partner, 19.5% were divorced, 5.1% were separated, and 2.3% were widowed; 1.4% did not report.

Eligibility was assessed in a two-step process. First, individuals completed a phone screen that was administered by a postbaccalaureate project manager or an undergraduate research assistant. After providing some demographic information, individuals indicated whether they had ever experienced either of the cardinal symptoms of MDD (i.e., low mood, loss of interest) most of the day, nearly every day, or for at least 2 weeks. Individuals who reported mood symptoms reflective of one of three groups (described below) were invited to complete an online survey and were scheduled for a laboratory session. At the laboratory session, participants (n = 324) completed a self-report depression measure and a diagnostic interview (described below).

Participants in the control group (n = 87) were required to have no current or past mood or anxiety disorders. Participants in the remitted-MDD group (n = 80) met criteria for at least two fully remitted MDEs in the context of MDD or persistent depressive disorder (PDD). More specifically, participants in this group had experienced two or more past MDEs but had experienced no significant symptoms of depression for at least 2 months before the interview. Participants in the current-MDD group (n = 48) met criteria for a current MDE in the context of MDD or PDD (regardless of previous MDEs). We recruited fewer participants in the current-MDD group because effect sizes of differences between them and the control group are expected to be larger than those between the control and remitted-MDD groups. Individuals with comorbid anxiety disorders were eligible for both depression groups. Exclusionary criteria for all groups included current or past diagnoses of bipolar I, bipolar II, or cyclothymic disorder or

endorsement of psychotic symptoms. Eligibility criteria for all groups included speaking English as a primary language and having no severe visual or hearing impairments.

The Structured Clinical Interview for DSM-5.0 (SCID-5-RV; First et al., 2015) was used to determine current and past psychiatric diagnoses. We administered Modules A: Mood Episodes, Cyclothymic Disorder, and Persistent Depressive Disorder; B: Psychotic and Associated Symptoms; and F: Anxiety Disorders (including generalized anxiety disorder, social anxiety disorder, panic disorder, and agoraphobia). Diagnostic interviews, which were audio recorded, were conducted by one of three advanced clinical psychology graduate students. Diagnostic disagreements were discussed at weekly group meetings supervised by R. J. Thompson, a licensed clinical psychologist, and complicated presentations were discussed via phone consultation. A random subset of interviews (n = 48) was coded for reliability purposes by one of the other two graduate student interviewers. Raters demonstrated perfect agreement in assessing for the presence of current MDD, current PDD, past MDD, and past PDD (κ = 1.0 for each disorder).

At the laboratory session, undergraduate experimenters helped participants install ESM software on their own iPhones or provided participants with a fourth-generation iPod Touch (Apple Inc., Cupertino, CA) with preinstalled software. We used the Status/Post iOS app, which was developed by Christopher Metts, MD, and collects data offline, obviating the need for Wi-Fi or a smartphone. Data were added to the database whenever devices joined Wi-Fi as well as when the device was returned to the lab. The experimenter led the participant through an individual, 30-min interactive ESM tutorial, which included a PowerPoint presentation and full practice survey. Throughout the tutorial, experimenters assessed whether participants understood the procedure and provided standardized examples as needed. At the end of the session, participants were financially compensated for their time.

During the 14-day ESM period, which started the day after the lab visit, participants were randomly prompted via an auditory tone to complete 70 surveys. Participants chose the 15-hr window during which they would complete surveys; prompts occurred at random times within five 3-hr windows per day. Participants had up to 15 min to start the survey (with reminder tones) before the survey was closed and data marked as missing. Surveys occurred at an average of 3 hr, 0 min, and 18 s apart (SD = 1 hr, 1 min, 35 s). The mean percentage of surveys completed was 74.8% (SD = 18.3%; range = 20%–99%). The sample of 215 does not include participants who experienced app problems (n = 7), withdrew (n = 7), or completed less than 20% of the surveys (n = 7) or whose behavior evoked concern about the validity of the data (n = 1). This compliance threshold of 20% is consistent with another study examining a sample with MDD (Hepp et al., 2017). After the ESM period, participants were debriefed via e-mail and compensated, and a bonus of $10 was given for completing at least 80% of surveys.

