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Reflective and ruminative processing of positive emotional memories in bipolar disorder and healthy controls

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ABSTRACT

Recent evidence suggests that reflective (i.e., distanced-why), as compared to ruminative (i.e., immersed-why), processing of negative memories is associated with reductions in negative affect. The present study extended this line of work by examining the effect of these two processing conditions on positive memories among persons with bipolar disorder (BD; $n = 27$) and a healthy control group (CT; $n = 27$). After a resting baseline period, participants were instructed to recall a happy autobiographical memory. Using a within-subjects design, participants were asked to process the happy memory in two different experimental conditions (reflective, ruminative) while their experiential, behavioral, and autonomic responses were measured. Consistent with hypotheses, reflective processing was associated with lower self-reported positive affect, positive thoughts, and heart rate compared to ruminative processing for all participants. When current symptoms were controlled for, BD participants reported greater positive affect across both conditions relative to CT participants. Prospective studies are needed to test the extent to which processing of positive emotion contributes to the course of symptoms in bipolar disorder.

Bipolar disorder is a severe and chronic psychiatric illness associated with profound functional impairment, morbidity, and mortality (Coryell et al., 1993). One of the cardinal symptoms of bipolar disorder includes disturbances in positive emotion, including an abnormally and persistently elevated mood (American Psychiatric Association, 2000). Experimental evidence indicates that bipolar disorder is associated with elevated reactivity to positive stimuli. At risk (defined using the Hypomanic Personality Scale; Eckblad & Chapman, 1986) and diagnosed bipolar disorder samples report greater positive feelings at the prospect of earning rewards compared to healthy controls (Johnson, Ruggero, & Carver, 2005; Meyer, Johnson, & Winters, 2001). People at risk for bipolar disorder exhibit increased startle attenuation while viewing positive photos of peaceful landscapes and pleasant imagery (Sutton & Johnson, 2002). At-risk bipolar samples also demonstrate elevated cardiac vagal tone, a putative autonomic marker of positive emotion (Gruber, Johnson, Oveis, & Keltner, 2008). Bipolar patients, compared to nonpatients, exhibit increased activity in the amygdala and putamen (Lawrence et al., 2004) as well as the orbitofrontal cortex (Elliott et al., 2004) in response to images of human smiles. Neural activity in these brain regions has been associated with the experience of positive affect and reward (Rolls, 2000).

Few studies have investigated the effect of cognitive processing strategies on positive emotion in bipolar disorder. Previous research in healthy populations has explored the effects of two important processing strategies – ruminative and reflective – on negative emotional events. *Ruminative processing* refers to the repetitive focus on the content, causes, and consequences of one's affective state not conducive to problem solving (Lyubomirsky & Nolen-Hoeksema, 1995). This type of cognitive processing has also been termed conceptual-evaluative rumination by Watkins (2004) and involves taking an evaluative stance regarding oneself (e.g., "Why did you feel this way?"). Typically, this involves adopting a first-person perspective in which the individual is immersed in the experience, likely focusing on recalling the specific chain of events that occurred and emotions felt (Kross, Ayduk, & Mischel, 2005). As a consequence, researchers argue this leads an individual to relive the emotion and hence elicit an emotional response (e. g., McIsaac & Eich, 2004). Consistent with this notion, ruminative processing of negative mood has been associated with negative outcomes, including escalation in negative affect (e.g., Nolen-Hoeksema, 2000; Watkins, 2004) and the onset of depressive symptoms in major depression (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008) and bipolar disorder (Johnson, McMurrich, & McKenzie, 2008; Thomas & Bentall, 2002). Persons at risk for mania

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(Feldman, Joorman, & Johnson, 2008) and those diagnosed with bipolar disorder report a greater tendency to ruminate over positive emotional information relative to controls (e.g., Johnson et al., 2008).

By contrast, *reflective processing* involves analyzing the causes or consequences of one's feelings in a way that is conducive to problem solving (e.g., Ayduk, Mischel, & Downey, 2002; Kross et al., 2005). More specifically, this involves altering the vantage point from which the emotion is recalled to a third-person perspective. It has been argued that distancing oneself from an emotional event enables a person to process their emotions in a more reflective manner that leads to reductions in emotional arousal (Kross et al., 2005). Recent empirical evidence has confirmed these hypotheses, suggesting that processing a negative memory in a reflective, or 'distanced-why' perspective is associated with reductions in negative affect compared to processing the memory in a ruminative, or 'immersed-why' manner (Ayduk et al., 2002; Kross et al., 2005).

