Emotion
2013, Vol. 13, No. 1, 168–175

1528-3542/13/$12.00 DOI: 10.1037/a0029381

Letting Go of the Bad: Deficit in Maintaining Negative, But Not Positive, Emotion in Bipolar Disorder

June Gruber and Amanda L. Purcell
Yale University

Michael J. Perna and Joseph A. Mikels
DePaul University

Bipolar disorder is a disorder of emotion regulation. Less is known, however, about the specific processes that foster the maintenance of such prolonged and intense emotions—particularly positive—over time in this disorder. We investigated group-related differences in the ability to maintain positive and negative emotion representations over time using a previously validated emotion working memory task (Mikels et al., 2005, 2008) among individuals with bipolar I disorder (BD; $n = 29$) compared with both major depressive disorder (MDD; $n = 29$) and healthy control ($n = 30$) groups. Results revealed that the BD group exhibited a selective deficit in maintaining negative—but not positive—emotions compared to both the MDD and the control groups. The MDD and control groups did not differ significantly. These findings suggest that the heightened magnitude and duration of positive emotion observed in BD may, in part, be accounted for by difficulties maintaining negative emotions.

Keywords: emotion, emotion regulation, working memory, bipolar disorder, depression

Bipolar disorder is a severe and chronic psychiatric disorder associated with functional and social impairment (Sanchez-Moreno, 2009; Faglioni, 2005), and it has been ranked as one of the top 10 causes of worldwide disability. Diagnostic criteria (American Psychiatric Association, 2000) for Bipolar Disorder Type I (BD) centrally features abnormally elevated or positive mood. Recent empirical evidence has further confirmed the notion that difficulties regulating positive emotion are a core feature of BD (e.g., Gruber, 2011a, 2011b; Gruber, Harvey, & Purcell, 2011; Johnson, Gruber, & Eisner, 2007). Few empirical studies, however, have delineated precisely what underlying mechanisms might maintain heightened positive mood in BD.

Emotion Disturbance in BD

There is burgeoning interest in the study of emotion regulation and psychopathology (e.g., Kring & Sloan, 2010). Unfortunately, the dysregulation of positive emotion has been left relatively unexplored (e.g., Dillon & Pizzagalli, 2009; Gruber, Mauss, & Tamir, 2011). Making progress in this domain is particularly important for studying BD, diagnostically featured as a disorder involving disturbances in positive emotion. Building empirical work based in affective science methodologies has shed insight into describing the emotional profile of individuals with BD, suggesting it is uniquely characterized both by heightened positive emotional reactivity and by difficulty with positive emotion regulation (e.g., Gruber, 2011a, 2011b). Specifically, BD has been associated with a greater magnitude of positive emotion reactivity in response to (i.e., liking), and in anticipation of (i.e., wanting), positive or rewarding stimuli (e.g., Alloy, Abramson, Urosevic, Bender, & Wagner, 2009; Gruber, 2011a; Johnson, 2005). These increases in positive emotion reactivity are evident after controlling for baseline mood and current symptoms, suggesting that it may be a trait-like marker of BD. First, individuals at risk for, and diagnosed with, BD self-report greater positive affect in response to neutral photos (M'Bailara et al., 2009), at the prospect of earning rewards (Meyer, Johnson, & Winters, 2001), and in response to emotionally evocative films (Gruber, Johnson, Oveis, & Keltner, 2008; Gruber, Harvey, & Purcell, 2011). Moreover, several studies have suggested that people with BD exhibit prolonged emotional responses to positive stimuli. For example, one study by Farmer et al. (2006) reported prolonged elevations in self-reported positive affect relative to controls. Another self-report study found that those with BD demonstrate a self-reported tendency to dwell on positive feelings and thoughts for a prolonged duration, referred to as *positive rumination* (Gruber, Eidelman, Johnson, Smith, & Harvey, 2011; Johnson, McKenzie, & McMurrich, 2008). Finally, in another study, participants with BD continued to exhibit heightened startle eyeblink magnitude following the presentation of positive photos compared to people with major depressive disorder (MDD) and healthy controls (Forbes, Miller, Cohn, Fox, & Kovacs, 2005). Experience-sampling studies have further revealed increased positive mood across daily life events in those falling within the BD spectrum (Hofmann & Meyer, 2006; Lovejoy & Steuerwald, 1995). Of import, physiological data converge with self-reported data to suggest that people with BD also exhibit increased psychophysiological correlates of positive emotion (i.e., respiratory sinus arrhythmia) in response to a variety of positive stimuli, including films, photos, and memories (Gruber, 2011a, 2011b; Gruber et al., 2008). Neuroimaging studies have also

This article was published Online First August 6, 2012.

June Gruber and Amanda L. Purcell, Department of Psychology, Yale University; Michael J. Perna and Joseph A. Mikels, Department of Psychology, DePaul University.

Correspondence concerning this article should be addressed to June Gruber, Department of Psychology, Yale University, 2 Hillhouse Avenue, P.O. Box 208205, New Haven, CT 06520. E-mail: june.gruber@yale.edu

suggested that patients with BD exhibit increased activity in the amygdala and putamen (Lawrence et al., 2004) as well as in the orbitofrontal cortex (Elliott et al., 2004)—brain regions typically associated with emotional salience and reward—in response to positive photos. In sum, behavioral work has suggested that individuals with BD exhibit a heightened initial positive emotion response, and that this heightened positive emotional response persists across stimuli classes and for extended durations, as compared to healthy controls.

