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BRIEF REPORT

Positive and Negative Affective Forecasting in Remitted Individuals with Bipolar I Disorder, and Major Depressive Disorder, and Healthy Controls

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Abstract Although emotional disturbances characterize mood disorders, little is known about the affective forecasts of these individuals. We examined forecasted intensity and accuracy for negative affect (NA) and positive affect (PA) among two remitted clinical groups: individuals with Bipolar I (BD; $n=31$) and Major Depressive Disorder (MDD; $n=21$), and healthy controls (CTL; $n=32$). We also examined whether each group's forecasting accuracy varied by valence. At the lab, participants forecasted their short-term (next day) and long-term (next week) NA and PA; then they completed a week of experience sampling. The MDD group forecasted lower PA and higher NA than the CTL group; the BD group's forecasts varied across time frames. There were no group differences in forecasting accuracies. Regarding within group forecasting accuracy, the CTL group was more accurate in PA than NA; the BD group was similarly accurate across valence, and the MDD group's accuracy varied based on the time frame.

Keywords Emotion · Affective forecasting · Bipolar disorder · Depression

When making decisions, people often simulate how they will feel during future events (Gilbert and Wilson 2007). Some choose a movie because they think it will make them feel happy. Some choose to go on a vacation because they think they will regret not going. Predicting how one will feel guides decision-making behaviors. In the laboratory, healthy adults have generally been found to be accurate in forecasting specific emotions (Robinson and Clore 2001). In everyday life, however, people tend to overestimate both the duration (Gilbert and Wilson 2000) and intensity of future affective experiences (e.g., Wilson et al. 2004, 2000). This affective overestimation may be driven by people's tendency to forecast pleasant events as more pleasant and negative events as more negative than the events prove to be (Liberman et al. 2002).

We know even less about affective forecasting for individuals who experience disturbances in emotion. Disturbances in positive and negative affective experiences have been posited to be important for understanding the etiology and course of different forms of psychopathology, including Bipolar Disorder (BD) and Major Depressive Disorder (MDD; e.g., Berenbaum et al. 2003; Kring and Bachorowski 1999). We examined affective forecasting across mood-disordered populations—BD and MDD adults whose episodes are in remission (i.e., are not in a manic, depressed, or mixed mood episode)—as well as healthy adults with no psychiatric history. If people with mood disorders show greater affective forecasting biases, such as under-estimating positive affect (PA) or greatly overestimating NA, this would likely affect their motivation, behaviors and even decision-making. For example,

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people with depression may start avoiding social events, which could weaken their relationships and social support, and thereby further sustain or worsen their depression. For clinical populations, this could even influence whether they seek treatment.

Affective Disturbances in BD and MDD

Bipolar Disorder

BD is a severe and chronic psychiatric disorder associated with profound social, functional, and occupational impairment (Coryell et al. 1993). Diagnostic criteria for BD centrally features abnormally elevated, expansive, or irritable mood (American Psychiatric Association 2013). Emerging research suggests that BD is associated with increased positive emotional reactivity (Gruber et al. 2008; M'Bailara et al. 2009; Meyer et al. 2001) and difficulty with regulating emotions (Johnson et al. 2007; Phillips and Vieta 2007). For example, BD is associated with a increased positive emotion reactivity both in response to (i.e., liking), and in anticipation of (i.e., wanting), pleasant stimuli (e.g., Alloy et al. 2009; Gruber 2011a). People diagnosed with BD have trouble regulating both positive (Farmer et al. 2006; Gruber et al. 2011; Johnson et al. 2008) and negative (e.g., Gruber et al. 2011; Johnson et al. 2008) emotion intensity as well.

Major Depressive Disorder

MDD is another mood disorder characterized by disturbances in emotion that is associated with great costs at both individual and societal levels. A diagnosis of MDD requires the presence of depressed mood and/or anhedonia (American Psychiatric Association 2013). Individuals with MDD exhibit other aberrations in emotion besides those encompassed by these diagnostic criteria, including but not limited to elevated affective instability (e.g., Thompson et al. 2012). Contemporary models of MDD highlight core deficits in the experience of positive emotion help differentiate MDD from other forms of psychopathology (e.g., Kring and Sloan 2009). Research is needed to continue to elucidate factors that help to explain aberrations in emotion that characterize BD and/or MDD. In this context, one promising direction is examining individuals' beliefs about future emotional experiences or their affective forecasting.

Affective Forecasting in BD and MDD

The notion that people diagnosed with mood disorders are poor at affective forecasting is inherent in many cognitive behavioral treatments. For example, assessments of negative automatic thoughts include evaluating clients' overestimation of their levels of negative emotions in MDD (e.g., Beck 2011), as well as, overly positive and ambitious future-oriented cognitions in BD (e.g., Johnson 2005). Even though these psychological treatments address biases in affective forecasting, little research has examined affective forecasting in BD and MDD primarily characterized by disturbances in emotion.

To our knowledge, only one study has examined affective forecasting relevant to BD. In a large non-clinical student sample, Hoerger et al. (2012) found that biases in affective forecasting for negative and positive emotions surrounding Valentine's Day were unrelated to lifetime symptoms of hypomania. As no work to date has examined affective forecasts among a sample of individuals diagnosed with BD, additional research using clinical samples spanning a larger age range is needed to better understand the role of affective forecasting in BD.

