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Emotion dynamics in current and remitted depression: an ecological momentary assessment study

Mariah T. Hawes and Daniel N. Klein

Department of Psychology, Stony Brook University, Stony Brook, NY 11794, USA

Original Article

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Corresponding author:
Mariah T. Hawes;
Email: hawes2mt@gmail.com

Abstract

Background. Individuals in a depressive episode and healthy controls exhibit robust differences on affect dynamics captured with ecological momentary assessment (EMA). However, few studies have explored affect dynamics in individuals in remission from depression, and results have been mixed.

Methods. A community sample of 18-year-olds ($N = 345$) completed diagnostic interviews and EMA probing emotions and low interest/motivation 5× daily for 2 weeks. Affect home base, variability, and inertia were compared across currently depressed, remitted, and never-depressed groups.

Results. Both depression groups had a higher negative affect (NA) and low interest/motivation home base, lower positive affect (PA) home base, greater variability of NA, PA, and low interest/motivation, and greater NA and low interest/motivation inertia than never-depressed participants. Additionally, the currently depressed group had a higher sad home base specifically, greater variability across most negative emotions and low interest/motivation, and greater low interest/motivation inertia than the remitted group. The currently depressed and remitted groups did not differ in anxious, upset, or PA home base, anxious or PA variability, and inertia of all negative emotions and PA.

Conclusions. Findings suggest that a number of abnormalities in emotion and reward functioning persist after a depressive episode resolves, however, the tendency to experience higher levels of sadness, greater range of a variety of negative emotions, and more variable and persistent low interest/motivation are exacerbated during depressive episodes. Conversely, greater intensity and persistence of some negative emotions (anxiety, upset) and blunted positive emotions appear to equally characterize depression in both the symptomatic and remitted state.

Problems with emotion and reward functioning are a central feature of depression. Diagnosis of a depressive disorder requires markedly depressed mood or low interest/pleasure (American Psychiatric Association, 2013). At the same time, the tendency to experience negative emotions and altered reward processing are risk factors shown to both predict future occurrence of a depressive disorder (e.g. Block, Gjerde, & Block, 1991; Bress, Foti, Kotov, Klein, & Hajcak, 2013; Krueger, 1999) and to persist after remission (e.g. Altaweel, Upthegrove, Surtees, Durdurak, & Marwaha, 2023; Hankin, Wetter, & Flory, 2012; Pechtel, Dutra, Goetz, & Pizzagalli, 2013). Teasing apart features that are concomitants of depressive episodes from those that reflect trait vulnerabilities is important for providing clues to etiology and informing effective prevention and intervention efforts. A common strategy for beginning to disentangle vulnerability factors from features of depressive episodes is to compare individuals in remission to those in a current depressive episode and to never-depressed participants.

Ecological momentary assessment (EMA) is particularly well-suited to studying emotional patterns in everyday life, and a number of metrics have been developed to describe these patterns, called *affect dynamics*. Some of the most studied affect dynamics include affective home base (typical affective state), variability (emotional range), and inertia (persistence of emotions; Kuppens & Verduyn, 2015; Kuppens, Oravecz, & Tuerlinckx, 2010). Kuppens et al. (2010) propose a complex systems framework for understanding these dynamic metrics. They suggest that affective home base can be conceptualized as an attractor state to which affect is pulled, variability reflects movement away from the emotional attractor state in response to a perturbation (disturbance) of the system, and inertia represents attractor strength or how quickly affect returns to the attractor state after a perturbation has moved it away from baseline (Kuppens et al., 2010; Wichers, Wigman, & Myin-Germeys, 2015). These metrics have been described as indicators of the resilience of a system, and there is interest in how they can be used to predict critical transitions, such as the onset/offset of a depressive episode (Scheffer et al., 2018; van de Leemput et al., 2014).