Findings have been less conclusive about observable negative emotion difficulties in BD. Specifically, research investigating BD patients' reactivity to negative emotional stimuli has revealed few, if any, differences. People at risk for, and diagnosed with, BD do not appear to differ from healthy controls in their experiential, behavioral, cognitive, or psychophysiological responses to negative failure feedback (Stern & Berrenberg, 1979; Ruggero & Johnson, 2006), interpersonal criticism (Cuellar, Johnson, & Ruggero, 2009), negative photos (Sutton & Johnson, 2002), and challenging math tests (Depue, Kleiman, Davis, Hutchinson, & Krauss, 1985). Studies of neural response to negative emotional stimuli in BD have provided mixed evidence. For example, Yurgelun-Todd et al. (2000) found that female (but not male) interepisode bipolar participants exhibited greater amygdala activation in response to viewing sad facial stimuli relative to controls. Taken together, there has not been any suggestive evidence to date that individuals with BD exhibit increased negative emotion responding. It has been suggested that observed negative emotion differences between BD and healthy controls appear to be best accounted for by current depressive symptom severity as opposed to a more trait-like marker of the disorder (e.g., Johnson et al., 2007).

Taken together, these studies have suggested that people with BD exhibit heightened and prolonged positive, but not negative, emotional responses across different types of contexts. However, models of emotion regulation emphasize that emotion regulation not only involves decreasing and increasing emotions—as has been studied in the context of BD—but also *maintaining* emotions (e.g., Gross, 1998). Maintenance of emotions—also referred to as *affective working memory*—is defined as a constellation of processes that maintain the subjective experience of emotion in order to guide goal-directed behavior, even in the absence of the original stimuli or elicitor (Mikels, Reuter-Lorenz, Beyer, & Fredrickson, 2008; Mikels, Larkin, Reuter-Lorenz, & Carstensen, 2005). To experimentally isolate and measure emotion maintenance, Mikels et al. (2008) developed a task in which participants view emotion-eliciting pictures and are instructed to maintain their subjectively experienced emotion. This task has been used to isolate domain-specific emotion maintenance processes in healthy adults (Mikels et al., 2008), aging adults (Mikels et al., 2005), and schizophrenia patients (Gard et al., 2011). With respect to schizophrenia, Gard et al. (2011) demonstrated emotion maintenance disruption, suggesting the importance of emotion maintenance in understanding the etiology and maintenance in clinical disorders. However, emotion maintenance has not been empirically tested in mood disorders including BD.

The Present Investigation

The present investigation aimed to isolate one putative mechanism that may underlie and foster the maintenance of heightened positive emotions in BD; namely, emotion maintenance (i.e., affective working memory). In this vein, we tested two competing hypotheses. The first hypothesis (*positive magnification*) predicted that individuals with BD would demonstrate enhanced affective working memory ability, or emotion maintenance, for positive emotions specifically, but not for negative emotions. This hypothesis was based on prior work that demonstrated that individuals with BD exhibit increased positive emotion across contexts (cf. Gruber, 2011a, 2011b) and an increased attentional bias toward positive stimuli (e.g., Leyman et al., 2009; Trevisani, Johnson, & Carver, 2008). The second hypothesis (*negative minimization*) predicts that individuals with BD would demonstrate diminished affective working memory for negative, but not positive, emotions. This hypothesis was grounded in findings that demonstrated that those with BD do not consistently demonstrate differences in negative emotion response (Johnson et al., 2007), exhibit impaired recognition of negative facial expressions (Lembke & Ketter, 2002), and fail to demonstrate attentional biases toward negative stimuli (Elliott, Rubinsztein, Sahakian, & Dolan, 2000). We note that these hypotheses are not mutually exclusive.

Method

Participants

All participants were recruited as part of a larger study on emotion and mood from the greater New Haven, Connecticut, area community. Participants included 29 individuals diagnosed with BD Type I, currently remitted for an average of 14.93 months ($SD = 18.38$). Two comparison groups were also recruited on which to compare BD-specific findings. This included a healthy control group (controls) comprising 30 individuals who did not meet current or past criteria for any Axis I disorder (First, Spitzer, Gibbon, & Williams, 2007), as defined in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (Text Revision)* (*DSM–IV–TR*; American Psychiatric Association, 2000), and a clinical comparison group of 29 individuals with MDD in remission for an average of 34.31 months ($SD = 28.19$). All three groups were currently remitted (i.e., not in a current manic, depressed, or mixed mood phase) in order to examine more trait-like patterns of emotion control independent of current mood phase. Exclusion criteria included report of a history of severe head trauma, stroke, neurological disease, severe medical illness (e.g., autoimmune disorder, HIV or AIDS), or current alcohol or substance abuse in the past 6 months. Demographic and clinical characteristics are listed in Table 1.

Measures of Clinical Functioning

Diagnostic evaluation. Diagnoses were confirmed using the Structured Clinical Interview for *DSM–IV* by licensed clinical psychologists, graduate students, and a trained research coordinator (SCID-IV; First et al., 2007). A subset ($n = 21$) of digitally videotaped interviews were rated by an independent reviewer. Ratings matched 100% ($\kappa = 1.00$) of primary diagnoses for the BD ($n = 9$), MDD ($n = 8$), and control ($n = 4$) groups.