In contrast to BD, several investigators have examined the relation between emotional forecasting and depression, both symptoms and diagnoses. Consistent with cognitive theories of depression (e.g., Beck 1976; Alloy et al. 1992), but not of depressive realism (e.g., Moore and Fresco 2012), higher levels of depressive symptoms in student samples were related to less accurate estimates of negative mood (Wenze et al. 2012) and negative affective reactions to a future event (Hoerger et al. 2012). Both studies found that higher levels of depressive symptoms were associated with overestimations of negative affect (Hoerger et al. 2012; Wenze et al. 2012). In addition, Hoerger et al. (2012) found that higher levels of depressive symptoms were associated with less accurate estimates of PA, with higher levels of depressive symptoms related to underestimations of PA. In a study with a clinical sample, compared to nondepressed controls, depressed individuals anticipated fewer future positive experiences (MacLeod and Salaminiou 2001). Importantly, these forecasting biases appear to be unique to symptoms of depression; they are not significantly related to symptoms of anxiety (Wenze et al. 2012; Macleod and Salaminiou 2001) or, as noted above, to symptoms of hypomania (Hoerger et al. 2012).

Other affective forecasting research has provided less support for cognitive theories of depression. For example, Yuan and Kring (2009) found that, compared to a nondysphoric group, dysphoric participants were less accurate in their affective forecasts of happiness during a gambling task, overestimating their levels of happiness. Similarly, Wenze et al. (2012) found that participants generally overestimated PA, but, inconsistent with Yuan and Kring's findings, those with higher levels of depressive symptoms were more accurate in their (over)estimations of PA. Given that the little research that has examined affective forecasting and MDD has had mixed findings, additional research

is needed. Further, research on those with MDD has been limited to those who are currently in episode. Examining the affective forecasting of individuals with MDD in remission will elucidate more trait-like patterns of affective forecasting independent of current mood phase.

The Present Investigation

The present study was designed to investigate the affective forecasting of three groups of participants: individuals with remitted BD, individuals with remitted MDD, and healthy controls (CTL). We tested whether there were group differences in the magnitude of forecasted intensity of PA and NA, as well as the accuracy of the forecasts. We also tested within group differences in forecasting accuracy. More specifically, we examined whether the accuracy with which each group forecasted their affect varied by valence. Including these three groups of participants allowed us to examine the extent to which forecasting processes are disorder-specific or common across mood disorders, which is consistent with recent calls for research to elucidate which emotional disturbances are transdiagnostic (Kring 2010; Insel et al. 2010). Recruiting individuals with mood episodes that were in remission also allowed us to examine potential trait-like differences in affective processes independent of phasic symptom severity.

All participants completed a baseline laboratory session during which they provided forecasts for PA and NA for two times frames: short-term (next day) and long-term (next week). Examining two time frames allowed us to examine the robustness of forecasting accuracy. Participants then completed a six-day experience sampling method (ESM) protocol in which they reported their current PA and NA several times a day in their naturalistic daily lives. This participant selection criteria and laboratory and experience-sampling design allowed us to test the following hypotheses (summarized in Table 3).

Aim 1: Do Groups Differ in Their Levels and Accuracy of Affective Forecasting?

The first aim was to examine between-group sources of variation in intensities of forecasts and accuracy of forecasts for both PA and NA. Compared to healthy controls, individuals with BD have been found to report greater PA at the prospect of earning future rewards, to set more ambitious future goals, and to exhibit more activity in the behavioral incentive system focused on experiencing and attaining pleasurable, future goals (e.g., Gruber 2011b; Johnson 2005; Alloy and Abramson 2010). Thus, for PA, we hypothesized that the BD group would forecast higher PA levels than both the CTL and MDD groups, and the CTL group would forecast higher PA levels than the MDD group (**Hypothesis 1a**). Individuals with MDD have been found to predict lower PA than do healthy controls (Wenze et al. 2012) and to be characterized by lower levels of PA and higher levels of NA, even following recovery from MDD (Watson et al. 1995a, b; Wenze et al. 2012). Moreover, investigators have found that higher levels of depressive symptoms are associated with a more pessimistic bias concerning future life events (Strunk and Adler 2009). Even individuals with MDD in remission often have a more negative cognitive style than do those without a history of MDD (Alloy et al. 2000; Haeffel et al. 2005). Therefore, for NA, we hypothesized that the MDD group would forecast higher NA than the CTL and BD groups, who we did not expect to differ (**Hypothesis 1b**). Finally, because affective forecasting is likely to be more difficult for individuals who are unclear about their affect and/or who experience affective instability, such as individuals who have been diagnosed with MDD or BD (e.g., Ehring et al. 2008; Gershon et al. 2012; Lovejoy and Steuerwald 1995; Solomon et al. 1996; Thompson et al. 2011), we expected the CTL group to make more accurate forecasts of PA and NA than would both clinical groups (**Hypothesis 1c**).

Aim 2: Are Individuals in Each Group More Accurate at Forecasting Their PA or NA?

The second aim was to examine within-group sources of variation in accuracy of affective forecasts. More specifically, we wanted to examine whether each group was more accurate in the forecasts of NA or PA. First, Finkenauer, Gallucci, van Dijk, and Pollmann (2007) found that individuals from the community forecasted levels of PA more accurately than they did levels of NA. We expect that the CTL group would forecast similarly to this community sample. Research has found that elevated emotional instability in MDD is greater for NA than PA (Houben et al. 2015). And when making predictions, people are likely to be more accurate when predicting something that is more stable than something that is more variable. Consequently, we hypothesize that the MDD group will also be more accurate in the forecasts of PA than NA. Research has shown that individuals with BD have unstable NA and PA, so we expect that the BD group will be similarly accurate in the forecasts of PA and NA (Lovejoy and Steuerwald 1995). In summary, we predicted that the CTL and MDD groups would more be accurate in their forecasts of PA than of NA, whereas the BD group would be similarly accurate across valences (**Hypothesis 2**).