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Many studies have explored differences in the affect dynamics of currently depressed and non-depressed individuals (Houben, Van Den Noortgate, & Kuppens, 2015). These studies tend to find that currently depressed individuals report a higher negative affect (NA) home base, lower positive affect (PA) home base, greater variability of emotions of both valences, and more inert NA. However, very few studies have explored affect dynamics in remitted individuals and results have been somewhat mixed.

Just one prior study has compared affect dynamics of individuals in remission to those in a current episode and never-depressed controls. Thompson, Bailen, and English (2021) found that the currently depressed group reported lower mean PA and higher mean NA, along with greater variability of NA but not PA than the remitted group. The remitted group, in turn, was higher in mean NA, lower in mean PA, and had greater NA variability than the never-depressed group. No differences were found in inertia of either valence between any of the groups. Another study compared groups of participants who had a current or previous diagnosis of a depressive and/or anxiety disorder, also finding highest levels of NA and PA variability in the current group, followed by the remitted group, and then the never depressed/anxious group (Schoevers et al., 2021). In contrast to Thompson *et al.* (2021), Schoevers et al. (2021) did observe higher levels of NA inertia across the three groups in the same pattern as variability, and higher levels of PA inertia in the remitted compared to the never depressed/anxious group, but no differences between the current and remitted groups. However, because study groups combined depression and anxiety, differences in affective patterns between these diagnoses may have been obscured.

A handful of additional studies have compared mean affect ratings of individuals in remission to never-depressed participants, finding higher levels of mean NA but not PA in the remitted group (Barge-Schaapveld & Nicolson, 2002; Funkhouser et al., 2021; Wichers et al., 2012). Notably, none of these studies compared the remitted and never-depressed groups on levels of variability. One study compared levels of inertia and instability, a related dynamic metric that is informed by both inertia and variability (Jahng, Wood, & Trull, 2008), and found no differences between groups on either metric for both NA and PA (Funkhouser et al., 2021).

Affective home base is predominantly represented with the mean of affect ratings across EMA surveys, however, one study compared *median* affect between remitted and never-depressed groups (Servaas et al., 2017). This study also looked at emotions individually, rather than aggregating to the composite valence level. Servaas et al. (2017) found that the remitted group was lower across all positive emotions and higher on some (agitated, restless) but not all (down, irritated, lonely) negative emotions than the control group. This divergence suggests that how the dynamics are quantified can impact what differences emerge. More recently, Ringwald and Wright (2022) demonstrated that when NA home base is quantified as the mean, it is highly confounded with NA variability because the mean is pulled towards more extreme deviations in affect. They argue that, conceptually, the mode is a more appropriate fit for affective home base as an individual's typical affective state and found that the mode is less confounded with variability than both the mean and median. Additionally, patterns at the composite valence level may not extend to all emotions that fall into these valence categories, consistent with research that finds differential associations between facets of neuroticism and depression (e.g. Goldstein, Kotov, Perlman, Watson, & Klein, 2018).

EMA studies of depression often explore PA dynamics alongside NA dynamics. However, low PA is not a hallmark of depression in the sense that loss of interest is. However, the dynamics of reward functioning, as reflected in loss of interest/low motivation, have rarely been studied with EMA. Just one prior study could be identified that assessed reward anticipation using EMA. Wu et al. (2017) found that, on average across EMA surveys, depressed individuals reported lower levels of anticipated pleasantness and higher levels of anticipated unpleasantness of future activities compared to controls. Whether these differences extend to individuals in remission from depression has not been unexplored.

The current investigation builds on prior research into the dynamic patterns of emotion in everyday life in depression by comparing patterns of NA, PA, and interest/motivation across currently depressed, remitted, and never-depressed individuals. A community sample of 18-year-olds participated in an EMA study assessing emotions and interest/motivation 5× daily for 2 weeks. Participants were part of a longitudinal study involving tri-annual diagnostic assessments from ages 3–18, providing an unusually precise lifetime depression history. We explored emotion dynamics both on the higher level of valence (PA/NA), as well as the lower level of individual negative emotions. Additionally, affective home base was represented by the mode of EMA surveys, which is a better conceptual fit for quantifying an individual's typical affective state and is less confounded with variability than the mean and median (Ringwald & Wright, 2022).