Mood symptoms. Current symptoms of mania were measured using the Young Mania Rating Scale (YMRS; Young, Biggs, Ziegler, & Meyer, 1978). Current symptoms of depression were

Table 1
Demographic and Clinical Participant Characteristics

Characteristics	BD	MDD	Control	Statistic
Age (years)	30.28 (8.76)	31.32 (11.32)	31.45 (9.13)	$F = 0.13$
Female (%)	66	64	68	$\chi^2 = 0.08$
White (%)	90	90	90	$\chi^2 = 6.54$
Education (years)	15.02 (2.31)	15.21 (2.26)	15.95 (2.41)	$F = 1.30$
YMRS score	1.97 (1.94)	1.44 (1.53)	1.17 (1.05)	$F = 2.03$
IDS-C score	4.17 (3.25)	4.93 (2.67)	2.00 (1.98)	$F = 9.55^{*}$
GAF score	75.38 (5.98)	78.86 (7.02)	88.00 (3.03)	$F = 40.60^{*}$
WAIS-IV score	10.48 (3.24)	12.45 (2.85)	12.30 (3.16)	$F = 3.66^{**}$
SILS score	32.10 (3.96)	33.34 (4.14)	33.37 (2.95)	$F = 1.11$
Age at onset (years)	16.03 (6.72)	16.22 (7.57)		
Illness duration (years)	14.28 (9.88)	15.12 (10.38)	—	—
No. of (hypo)manic episodes	9.09 (13.16)	—	—	—
No. of depressive episodes	13.04 (18.00)	5.74 (7.68)	—	—
No. of psychotropic medications	2.00 (1.58)	0.61 (0.88)	—	—
No. of comorbid disorders	0.58 (1.05)	0.72 (1.03)	—	—

Note. Values are means (standard deviations) or as otherwise indicated. BD = bipolar disorder group; MDD = major depressive disorder group; Control = healthy control group; YMRS = Young Mania Rating Scale; IDS-C = Inventory of Depressive Symptomatology−Clinician Rating; GAF = Global Assessment of Functioning; WAIS-IV = Working Memory Index Letter−Number Sequencing subtest from Wechsler Adult Intelligence Scale, Fourth Edition; SILS = Shipley Institute of Living Scale; No. of psychotropic medications = number of psychotropic medications currently taken (including anticonvulsants, lithium, neuroleptics, anxiolytics, stimulants, antidepressants, and sedative-hypnotics); No. of comorbid disorders = number of current Axis I comorbidities, as defined by the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (Text Revision)* (including panic disorder, agoraphobia, social phobia, specific phobia, obsessive−compulsive disorder, generalized anxiety disorder, hypochondriasis, body dysmorphic disorder, binge-eating disorder, and bulimia).
$^{*} p < .001$. $^{**} p < .05$.

measured using the Inventory of Depressive Symptomatology-Clinician Rating (IDS-C; Rush, Gullion, Basco, Jarrett, & Trivedi, 1996). The YMRS is an 11-item, clinician-rated measure of current manic symptoms. Scores range from 0–60, with scores ≥7 represent clinically significant manic symptom levels. The IDS-C is a 30-item, clinician-rated measure of current depressive symptoms. Scores range from 0–84, with scores ≥11 represent clinically significant depressive symptom levels. Current remitted mood status (i.e., neither manic, depressed, nor mixed mood state) for all groups was verified according to SCID-IV criteria and cutoff scores on the YMRS (≤7), and IDS-C (≤11). The intraclass correlation coefficient (*ICC*) for absolute agreement between the original interviewer and an independent rater for approximately one third of participants ($n = 23$) were strong for both the YMRS ($ICC = 0.98$) and IDS-C ($ICC = 0.98$).

Measures of Cognitive Functioning

Similar to prior studies on affective working memory (e.g., Mikels et al., 2005; Gard et al., 2011), two facets of baseline cognitive functioning were measured, including working memory and general intellectual functioning.

Working memory. Participants were administered the Letter-Number Sequencing subtest of the Wechsler Adult Intelligence Scale, Fourth Edition (WAIS-IV; Wechsler, 2008). In the Letter-Number Sequencing subtest, participants are read aloud a series of increasingly long lists of randomly ordered numerical digits and alphabetical letters. After the list is read aloud, participants are asked to verbally repeat back all numbers (in numerical order) first, followed by all letters (in alphabetical order). This subtest takes approximately ten minutes to administer. Raw scores (range: 0–21) were calculated as the total number of trials correct, from which WAIS-IV age-normed scaled scores were computed.

General intellectual functioning. The Shipley Institute of Living Scale (SILS; Shipley, 1986) was included as a conventional measure of general intellectual functioning in adults. The Vocabulary subtest of the SILS was administered, consisting of 40 multiple-choice questions in which the participant is asked to select one of four words closest in meaning to the target word. This subtest is stipulated to rely on verbal reasoning skills, including reading ability, verbal comprehension, acquired knowledge, long-term memory, and concept formation. Scores range from 0–40. Time to complete the SILS vocabulary subtest is approximately ten minutes.

Affective Working Memory Task

The design and procedures for the negative and positive emotion maintenance tasks were based on those used by Mikels et al. (2005, 2008), as depicted in Figure 1. Images were drawn from the International Affective Picture System (Lang, Bradley, & Cuthbert, 1999) as well as additional images acquired by Mikels et al. (2008). The task required participants to compare the emotional intensity of two visual images that differed in their emotional intensity, which were individually rated on a scale from 1 (*none at all*) to 7 (*a great amount*).