Taken together, the research on reflective and ruminative processing has focused almost entirely on negative emotions. Hence the aim of the present study was to answer two questions. First, do reductions in emotional arousal associated with reflective processing of negative emotion (Ayduk et al., 2002; Kross et al., 2005) extend to positive emotion? Based on recent findings suggesting reflective processing is associated with reductions in the intensity of negative emotions (Ayduk et al., 2002; Ayduk & Kross, 2009; Kross et al., 2005), we predicted that both bipolar and healthy control participant groups would exhibit decreases in the intensity of positive emotions in the reflective compared to the ruminative processing condition. In the present study, this would be evidenced by decreases in self-reported positive affect, positive thoughts, positive emotion behavior, and psychophysiological activity in the reflective compared to the ruminative processing condition. Second, are there differences between bipolar disorder and healthy controls in their emotional responses when engaging in reflective and ruminative processing? Based on work research suggesting that bipolar disorder is associated with heightened positive emotional responses (Johnson, 2005; Johnson, Gruber, & Eisner, 2007) and amplified emotional responses to emotional images (Holmes, Geddes, Colom, & Goodwin, 2008), we predicted that bipolar participants would exhibit increased positive emotion reactivity during both processing conditions compared to controls. However, we expected the difference between bipolar and controls to be largest during the ruminative processing condition given that bipolar disorder is thought to reflect trouble regulating positive emotion and a tendency to ruminate over positive events (Feldman et al., 2008; Johnson et al., 2007; Johnson et al., 2008). In the present study, this would be evidenced by increases in self-reported positive affect, positive thoughts, positive emotion behavior, and psychophysiological activity in bipolar compared to control participants across both the reflective and ruminative processing conditions. Furthermore, we expected bipolar participants to exhibit greater increases in the aforementioned measures compared to control participants specifically during the ruminative relative to the reflective processing condition. In the present study, after a 60-second resting baseline period at the beginning of the task, participants completed an autobiographical imagery procedure (adapted from Kross et al., 2005) in which they recalled a happy memory. Using a within-subjects design, participants were then asked to reflect on the same memory across two different conditions. In the ruminative processing condition (i.e., immersed-why), participants were instructed to imagine the positive event by focusing on their deepest thoughts and feelings. In reflective processing condition (i.e., distanced-why), participants were instructed to adopt a third-person perspective when recalling the event. Throughout the experiment, participants' experiential, behavioral, and autonomic responses were measured.

Method

Participants

Participants were 27 persons diagnosed with bipolar I disorder (BD) and 27 healthy controls (CT) who were fluent in English and between 18 and 63 years of age. They were recruited from the San Francisco Bay Area community via recruitment ads and flyers posted online and in mental health centers. Exclusion criteria included report of a history of severe head trauma, stroke, neurological disease, severe medical illness (e.g., autoimmune disorder), or current alcohol or substance abuse given that these variables are known to influence emotional responding.

Diagnoses of bipolar I disorder were confirmed using the Structured Clinical Interview for DSM-IV (SCID-IV; Spitzer, Williams, Gibbon, & First, 1990). Current euthymic mood status (i.e., neither manic, depressed, nor mixed mood state) for the BD group was verified according to SCID-IV criteria and cutoff scores from the Clinician-Rated Inventory of Depressive Symptoms (IDS-C; score $\leq$ 11; Rush, Gullion, Basco, Jarrett, & Trivedi, 1996; Trivedi et al., 2004) and the Young Mania Rating Scale (YMRS; score $\leq$ 7; Young, Biggs, Ziegler, & Meyer, 1978). We focused on euthymic BD participants to examine whether disturbances in processing positive emotions were independent of current mood state.

The average age at onset for the BD group was 19.52 years (SD = 12.07) and average illness duration was 16.20 years (SD = 11.10). The lifetime average of manic/hypomanic episodes for BD participants was 8.65 (SD = 11.71) and for major depressive episodes was 9.72 (SD = 10.61). All BD participants except four were receiving psychotropic medication, including lithium (14.3%), anticonvulsants (42.9%); antidepressants (64.3%), neuroleptics (39.3%); benzodiazepines (14.3%), sedatives (3.6%), stimulants (3.6%), and sleep-enhancing agents (3.6%). A drug-free BD group would have been unrepresentative and unfeasible.[1]

BD participants were not excluded on the basis of comorbid disorders (aside from current substance or alcohol use disorders) given that BD is commonly comorbid with one or more disorders (e.g. Kessler, Chiu, Demler, & walter, 2005). Hence, this enabled us to have a more ecologically valid BD sample. We did, however, ensure that bipolar disorder was the primary diagnosis defined as the most distressing and disabling disorder (Di Nardo, Moras, Barlow, Rapee, & Brown, 1993). Current Axis I comorbidities included agoraphobia (n = 2), social phobia (n = 4), specific phobia (n = 5), obsessive-compulsive disorder (n = 2), generalized anxiety disorder (n = 5), hypochondriasis (n = 1), anorexia (n = 1), and binge eating disorder (n = 1).

Our control group did not meet criteria for any current or lifetime Axis I disorders assessed (i.e., no anxiety disorders, major depression, mania/hypomania, dysthymia, schizophrenia, schizoaffective disorder, substance abuse, eating disorders, hypochondriasis, pain disorder, and adjustment disorders) using the SCID-IV. Similar to BD participants, control participants also scored below standardized cut-offs on the YMRS and IDS-C.