Methods

Participants

Participants were part of an ongoing study on the development of psychopathology that has followed children and their families tri-annually since the children were three years old (Klein & Finsaas, 2017). At the onset of the study, families with a 3-year-old child living within a 20-mile radius of Stony Brook, New York were recruited via commercial mailing lists. At least one biological parent who spoke English was required to participate alongside their child. Children with a significant history of medical disorders or a developmental disability were excluded. Prior to age 18, parents provided informed consent on behalf of themselves and their child, and children provided assent starting at age 9. After age 18, the child participants, who were now legal adults, provided consent. Online Supplementary Table S1 in the online Supplement displays the breakdown of the characteristics of the original study sample ($N = 609$) and after attrition/inclusion cut-offs.

Procedures

At all waves of the study, a parent (primarily mothers), the participant, or both completed a semi-structured diagnostic interview about the participant. The age 18 wave of the study also included EMA. Greater detail of the EMA protocol is included in the online Supplement. Briefly, participants were sent 5 surveys randomly throughout the day for 14 consecutive days. To maximize compliance, participants were allowed to pick among different survey timing windows, staff monitored compliance on a daily basis, and payment doubled after the first 40 surveys from 1$ to 2$ per survey. We set the following thresholds for filtering data of questionable quality, based on previously recommended criteria (Viechtbauer & Constantin, 2019). Individual survey

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responses were excluded if survey completion time was equivalent to an average response of less than one second per item or greater than 45 min. Participants were excluded if they completed fewer than 14 surveys or had zero variability in affect responses across both positive and negative domains. The Stony Brook University Institutional Review Board approved all study procedures.

Measures

Depression diagnosis and history

At ages 3 and 6, parents were interviewed with the Preschool Age Psychiatric Assessment (PAPA; Egger et al., 2006), which assesses psychopathology in the past 3 months. At ages 9, 12, and 15, both the child participant and a parent were interviewed using the Kiddie-Schedule of Affective Disorders and Schizophrenia-Present and Lifetime (K-SADS-PL; Axelson, Birmaher, Zelazny, Kaufman, & Gill, 2009). Symptom ratings combined parent and child report. At age 18, just the child (now adult) participant was interviewed using the K-SADS-PL. Diagnostic interviews were administered by trained doctoral students and a masters-level clinician. All interviews probed current symptoms (past month). Symptoms since that the last interview were also assessed at ages 12, 15, and 18, and symptoms across the lifetime were assessed at age 9 to capture periods not covered in the age 3 and 6 PAPA interviews. All interviews with a suspected diagnosis were reviewed in a case conference with a child psychiatrist and clinical psychologist. For the current investigation, individuals meeting criteria for major depressive disorder, dysthymia (DSM-IV)/persistent depressive disorder (DSM-5), or depressive disorder not otherwise specified (NOS) were included in the depression groups. Diagnoses of depressive disorder NOS were assigned when either the symptom count or duration thresholds were not met but there was clinically significant impairment, suicidality, or the individual received treatment for depression. No comorbidity exclusions were applied. One participant in the remitted group met criteria for bipolar II and was not in a hypomanic episode at the time of data collection.

Ecological momentary assessment of affect and interest

Affect questions designed for use in the current study were modeled after commonly used non-EMA affect questionnaires (e.g. the PANAS; Watson, Clark, & Tellegen, 1988). The affect questions were preceded by a prompt that instructed participants to 'think about how you were feeling right before you started the survey,' to reduce reactivity effects (e.g. increased irritability at having to complete another survey). Affect items instructed participants to rate 'To what extent did you feel (emotion)' on a Likert-scale from *not at all* (1) to *extremely* (5). To balance survey brevity with maximal coverage of valence domains, some items combined several closely related emotional states. Four questions assessed positive valence emotions: (1) happy, (2) excited, (3) cheerful, and (4) content or peaceful. Four questions assessed negative valence emotions: (1) sad, down, or depressed, (2) anxious, worried, or nervous, (3) irritated, annoyed, or angry, and (4) upset. A prior study analyzing a subset of current participants found that the affect items can be combined into internally consistent PA and NA composites along the proposed item groupings (Hawes, Olino, & Klein, 2023). A ninth item not included in either valence composite assessed the extent to which a participant felt 'unmotivated or not interested' on the same rating scale, thus higher scores corresponded to lower interest/motivation.