Specific images were grouped into pairs based on valence, such that 20 positive valenced image pairs formed the positive condition (i.e., total of 40 positive photos), and 20 negative valenced image pairs (i.e., total of 40 negative photos) formed the negative con-

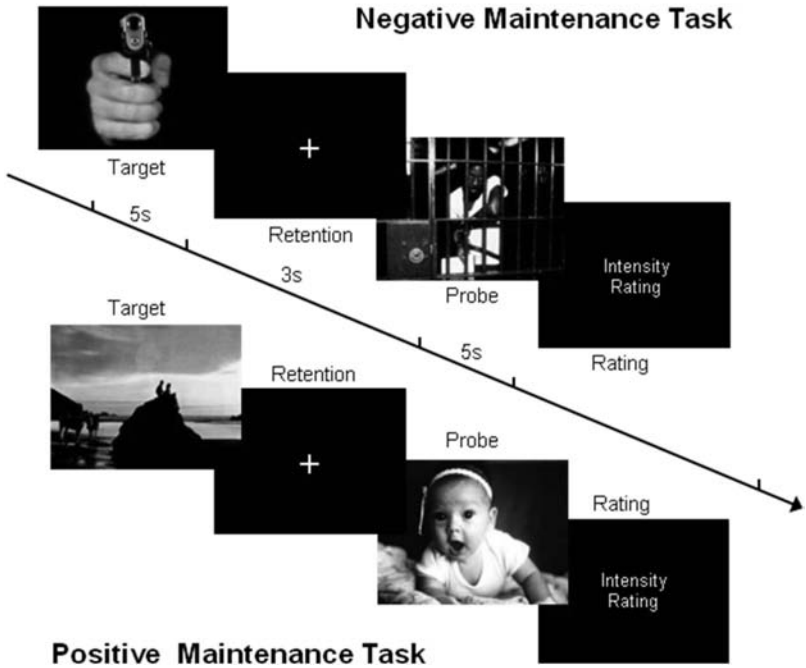

Figure 1. Affective maintenance task overview.

dition. Several considerations were made to ensure that the positive and negative conditions were equivalent in emotion intensity. First, pictures were selected using the normative ratings reported in Mikels et al. (2008). From this, the overall intensity of the 40 negative images was 3.71 ($SD = 0.68$) and the overall intensity of the 40 positive images was 3.68 ($SD = 0.64$). Second, both the positive and the negative conditions counterbalanced the emotional intensity order of the image pairs, such that, in each condition, the second image in half of the trials was higher in emotional intensity than the first; and for the other half of trials, the second image was lower in intensity. The emotional intensity order of the images in a pair was randomly distributed within trials. Third, both the positive and the negative conditions were created to be equally difficult. For each valence condition, we divided the pairs by their intensity similarity: 10 highly similar pairs (emotional intensity difference of 0.85 or less for the negative trials and 0.80 or less for the positive trials; i.e., difficult trials) and 10 highly dissimilar pairs (emotional intensity difference of 1.03 or more for the negative trials and 1.02 or more for the positive trials; i.e., easy trials). The image pair similarity was randomly distributed within the trials. Thus, the positive and negative conditions were matched for emotional intensity, image pair order, and image pair difficulty. As such, we believe that the positive and negative conditions were equivalent in emotional arousal and it is unlikely that the arousal ratings of the conditions biased the findings.

The task parameters were the same for all trials across both conditions: an image was presented for 5 s (target), immediately followed by a retention interval with a fixation cross (3 s), a second probe image for (5 s), and picture rating (variable). Participants were told that in each trial they would view an emotion-eliciting image and that they should let their feelings occur naturally. After the image disappeared, participants were instructed to maintain their gaze on a fixation cross and to sustain the feeling at the same intensity that they felt while viewing the first image. After the delay, participants viewed a second image of a different intensity (based on the ratings reported by Mikels et al., 2008) and were instructed to experience the emotions elicited by this second image. After viewing the second image, participants rated whether their feelings from the second image had a higher or lower emotional intensity compared with their feelings from the first image in the pair. Individual trials were separated by an intertrial interval fixation cross.

Also following the procedures of Mikels et al. (2005, 2008), for half of the trials in each subset (10 pairs), the second image presented was higher in emotional intensity than the first, and for the remaining pairs (the other 10 pairs), the second image was lower in intensity. The emotional intensity order of the images in a pair was randomly distributed within trials. Following the procedures of Mikels et al. (2005), to make the tasks sufficiently difficult, for each valence condition, we divided the pairs by their intensity similarity: 10 highly similar pairs (emotional intensity difference of 0.85 or less for the negative trials and 0.80 or less for the positive trials; i.e., difficult trials) and 10 highly dissimilar pairs (emotional intensity difference of 1.03 or more for the negative trials and 1.02 or more for the positive trials; i.e., easy trials). Emotion maintenance task trials were completed in two blocks, a positive trial block and a negative trial block, in counterbalanced order. Pairs of images (either positive-positive or negative-negative) were presented randomly within each block. After performing the maintenance tasks, participants viewed all positive and negative images presented during the experiment and were instructed to provide intensity ratings for each image on a scale of 1 (*not at all*) to 7 (*extremely*).

Procedure

After obtaining informed consent, trained clinical psychology faculty, graduate students, or trained postbaccalaureate researchers administered the SCID-IV, YMRS, IDS-C, and the cognitive measures. The task was completed in an individual testing room in front of a 26-in. high-resolution Sony computer monitor. Participants were initially oriented to the affective working memory task verbally by the experimenter, and were then self-guided through the remainder of the task using computerized software (MediaLab, Version 2008, Lawrenceville, GA). Once the experiment ended, participants completed a series of questionnaires, including the SILS. Participants were debriefed and compensated for their participation.