Measures

Emotional intensity. At each survey, participants rated their current levels of NA and PA. Using a 5-point scale ranging from 0 (*not at all*) to 4 (*extremely*), participants indicated the extent to which they were currently feeling a series of emotions: "I felt [EMOTION] at the time of the beep." Both NA and PA were assessed with six items. NA items included bored, sluggish, sad, frustrated, nervous, and angry, and PA items included relaxed, content, calm, happy, excited, and enthusiastic. Mean levels of NA and PA were computed for each survey for each participant. Emotions included low and high arousal emotions from the affective circumplex (Barrett & Russell, 1999). Similar scales have been used by others (e.g., Selby et al., 2014). As recommended by Nezlek (2017), we computed the mixed modeling functional equivalent to Cronbach's α for NA and PA, which were .65 and .74, respectively. The intraclass correlation (ICC) for NA was .42, meaning that 42% and 58% of the variance was at the between-persons and within-persons levels, respectively. The ICC for PA was .43. These values are in an acceptable range (Nezlek, 2017) and are comparable with those reported in other ESM studies (e.g., Houben & Kuppens, 2020).

Depressive symptoms. Participants indicated the extent to which they experienced depressive symptoms in the past week using the anhedonic depression scale of the Mood and Anxiety Symptom Questionnaire (MASQ; Watson et al., 1995). Item ratings ranging from 1 (*not at all*) to 5 (*extremely*) were summed to form a composite score. Research has found that anxiety and depressive symptoms can be distinguished psychometrically (e.g., Watson et al., 1995). Consistent with this, the MASQ anhedonic depression subscale has been found to be unique from forms of anxiety, anxious apprehension, and anxious arousal (Nitschke et al., 2001). This scale has strong psychometric properties in community (Nitschke et al., 2001; Watson et al., 1995) and clinical samples (e.g., Watson et al., 1995). Internal consistency for the depression items was excellent in this sample (α = .94).

Analytic plan

First, we examined whether demographic and clinical characteristics differed by group status using χ^2 and analysis of variance (ANOVA) tests. For the remaining analyses,

Table 1. Demographic Information and Clinical Characteristics by Diagnostic Group

	Remitted-MDD group (n = 80)	Current-MDD group (n = 48)	Control group (n = 87)	Difference test
Age	M = 44.3 (SD = 16.3)	M = 42.0 (SD = 14.2)	M = 45.5 (SD = 16.9)	$F(2, 212) = 0.72$, $p = .49$
Gender (women)	71.3	72.9	57.5	$\chi^2(2, N = 215) = 4.83$, $p = .09$
Race/ethnicity (%)				$\chi^2(8, N = 214) = 6.04$, $p = .64$
Asian	0	4.2	4.6	
African or Black	18.8	20.8	19.5	
White	72.5	70.8	66.7	
Native American or Alaska Native	0	0	1.1	
Other/multiracial	7.5	4.2	8.0	
Hispanic	2.5	0	1.1	$\chi^2(2, N = 215) = 1.43$, $p = .49$

Note: Values are percentages unless otherwise specified.

we examined whether the following differed by group: (a) intensity, (b) variability, and (c) inertia (Koval et al., 2012, 2015; Kuppens et al., 2010) of NA and PA.

To index emotional variability, we computed the standard deviation of the NA and PA intensity values across each participant's surveys, obtaining one NA value and one PA value per person. For analyses involving variability, we used a multivariate analysis of variance, following up with individual ANOVA tests as appropriate. For any significant group effects on variability, we examined whether the effect remained after controlling for mean affect using analysis of covariance tests. Analyses using different indices, including variance and MSSD, are provided in the Supplemental Material available online. We chose to focus on standard deviation because it is straightforward to interpret. It is not a function of more than one index of temporal dynamics, such as MSSD, which reflects both the range of fluctuations of magnitude (i.e., variance) and a temporal component (i.e., inertia; Jahng et al., 2008). Furthermore, as would be expected given the large correlation between these three variability indices, the results using variance of affect show the same pattern as those using standard deviation of affect, and those using MSSD are highly similar to those using standard deviation. The range of the correlation coefficients among the NA indices is .84 to .95 (mean r value = .88), and among the PA, indices range from .82 to .97 (mean r value = .87).