[1] Levels of each class of medication was recorded using The Somatotherapy Index (Bauer, McBride, Shea, & Gavin, 1997). Bivariate correlations conducted between intensity of medication dosage and our emotion responding variables were modest, inconsistent, and not indicative of a general blunting in emotional responding.

Measures of clinical functioning

Diagnostic evaluation

Three trained clinical psychology doctoral candidates and one postdoctoral psychology fellow administered the SCID-IV (Spitzer et al., 1990). Fifteen randomly selected audiotapes were rated by an independent reviewer to ascertain diagnostic reliability. Ratings matched 100% ($\kappa = 1.00$) of the primary diagnoses (i.e., BD or CT) made by the interviewer.

Mania and depression symptom severity

The Young Mania Rating Scale (YMRS; Young et al., 1978) is an 11-item, clinician-rated measure of current manic symptoms with scores ranging from 0 to 60, with higher scores indicating greater manic severity. The YMRS has good psychometric properties, including inter-rater reliability of 0.93 and predictive validity of 0.66. Scores on the YMRS ≤ 7 represent clinically significant manic symptom levels. The Inventory of Depressive Symptomatology (IDS-C; Rush et al., 1996) is a 30-item, clinician-rated measure of current depressive symptoms with scores ranging from 0 to 84, with higher scores indicating greater depressive severity. The IDS-C has strong psychometric properties including internal reliability estimates of 0.67–0.94. Scores on the IDS-C ≤ 11 represent clinically significant depressive symptom levels. The IDS-C has been validated in individuals with bipolar disorder (Trivedi et al., 2004) and strongly correlates with other measures of depression severity (Rush et al., 1996). Intra-class correlations (ICC; Shrout & Fleiss, 1979) for absolute agreement between the original interviewer and an independent rater for a randomly chosen subset of study participants in combination with additional interviews ($n = 9$) were strong for the IDS-C ($= 0.98$) and YMRS ($= 0.99$).

Measurement of three channels of emotional response

We employed a multi-method approach to measure positive emotion response at experiential, behavioral, and autonomic levels of analysis. These data were assessed across three conditions: baseline (at the beginning of the experiment), reflective processing, and ruminative processing condition. Self-reported measures of emotion experience were assessed separately at the end of each of the condition. Behavioral and autonomic data were recorded continuously for each of the three 60-second conditions.

Emotion experience

Emotion experience was measured using self-reported positive affect and the number of positive thoughts. Positive affect was assessed using the 10-item short form of Positive and Negative Affect Schedule (PANAS; Mackinnon et al., 1999). Participants were instructed to use a 5-point Likert scale (1 = very slightly or not at all; 5 = extremely) to indicate "to what extent you feel this way now?" for five different positive adjectives (excited, alert, enthusiastic, inspired, and determined) that are summed to calculate a positive affect composite score. In prior research by MacKinnon and colleagues, the short form of the PANAS demonstrated good internal consistency ($\alpha = 0.98$) and test-retest reliability ($r = 0.42$). The number of positive thoughts was assessed based on the fact that rumination involves repetitive emotion-laden thoughts (e.g., Lyubomirsky & Nolen-Hoeksema, 1995). Here, participants were asked to report the number of thoughts on a 1 (*none at all*) to 6 (*very many*) scale (Siemer, 2005).

Emotion behavior

Participants' facial expressions were recorded unobtrusively by a remotely controlled video camera. A second camera monitoring the experimental computer screen enabled the participant's facial behavior to be synchronized with the different experimental periods. Participants' facial behavior was coded using the Emotion Facial Action Coding System (EMFACS; Ekman & Rosenberg, 1997), an anatomically based system for coding specific units of visible facial muscle movements corresponding to prototypical emotion expressions. Happy facial behavioral expressions (AU6 [cheek raiser] + AU12 [lip corner puller]) received a score from 1 ("trace") to 5 ("marked") or 0 ("absent") if there was no happy expression. The average happiness emotion behavior intensity was computed individually for the baseline, reflective, and ruminative conditions. Intra-class correlations (ICC; Shrout & Fleiss, 1979) for absolute agreement between the two FACS coders were strong across the baseline ($= 0.98$) reflective ($= 0.98$), and ruminative ($= 0.97$) conditions. Thus, values were averaged between the two coders for use in final analyses.

Autonomic physiology

Three measures were selected to allow for continuous measurement, to minimize obtrusiveness, and to provide a broad sample of peripheral autonomic activity. Specifically, we chose one measure of general cardiovascular activity (Interbeat Interval), one measure of sympathetic arousal (Pulse Transmission Time to the Ear; PTE), and one measure of parasympathetic activity (Respiratory Sinus Arrhythmia; RSA). All physiological data was recorded continuously at 1000 Hz using a Biopac multi-channel device (MP150-BIOPAC Systems Inc., Goleta, CA). Physiological data were acquired and analyzed with AcqKnowledge v3.9.1 software. Artifacts and recording errors were corrected offline using linear interpolation. Following convention (e.g. Rainville, Bechara, Naqvi, & Damasio, 2006), values more than three standard deviations from the group mean were deemed outliers and substituted with mean values (constituting 3.8% of all data). A transistor-transistor Logic (TTL) digital signal automatically enabled the synchronization of physiological data with the different experimental periods.