Data Analysis Strategies

First, using the Kolmogorov–Smirnov test, we examined whether our emotion maintenance scores were normally distributed. Both the negative and the positive maintenance conditions met this criterion for all three groups separately (zs < 1.01, $p >$ .26). Second, we tested whether there were group differences in the baseline working memory task. Note that the BD and control groups differed, but these scores were not meaningfully associated for any group with accuracy scores in the positive (rs $<$ .19) or negative (rs $<$ .35) maintenance conditions (ps $>$ .05). Thus these scores were not included in subsequent analyses. Third, we found no main effects for order (ps $>$ .30) or gender (ps $>$ .39) for all main variables. Fourth, following the procedures used by Gard et al. (2011), we used the posttask intensity ratings to create idiographic-based accuracy scores on each trial. Specifically, using each participant's intensity rating for each picture in a pair, we computed a maintenance percent accuracy score for each task separately for each participant. We coded each maintenance trial according to the subjective ratings provided by participants as to the correct higher or lower intensity designation. For example, for a given pair, if a participant rated the emotional intensity of image A as 6 and image B as 5, the correct maintenance response for that pair was coded with image B as lower than image A. For the maintenance accuracy score, if that participant responded that image B was lower than image A, that person's response was coded as correct. An average accuracy score was then calculated for each participant.

Results

Demographic and Clinical Characteristics

As seen in Table 1, BD, MDD, and control participants did not differ significantly with respect to age, gender, ethnicity, or education (ps $>$ .28). Not surprisingly, the BD and MDD groups scored lower on global functioning than the control group. Although all groups scored below YMRS ($\leq$7) and IDS-C ($\leq$11) cutoffs, BD and MDD participants scored higher than control participants on the IDS-C (ps $<$ .01). The groups also differed on the baseline working memory measure, such that BD participants scored lower than both the control and MDD participants. Groups did not differ in general intellectual functioning on the SILS.

Main Analyses

Given our differential a priori predictions for positive versus negative emotion maintenance, we examined each condition separately using two one-way analyses of variance (as recommended by Keppel & Zedeck, 1989). A Greenhouse-Geisser correction was used when assumptions for sphericity were not met, and adjusted F and p values are reported. Effect sizes are reported as partial eta squared (partial η^2). All reported p values are two-tailed.

As seen in Table 2, no group differences emerged for the maintenance of positive emotions, $F(2, 85) = 0.03$, $p > .95$, partial $\eta^2 = .001$. However, a significant group difference was detected between the groups in the maintenance of negative emotions, $F(2, 80) = 3.33$, $p < .05$, partial $\eta^2 = .08$.[1] Planned contrasts revealed that the performance of the BD group was significantly lower in negative emotion maintenance compared to both MDD and control groups, $t(51) = 2.21$ and $t(54) = 2.21$ (ps $<$ .05), respectively.

Secondary Analyses: Potential Confounds

We examined two potential confounders: current mood symptoms and baseline working memory. First, because BD is associated with deficits in working memory (e.g., Clark, Kempton, Scarna, Grasby, & Goodwin, 2005), we examined whether performance on the emotion maintenance task was meaningfully predictive of performance on the WAIS-IV working memory task. For the BD group, baseline working memory did not correlate with either negative or positive maintenance, $r = .03$, $p > .89$; $r = .16$, $p > .40$, respectively. We thus opted not to include working memory as a covariate in our analyses.

Second, because the BD and MDD groups scored higher in subsyndromal depressive symptoms (IDS-C), we examined whether observed group differences were influenced by depressive symptoms. Once again, IDS-C scores did not correlate with negative maintenance (BD: $r = -.21$, MDD: $r = -.03$, controls: $r = .13$, ps $>$ .29) or positive maintenance (BD: $r = -.21$, MDD: $r = -.25$, controls: $r = -.03$, ps $>$ .21) for all groups. Thus, IDS-C score was not included as a covariate in our analyses. This decision was further supported by two conceptual reasons. First, controlling for current symptoms violates important statistical assumptions, because they are intended to minimize within group variability, not between group variability, especially where group status is not randomly assigned. Second, all groups scored well below the clinical threshold scores on all symptom measures, suggesting minimal variability in depressive symptoms (see Table 1). We suggest that future studies compare BD and MDD participants who score high and low on symptom measures to properly examine the relative influence of symptoms on emotion regulation.

Discussion

BD is fundamentally a disorder of emotion dysregulation. A growing body of work has focused on delineating precisely how emotion is disrupted in this severe and chronic mood disorder (e.g., Gruber, 2011a, 2011b; Johnson, 2005; Phillips & Vieta, 2007).

[1] For these analyses, five participants were unable to complete the negative maintenance task (three bipolar disorder and two major depressive disorder participants).

Table 2
Group Differences in Positive and Negative Emotion Maintenance Accuracy

Emotion maintenance	BD	MDD	Control	*F*
Positive accuracy (%)	86.1 (14.9)	86.7 (9.2)	86.8 (7.6)	0.03
Negative accuracy (%)	82.5 (11.2)	88.9 (9.7)	88.9 (10.3)	3.33*

Note. Mean accuracy scores (standard deviation) rated on a 0–100% scale. BD = bipolar disorder group; MDD = major depressive disorder group; Control = healthy control group.
* $p < .05$.

However, it remains less clear what potential mechanisms may underlie, and give rise to, heightened mood states—particularly positive—in this disorder. The present investigation represents three important areas of strength. First, this study is one of the first to use a rigorous experimental approach adopting a previously validated affective working memory task to examine potential mechanisms that may underlie and foster the maintenance of heightened positive emotions in BD. Second, this study adopted a transdiagnostic approach (Harvey, Watkins, Mansell, & Shafran, 2004) to examine emotion maintenance, not just in comparison to a healthy control group, but also in comparison to a second clinical comparison group of individuals diagnosed with a history of MDD. As such, this study enabled us to tease apart which aspects of emotion maintenance disturbance were disorder-specific to BD versus more transdiagnostic features of mood disorders generally. Third, we systematically measured several potentially important confounders—including symptom severity, baseline working memory, and general cognitive functioning—to rule out other potential explanations for the observed findings.