For analyses involving intensity and inertia (i.e., the extent to which affect at one survey time, t, is predicted by affect at the previous survey, $t - 1$, within day), we conducted multilevel modeling to accommodate the nested structure of the data (i.e., surveys nested within people). Multilevel modeling is appropriate because it does not assume independence of data points and simultaneously estimates within-persons and between-persons effects (Krull & MacKinnon, 2001) while handling varying time intervals between prompts and missing data (Snijders & Bosker, 2011). All models included two diagnostic group variables (uncentered) at Level 2. For models examining inertia, all predictor variables entered at Level 1 (e.g., NA_{t-1}) were person-mean centered. We report parameter estimates with robust standard errors. Full models, all of which were random effects models (i.e., intercepts and slopes were allowed to vary), are described. In the equations below, i represents surveys, and j represents participants. We used Hierarchical Linear Modeling software (Version 7.03; Raudenbush et al., 2011).

We conducted all analyses separately for NA and PA, but we present equations only for the models testing NA because of space concerns. We also ran multilevel models so that all possible diagnostic group differences were examined but present the full equations only for models that have the control group as the referent group.

Results

Demographic and clinical characteristics of participants

Demographic characteristics of the groups are presented in Table 1. The time between surveys did not vary by group, $F(2) = 0.20$, $p = .82$, and the groups did not vary on the percentage of surveys completed either, $F(2) = 0.30$, $p = .74$. There were no group differences in age, gender, distribution by race/ethnicity, or distribution by Hispanic status, as shown in Table 1. In addition, the three groups did not differ on the highest level of education completed, $\chi^2(10, 212) = 10.74$, $p = .38$; employment status, $\chi^2(16, 212) = 23.26$, $p = .11$; or relationship status, $\chi^2(2, 212) = 13.18$, $p = .21$. Consistent with clinical diagnoses and past research (e.g.,

Figueroa et al., 2018; Kerestes et al., 2012), all three groups significantly differed from each other in depressive symptoms, $F(2, 211) = 64.17$, $p < .001$ (remitted-MDD group: $M = 56.5$, $SD = 16.0$; current-MDD group: $M = 78.5$, $SD = 15.5$; control participants: $M = 48.0$, $SD = 13.5$). The mean of the control group was similar to those found in other community samples (e.g., Bredemeier et al., 2010; Buckby et al., 2007). Furthermore, a clinical cutoff of 76 has been established (Buckby et al., 2007); note that the control and remitted-MDD groups' averages were well below this. In addition, as expected according to eligibility criteria, groups varied on the prevalence of current anxiety disorders, $\chi^2(2, 215) = 89.38$, $p < .001$ (remitted-MDD group: 18.8%; current-MDD group: 70.8%; control group: 0%). There were no significant differences between the two depression groups in the number of participants who were (a) currently prescribed antidepressant medication, $\chi^2(1, 123) = .000$, $p = 1.00$, or (b) in ongoing treatment with a psychotherapist, $\chi^2(1, 123) = .218$, $p = .640$.

Emotional intensity

We then examined group differences in the intensity of NA and PA. We entered diagnostic group as Level 2 variables predicting either NA or PA intensity:

Model 1:

Level 1:

$$\mathrm{NA} = \beta_{0j} + r \tag{1a}$$

Level 2:

$$\begin{aligned}\beta_{0j} = \gamma_{00} &+ \gamma_{01} \times (\text{remitted MDD}_j) \\ &+ \gamma_{02} \times (\text{current MDD}_j) + u_{0j}\end{aligned} \tag{1b}$$

At Level 1, β_{0j} represents each person's mean negative or positive affect across surveys. At Level 2, γ_{00} represents the mean of the outcome variable for the control group, γ_{01} is the difference in the mean outcome variable between the control and the remitted-MDD groups, and γ_{02} is the difference in the mean outcome variable between the control and current-MDD groups.

In all three groups, NA intensity was significantly greater than zero, $ts(212) > 9.00$, $ps < .001$. As predicted, the two depression groups reported greater NA intensity than the control group, $ts(212) > 2.10$, $ps < .05$. Also consistent with hypotheses, the current-MDD group reported greater NA intensity than did the remitted-MDD group, $b = 0.29$, $t(212) = 4.29$, $p < .001$.