Data analysis

Computing affect and interest dynamics

At each survey, the four positive and negative emotion items were averaged to create PA and NA composites, respectively. Affect dynamics were computed using these survey-level valence composites, along with the four individual negative emotion items and the unmotivated/not interested item. Group comparisons of individual positive emotion dynamics are reported in online Supplement Table S2.

Affective home base, or the most typical affective state, was represented with the person-specific mode. When an individual had multiple modes, the smallest mode was retained for NA, the individual negative emotion items, and the unmotivated/not interested item, and the largest mode was retained for PA to approximately preserve the skewness of these variables. This approach was proposed by Ringwald and Wright (2022) so as not to artificially reduce the natural skew in these variables. Variability was represented with the person-specific standard deviation around the mode. Finally, inertia was represented as the person-specific autoregressive slope estimate from a multilevel model regressing the current emotion item or composite on a lagged version of the same variable from the prior survey, ignoring overnight lags. Lagged variables were person-mean centered prior to being entered into the models (Hamaker & Grasman, 2015) and random effects were specified for both the intercept and autoregressive slope. All multilevel models were computed with the lme4 package for R (Bates, Maechler, Bolker, & Walker, 2015).

Group comparisons in the emotion and interest/motivation dynamics were made through a series of one-way ANOVAs. Each NA, PA, and interest/motivation dynamic was considered a separate family of tests and alpha was set at 0.05. The individual negative emotion items were considered part of the NA family of tests; ANOVAs for these items' dynamics were only conducted if the NA ANOVA was significant and were adjusted with the Holm-Bonferroni correction to protect against inflated family-wise error (Abdi, 2010). Significant omnibus *F*-tests were followed up with pairwise group comparisons also applying the Holm–Bonferroni correction.

All analyses were conducted in R version 4.2.2 (R Core Team, 2023). Annotated code and output can be found at this link: https://osf.io/65bzs/?view_only=3a41a57d109748b19712e17c720fdac5

Results

Sample characteristics

Table 1 displays the final sample ($N = 348$) characteristics. Participants were predominantly White and non-Hispanic or Latino (287, 82.5%) and approximately evenly split between females (182, 52.3%) and males. Participant family income[†1] was distributed as follows: 29.6% < $70 000, 20.4% $70–$90 000, 26.5% $90–$12 000, and 23.5% > $120 000. Participant sex differed by group ($\chi^2(2) = 7.57$, $p = 0.023$). Specifically, the group in remission contained more females than the never-depressed group (pairwise $\chi^2(1) = 6.83$, $p = 0.009$), but did not differ in sex distribution from the currently depressed group. This is consistent with robust sex differences in depression (Salk, Hyde, & Abramson, 2017). Surprisingly, the currently depressed group

[†]The notes appear after the main text.

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Table 1. Sample characteristics

	Whole sample (*N* = 348)	Currently depressed (*N* = 30)	In remission (*N* = 86)	Never- depressed (*N* = 232)
Female	182(52.3%)	15(50%)	56(65.1%)[a]	111(47.8%)[a]
Non-White/Hispanic or Latino	61(17.5%)	3(10.0%)	17(19.8%)	41(17.6%)
Family income				
< 70 000	87(29.6%)	5 (20.0%)	24 (33.3%)	58(29.4%)
70–90 000	60(20.4%)	5 (20.0%)	18(25.0%)	37(18.8%)
90–120 000	78(26.5%)	8 (32.0%)	15(20.1%)	55(27.9%)
> 120 000	69(23.5%)	7(28.0%)	15(20.1%)	47(23.9%)
Primary depression diagnosis	*N* = 116			
MDD	46(39.7%)	11(36.7%)	35(40.7%)	–
Dysthymia/PDD	10(8.6%)	3(10.0%)	7(8.2%)	–
Depression NOS	60(51.7%)	16(53.3%)	44(51.2%)	–