Study Limitations and Future Directions

Our findings should be interpreted within the confines of several limitations. First, although the images used in the present study are standardized and reliable elicitors of emotions, it may be argued that the results may not be generalizable to everyday emotional encounters in the lives of patients with BD. It will thus be important for future paradigms to assess more ecologically valid stimuli that are both dynamic in nature and personally salient and possibly more engaging. Second, the maintenance of positive emotion was assessed broadly, and as such it is unclear whether differences might emerge for specific positive emotions related to reward striving and achievement, implicated in BD (Gruber & Johnson, 2009). Related, it will be important for future work to consider how these findings contribute to the broader literature suggesting the relative independence of positive and negative affect processes, including maintenance of these distinct affective states (e.g., Diener & Emmons, 1984). Third, the present study did not include a specific experimental control condition on which to directly compare the obtained study results (i.e., brightness maintenance condition; Mikels et al., 2005, 2008). However, we note that such results are unlikely to be accounted for by a deficit in maintenance processes more generally, for several reasons. For example, our results suggested a specific valence difference in negative but not positive emotion maintenance. Moreover, given the separability of emotion maintenance from more general maintenance processes previously studied (e.g., Mikels et al., 2005, 2008), we would not expect a general working memory deficit to explain the current results. Additionally, the lack of a correlation between the baseline working memory task and the emotion maintenance tasks in the BD group further indicates that performance of the emotion maintenance task is independent of working memory processes used in the nonemotional baseline task. Fourth, we did not exclude participants with BD on the basis of comorbidities or medication status. Although this may represent a more ecologically valid sample, it leaves unclear whether the presence of comorbid disorders or medication might account for observed group differences or lack thereof. Future research might include a control group that is matched on the same comorbid conditions, as well as random assignment of individuals with BD on different medication classes (e.g., antidepressants, mood stabilizers, anxiolytics). Finally, this study was cross-sectional, and so it could not address hypotheses regarding how deficits in negative emotion maintenance may predict the onset of heightened emotion responding in the short term, and mood relapse in the long term.

Implications for BD and Emotion

Despite these caveats, the present investigation provides important insights into underlying mechanisms associated with positive emotional disturbance in a severe and chronic psychiatric disorder. Specifically, the present investigation isolated a specific process of interest—emotion maintenance, also referred to as affective working memory—in order to examine which cognitive processes are involved in maintaining online representations of affective content.

Results from the present study supported a "negative minimization" account of affective working memory in BD. Specifically, participants diagnosed with BD exhibited selective deficits in negative (but not in positive) emotion maintenance compared to both control and MDD comparison groups. Of import, the MDD and control groups did not differ from each other, suggesting that negative emotion maintenance deficits are a disorder-specific feature of BD, as opposed to a more transdiagnostic feature of mood disorders generally. These results are consistent with findings suggesting that individuals with BD exhibit impaired recognition of negative—but not positive—facial expressions (Lembke & Ketter, 2002) and fail to demonstrate attentional biases for negative stimuli more generally (Elliott et al., 2000). Such findings suggest that heightened positive emotion in BD may be accounted for, in part, by an inability to maintain competing negative emotions in working memory that may serve to decrease positive mood. In other words, the absence of negative emotional representations in one's current mind may instead lead an otherwise transient positive thought or feeling to last longer and at a greater degree. The ability to hold on to and maintain negative emotional representations in working memory also serves an important survival function, keeping our attention alerted to potential dangers and assisting in modulating positive emotions that may not adaptively match a given context. A deficit in negative emotion maintenance in BD may thus signal an even greater sign of trouble for this population, because negative emotions may serve to help down-regulate the overly positive and intense positive moods characteristic of BD.

These findings stand in contrast to a "positive magnification" view of emotion maintenance in BD that suggests that prolonged and intense positive emotions in BD are fueled by focused efforts to maintain positive emotions. However, our findings appear consistent with two central empirical findings in BD. Specifically, one line of work has documented an increased attention bias toward positive stimuli (e.g., Trevisani et al., 2008). Another line of work documents heightened positive rumination—or dwelling on the causes and consequences of one's positive feelings—in BD (Gruber et al., Johnson et al., 2008). We propose that our findings are not only consistent with these facts but also may actually help explain them. That is, it is possible that difficulty holding onto negative emotions may be explained by a tendency to attend selectively to positive stimuli, and actively focus one's regulatory efforts toward dwelling on the causes of one's positive feelings. This apparent bias toward attending to and ruminating over positive emotion may actually come at the expense of maintaining accurate representations of negative emotions; focusing on positive feelings perhaps allows letting go of too many negative feelings in BD, or too soon.

References

Alloy, L. B., Abramson, L. A., Urosevic, S., Bender, R. E., & Wagner, C. A. (2009). Longitudinal predictors of bipolar spectrum disorders: A behavioral approach system (BAS) perspective. *Clinical Psychology: Science and Practice, 16,* 206–226. doi:10.1111/j.1468-2850.2009.01160.x

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders: DSM-IV-TR* (4th ed., text revision). Washington, DC: Author.