In all three groups, PA intensity was significantly greater than zero, $ts(210) > 13.00$, $ps < .001$. Consistent with hypotheses, the current-MDD group reported significantly lower PA intensity compared with the control group, $b = 0.46$, $t(212) = 4.19$, $p < .001$. Inconsistent with hypotheses, the control and remitted-MDD groups did not significantly differ in PA intensity, $t(212) = 0.19$, $p = .85$. The two depression groups' PA intensity were significantly different, $b = 0.44$, $t(212) = 4.07$, $p < .001$; the remitted-MDD group reported higher levels than the current-MDD group, as expected.

Emotional dynamics

Emotional variability. Using Pillai's trace, there was a significant effect of group on variability (i.e., *SD*) of NA and PA, $V = 0.17$, $F(4, 424) = 9.80$, $p < .001$, $\eta_p^2 = .09$. Separate univariate ANOVAs on the outcome variables revealed a significant effect of group on variability of NA, $F(2, 212) = 18.98$, $p < .001$, $\eta_p^2 = .15$, but not variability of PA, $F(2, 212) = 2.09$, $p = .13$, $\eta_p^2 = .02$. Post hoc tests using Hochberg's GT2 showed that all groups significantly differed from each other in variability of NA, $ps < .01$. We included mean NA as a covariate variable. Both mean NA and diagnostic group demonstrated significant effects on variability of NA, $ps < .01$, suggesting that the effect of diagnostic group was not accounted for by mean NA.

Emotional inertia. Next, we examined how emotional inertia differed according to diagnostic group. We conducted separate multilevel models for inertia of NA and PA; the equations for inertia of NA are illustrated in Model 2:

Level 1:

$$\mathrm{NA}_{(t)_{ij}} = \beta_{0j} + \beta_{1j} \times \mathrm{NA}_{(t-1)} + r_{ij} \tag{2a}$$

Level 2:

$$\begin{aligned}\beta_{0j} = \gamma_{00} &+ \gamma_{01} \times (\text{remitted MDD}_j) \\ &+ \gamma_{02} \times (\text{current MDD}_j) + u_{0j}\end{aligned} \tag{2b}$$

$$\begin{aligned}\beta_{1j} = \gamma_{10} &+ \gamma_{11} \times (\text{remitted MDD}_j) \\ &+ \gamma_{12} \times (\text{current MDD}_j) + u_{1j}\end{aligned} \tag{2c}$$

Coefficients in Model 2 that were not also included in Model 1 are described as follows. At Level 1, β_{1j} represents the degree to which NA_{t-1} is related to NA_t (i.e., the autocorrelation or inertia; Kuppens et al., 2010) at each person's mean level of NA. At Level 2, γ_{10} represents the slope between NA_{t-1} and NA_t for the control group, γ_{11} represents the difference in the slopes between NA_{t-1} and NA_t between the remitted-MDD group and the control group, and γ_{12} represents the difference in the slopes NA_{t-1} and NA_t between the current-MDD group and the control group.

Table 2. Emotional Inertia by Diagnostic Group

Fixed effect	*b* (*SE*)	*t*(210)	*p*
Outcome: NA*t*			
Intercept (mean level), β_0			
Intercept (control group), γ_{00}	0.33 (0.04)	8.66	.000
Remitted-MDD group, γ_{01}	0.11 (0.05)	2.14	.033
Current-MDD group, γ_{02}	0.40 (0.07)	5.73	.000
Slope (inertia), β_1			
Intercept (control group), γ_{10}	0.16 (0.03)	5.94	.000
Remitted-MDD group, γ_{11}	0.03 (0.04)	0.74	.459
Current-MDD group, γ_{12}	0.05 (0.05)	1.11	.268
Outcome: PA*t*			
Intercept (mean level), β_0			
Intercept (control group), γ_{00}	1.63 (0.06)	25.23	.000
Remitted-MDD group, γ_{01}	−0.02 (0.09)	−0.18	.855
Current-MDD group, γ_{02}	−0.48 (0.11)	−4.41	.000
Slope (inertia), β_1			
Intercept (control group), γ_{10}	0.25 (0.03)	9.75	.000
Remitted-MDD group, γ_{11}	−0.01 (0.04)	−0.30	.761
Current-MDD group, γ_{12}	0.03 (0.04)	0.58	.565

Note: This table presents emotional inertia findings with the control group as the referent group. Consequently, the remitted-MDD group represents the contrast between the control group and remitted-MDD group, and current-MDD group represents the contrast between the control group and current-MDD group.