Interbeat interval

Heart rate is influenced by both sympathetic and parasympathetic branches of the autonomic nervous system and was assessed as a general index of cardiovascular arousal. ECG recordings were obtained with two pre-jelled Ag–AgCl snap disposable vinyl electrodes placed in a modified Lead II configuration. A Biopac ECG100C amplifier, using a bandpass filter of 35 Hz and 2.0 Hz, was used and the ECG signal was converted to R-wave intervals to the nearest millisecond. Higher values reflect a slower heart rate, while lower values reflect a faster heart rate.

Pulse Transmission Time to Ear (PTE)

PTE, measured in milliseconds, was assessed as a broad measure of sympathetic nervous system activity (e.g., Fredrickson & Levenson, 1998; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). PTE reflects the contractile force of the heart in conjunction with the distensibility of the blood vessels that are mediated by the sympathetic nervous system (Newlin & Levenson, 1979). Blood volume in the ear was measured using a plethysmograph transducer attached to the participant's left ear lobe, and PTE was quantified offline using AcqKnowledge v3.9.1 software as the time in milliseconds (ms) elapsed between the closest previous R-wave of the ECG and the upstroke of the peripheral pulse wave at the ear. Shorter PTE reflects greater autonomic sympathetic activation and longer PTE reflects less sympathetic activation.

Respiratory sinus arrhythmia (RSA)

RSA was employed as a noninvasive index of parasympathetic nervous activity. RSA refers to the natural variation in heart rate due to respiratory factors (for review, see Berntson et al., 1997;

Grossman & Taylor, 2007). RSA was derived with the same Biopac ECG100C amplifier (described above) and a respiration signal using Biopac's RSP100C respiration module with a high-pass filter at 0.05 Hz and low-pass filter of 1 Hz. RSA was calculated offline using AcqKnowledge v3.9.1 software that followed a well-validated peak-valley method (Grossman, van Beek, & Wientjes, 1990) in which expiratory and inspiratory periods were used as windows to determine the range of cardiac-interval fluctuations associated with the respiratory phase. The maximum heart rate ("peak") expressed in milliseconds (IBI) during the expiration window of the respiration cycle was subtracted from the minimum heart rate ("valley") during the inspiration window of the respiration cycle. The RSA index was calculated in ms, with higher values reflecting greater parasympathetic activity (or cardiac vagal tone).

Manipulation checks

Following prior work (e.g., Kross et al., 2005), at the end of the reflective and ruminative processing conditions participants rated the extent to which they were an observer of what happened from a third-person. Three questions were also included that assessed the extent to which participants experienced the same (1) thoughts, (2) emotions, and (3) physiological sensations in the experiment as they originally felt during the positive memory. One question assessed the vividness of the memory recalled during the experiment and another question assessed the degree to which participants felt engaged in the task. All manipulation check items noted above were rated on a 1 (*not at all*) to 7 (*a lot*) scale. Furthermore, to ensure there were no differences in the social content of the recalled event, participants were instructed to note whether another person (e.g., romantic partner, friend, relative, other) was involved in the memory.

Procedure

After obtaining informed consent, trained doctoral students or postdoctoral fellows administered the SCID, YMRS and IDS-C. Participants were then seated in front of a 17″ high-resolution computer monitor. Physiological sensors were attached and participants spent approximately 10 min completing demographic questionnaires. Participants were self-guided through the experiment using computerized software (MediaLab v2006, MediaLab, Inc., Atlanta, GA) that presented pre-recorded audio instructions and collected questionnaire information.

At the beginning of the experiment, a resting baseline period (60 s) was acquired. Participants read the following message on the computer screen: "Please relax and watch the screen for the next minute." After this baseline period ended, participants completed the PANAS and reported the number of positive thoughts experienced during the baseline period.

Next, participants listened to an audio-recorded script orienting them to the task. After this, they recalled autobiographical experience in which they felt intense happiness (procedure adapted from Ayduk et al., 2002; Kross et al., 2005). Once they had identified a memory, they were instructed to press the space bar on the computer keypad to continue.

Using a within-subjects design, participants then completed both the ruminative processing (immersed-why) and reflective processing (distanced-why) conditions with the same positive memory recalled earlier. The order of the reflective and ruminative processing conditions was counterbalanced. The following instructions for both conditions were adapted from the paradigm by Kross et al. (2005). In the *reflective processing* condition, participants were asked to "Go back to the time and place of the same happy event you recalled earlier and see the scene in your mind's eye. Take a few steps back. Move away from the situation to a point where you can now watch the event from a distance. As you do this, focus on what has now become the distant you. Watch the event unfold as if it was happening all over again to the distant you. Replay the interaction as it progresses in your mind's eye." Participants were given 60 s to do this. At the end of the reflective condition, participants completed the PANAS, frequency of positive thoughts, and manipulation check items.