Method

Participants

Participants were recruited as part of a broader study on emotion and mood from the greater New Haven, CT community. A total of 84 individuals between the ages of 18 and 60 were recruited using online advertisements and flyers posted in New Haven, CT and surrounding communities. Specifically, participants included 31 individuals diagnosed with BD I, 21 individuals diagnosed with MDD, and 32 individuals who did not meet current or past criteria for any *Diagnostic and Statistical Manual for Mental Disorders* (DSM)-IV-TR Axis I disorders comprised our CTL group. Both clinical groups were currently remitted for at least one month (i.e., not in a current manic, depressed, or mixed mood phase) in order to examine more trait-like patterns of affective forecasting independent of current mood phase that might represent a vulnerability factor during relatively asymptomatic phases of the illness. See Table 1 for demographic and clinical characteristics.

Because both BD and MDD are frequently comorbid with other Axis I disorders (e.g., Kessler et al. 2003, 2005; Weissman et al. 1996), we did not exclude participants in the BD and MDD groups on the basis of Axis I comorbidities with the exception of current substance use disorders. Exclusion criteria for all groups included history of severe head trauma, stroke, neurological disease, severe medical illness (e.g., autoimmune disorder, cardiovascular disease, HIV/AIDS), or current alcohol or substance abuse or dependency in the past 6 months.

Measures of Clinical Functioning

Diagnostic Evaluation

To determine eligibility, participants' current and past histories of Axis I disorders were assessed using the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I; First et al. 2007). Extensively trained clinical psychology faculty, psychology doctoral candidates, or post-baccalaureate research fellows administered the diagnostic interviews. During the SCID, additional information concerning illness duration and lifetime number of depressive and manic mood episodes was collected.

Mood Symptoms

Current symptoms of mania were measured using the Young Mania Rating Scale (YMRS; Young et al. 1978). The YMRS is an 11-item, clinician-rated measure of current manic symptoms. Scores on the YMRS range from 0 to 60, with scores of seven or greater representing clinically significant symptoms. Current symptoms of depression were measured using the Inventory of Depressive Symptomatology (IDS-C; Rush et al. 1996). The IDS-C is a 30-item, clinician-rated measure of current depressive symptoms. Scores on the IDS-C range from 0 to 84, with scores of eleven or greater representing clinically significant symptoms. Current remitted mood status (i.e., neither manic, depressed, or mixed mood state) for MDD and BD groups was verified according to SCID-IV criteria and cutoff scores on the YMRS ($\leq$7), and IDS-C ($\leq$11). The CTL group also scored below these cutoff scores.

Measures of Emotional Experience

Forecasted Affect

At the first laboratory session, participants forecasted their levels of PA and NA across two distinct future time frames, including short-term (i.e., "Please rate the extent to which you predict you will feel each of the following emotions TOMORROW") and long-term frame (i.e., "Please rate the extent to which you predict you will feel each of the following emotions OVER THE NEXT WEEK") using the Modified Differential Emotion Scale (mDES; Cohn et al. 2009). Specifically, the PA subscale of the mDES consisted of nine individual positive emotion triplets measuring amusement, awe, compassion, contentment, gratitude, hope, joy, love, and pride; the NA mDES subscale consisted of 8 individual negative emotion triplets reflecting anger, contempt, disgust, embarrassment, fear, guilt, sadness, and shame. Each triplet (e.g., angry, irritated, annoyed) was rated on a 5-point scale (1 = *not at all*, 5 = *extremely*). The PA and NA composite scores were created by taking the mean scores across the positive and negative items for the respective time frames. Internal consistency scores, measured using Cronbach's alpha, across the values were high for forecasts for the short-term (PA: 0.91; NA: 0.88) and long-term (PA: 0.89; NA: 0.86).

Actual Affect

PA and NA in the current moment were measured using the same mDES scale described above (Cohn et al. 2009) in participants' daily lives. However, items were modified to reflect current affect experience (i.e., "how much do you feel…"). Specifically, experienced PA and NA were measured naturalistically across a 6-day ESM study period using an electronic Palm Pilot M500 handheld device that was pre-programmed using the open-source Experience Sampling Program (ESP; http://www.experience-sampling.org). Participants were prompted for PA and NA quasi-randomly four times each day (i.e., once within each 3-h block: 9am-12pm, 12-3pm, 3-6pm, 6-9pm) for a total of 24