Note: Acronyms are defined as follows: MDD, major depressive disorder; PDD, persistent depressive disorder (DSM-5); NOS, not otherwise specified. Family income was reported at initial recruitment (between 2004 and 2009) and was missing for 54 participants. Group differences were tested with the chi-squared test for independence.
[a]The group in-remission had a higher proportion of females than the never-depressed group. For primary depression diagnosis, when an individual had multiple depression diagnoses, their primary diagnosis was assigned hierarchically (MDD > dysthymia/PDD > depression NOS).

did not differ from the never depressed group in proportion of females, though this may be a consequence of the small sample size. Groups did not differ by race/ethnicity or family income and the two depression groups did not differ by primary depression diagnosis.

Group differences in home base

Table 2 displays the results of the ANOVAs comparing dynamics across groups. Group differences were found for home base of all emotion and interest dynamics except for upset and angry emotions. Relative to the never-depressed group, the currently depressed group had a higher average NA, sad emotions, anxious emotions, and low interest/motivation home base and a lower PA home base. The group in remission from depression had a higher sad emotions, anxious emotions, and low interest/motivation home base and a lower PA home base than the never-depressed group. Finally, the currently depressed group had a higher NA and sad emotions home base than the group in remission. The two depression groups did not differ across any of the other negative emotions, PA, or interest/motivation.

Group differences in variability

Group differences were found for variability of all emotion and interest dynamics. Both the currently depressed group and the group in remission from depression had higher variability of NA, all negative emotions, PA, and low interest/motivation than the never-depressed group. The currently depressed group had higher variability of NA, sad emotions, angry emotions, upset, and low interest/motivation than the group in remission, but no differences between the depression groups were found in variability of anxious emotions or PA.

Group differences in inertia

Group differences were found for inertia of NA, sad emotions, angry emotions, and interest/motivation but not for anxious emotions. Additionally, the omnibus tests were significant for group comparisons of upset and PA, however, none of the pairwise comparisons were significant after correction for family-wise error inflation. Both the currently depressed group and the group in remission had more inert NA, sad emotions, and low interest/motivation than the never-depressed group. Finally, the currently depressed group had more inert low interest/motivation than the group in remission, but no differences between the depression groups were found in inertia of any emotion variables.

Sensitivity analyses

A number of sensitivity analyses were conducted to evaluate the impact of analysis decisions. First, a more liberal exclusion criteria for low compliance was applied, repeating main study analyses with an expanded sample of participants with at least 7 surveys completed, reduced from the 14 survey threshold used in the original analyses. One participant, who completed exactly 7 surveys, was excluded due to having no consecutive surveys and thus inertia could not be computed. Results are reported in online Supplement Table S4 and were substantively unchanged from the main findings, with the exception that one pairwise comparison (NA in remitted *v.* never-depressed) that was previously marginally non-significant ($p = 0.051$) became significant ($p = 040$).

Second, considering sex differences between the remitted and never-depressed groups, two-way ANOVAs controlling for sex and exploring interaction effects between depression group and sex were conducted. Results are reported in online Supplement Table S5. Group differences in affect dynamics remained after controlling for sex and no significant interaction effects were observed.