NA inertia (i.e., slope of NA_{t-1} on NA_t) was significantly different from zero for all diagnostic groups, *t*s(210) > 5.39, *p*s < .001. However, NA inertia did not vary between the control group and (a) remitted-MDD group or (b) the current-MDD group (see Table 2 for more details). Furthermore, NA inertia did not differ between the current- and remitted-MDD groups, $b = -0.02$, $SE = 0.05$, $t(210) = 0.47$, $p = .64$.

PA inertia was significantly different from zero for all diagnostic groups, *t*s(212) > 7.75, *p*s < .001. However, PA inertia did not vary between the control group and either the remitted-MDD group or the current-MDD group (see Table 2). Furthermore, the PA inertia did not differ between the current- and remitted-MDD groups, $b = -0.04$, $SE = 0.04$, $t(210) = 0.85$, $p = .40$.

Discussion

MDD is one of the leading causes of disability both in the United States and worldwide (World Health Organization & World Banks, 2011). It is a highly recurrent disorder with a prevalence rate that has been increasing in recent years (e.g., Weinberger et al., 2018). One way to reduce the individual and societal burden of MDD is to decrease its recurrence rate. There has been some success preventing recurrence of MDD (i.e., secondary prevention) using selective serotonin reuptake inhibitors, but adults often stop taking them because of side effects (e.g., Balsikci et al., 2014). To find new targets for secondary prevention efforts, we examined the emotional architecture of individuals with current MDD and MDD in full remission using intensive longitudinal sampling.

We hypothesized that the remitted-MDD group would be characterized by the same emotional disturbances that characterize the current-MDD group, albeit to a lesser degree. We found support for this pattern with intensity and variability of NA: The remitted-MDD group experienced significantly (a) higher NA intensity and greater variability of NA than did the control group and (b) lower NA intensity and lower variability of NA than did the current-MDD group. Note that the findings for variability of NA held after controlling for NA mean. There were no group differences in NA inertia. Regarding PA, the remitted-MDD group experienced PA intensity similar to that of the control group. Both the remitted-MDD and control groups reported higher PA intensity than the current-MDD group, consistent with the literature (Barge-Schaapveld & Nicolson, 2002; Knowles et al., 2007; Wichers et al., 2012). Groups did not differ in the variability or inertia of their PA.

These findings both replicate and extend prior findings in several ways. The intensity findings (i.e., that the remitted-MDD group has higher NA intensity but comparable PA intensity with the control group) replicates the results of the majority of existing research

(Barge-Schaapveld & Nicolson, 2002; Knowles et al., 2007; Wichers et al., 2012). NA intensity being significantly lower among the remitted-MDD group compared with the current-MDD group further clarifies the emotional architecture of MDD. The variability findings provide support for the pattern of elevated emotional variability that has been found to characterize remitted-MDD group samples (Schoevers et al., 2020; Thompson et al., 2011). The present findings suggest that elevated variability is valence-specific; that is, people whose MDD was in remission exhibited increased variability only of NA, not PA, compared with the control group. Consistent with this, Schoevers et al. (2020) found that people with remitted depressive disorders had higher variability of NA than people without depressive disorders. However, Schoevers et al. also found that people with remitted depressive disorders had higher variability of PA than people without depressive disorders, but their findings involving variability of NA were more robust—larger and more consistent than their findings involving variability of PA.

The findings involving the remitted-MDD group's NA patterns provide indirect evidence that intensity and variability of NA may decrease from peak depression levels after remission from an MDE but remain elevated compared with people who have never had an MDE. Given this pattern, intensity and variability of NA are unlikely state-dependent effects of MDD. However, given the findings of the current study, which composed one wave of data, it is unclear whether this pattern reflects a risk factor for, compared with a scar of, MDD. On the one hand, the present levels of intensity and variability of NA may have existed before the onset of participants' MDD. Indeed, the possibility of elevated intensity of NA as a risk factor is supported by research showing that individuals with elevated neuroticism—a personality factor that is highly associated with negative emotional intensity—are more likely to experience depression later in life (e.g., Kendler et al., 2006; Ormel et al., 2001). Likewise, variability prospectively predicts increases in depressive symptoms among young adult women (Thompson et al., 2011) and the onset and recurrence of MDD in middle-age and older-age adults (Eldesouky et al., 2018). On the other hand, this pattern of findings for NA among people with MDD in full remission is also consistent with the complications or scar model of MDD (e.g., Allen & Sheeber, 2008)—MDD has enduring effects on temperament that persists even after recovery. Finally, it is possible that people who ultimately develop MDD had elevated intensity and more variable NA before the disorder onset and that these levels are also comparably higher after the remission of their MDEs, which would suggest that these emotional indices are both a risk factor for and a scar of depression. However, further longitudinal research is needed to fully test whether these emotional patterns are truly risk factors, scars, or both.