Table 1 Demographic and clinical information about sample by diagnostic group

	BD (n = 31)	MDD (n = 21)	CTL (n = 32)	Statistic
Demographic information				
Age (M, SD)	31.3 (10.7)	31.5 (11.4)	30.8 (8.8)	$F(2, 77) = 0.03$, $p = 0.97$
Gender				$\chi^2_{(2)} = 0.52$, $p = 0.77$
Male	13 (42%)	7 (33%)	12 (38%)	
Female	17 (55%)	14 (67%)	19 (59%)	
Ethnicity				$\chi^2_{(6)} = 6.28$, $p = 0.39$
Caucasian	28 (90%)	19 (90%)	28 (88%)	
African-American	1 (3%)	0	2 (6%)	
Asian-American	1 (3%)	0	0	
Hispanic/Latino	0	2 (10%)	1 (3%)	
Education (M, SD)	14.9 (2.0)	15.3 (2.6)	16.0 (2.3)	$F(2,78) = 1.71$ $p = 0.19$
Employed				$\chi^2_{(8)} = 13.57$, $p = 0.09$
Full-time	4 (13%)	4 (19%)	11(34%)	
Part-time	10 (32%)	6 (29%)	10 (31%)	
Unemployed (not a student)	3 (10%)	5 (24%)	4 (13%)	
Unemployed (student)	13 (42%)	6 (29%)	4 (13%)	
Retired	0	0	2 (6%)	
Income				$\chi^2_{(8)} = 7.40$, $p = 0.49$
Less than 25 K	8 (26%)	6 (29%)	8 (25%)	
26-50K	10 (32%)	10 (48%)	9 (28%)	
51-75K	2 (6%)	3 (14%)	6 (19%)	
76-100K	6 (19%)	0	4 (13%)	
More than 100 K	4 (13%)	2 (10%)	4 (13%)	
Marital status				$\chi^2_{(2)} = 3.73$, $p = 0.16$
Single	15 (48%)	15 (71%)	14 (44%)	
In relationship	15 (48%)	6 (29%)	17 (53%)	
Clinical information				
Depression[a] (M, SD)	4.7 (5.3)	5.5 (2.8)	1.8 (1.8)	$F(2,81) = 7.81$, $p < 0.01$
Mania[a] (M, SD)	2.1 (2.2)	1.8 (2.1)	1.1 (1.1)	$F(2, 80) = 2.29$, $p = 0.11$
Months remitted Depressive Episode	37.6 (54.5)	44.8 (53.4)	–	$t(62) = 0.53$, $p = 0.59$
Months remitted manic episode	28.7 (59.0)	–	–	
Age of depression onset (years)	16.0 (7.3)	15.1 (6.8)		
Lifetime number depressive episodes	14.4 (23.3)	4.3 (2.8)		
Age of first manic episode (years)	18.4 (4.3)	–		
Lifetime manic/hypomanic episodes	12.3 (20.6)	–		
Current comorbidities				
Social phobia	4 (13%)	4 (19%)		
Generalized anxiety disorder	3 (10%)	3 (14%)		
Obsessive–compulsive disorder	4 (13%)	1 (5%)		
Panic disorder	1 (3%)	2 (10%)		
Agoraphobia	1 (3%)	1 (5%)		
Agoraphobia without panic disorder	0	0		
Post-traumatic stress disorder	0	0		
Specific phobia	5 (16%)	3 (14%)		

Note Controls—healthy control group; *BD* bipolar disorder group; *MDD* major depressive disorder group

[a]Depressive symptoms were assessed using the Inventory of Depressive Symptomatology (Rush et al. 1996); Mania symptoms were assessed using the Young Mania Rating Scale (Young et al. 1978)

prompts. Participants were given up to 15 min to respond to the tone after which the Palm Pilot device would no longer accept responses and data were considered missing. Time between surveys within day ranged from one minute to 6.2 h ($M = 3.1$ h, $SD = 1.3$ h). On average, participants completed 18.4 total trials ($SD = 3.8$), with no significant differences between the BD ($M = 18.8$, $SD = 3.8$), CTL ($M = 18.4$, $SD = 3.7$) and MDD ($M = 18.0$, $SD = 4.2$) groups in response rates, $F(2, 81) = 0.26$, $p = 0.78$. Group differences in PA and NA across the ESM week are described in more detail in Gruber, Kogan, Mennin, and Murray (2013).

Actual PA and NA scores were created for the short-term (i.e., the first full ESM day, Day 2) and long-term (ESM week, Days 2 though 7) by taking the mean scores across the positive and negative items for the respective time frame. Internal consistency scores were calculated separately by valence using Cronbach's alpha. For short-term, internal consistency scores were calculated across ESM items occurring on Day 2 (PA: 0.89; NA: 0.82). For long-term, internal consistency scores were calculated across the aggregated mean values for each emotion item across ESM sampling (PA: 0.94; NA: 0.94).

Procedure

The university institutional review board approved the protocol. The study procedure had four stages. First, study participants arrived at the laboratory and provided written and verbal informed consent. Participants then underwent a diagnostic assessment interview to determine eligibility for diagnostic group (BD, MDD, or CTL) and confirm remitted mood status using the YMRS (≤ 7) and IDS-C (≤ 11). Second, after completing an unrelated set of laboratory tasks, participants were asked to complete an anonymous Qualtrics survey that included the affective forecasting measures. Third, participants were then invited to participate in an ESM study protocol for the subsequent week from which measures of actual affect were obtained. Interested participants underwent a thorough training session with the experimenter including review of ESM items, use of the Palm Pilot and a full practice trial reading aloud all individual items and clarifying questions that arose. Participants then completed an acclimatization period including completing up to three practice trials at home that same day (i.e., Day 1). Participants were encouraged to contact the experimenter if any questions arose during this period. Following the acclimatization day, participants completed six consecutive days of the ESM protocol (i.e., Days 2–7). Approximately one week later, participants returned to the laboratory to complete a second session, return equipment, and receive compensation and debriefing. At this second laboratory visit, current symptoms were reassessed to confirm remitted status (i.e., YMRS < 7; IDS-C < 11) for all groups during the past week covering the ecological sampling method (ESM) study period.

Data Analytic Approach

We first examine whether (1) demographic characteristics of our sample vary across the three groups and (2) clinical variables differ between the two clinical groups. Then we present descriptive information about actual PA and NA for both the short-term (i.e., Day 2 or the first full ESM day) and long-term (i.e., Days 2–7 of the ESM week) timeframes by group before we examine our four main hypotheses across the two timeframes. First, we examined forecasting intensity for PA (**Hypothesis 1a**) and NA **(Hypothesis 1b)**. Then we examined the forecasting accuracy of PA and NA (**Hypothesis 1c**). Finally, we tested whether each group was more accurate at forecasting their PA or NA (**Hypothesis 2**).

For forecasted affect (**Hypotheses 1a and 1b**), we examined participants' forecasted PA and NA for short- and long-term by conducting a series of multivariate analyses of variance (MANOVAs) on PA and NA with diagnostic group (BD, MDD, CTL) as a fixed effect. Significant effects were followed up by univariate analyses of variance (ANOVAs).