In the *ruminative processing* condition, participants were asked to "Go back to the time and place of the same happy event you recalled earlier and see the scene in your mind's eye. Relive the situation as if it were happening to you all over again. Re-experience the situation as it progresses in your mind's eye. As you continue to relive the happy memory, try to understand the emotion that you experienced as the event unfolded. Why did you have those feelings? What were the underlying causes and reasons?" Participants were given 60 s to do this. At the end of the ruminative condition, participants completed the PANAS, frequency of positive thoughts, and manipulation check items. At the end of the experiment physiological sensors were disconnected and participants were debriefed.

Results

Preliminary analyses

First, we examined the distribution of the six main variables (positive affect, positive thoughts, happy behavior, interbeat interval, PTE, and RSA). Positive affect, positive thoughts, and interbeat interval mirrored a normal distribution and were thus not transformed. Given that happy behavior, PTE, and RSA were positively skewed and leptokurtic across the baseline, ruminative, and reflective conditions, log transformations were successfully performed to normalize the distribution for these variables in final analyses.

Second, we examined whether gender or order of experimental condition (i.e., whether the reflective or ruminative processing condition came first) was related to emotional responding. We did so by entering either gender or order as the between subjects variable in a 2 (Gender or Order) $\times$ 3 (Condition: baseline, reflective, ruminative) repeated-measures analyses of variance for each of the six main variables across experiential, behavioral, and autonomic channels. There were no significant main effects or interactions for either gender or order in these analyses. Hence, gender and condition order were not included as covariates in subsequent analyses.

Manipulation checks

Consistent with the intended experimental manipulation, participants across both groups reported a greater extent to which they were an observer of what happened from a third-person perspective in reflective compared to the ruminative processing condition ($p < .05$). For both the reflective and ruminative processing conditions, BD and CT participants did not differ in the extent to which they experienced the same thoughts, emotions, and physiological sensations as during the original event recalled. BD and CT participants also did not differ in task engagement or memory vividness ($p > .05$). Finally, there were no differences in the social content of the memory, as all memories (100%) involved other people. Means and standard deviations for manipulation check variables are presented in Table 2.

Demographic and clinical characteristics

As evident in Table 1, BD and CT participants did not significantly differ with respect to age, gender, ethnicity, education, employment status, partnership status, and living status ($ps > 0.40$). Although both groups scored well below standardized clinical cut-offs on the YMRS (≤ 7) and IDS-C (≤ 11), BD participants scored higher on both measures than CT participants ($ps < 0.05$).

Differences in reflective and ruminative processing of positive emotion

Following prior research sampling across multiple channels of emotional response (e.g., Mauss et al., 2005; Rottenberg, Gross, & Gotlib, 2005) six separate 2 (Group: BD, CT) × 3 (Condition: baseline, reflective, ruminative) repeated-measures analyses of variance were conducted separately for each channel of emotion response (positive affect, positive thoughts, happy behavior, interbeat interval, PTE, RSA). A Greenhouse–Geisser correction was used when assumptions for sphericity were not met and adjusted *F* and *p* values are reported. Effect sizes for significant results are reported as partial eta squared (η^2_p). All reported *p* values are two-tailed. Means and standard deviations for scores on all emotion reactivity variables are presented in Table 3.

Positive affect

For self-reported positive affect, there was a main effect of Condition, F (2, 102) = 17.68, $p < .001$, $\eta^2_p = 0.26$. No other main effects or interactions were significant. Follow-up pairwise comparisons for the Condition main effect indicated that all participants reported greater positive affect during the ruminative (M = 13.88, SE = 0.60) compared to the reflective (M = 12.58, SE = 0.67) and baseline (M = 10.95, SE = 0.49) conditions ($ps < 0.01$). The reflective condition was associated with greater positive affect than the baseline condition ($p < 0.01$).

Positive thoughts

For the number of positive thoughts, there a main effect of Condition, F (1.71, 106.91) = 17.48, $p < .001$, $\eta^2_p = 0.26$. No other main effects or interactions were significant. Follow-up pairwise comparisons for the Condition main effect indicated that all participants reported a greater number of positive thoughts during the ruminative (M = 4.45, SE = 0.18) compared to the reflective (M = 4.06, SE = 0.20) and baseline (M = 3.30, SE = 0.19) conditions ($ps < 0.01$). The reflective condition was associated with a greater number of positive thoughts than the baseline condition ($p < 0.01$).

Table 1
Demographic and clinical characteristics of BD and CT participants.