In contrast, it seems that the symptom of decreased PA intensity is not a risk factor or scar of MDD. Rather, the findings indirectly support that elevated PA intensity may be a symptom that dissipates when MDD remits, in line with the state-dependent model of MDD (e.g., Allen & Sheeber, 2008). Taken together, these findings support the idea that remitted MDD, like current MDD (Nelson et al., 2020), is more strongly characterized by disturbances in NA than PA. This may reflect that NA symptoms are more resistant to change than PA symptoms given that people with MDD have relatively high and variable NA even after their MDE has remitted. Although the current study did not assess why this pattern emerged, factors that influence whether MDEs go into remission may inadvertently target PA to a greater extent than NA. For example, we know that physical activity specifically leads to increases in PA but does not affect NA among people with current MDD (e.g., Mata et al., 2012). Likewise, some psychotherapies also largely focus on activities designed to affect PA (e.g., behavioral activation; Martel et al., 2010). Future work could examine differences in emotional functioning among people whose MDD remits after therapy, after they initiate antidepressants, or spontaneously.

There are many possible factors that contribute to emotional disturbances in individuals with remitted MDD. First, we posit that the patterns of increased intensity and variability of NA could be triggered by the propensity to select and implement maladaptive emotion-regulation strategies. People with remitted MDD use putatively maladaptive emotion-regulation strategies such as rumination, avoidance, and suppression, more habitually than do control participants (D. Y. Liu & Thompson, 2017; Visted et al., 2018). Although these strategies can be effective in certain situations, they have been shown to lead to increased NA over the short term (i.e., minutes to hours; Bailen et al., 2019; Campbell-Sills et al., 2006; Moberly & Watkins, 2008) and decreased well-being in the long term (e.g., Abela & Hankin, 2011; Nolen-Hoeksema, 2000). Another reason for comparatively high intensity and variability of NA in remitted MDD could be increased exposure to negative events. It has long been documented that negative events precede the onset of MDD (Hammen, 2005), but the stress generation theory of chronicity in MDD further posits that MDD actually raises the likelihood of experiencing negative events that are influenced in part by the individual (R. T. Liu & Alloy, 2010). Higher frequencies of these negative dependent life events have been found to occur not only during periods of active MDD but also during periods of remission

from MDD (e.g., Chun et al., 2004; Hammen & Brennan, 2002). Ostensibly, the increased frequency of negative dependent events in remitted individuals' lives could lead to the increased intensity and variability of NA that we found in our remitted sample, further increasing risk for relapse. Future longitudinal research should further explore whether emotion-regulation choices and exposure to negative events influence the emotional experience of people with remitted MDD and, if so, to what extent.

Regarding the current-MDD group, our findings comparing them with the control group largely replicated prior findings. For instance, we found that individuals with current depression experience more intense and more variable NA than individuals in the control group (e.g., Houben et al., 2015; Nelson et al., 2020; Schoevers et al., 2020). Also consistent with most of the extant literature, we found that in comparison with the control group, the current-MDD group reported diminished intensity of PA but similar levels of PA variability (e.g., Nelson et al., 2020; Peeters et al., 2006; Thompson et al., 2012; for an exception, see Schoevers et al., 2020).