For affective forecasting accuracy **(Hypothesis 1c)**, we used robust linear regression (Huber and Ronchetti 2009) to test the effect of group on the relationship between (i) short-term forecasted and actual PA and NA, separately and (ii) long-term forecasted and actual PA and NA, separately. Robust regression protects against deviations from the assumptions of OLS regression. Specifically, it protects against the leverage of outliers over the estimation of regression coefficients (Huber 1981). Likelihood ratio tests were used to test the significance of the interactions between group and both short-term forecasted levels or long-term forecasted levels. Positive accuracy scores indicate that participants underestimated the actual level of affect they reported experiencing during the ESM study, and negative accuracy scores indicate that participants overestimated the actual experienced level of affect they reported experiencing during the ESM study.

Finally, for each group we examined whether they were more accurate in forecasting their PA or NA (**Hypothesis 2**). To examine forecasting accuracy by group, we first regressed actual affect on the interaction between short-term forecasted affect and valence using linear mixed-effects models, for each diagnostic group, separately. We used this model to test whether the relation between short-term forecasted affect and actual affect differed by valence. A similar model was used to evaluate the effect of long-term forecasted affect on actual affect and whether it differed by valence. All

models included a random effect for valence. Likelihood ratio tests were used to test the significance of the interaction terms. Model fits were inspected by an analysis of the residuals.

All analyses were done in R v2.12.2 (r-project.org) and SPSS v20.

Results

Demographic and Clinical Characteristics

Demographic and clinical characteristics are listed in Table 1. With respect to demographic characteristics, there were no significant differences in distributions of gender, race/ethnicity, education employment status or income across the three groups. Because of sparsely populated cells, we coded marital status as currently or not currently in a relationship; the groups did not differ in relationship status.

With respect to clinical variables, age of onset of mania for the BD group was approximately 18 years, and age of onset of a major depressive episode for the MDD group was approximately 15 years. As expected, a subset of the clinical participants had current comorbid Axis I diagnoses. For the BD group, social phobia, social anxiety disorder, and obsessive compulsive disorder were the most common comorbid diagnoses; for the MDD group, social anxiety disorder, generalized anxiety disorder, and specific phobia were the most common comorbid diagnoses (See Table 1). Also shown in Table 1, there was a significant effect of diagnostic group for depressive symptoms but not for manic symptoms. Although all groups scored well below cutoffs on the IDS-C, the MDD and BD groups scored somewhat higher on subsyndromal depression symptoms ($p < 0.01$); the MDD and BD groups did not significantly differ from each other however ($p = 0.48$). We opted not to include depressive symptoms, however, as a covariate in final our analyses for three reasons. First, controlling for current symptoms violates important statistical assumptions, as they are intended to minimize within-group, not between-group variability, especially when group status is not randomly assigned (e.g., Miller and Chapman 2001). Second, all groups scored well below the clinical threshold scores on all symptom measures, suggesting minimal variability in depressive symptoms (Table 1). Third, depressive symptoms were not significantly related to forecasted levels of NA or PA for either short- or long-term time frames for either clinical group (BD *r*s: −0.20 to 0.10; MDD *r*s: −0.25 to 0.13).

Actual Affective Experience

We describe participants' actual affective experience (1) to provide readers a context with which to interpret the forecasted NA and PA; and (2) because forecasted affect ratings are subtracted from the actual affect ratings to compute one of the affective forecasting accuracy values. To examine group differences in actual affect, we conducted two one-way (by group) MANOVAs on PA and NA—one on levels of NA and PA reported for the short term and one on levels of NA and PA reported for the long term. The latter group differences are only briefly described below because they are thoroughly described in Gruber et al. (2013).

Short-Term Actual Affect

For short-term, there was a significant effect of group, $F(4,156) = 4.14$, $p < 0.01$. Separate follow-up univariate ANOVAs yielded significant group effects for both PA, $F(2, 78) = 3.88$, $p = 0.03$, and NA, $F(2, 78) = 5.69$, $p = 0.01$. As shown in Fig. 1b and as supported by *post hoc* tests, the MDD group reported experiencing significantly less PA than did the CTL group ($p = 0.01$) and marginally less PA than did the BD group ($p = 0.07$), who did not differ significantly from the CTL group ($p = 0.27$). Both the MDD and the BD groups reported experiencing significantly higher levels of NA than did the CTL group ($p = 0.01$ and $p < 0.01$, respectively), but did not differ significantly from each other, ($p = 0.92$).

Long-Term Actual Affect

Group differences in PA and NA across the entire ESM week are described in Gruber et al. (2013). As shown in Fig. 1b, the MDD group reported experiencing significantly less PA than did the CTL group and marginally less PA than did the BD group, who did not differ significantly from the CTL group. Both the BD and the MDD groups reported experiencing significantly higher levels of NA than did the CTL group, but did not differ significantly from each other.

Hypotheses 1a-1b: Do Groups Differ in Their Levels of Affective Forecasting?