Finally, because use of the mode for calculating home base and variability (standard deviation around the mode) is novel, analyses were repeated using the traditional mean and standard deviation (around the mean) for comparison to past findings. These results are reported in online Supplement Table S6. The currently depressed group had a higher mean home base and variability than the group in remission, which was higher than the never-depressed group, across almost all emotions and interest/motivation, with a few exceptions. The currently depressed and remitted

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Table 2. Group differences in emotion and interest dynamics

	Currently depressed	In remission	Never- depressed	*F*	*p*
Home base					
Negative affect	1.49(0.72)	1.26(0.49)[a]	1.15(0.39)[a]	15.79	< 0.001
Sad, down, or Depressed	1.67(0.84)	1.22(0.54)	1.10(0.35)	34.14	< 0.001
Anxious, worried, or nervous	1.63(0.96)[a]	1.41(0.83)[a]	1.20(0.52)	15.50	< 0.001
Irritated, annoyed, or angry	1.23(0.57)[a]	1.19(0.45)[a]	1.13(0.43)[a]	1.86	0.173*
Upset	1.30(0.70)[a]	1.13(0.37)[a]	1.10(0.37)[a]	5.05	0.025*
Positive affect	2.47(1.14)[a]	2.69(0.95)[a]	3.00(0.97)	11.67	< 0.001
Unmotivated or not Interested	1.87(1.25)[a]	1.60(0.99)[a]	1.28(0.68)	19.30	< 0.001
Variability					
Negative affect	0.82(0.37)	0.60(0.30)	0.43(0.30)	53.44	< 0.001
Sad, down, or depressed	1.02(0.41)	0.68(0.37)	0.46(0.36)	71.40	< 0.001
Anxious, worried, or nervous	0.97(0.45)[a]	0.83(0.42)[a]	0.60(0.44)	30.36	< 0.001
Irritated, annoyed, or angry	1.03(0.41)	0.86(0.35)	0.62(0.38)	48.63	< 0.001
Upset	0.98(0.45)	0.71(0.40)	0.50(0.38)	50.60	< 0.001
Positive affect	0.93(0.39)[a]	0.87(0.34)[a]	0.71(0.30)	24.16	< 0.001
Unmotivated or not interested	1.28(0.50)	0.99(0.52)	0.73(0.46)	44.76	< 0.001
Inertia					
Negative affect	0.30(0.14)[a]	0.26(0.14)[a]	0.22(0.12)	13.83	< 0.001
Sad, down, or depressed	0.30(0.17)[a]	0.26(0.14)[a]	0.20(0.12)	22.92	< 0.001
Anxious, worried, or nervous	0.21(0.14)[a]	0.21(0.15)[a]	0.20(0.11)[a]	0.70	0.403*
Irritated, annoyed, or angry	0.19(0.13)[a]	0.15(0.12)[ab]	0.13(0.09)[b]	9.67	0.002
Upset	0.22(0.16)[a]	0.20(0.15)[a]	0.17(0.13)[a]	7.01	0.008
Positive affect	0.36(0.12)[a]	0.36(0.11)[a]	0.33(0.09)[a]	5.45	0.020
Unmotivated or not interested	0.29(0.13)	0.23(0.12)	0.18(0.10)	31.70	< 0.001

Note: Group column cells report group mean (standard deviation). Group means sharing the same superscript are not significantly different (Holm–Bonferroni, $p < 0.05$). The Holm–Bonferroni correction was also applied to the *F* test *p* values for the individual negative emotion dynamics, as these were considered part of a negative affect family of tests. Thus, within each dynamic, the most significant individual negative emotion *F* test was held to an alpha of 0.05/4 = 0.0125; the second most significant test was held to an alpha of 0.05/3 = 0.0167; the third most significant test was held to an alpha of 0.05/2 = 0.025; the last test was held to an alpha of 0.05. Individual negative emotion *F* tests that did not meet the corrected alpha threshold are indicated with *.

groups did not differ in mean home base and variability of PA, and variability of anxious or angry emotions.