Clark, L., Kempton, M. J., Scarna, A., Grasby, P. M., & Goodwin, G. M. (2005). Sustained attention-deficit confirmed in euthymic bipolar disorder but not in first degree relatives of bipolar patients or euthymic unipolar depression. *Biological Psychiatry, 57,* 183–187. doi:10.1016/j.biopsych.2004.11.007

Cuellar, A. K., Johnson, S. L., & Ruggero, C. J. (2009). Affective reactivity in response to criticism in remitted bipolar disorder: A laboratory analog of expressed emotion. *Journal of Clinical Psychology, 65,* 925–941. doi:10.1002/jclp.20596

Depue, R. A., Kleiman, R. M., Davis, P., Hutchinson, M., & Krauss, S. P. (1985). The behavioral high-risk paradigm and bipolar affective disorder: VIII. Serum free cortisol in nonpatient cyclothymic subjects selected by the General Behavior Inventory. *The American Journal of Psychiatry, 142,* 175–181.

Diener, E., & Emmons, R. A. (1984). The independence of positive and negative affect. *Journal of Personality and Social Psychology, 47,* 1105–1117. doi:10.1037/0022-3514.47.5.1105

Dillon, D. G., & Pizzagalli, D. A. (2009). Maximizing positive emotions: A translational, transdiagnostic look at positive emotion regulation. In: A. M. Kring & D. M. Sloan (Eds.), *Emotion regulation and psychopathology* (pp. 229–252). New York: Guilford Press.

Elliott, R., Ogilvie, A., Rubinsztein, J. S., Calderon, G., Dolan, R. J., & Sahakian, B. J. (2004). Abnormal ventral frontal response during performance of an affective go/no go task in patients with mania. *Biological Psychiatry, 55,* 1163–1170. doi:10.1016/j.biopsych.2004.03.007

Elliott, R., Rubinsztein, J., Sahakian, B., & Dolan, R. (2000). Selective attention to emotional stimuli in a verbal go/no-go task: An fMRI study. *NeuroReport: For Rapid Communication of Neuroscience Research, 11,* 1739–1744. doi:10.1097/00001756-200006050-00028

Faglioni, A., Kupfer, D. J., Masalehdan, A., Scott, J. A., Houck, P. R., & Frank, E. (2005). Functional impairment in the remission phase of bipolar disorder. *Bipolar Disorders, 7,* 281–285. doi:10.1111/j.1399-5618.2005.00207.x

Farmer, A., Lam, D., Sahakian, B., Roiser, J., Burke, A., O'Neill, N., . . . McGuffin, P. (2006). A pilot study of positive mood induction in euthymic bipolar subjects compared with healthy controls. *Psychological Medicine, 36,* 1213–1218. doi:10.1017/S0033291706007835

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

Forbes, E. E., Miller, A., Cohn, J. F., Fox, N. A., & Kovacs, M. (2005). Affect-modulated startle in adults with childhood-onset depression: Relations to bipolar course and number of lifetime depressive episodes. *Psychiatry Research, 134,* 11–25. doi:10.1016/j.psychres.2005.01.001

Gard, D. E., Cooper, S., Fisher, M., Genevsky, A., Mikels, J. A., & Vinogradov, S. (2011). Evidence for an emotion maintenance deficit in schizophrenia. *Psychiatry Research, 187,* 24–29. doi:10.1016/j.psychres.2010.12.018

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2,* 271–299. doi:10.1037/1089-2680.2.3.271

Gruber, J. (2011a). When feeling good can be bad: Positive emotion persistence (PEP) in bipolar disorder. *Current Directions in Psychological Science, 20,* 217–221. doi:10.1177/0963721411414632

Gruber, J. (2011b). A review and synthesis of positive emotion and reward disturbance in bipolar disorder. *Clinical Psychology & Psychotherapy, 18,* 356–365. doi:10.1002/cpp.776

Gruber, J., Eidelman, P., Johnson, S. L., Smith, B., & Harvey, A. G. (2011). Hooked on a feeling: Rumination about positive and negative emotion in inter-episode bipolar disorder. *Journal of Abnormal Psychology, 120,* 956–961. doi:10.1037/a0023667

Gruber, J., Harvey, A. G., & Purcell, A. L. (2011). What goes up can come down? A preliminary investigation of emotion reactivity and emotion recovery in bipolar disorder. *Journal of Affective Disorders, 133,* 457–466. doi:10.1016/j.jad.2011.05.009

Gruber, J., & Johnson, S. L. (2009). Positive emotional traits and ambitious goals among people at risk for mania: The need for specificity. *International Journal of Cognitive Therapy, 2,* 176–187. doi:10.1521/ijct.2009.2.2.176

Gruber, J., Johnson, S. L., Oveis, C., & Keltner, D. (2008). Risk for mania and positive emotional responding: Too much of a good thing? *Emotion, 8,* 23–33. doi:10.1037/1528-3542.8.1.23

Gruber, J., Mauss, I. B., & Tamir, M. (2011). A dark side of happiness? How, when and why happiness is not always good. *Perspectives on Psychological Science, 6,* 222–233. doi:10.1177/1745691611406927

Harvey, A. G., Watkins, E., Mansell, W., & Shafran, R. (2004). *Cognitive behavioural processes across psychological disorders: A transdiagnostic approach to research and treatment*. Oxford, England: Oxford University Press.

Hofmann, B. U., & Meyer, T. D. (2006). Mood fluctuations in people putatively at risk for bipolar disorders. *British Journal of Clinical Psychology, 45,* 105–110. doi:10.1348/014466505X35317

Johnson, S. L. (2005). Mania and dysregulation in goal pursuit. *Clinical Psychology Review, 25,* 241–262. doi:10.1016/j.cpr.2004.11.002

Johnson, S. L., Gruber, J., & Eisner, L. (2007). Emotion and bipolar disorder. In S. L. Johnson (Eds.), *Emotion and psychopathology: Bridging affective and clinical science* (pp. 123–150). Washington, DC: American Psychological Association. doi:10.1037/11562-006

Johnson, S. L., McKenzie, G., & McMurrich, S. (2008). Ruminative responses to positive and negative affect among students diagnosed with bipolar disorder and major depressive disorder. *Cognitive Therapy and Research, 32,* 702–713. doi:10.1007/s10608-007-9158-6

Keppel, G., & Zedeck, S. (1989). *Data analysis for research designs: Analysis of variance and multiple regression/correlation approaches*. New York, NY: Freeman & Co.