Short-Term Forecasting Levels

Again, the short-term time frame refers to participants forecasting their affect for the next day. We examined group differences in short-term forecasts of PA and NA. Using Pillai's trace, the MANOVA yielded a significant effect of diagnostic group on PA and NA, $F(4,146) = 3.36$, $p = 0.01$. Separate univariate ANOVAs yielded significant effects

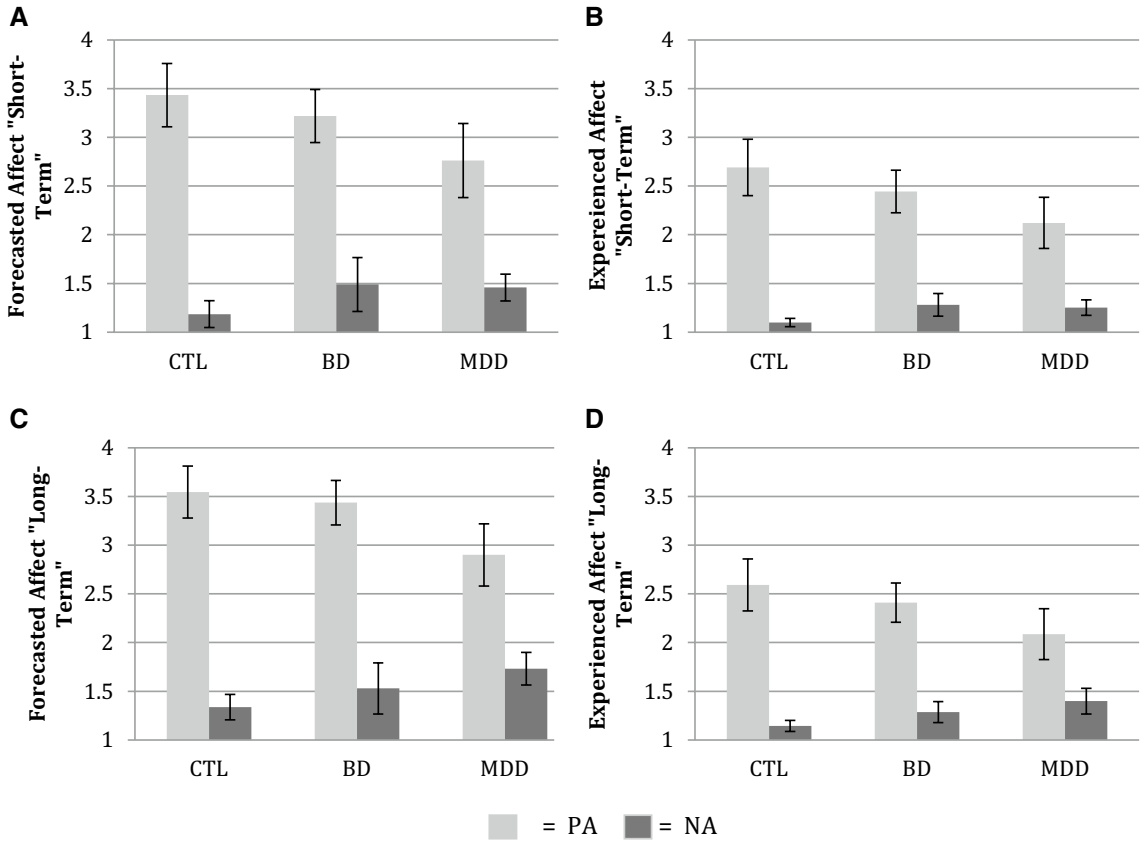

Fig. 1 **a–d** Forecasted and actual levels of PA and NA for short-term (next day) and long-term (next week). CTL—control group; *BD* remitted Bipolar I Disorder group; *MDD* remitted Major Depressive Disorder group. *Error bars* represent 95% confidence intervals

of diagnostic group for both PA, $F(2, 73) = 4.21$, $p = 0.02$, and NA, $F(2, 73) = 4.14$, $p = 0.02$. As shown in Fig. 1a and as supported by *post hoc* tests, the MDD group forecasted significantly lower levels of PA than did both the BD ($p = 0.04$) and the CTL ($p = 0.01$) groups, who did not differ significantly from each other **(Hypothesis 1a)**. Both the MDD and the BD groups forecasted significantly higher levels of NA than did the CTL group ($p = 0.01$ and $p = 0.02$, respectively), and did not differ significantly from each other ($p = 0.69$) **(Hypothesis 1b)**.

Long-Term Forecasting Levels

Again, the long-term time frame refers to participants forecasting their affect for the next week. We examined group differences in long-term forecasts of PA and NA. Using Pillai's trace, the MANOVA yielded a significant effect of diagnostic group on PA and NA, $F(4,146) = 3.86$, $p < 0.01$. Separate ANOVAs yielded significant effects of diagnostic group for both PA, $F(2, 73) = 6.20$, $p < 0.01$, and NA, $F(2, 73) = 5.15$, $p < 0.01$. As supported by *post hoc* tests, the MDD group forecasted significantly lower levels of PA than did both the BD ($p < 0.01$) and the CTL ($p < 0.01$) groups, who did not differ significantly from each other ($p = 0.70$) **(Hypothesis 1a)**. The MDD group forecasted significantly higher levels of NA than did both the CTL group ($p < 0.01$) and BD group ($p = 0.04$), who did not differ significantly from each other ($p = 0.26$) **(Hypothesis 1b)**.

Hypothesis 1c: Do Groups Differ in Their Levels Accuracy of Affective Forecasting?