	BD	CT	Statistic
Demographic			
Age (Yrs)	34.37 (15.78)	37.00 (10.29)	$F = 0.48$
Female (%)	77.8%	63.0%	$\chi^2 = 1.00$
Caucasian (%)	55.6%	69.2%	$\chi^2 = 1.05$
Education (Yrs)	14.70 (4.73)	15.38 (2.50)	$F = 0.62$
Employed (%)	63.0%	73.1%	$\chi^2 = 0.15$
Partnered (%)	26.1%	36.8%	$\chi^2 = 0.56$
Living Alone (%)	34.6%	32.0%	$\chi^2 = 0.04$
Clinical			
YMRS	2.44 (2.28)	1.00 (1.25)	$F = 7.61^{**}$
IDS-C	7.04 (3.86)	3.62 (2.67)	$F = 13.16^{**}$

Note: BD = Bipolar participants; CT = Healthy control participants; YMRS = Young Mania Rating Scale; IDS-C = Inventory to Diagnose Depression. Mean values are displayed with standard deviations in parentheses where applicable.
$^*p < 0.05$; $^{**}p < 0.01$.

Table 2
Means (and standard deviations) of the manipulation check variables.

	BD	CT
Reflective Processing		
Observer of experience	5.12 (1.36)	5.30 (1.46)
Experienced same thoughts	3.78 (1.42)	3.61 (1.32)
Experienced same emotions	3.59 (1.39)	3.54 (1.29)
Experienced same physiology	2.63 (1.71)	2.36 (1.39)
Memory vividness during task	5.07 (1.64)	5.39 (1.26)
Task engagement	5.37 (1.47)	4.89 (1.62)
Ruminative Processing		
Observer of experience	3.71 (1.71)	3.37 (1.47)
Experienced same thoughts	5.07 (1.49)	4.50 (1.17)
Experienced same emotions	4.96 (1.56)	4.36 (1.28)
Experienced same physiology	4.07 (1.82)	2.96 (1.60)
Memory vividness during task	5.44 (1.34)	5.36 (1.22)
Task engagement	5.44 (1.28)	4.89 (1.34)
Across Experiment		
Social Content of Memory (%)	100%	100%

Note: BD = Bipolar disorder; CT = Healthy controls. All items were rated on a 1 (*not at all*) to 7 (*a lot*) scale unless otherwise noted. $^*p < 0.05$.

Happy emotion behavior

There were no main effects or interactions for happy behavior. It should be noted, however, that the total frequency of happy facial expressions across all participants during the baseline (n = 4), reflective (n = 5) and ruminative (n = 5) conditions was extremely low.

Interbeat interval

For interbeat interval, there a main effect of Condition, F (2, 105) = 3.58, $p < 0.05$, $\eta^2_p = 0.07$. No other main effects or interactions were significant. Follow-up pairwise comparisons for the Condition main effect indicated that the ruminative condition (M = 0.81, SE = 0.03) was associated with a higher heart rate compared to the reflective (M = 0.83, SE = 0.03) and baseline

Table 3
Means (and standard deviations) for positive affect, positive thoughts, emotional behavior, and autonomic responding by condition and diagnostic group.

	BD	CT
Baseline		
Positive affect	11.23 (4.01)	10.71 (2.98)
Positive thoughts	3.27 (1.37)	3.64 (1.13)
Happy behavior	0.02 (0.10)	0.12 (0.36)
Interbeat interval	0.85 (0.15)	0.84 (0.15)
PTE	0.44 (0.06)	0.43 (0.05)
RSA	214.05 (335.94)	245.64 (200.65)
Reflective Processing		
Positive affect	13.48 (5.19)	11.86 (4.38)
Positive thoughts	4.26 (1.38)	4.07 (1.30)
Happy behavior	0.13 (0.46)	0.00 (0.00)
Interbeat interval	0.84 (0.14)	0.83 (0.14)
PTE	0.44 (0.06)	0.43 (0.04)
RSA	239.41 (433.78)	246.55 (255.15)
Ruminative Processing		
Positive affect	15.00 (5.33)	13.00 (3.14)
Positive thoughts	4.74 (1.13)	4.43 (1.10)
Happy behavior	0.12 (0.63)	0.04 (0.20)
Interbeat interval	0.83 (0.14)	0.82 (0.14)
PTE	0.45 (0.08)	0.44 (0.05)
RSA	239.23 (367.26)	255.95 (266.86)

Note: BD = Bipolar participants; CT = Healthy control participants; PTE = Pulse Transmission Time to Ear; RSA = Respiratory sinus arrhythmia. Positive affect rated on a 1 (very slightly or not at all) to 7 (extremely) scale. Positive thoughts rated on a 1 (none at all) to 6 (very many) scale. Happy behavior coded on a 0 (none) to 5 (marked) scale.

($M = 0.83$, $SE = 0.32$) conditions ($p = <0.05$). The reflective and baseline conditions did not significantly differ ($p > 0.50$).

RSA. There were no main effects or interactions for RSA.