We found no differences between the current-MDD and control groups in inertia of NA or PA, which is inconsistent with findings from a meta-analysis by Houben et al. (2015) that showed that current MDD diagnosis is associated with increased emotional inertia. One reason we were unable to replicate prior findings may be the EMA sampling rate, which was five times across a 15-hr period daily. Consequently, the average time between surveys was approximately 3 hr apart, which is longer than in many lab-based studies (e.g., Kuppens et al., 2010) and ESM-based studies (e.g., Koval & Kuppens, 2012; Kuppens et al., 2010) of NA inertia. This argument is consistent with Thompson et al. (2012), who also used EMA sampling that occurred on average 3 hr apart and did not find that inertia varied according to MDD status. Another possible reason for the lack of significant group differences in inertia may be because of the age of our sample. Virtually all inertia studies focus on adolescents (e.g., Kuppens et al., 2012; van Roekel et al., 2018) or young adults (e.g., Koval et al., 2015, 2016), whereas our sample represented individuals across most of the adult life span. It may be that older adults, possibly even older adults with MDD, do not typically exhibit highly inert NA or PA. This pattern is consistent with the healthier patterns that typically characterize the emotional experiences of older adults (e.g., diminished NA and less variable NA) compared with younger adults (e.g., Carstensen et al., 2011). Emotional inertia has not been previously examined in older adult samples, so more work is needed in this area.

Our study has several strengths, including our use of a relatively diverse sample and the high ecological validity afforded by our ESM procedure, but we note two limitations. First, because our study was composed of one wave, it is not clear, for example, whether the emotional disturbances that characterize the remitted-MDD group will characterize the people in the current-MDD group whose MDD remits in the future. To test whether NA intensity and variability are risk factors or scars, as detailed above, researchers will need to track these patterns longitudinally through the onset and remission of one or more MDEs. Second, our study focused on MDD specifically, but other disorders also involve dysregulated emotion. For example, some research suggests that patients who are between bipolar disorder mood episodes reported lower PA intensity and higher NA intensity than control participants (Havermans et al., 2010), suggesting that other indices of emotional dynamics, such as instability, might differ from control participants in these in-between stages as well.

Our findings may provide insight for why two leading treatments are effective for preventing relapse in remitted MDD and provide novel treatment targets. Selective-serotonin reuptake inhibitors function to dampen amygdala reactivity and decrease NA (e.g., Arce et al., 2008), which was elevated in our remitted MDD sample. Likewise, mindfulness-based cognitive therapy teaches patients skills such as acceptance and cognitive restructuring that function to reduce emotional avoidance and decrease NA intensity (Gu et al., 2015). Mindfulness training in mindfulness-based cognitive therapy could also indirectly serve to reduce NA variability given that greater self-reported mindfulness has been found to be associated with lower levels of emotional variability (Hill & Updegraff, 2012). Treatments may be improved by targeting emotional variability more directly. For instance, dialectical behavior therapy, which fosters mindfulness, distress tolerance, emotion regulation, and interpersonal effectiveness skills, has been shown to successfully reduce emotional variability in mental health outpatients (Stepp et al., 2008). These outcomes suggest that some elements of dialectical behavior therapy could be useful for secondary prevention efforts in individuals with remitted MDD. Overall, our findings can inform the development of clinical treatments for MDD that target novel emotional processes.

Transparency

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Author Contributions

R. J. Thompson developed the study concept. All of the authors contributed to the study design. Data collection was performed under the supervision of R. J. Thompson.

R. J. Thompson performed the data analysis. R. J. Thompson and N. H. Bailen drafted the manuscript, and T. English provided critical revisions. All of the authors approved the final manuscript for submission.

Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Supplemental Material

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Notes

1. In addition to standard deviation and MSSD, variance and relative standard deviation (i.e., *SD**; Mestdagh et al., 2018) are used to assess fluctuations in affect across a sampling period. Researchers have also examined residuals of affect as a measure of instability (Nelson et al., 2020; Thompson et al., 2012). Although many of these terms are used interchangeably, some patterns in the literature have emerged. Researchers frequently refer to indices of standard deviation, corrected standard deviation, and variance as emotional variability, whereas MSSD is frequently used to operationalize emotional instability. As demonstrated by Jahng et al. (2008), MSSD is a function of variance and autocorrelation; consequently, *emotional instability* is often used as an umbrella term that includes both the range of fluctuations of magnitude (i.e., variance) as well as a temporal component (i.e., inertia).

2. Schoevers et al. (2020) also examined emotional intensity and inertia among groups with current and remitted depressive disorders, but both groups included participants who were diagnosed only with anxiety disorders and not depressive disorders. Unlike for variability, findings excluding the participants with only anxiety disorders were not presented. Consequently, it is unclear how the pure anxious participants affected results.

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