Short-Term Forecasting Accuracy

We examined group differences in short-term forecasting accuracy of PA and NA. The relation between short-term forecasted PA and actual PA (i.e., ESM Day 2) did not differ by diagnosis ($\chi^2 = 0.59$, $p = 0.75$). As can be seen in Table 2, a one-unit increase in short-term forecasted PA was associated with a 0.78 unit increase in actual PA for the control group ($p < 0.01$), a 0.49 unit increase in actual PA for the BD group ($p < 0.01$), and a 0.35 unit increase

Table 2 Forecasted affect (by valence and time frame) predicting actual affect

Group	β	SE	*p*
Short-term forecasts			
PA			
Controls	0.78	0.11	<0.01
BD	0.49	0.13	<0.01
MDD	0.35	0.12	<0.01
NA			
Controls	0.08	0.08	0.32
BD	0.30	0.05	<0.01
MDD	−0.09	0.12	0.43
Long-term forecasts			
PA			
Controls	0.75	0.13	<0.01
BD	0.33	0.16	0.05
MDD	0.41	0.15	<0.01
NA			
Controls	0.27	0.08	<0.01
BD	0.09	0.05	0.06
MDD	0.28	0.09	<0.01

Note Controls = healthy control group; remitted BD = Bipolar I Disorder group; *MDD* remitted Major Depressive Disorder group. *PA* positive affect; *NA* negative affect

in actual PA for the MDD group ($p < 0.01$). The relation between short-term forecasted NA and actual NA did not differ by diagnosis ($\chi^2 = 1.86$, $p = 0.39$). A one-unit increase in short-term forecasted NA was associated with a 0.08 unit increase in actual NA for the control group ($p = 0.32$), a 0.30 unit increase in actual NA for the BD group ($p < 0.01$), and a 0.09 unit decrease in actual NA for the MDD group ($p = 0.43$).

Long-Term Forecasting Accuracy

We also examined group differences in long-term forecasting accuracy of PA and NA. The relation between long-term forecasted PA and actual PA (ESM Days 2–7) did not differ by diagnosis ($\chi^2 = 5.03$, $p = 0.08$). As can be seen in Table 2, a one-unit increase in long-term forecasted PA was associated with a 0.75 unit increase in actual PA for the control group ($p < 0.01$), a 0.33 unit increase in actual PA for the BD group ($p = 0.05$), and a 0.41 unit increase in actual PA for the MDD group ($p < 0.01$). The relation between long-term forecasted NA and actual NA did not differ by diagnosis ($\chi^2 = 3.40$, $p = 0.18$). A one-unit increase in long-term forecasted NA was associated with a 0.27 unit increase in actual NA for the control group ($p < 0.01$), a 0.09 unit increase in actual NA for the BD group ($p = 0.06$), and a 0.28 unit increase in actual NA for the MDD group ($p < 0.01$).

Hypothesis 2: Are Individuals in Each Group Better at Forecasting Their NA or PA?

Short-Term Valence Accuracy

For the CTL group, levels of short-term forecasted and actual affect were related more strongly for PA than for NA, $\beta = 0.60$, $p < 0.01$, $n = 27$. In contrast, for the BD group, the relations between the levels of short-term forecasted and actual affect did not differ significantly for PA and NA, $\beta = 0.23$, $p = 0.16$, $n = 26$. Similar to the CTL group, the MDD group had levels of forecasted and actual affect that were related more strongly for PA than for NA, $\beta = 0.46$, $p < 0.01$, $n = 20$. These findings were consistent with our hypotheses.

Long-Term Valence Accuracy

For the CTL group, levels of long-term forecasted and experienced affect were related more strongly for PA than for NA, $\beta = 0.45$, $p < 0.01$, $n = 29$. In contrast, the relations between the levels of long-term forecasted and actual affect did not differ significantly for the BD group, PA and NA, $\beta = 0.17$ $p = 0.36$, $n = 26$, or the MDD group, $\beta = 0.05$, $p = 0.82$, $n = 21$.

Discussion

Disturbances in emotion are an integral part of mood disorders. We examined affective forecasting as a potential facet of emotion disturbance among individuals with BD or MDD. In addition to examining whether the affective experiences of those with mood disorders differed from those of a healthy sample, including two clinical samples allowed us to test further whether emotional disturbances were transdiagnostic or unique to MDD or BD. Importantly, because we recruited individuals who were not currently in a manic, mixed or depressive episode, any obtained group differences cannot be due to the state effects of current mood episodes. For convenience, our hypotheses and findings are summarized in Table 3.

We examined group differences in the forecasted intensity of affect, separately for PA and NA, and for both short-term and long-term time frames **(Hypotheses 1a & 1b)**. For PA, we predicted that the BD group would forecast the highest levels, followed by the CTL group and then the MDD group **(Hypothesis 1a)**. We found that the BD and CTL groups forecasted higher PA than did the MDD group. The BD and CTL groups did not differ from each other for either time frame, which may reflect a source of strength or relative preservation in affective processes of people with BD during periods of remission (e.g., Lobban et al. 2012).

Table 3 Summary of hypotheses and findings

	Valence	Short –term		Long-term	
		Hypotheses	Findings	Hypotheses	Findings
Between group					
Intensity	PA	MDD < CTL < BD	MDD < (BD = CTL)	MDD < CTL < BD	MDD < (BD = CTL)
	NA	(MDD) > (BD = CTL)	(MDD = BD) > CTL	MDD > (BD = CTL)	MDD > (BD = CTL)
Accuracy	PA	(MDD = BD) < CTL	MDD = BD = CTL	(MDD = BD) < CTL	MDD = BD = CTL
	NA	(MDD = BD) < CTL	MDD = BD = CTL	(MDD = BD) < CTL	MDD = BD = CTL
Within group accuracy					
CTL		PA > NA	PA > NA	PA > NA	PA > NA
BD		PA = NA	PA = NA	PA = NA	PA = NA
MDD		PA > NA	PA > NA	PA > NA	PA = NA

Note CTL healthy control group; *BD* remitted Bipolar I Disorder group; *MDD* remitted Major Depressive Disorder group. *PA* postivie affect; *NA* negative affect. Findings that are significantly different by group (for between group analyses) or by valence (within group analyses) are indicated by greater or less than signs

This is the first study to demonstrate that decreased levels of PA characterize the affective forecasts of individuals with MDD in remission, which is a similar pattern to their experiences of current affect. Future research should to test how affective forecasting processes vary as a function of current manic and depressive mood severity. The BD group forecasting higher levels of PA for short-term and long-term time frames than did the MDD group is important because all individuals in the BD group had experienced major depressive episodes. Consequently, these findings suggest that lower forecasts of PA are unique to MDD and not characteristic of all mood disorders. These findings converge with laboratory and survey studies suggesting that heightened and persistent positive emotionality distinguish individuals with BD from those with MDD (e.g., Gruber 2011a, b).