PTE. There were no main effects or interactions for PTE.[2]

Potential confounds

We examined the influence of two potential confounds on emotion responding including current symptoms of mania and depression and the presence of comorbid anxiety disorders. For current symptom severity, although there were group differences in current manic and depressive symptoms, both groups scored well below the clinical cutoff scores on both these measures (See Table 1). Furthermore, as evident in Table 4, manic current symptoms were unrelated to emotional responding variables. Depressive symptoms were minimally associated with responding variables, with some association between increased depressive symptoms and increased PTE (indicative of reduced sympathetic arousal) during the reflective and ruminative processing conditions. We thus conducted parallel analyses to consider group effects after controlling for the YMRS and IDS-C as covariates. After controlling for current symptoms, the ruminative processing condition continued to be associated with greater positive affect compared to the reflective processing and baseline conditions. Also parallel to our original findings was the lack of main effects or interactions for happy emotion behavior, PTE, and RSA. In contrast with the original results, a significant Group main effect emerged for positive affect, $F(1, 46) = 4.75$, $p < 0.05$, $\eta_p^2 = 0.09$. Pairwise comparisons suggested that BD participants ($M = 13.70$, $SE = 0.77$) reported higher positive affect across all conditions relative to CT participants ($M = 11.10$, $SE = 0.80$). Furthermore, the three experimental conditions no longer significantly differed with respect to interbeat interval or positive thoughts. We re-ran these analyses controlling for YMRS and IDS-C separately as covariates to examine whether manic or depressive symptoms drove these results. Parallel results as those reported above were obtained with the exception of positive affect. Specifically, controlling for IDS-C scores (but not YMRS scores) revealed the significant Group main effect noted above, $F(1, 47) = 5.78$, $p < 0.05$, $\eta_p^2 = 0.11$. With respect to comorbid anxiety disorders, we note that anxiety disorders were common in our BD participants ($n = 12$) and are known to influence emotion responding (e.g., Menin, Heimberg, Turk, & Fresco, 2005). When we also re-ran all analyses covarying for the presence of at least one comorbid anxiety disorder, it did not significantly change the pattern of results.

Discussion

This study examined the impact of two distinct cognitive processing strategies on positive emotion among individuals with bipolar disorder and healthy controls. The first hypothesis tested was that both groups would exhibit decreases in the intensity of positive emotions in the reflective compared to the ruminative processing condition. Both BD and CT participants exhibited decreases in positive affect, positive thoughts, and heart rate (i.e., interbeat interval) in the reflective (i.e., distanced-why) compared to the ruminative (i.e., immersed-why) processing condition. In other words, reflective processing was associated with reductions in self-reported positive emotion experience and general cardiovascular arousal relative to ruminative processing. These findings extend previous research on negative emotion (e.g., Ayduk & Kross, 2009; Kross et al., 2005) to demonstrate that reflective processing of emotional events from a third-person perspective is associated with reductions in the intensity of positive emotions.

Table 4
Correlations between current symptoms and emotional response measures in BD participants.

	YMRS	IDS-C
Baseline		
Positive affect	−0.21	−0.39
Positive thoughts	−0.35	−0.21
Happy behavior	−0.04	0.31
Interbeat interval	−0.32	0.36
RSA	0.09	0.02
PTE	−0.13	0.37
Reflective Processing		
Positive affect	0.09	−0.29
Positive thoughts	0.22	0.09
Happy behavior	0.03	−0.28
Interbeat interval	−0.32	0.35
RSA	0.01	−0.05
PTE	−0.24	0.47*
Ruminative Processing		
Positive affect	0.06	−0.33
Positive thoughts	−0.04	0.12
Happy behavior	−0.04	−0.37
Interbeat interval	−0.32	0.26
RSA	−0.04	−0.05
PTE	−0.12	0.41*

Note: BD = Bipolar disorder participants; YMRS = Young Mania Rating Scale; IDS-C = Inventory to Diagnose Depression; PTE = Pulse Transmission Time to Ear; RSA = Respiratory sinus arrhythmia.
*$p < 0.05$.

We note that reflective processing was not associated with differences in happy behavior, PTE, or RSA compared to ruminative processing across both groups. There are several potential explanations for these findings. First, as noted earlier, there was a low base rate of happy facial expressions across both processing conditions. The lack of intense emotional behavior throughout the task is consistent with findings from individual emotion elicitation paradigms in bipolar risk populations (e.g., Gruber et al., 2008) as well as in discussions of imagery procedures and emotion more generally (Hirsch & Holmes, 2007). Hence, the task did not elicit sufficiently strong or frequent facial behavior to allow for examination of differences between distinct cognitive processing strategies and our two comparison groups. Second, the lack of differences in PTE may relate to the fact that other measures tapping into sympathetic nervous system activity typically covary with negative, but not positive, emotion (Levenson, 1992). Given the aim of the study was to elicit positive emotion, these autonomic indices may not have been sufficiently activated.[2] Third, we were surprised by the lack of significant findings with respect to RSA given recent work positing RSA as an autonomic marker of positive affect (Oveis et al., 2009; Porges, 1991) and resilience (Fabes & Eisenberg, 1997). At the same time, there is considerable debate surrounding the affective function of RSA with accruing evidence also implicating RSA more generally in emotion regulatory processes (Beauchaine, 2001; Butler, Wilhelm, & Gross, 2002). It is also quite likely that more subtle psychophysiological parameters such as RSA may be less susceptible to potential demand characteristics of the different experimental conditions.