Discussion

Affect dynamics are an increasingly popular method for studying emotional functioning in everyday life. The current investigation builds on literature identifying distinct patterns of affect dynamics in depression by expanding comparisons to individuals in remission. In addition, we examined dynamics for individual negative emotion categories separately and included an EMA measure of low interest/motivation. Moreover, we quantified affect home base in a novel way (the mode) that has been shown to be less confounded with variability than the traditional approach (the mean; Ringwald and Wright, 2022). We found that the group of formerly depressed individuals differed from the never-depressed group across a number of emotion and interest dynamics, suggesting that abnormalities in emotion and reward functioning persist even after a depressive episode resolves. However, some dynamics also differed between currently depressed and remitted groups, suggesting that certain problems in emotion and reward functioning are exacerbated during a depressive episode. Notably, consistent with concerns about confounding of the mean with variability (Ringwald & Wright, 2022), results for affect home base calculated with the mean largely mirrored results for variability when calculated both as deviations around the mean and the mode.

Consistent with past studies (Houben et al., 2015), the currently depressed group was found to have a lower PA home base and higher NA home base, greater variability of both valence composites, and greater inertia of NA but not PA than the never-depressed group. Most of these group differences extended to the individual negative emotions, however, some distinctions emerged for inertia in particular. Specifically, the currently depressed group had more inert sad emotions ('sad, down, or depressed') and angry emotions ('irritated, annoyed, or angry') than the never-depressed group, but none of the groups differed in inertia of anxious emotions ('anxious, worried, or nervous') or feeling upset. Research exploring the relationships between specific negative emotion dynamics and depression is extremely limited, however, one prior study found that dysphoria and sad inertia were associated with depressive symptoms, while angry

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and anxious inertia were not (Koval, Kuppens, Allen, & Sheeber, 2012). This study differed in a number of ways from the current investigation (e.g. frequency of EMA surveys, affect measure wording, dimensional depression measure), thus further research is needed to understand why our results diverged with regards to angry inertia.

As noted previously, just one prior study has directly compared affect dynamics between currently depressed, remitted and never-depressed groups, however, this study did not look at individual negative emotions or low interest and they represented home base with the mean (Thompson et al., 2021). Similar to Thompson et al. (2021), we found that NA home base and variability were greater in the currently depressed group than the remitted group, however, we found that not all individual negative emotion dynamics differed between the two groups. The only negative emotion home base that was higher in the currently depressed than the remitted group was sad emotions. For variability, sad emotions, angry emotions and feeling upset were more variable in the currently depressed group compared to the remitted groups, but there was no difference for anxious emotions. Importantly, the remitted group was also higher on these dynamics than the never-depressed group. Moreover, the remitted group additionally had a higher home base and more variable anxious emotions than the never-depressed group. Taken together, our findings suggest that more extreme fluctuations in a range of negative emotions is characteristic of individuals with a history of depression, consistent with research suggesting that neuroticism, a robust risk factor for depression (Kotov, Gamez, Schmidt, & Watson, 2010), reflects greater variability in negative emotions in daily life (Mader, Arslan, Schmukle, & Rohrer, 2023; Ringwald & Wright, 2022). Further, a current episode is characterized by exacerbations of baseline problems with general emotion dysregulation, particularly for sadness.

Unlike Thompson et al. (2021), we found some group difference in inertia. Specifically, both the currently depressed and remitted groups had more inert sad emotions than the never-depressed group, though the depression groups did not differ from each other. Additionally, although the currently depressed group also had more inert angry emotions than the never-depressed group, the remitted group did not differ from the never-depressed group on angry inertia. However, similar to Thompson et al., we did not observe group differences in inertia of NA or PA. The different pattern of findings between individual negative emotions highlights the importance of examining dynamics at this more differentiated level. Had we not explored individual negative emotions, like Thompson et al., we would have missed group differences in specific negative emotion dynamics.