For NA, we hypothesized that the MDD group would forecast the highest intensities of NA and PA but expected no differences between the BD and CTL groups (**Hypothesis 1b**). This hypothesis was partially supported as the MDD group forecasted higher intensity of NA than did the CTL group for both time frames, providing the first evidence that individuals with MDD in remission forecast elevated intensities of NA, a pattern similar to research demonstrating that individuals with MDD in remission report elevated current NA (e.g., Wenze et al. 2012). This finding adds to the growing literature documenting emotional disturbances that characterize individuals with MDD in remission (e.g., elevated levels of affective instability; Thompson et al. 2011). For the BD group, findings varied across time frame. Because the pattern was surprising, we suggest that findings for the BD group are interpreted with caution.

Although we expected some group differences in the forecasting accuracy **(Hypothesis 1c)**, we found that the groups were similarly accurate in their forecasting of PA and NA for both short- and long-term time frames. These findings suggest that forecasting accuracy of both clinical groups is intact when they are out of episode. Had the clinical samples been in current mixed, manic or depressive episodes, one might predict group differences in forecasting accuracy. In a related line of research, however, Wu et al. (2017) examined the accuracy of anticipatory pleasure and displeasure—constructs that encompass affective forecasting of PA and NA, respectively, in people with MDD and healthy controls. These investigators found that the MDD and healthy control groups accurately predicted their pleasure, and both groups similarly overestimated their anticipatory displeasure. These results are consistent with the current findings, suggesting that the emotional aberrations that characterize people who are experiencing major depressive episodes do not extend to affective forecasting. Future research is needed to examine forecasting accuracy of individuals in hypomanic and manic episodes.

We also examined whether each group was more accurate at forecasting their PA or NA **(Hypothesis 2)**. Examining within group differences in forecasting accuracy is an important strength of our study. We hypothesized that the CTL and MDD groups would be more accurate in forecasting PA than in forecasting NA, which was supported for the CTL group across both time frames. It is important to note that levels of NA were diminished in comparison to PA for the CTL group. Thus, despite levels of affect varying across valences, PA forecasts were nevertheless more accurate than NA forecasts. These findings highlight the importance of examining emotional disturbances separately by valence. This is consistent with previous research documenting that an unselected sample of participants was more accurate in their forecasting of PA than NA (e.g., Finkenauer et al. 2007). It will be interesting for future research to elucidate why healthy individuals are better at forecasting PA than

NA. Perhaps, they accurately predict the occurrence of positive events while they underestimate negative events (i.e., positivity bias). Findings varied by time frame for the MDD group; we suggest that these results are interpreted with caution due to the small sample size and our not having *posthoc* interpretations. Finally, consistent with our hypotheses, the forecasting accuracy of the BD group did not differ as a function of valence for either the short-term or long-term time frames. For the BD group, levels of PA were higher than levels of NA, so accuracy did not differ as a function of emotional intensity. Because individuals with BD exhibit more activity in the behavioral incentive system focused on experiencing and attaining future goals (e.g., Gruber 2011a; Johnson 2005; Alloy and Abramson 2010), it will be important for future research to replicate these findings.

Strengths of this study include careful diagnosis of the samples and the use of ecological momentary assessment in assessing participants' actual affective experience. These are methodologically strong but time-consuming procedures, and ultimately limited the number of individuals recruited. In particular, the MDD group was small, which is why we suggested interpreting any findings that did not replicate across time frames with caution. Consequently, it will be important that these findings be replicated in future research. In addition, individuals with comorbid substance use disorders were ineligible for participation. Because these disorders commonly co-occur with mood disorders, it will be important for future research to include individuals with these disorders to increase the generalizability of our findings. Also, because people had already experienced depressive and/or manic episodes, it is unclear if differences between the clinical groups and the CTL group existed prior to the onset of the disorder. Future longitudinal research should examine affective forecasting of people at risk for MDD and BD.

Nevertheless, the present study is important because it examined whether and how affective forecasting differed among healthy controls, people with remitted MDD, and people with remitted BD. First, we found that people in the MDD group forecasted higher NA and lower PA than did the healthy controls, highlighting one way in which the MDD group differed form the healthy control group. Interestingly, this pattern of affective experience is similar to what healthy controls and people with current MDD report feeling in the moment; our results are notable, however, because the MDD participants' depressive episodes were in remission. Second, the current findings identify aspects of affective forecasting that did not differ as a function of diagnostic group. The three groups were similarly accurate in their forecasts of NA and PA across both timeframes. Finally, our results highlight aspects of affective experience in which the BD and MDD groups differed from each other: participants in the BD group were equally accurate in their forecasts of NA and PA, whereas participants in the MDD and CTL groups tended to be more accurate in their forecasts of PA than of NA. Future research could profitably examine the costs and benefits of being accurate in affective forecasting.

Compliance with Ethical Standards

Conflict of Interest Renee J. Thompson, Aleksandr Kogan, Philip Insel, Douglas Mennin, Ian H. Gotlib, June Gruber declare that they have no conflicts of interest.

Informed Consent Informed consent procedures were followed in accordance with the ethical standards of the responsible committees on human experimentation at Yale University and the University of Colorado Boulder. Informed consent was obtained from all individual subjects participating in the study.

Animal Rights No animal studies were carried out by the authors for this article.

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