Our second hypothesis was that BD participants would exhibit greater positive emotion across both reflective and ruminative

[2] We also assessed skin conductance response rate as another measure of sympathetic nervous activity and parallel results were obtained as for PTE. For ease of presentation, we present results for PTE only.

conditions compared to CT participants. Counter to this prediction, BD participants did not differ across any channels of emotional responding in the main analyses. After controlling for current manic and depressive symptoms, however, BD participants were found to report higher positive affect across baseline, ruminative, and reflective processing conditions compared to CT participants. Additional analyses indicated that controlling for depressive symptoms that drove this finding, suggesting that depressive symptoms may have been the strongest contributor to dampening levels of self-reported positive affect in BD compared to CT participants across all conditions. Such findings dovetail with the perspective that bipolar disorder is associated with elevated self-reported positive emotion experience across differing contexts (Gruber et al., 2008; Hofmann & Meyer, 2006; Johnson et al., 2007; Lovejoy & Steuerwald, 1995).[3] Such a possibility should be interpreted with caution, however, as there are considerable concerns about the statistical validity of controlling for current symptoms (Miller & Chapman, 2001). We suggest that future studies be conducted comparing BD participants who score high and low on symptom measures to examine the relative influence of symptoms on emotional responding. Furthermore, it is important not to overstate the nature of these findings as group differences in positive affect were modest, only occurred when controlling for current symptoms, and there were no group differences in behavior or psychophysiological arousal.

Although we found few group differences in the present study, we believe this is important for several reasons. First, these findings suggest that strategies typically considered to regulate negative emotions may apply to the regulation of positive emotion similarly in people with bipolar disorder, marked by extreme perturbations in positive emotion, and healthy controls. This is important given that few studies have examined which strategies are effective in regulating positive emotions in bipolar disorder. Furthermore, such findings may bear on the applicability of mindfulness-based approaches to regulate positive mood given the palpable parallels between reflective processing and mindfulness-based approaches that both involve observing one's emotional experiences in a way that decrease their emotional intensity (e.g., Fulton, Germer, & Siegel, 2005). Such findings are also consistent with the emphasis on cognitive processing techniques to regulate positive mood in current psychological treatments for bipolar disorder (e.g., Johnson & Fulford, 2009; Lam, Wong, & Sham, 2001; Newman, 2001).

Limitations and future directions

Findings from the present study should be interpreted within the confines of several limitations. First, the findings obtained were based on short instructional periods (i.e., 60 s) across both reflective and ruminative processing conditions. Moreover, participants followed these strategies in response to a memory of a past event rather than an online emotional experience itself. Thus, it will be critical to more carefully examine whether momentary experimental manipulations of these two processing strategies generalize to everyday efforts to process online positive emotions. Second, although we examined the extent to which participants adopted a reflective versus ruminative perspective, we did not assess other potential strategies participants may have engaged in during the experimental period. It will be crucial to employ narrative techniques or other open-ended response formats to assess the myriad of possible cognitive strategies being employed simultaneously. Third, we did not clearly distinguish between various types of positive emotions that may have been recalled during the experiment. It will be important to more clearly delineate whether reward and achievement oriented positive emotions implicated in bipolar disorder (e.g., Gruber & Johnson, in press; Johnson, 2005) as compared to other-oriented, prosocial emotions (e.g., compassion; Shiota, Keltner, & John, 2006) are equally amenable to reflective processing.

We also note four limitations with respect to elucidating positive emotional disturbance in bipolar disorder. First, the sample sizes were modest and thus there may not have been sufficient statistical power to reject the null hypothesis. Thus, we see this study as a first step in the domain of experimentally examining positive emotion regulation in bipolar disorder and note it will be important to replicate these findings in a larger sample. Second, BD participants were not excluded on the basis of comorbidities to ensure a more ecologically valid sample. Although we did not find evidence to suggest comorbid anxiety disorders in the BD group influenced processing of positive emotions, it remains unclear precisely how the presence of other comorbid disorders might account for observed group differences (or a lack thereof). Third, our BD and CT participants did not differ from one another in employment status, partnership status, and living status. Hence, findings from the BD participants in the present study may not generalize to more functionally and psychosocially impaired individuals with bipolar disorder. Fourth, given the possible confound of psychotropic medication in a BD sample, future studies with larger sample sizes and random assignment to different medication classes are warranted as an unmedicated BD sample is unfeasible and unrepresentative.

Despite these limitations, to our knowledge this is the first attempt to examine whether cognitively manipulating the vantage from which a positive memory is recalled influences the intensity of positive emotional responding both in bipolar disorder and healthy adults. These results suggest that reflecting upon positive memories from a distance led to decreases in positive emotion experience and some domains of physiological arousal. Future work is needed to determine the mechanism involved in adaptive processing of positive emotions in both healthy and clinical populations.

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[3] Although we measured self-reported negative affect and the frequency of negative thoughts, they were not a central goal of the present study that included a more specific focus on positive affect and thoughts. However, we note that no significant main effects or interactions emerged for these two variables ($ps > 0.05$).

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