As noted, the past literature on affect dynamics in remitted depression has been mixed for PA, with some studies finding group differences from never-depressed participants and others not. In the present study, currently depressed and remitted groups did not differ on any of the PA dynamics, while both depression groups had a lower PA home base and greater PA variability than the never-depressed groups. This was also the case in sensitivity analyses using the traditional approach of quantifying home base using the mean. The absence of depression group differences in PA suggests that blunted joy in everyday life remains evident even after an episode has remitted and with no evidence of even partial recovery. Conversely, deficits in interest/motivation appear to be present both during and after an episode but are more severe during an episode. We found that both depression groups had a higher home base, greater variability, and more inert low interest/motivation than the never-depressed group. Further, the currently depressed group had even more variable and inert low interest/motivation than the remitted group. These differences between PA and low interest/motivation are consistent with efforts to separate consummatory and anticipatory or motivational anhedonia, which have distinct correlates and neurobiological underpinnings (Treadway & Zald, 2011). Moreover, the relevance of low interest/motivation dynamics to current episodes is notable in light of the efficacy of interventions that are designed to address deficits in blunted interest/motivation for rewards, namely, behavioral activation (Craske et al., 2019; Cuijpers, Van Straten, & Warmerdam, 2007).

Strengths and limitations

This study possesses a number of strengths. First, contrasting currently depressed, remitted, and control groups all in the same study allowed us to begin disentangling trait from state differences in emotional and reward functioning. Second, the multiple levels of longitudinal design (i.e. repeated diagnostic interviews across development and intensive sampling of emotions/interest across a 2-week period) allowed for more accurate assessment of both diagnostic history and emotional/reward functioning. Third, the inclusion of a momentary measure of diminished interest/motivation was highly novel. Fourth, computing dynamics separately for negative emotion items allowed us to capture more fine-grained differences in emotional functioning than most EMA studies of depression in the literature. Finally, representing affective home base with the mode instead of the mean allowed us to separate affect intensity from variability.

Despite these many strengths, several limitations should also be considered. First, despite our large overall sample, because participants were recruited from the community, our currently depressed group was fairly small ($N = 30$). Also, we included cases of depression NOS to maximize group sizes. Most of these cases fell just below cut-offs for the symptom count or duration criteria (e.g. for major depressive episode only 4 threshold symptoms or a duration of 12 days) and all exhibited clinically significant impairment, received treatment for depression, or were suicidal, however, we were not sufficiently powered to conduct sensitivity analyses exploring the impact of this decision. While early adulthood is a period of especially high incidence of depression, that our sample was restricted to a single age group prohibited us from exploring age-related differences in these relationships and may not generalize to older adult samples. Additionally, our sample is relatively homogeneous with respect to race and ethnicity, limiting generalizability to more diverse populations. Lastly, while studying remitted individuals is a first step in understanding risk, we cannot disentangle vulnerability factors from changes resulting from an episode (i.e. the scar model).

Conclusion

The purpose of the current study was to contrast the dynamic patterns of affect and low interest/motivation between currently depressed, formerly depressed, and never-depressed individuals. Findings suggest that a number of abnormalities in emotion and reward functioning persist after a depressive episode resolves, suggesting that they may represent trait vulnerabilities. Some of these abnormalities, such as the greater intensity and persistence

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of some negative emotions (anxiety, upset) and blunted positive emotions, appear to equally characterize active depression and remission and differentiate them from never-depressed participants, and thus may reflect trait vulnerabilities. From a complex systems perspective, these could be markers of low systemic resilience and increased risk of critical transitions in and out of disordered states (i.e. a depressive episode), consistent with the recurrent nature of depression. Others (the tendency to experience higher levels of sadness, greater range of a variety of negative emotions, and more variable and persistent low interest/motivation) differentiate remitted from never-depressed individuals, but were exacerbated in individuals in a current depressive episode, indicating that they have both trait and state components. However, without contrast to a group that will become depressed in the future, vulnerability cannot be disentangled from scarring. Future research should seek to identify prospective relationships between affect dynamics and depression onset. A small but growing literature is realizing the value of dynamic metrics captured with EMA as markers of treatment response (e.g. Bosley, Soyster, & Fisher, 2019; Helmich, Wichers, Peeters, & Snippe, 2022). Our findings suggest that these efforts, along with attempts to identify persons at risk, may be improved by including EMA measures of low interest/motivation and exploring negative emotions individually.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S0033291724000369

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Note

1. Family income was reported at initial study intake, which occurred between 2004 and 2009.

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