Kring, A. M., & Sloan, D. S. (2010). *Emotion regulation and psychopathology*. New York, NY: Guilford Press.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2005). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual (Technical Report A-6)*. Gainesville, FL: University of Florida.

Lawrence, N. S., Williams, A. M., Surguladze, S., Giampietro, V., Brammer, M. J., Andrew, C., . . . Phillips, M. L. (2004). Subcortical and ventral prefrontal cortical neural responses to facial expressions distinguish patients with bipolar disorder and major depression. *Biological Psychiatry, 55,* 578–587. doi:10.1016/j.biopsych.2003.11.017

Lembke, A., & Ketter, T. A. (2002). Impaired recognition of facial emotion in mania. *The American Journal of Psychiatry, 159,* 302–304. doi:10.1176/appi.ajp.159.2.302

Leyman, L., De Raedt, R., & Koster, E. H. W. (2002). Attentional biases for emotional facial stimuli in currently depressed patients with bipolar disorder. *International Journal of Clinical and Health Psychology, 9,* 393–410.

Lovejoy, M. C., & Steuerwald, B. L. (1995). Subsyndromal unipolar and bipolar disorders: Comparisons on positive and negative affect. *Journal of Abnormal Psychology, 104,* 381–384. doi:10.1037/0021-843X.104.2.381

M'Bailara, K., Demotes-Mainard, J., Swendsen, J., Mathieu, F., Leboyer, M., & Henry, C. (2009). Emotional hyper-reactivity in normothymic bipolar patients. *Bipolar Disorders, 11,* 63–69. doi:10.1111/j.1399-5618.2008.00656.x

Meyer, B., Johnson, S. L., & Winters, R. (2001). Responsiveness to threat and incentive in bipolar disorder: Relations of the BIS/BAS scales with symptoms. *Journal of Psychopathology and Behavioral Assessment, 23,* 133–143. doi:10.1023/A:1010929402770

Mikels, J. A., Larkin, G. R., Reuter-Lorenz, P. A., & Carstensen, L. L. (2005). Divergent trajectories in the aging mind: Changes in working memory for affective versus visual information with age. *Psychology and Aging, 20,* 542–553. doi:10.1037/0882-7974.20.4.542

Mikels, J. A., Reuter-Lorenz, P. A., Beyer, J. A., & Fredrickson, B. L. (2008). Emotion and working memory: Evidence for domain-specific processes for affective maintenance. *Emotion, 8,* 256–266. doi:10.1037/1528-3542.8.2.256

Phillips, M. L., & Vieta, E. (2007). Identifying functional neuroimaging markers of bipolar disorder: Towards DSM-V. *Schizophrenia Bulletin, 33,* 893–904. doi:10.1093/schbul/sbm060

Ruggero, C. J., & Johnson, S. L. (2006). Reactivity to a laboratory stressor among individuals with bipolar I disorder in full or partial remission. *Journal of Abnormal Psychology, 115,* 539–544. doi:10.1037/0021-843X.115.3.539

Rush, A. J., Gullion, C. M., Basco, M. R., Jarrett, R. B., & Trivedi, M. H. (1996). The Inventory of Depressive Symptomatology (IDS): Psychometric properties. *Psychological Medicine, 26,* 477–486. doi:10.1017/S0033291700035558

Sanchez-Moreno, J., Martinez-Aranb, A., Tabarés-Seisdedosd, R., Torrenta, C., Vietab, E., & Ayuso-Mateosc, J. L (2009). Functioning and disability in bipolar disorder: An extensive review. *Psychotherapy and Psychosomatics, 78,* 285–297.

Shipley, W. C. (1986). *Shipley Institute of Living Scale*. Los Angeles, CA: Western Psychological.

Stern, G. S., & Berrenberg, J. L. (1979). Skill-set, success outcome, and mania as determinants of the illusion of control. *Journal of Research in Personality, 13,* . doi:10.1016/0092-6566(79)90031-X206–220

Sutton, S. K., & Johnson, S. L. (2002). Hypomanic tendencies predict lower startle magnitudes during pleasant pictures. *Psychophysiology, 39,* S80.

Trevisani, D. P., Johnson, S. L., & Carver, C. S. (2008). Positive mood induction and facial affect recognition among students at risk for mania. *Cognitive Therapy and Research, 32,* 639–650. doi:10.1007/s10608-007-9140-3

Wechsler, D. (2008). *WAIS-IV technical and interpretive manual*. San Antonio, TX: Pearson.

Young, R. C., Biggs, J. T., Ziegler, V. E., & Meyer, D. A. (1978). A rating scale for mania: Reliability, validity, and sensitivity. *The British Journal of Psychiatry, 133,* 429–435. doi:10.1192/bjp.133.5.429

Yurgelun-Todd, D. A., Gruber, S. A., Kanayama, G., Killgore, W. D., Baird, A. A., & Young, A. D. (2000). fMRI during affect discrimination in bipolar affective disorder. *Bipolar Disorders, 2,* 237–248. doi:10.1034/j.1399-5618.2000.20304.x

Received February 24, 2012
Revision received May 16, 2012
Accepted May 29, 2012 ■