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Emotional and physiological responses to normative and idiographic positive stimuli in bipolar disorder

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Abstract

Background—Few studies have examined differences in emotional responding among distinct types of positive stimuli. This is important to understand both for individuals characterized by extreme positive mood (i.e., bipolar disorder) and healthy adults.

Methods—Using a multi-method within-subjects design, the current study examined physiological, behavioral, and self-reported responses to normative (film) and idiographic (memory) happy stimuli in bipolar (BD; *n*=25) and healthy control groups (CTL; *n*=23).

Results—For both groups, the happy films were associated with greater self-reported and behavioral displays of positive emotion compared to the happy memory. Furthermore, the BD group displayed greater cardiac vagal tone – a putative marker of positive emotion – across both the film and memory.

Conclusion—Normative stimuli were more potent elicitors of positive emotion compared to idiographic stimuli. The study provided further evidence for cardiac vagal tone as a potential biomarker of extreme positive emotion in BD.

Keywords

Bipolar disorder; Positive emotion; Idiographic; Normative

1. Introduction

Disrupted affective functioning, including periods of elevated mood, grandiosity, and excessive engagement in pleasurable activities, are core diagnostic criteria for bipolar disorder (BD; American Psychiatric Association, 2000). However, extreme perturbations in emotion are an understudied feature of BD (e.g., Johnson et al., 2007). Only recently have affective scientists begun to explore emotion disturbances that characterize the illness.

Recent evidence indicates that BD is associated with increased positive emotion in anticipation of (Johnson, 2005) and in response to positive stimuli (e.g., Johnson et al., 2007). For example, those with BD report greater happiness when anticipating rewards in their daily lives (Meyer et al., 2001) and in response to both daily life events (Hoffman and Meyer, 2006; Lovejoy and Steuerwald, 1995) and evocative photos and films in controlled

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laboratory environments (Gruber et al., 2008; M'Bailara et al., 2009). Furthermore, individuals at risk for BD demonstrate greater startle attenuation while viewing positive photos (Sutton and Johnson, 2002) and greater vagal tone – associated with positive emotion – in response to positive, negative, and even neutral films (Gruber et al., 2008). While a significant body of research has investigated negative emotional responses in BD, a clear pattern has yet to emerge. Some studies have found that individuals with, and at risk for, BD do not differ from controls in response to negative stimuli, including failure feedback (Ruggero and Johnson, 2006), interpersonal criticism (Cuellar et al., 2009), or negative photos (Sutton and Johnson, 2002).

Taken together, empirical evidence suggests that BD is associated with elevated responses to positive stimuli, with inconclusive data regarding responsivity to negative stimuli. However, research in the area has been limited in two critical respects. First, most research has tended to use one channel of emotional response, focusing exclusively on self-reported affect or physiological measures which does not provide the most comprehensive portrait of dysfunctional emotion in BD as compared to a multi-method approach. Second, few studies have examined whether distinct classes of stimuli more strongly elicit positive emotion. Researchers have utilized either normative (standardized across participants), or idiographic (person-specific) stimuli. Whereas normative stimuli are more standardized and reliable, and have higher internal validity, idiographic stimuli are theorized to be more active, engaging, and personally salient (e.g., Dickerson et al., 2004). However, emotional responses to one class of stimuli may not always be generalized to describe emotional responses more broadly as evident in major depression (Rottenberg et al., 2005). The differential effects of these two classes of stimuli have not yet been explored in BD.

The goal of the present study was to assess differences in reactivity to normative and idiographic positive stimuli in BD. The first hypothesis was that both groups would be associated with greater positive emotional responding across experiential, behavioral, and physiological response domains to idiographic than to normative stimuli, based on work suggesting that idiographic stimuli elicit more emotionally evocative responses (e.g., Dickerson et al., 2004; Rottenberg et al., 2005). The second hypothesis was that the BD group would exhibit greater positive emotional responding across experiential, behavioral, and physiological response domains compared to the CTL group across both normative and idiographic stimuli, based on work implicating heightened positive emotional responses in BD across different stimuli contexts (Gruber et al., 2008).

2. Materials and methods

2.1. Participants

Participants were 26 persons diagnosed with BD (67% female, 70% Caucasian) type I (n=24) or type II (n=2) and 23 healthy controls (CTL; 62% female, 77% Caucasian) who were fluent in English, between 18 and 63 years of age (BD group: M=36.94 (±12.08) years; CTL group: M=36.65 (±10.65) years). Exclusion criteria included history of severe head trauma, stroke, neurological diseases, autoimmune disorders and arrhythmias, or current alcohol and/or substance abuse.

Diagnoses were confirmed using the Structured Clinical Interview for DSM-IV (SCID-IV; First et al., 1995). Current inter-episode status was verified using the SCID-IV and previously determined cutoff scores on the Clinician-Rated Inventory of Depressive Symptoms (IDS-C≤11; Rush et al., 1996) and the Young Mania Rating Scale (YMRS≤7; Young et al., 1978).

The average age at onset for the BD group was 19.00 years (±11.79) and average illness duration was 16.63 years (±10.78). The lifetime average number of episodes was 8.47 (±11.29) for hypomania/mania and 9.85 (±10.36) for depression. Psychotropic medications included lithium (*n*=4), anticonvulsants (*n*=14) antidepressants (*n*=19), neuroleptics (*n*=13), benzodiazepines (*n*=4), stimulants (*n*=1), and sedative-hypnotics (*n*=1). Given that BD is often comorbid with other disorders (e.g., Kessler et al., 2005), BD participants were not excluded on the basis of comorbid disorders (aside from current substance or alcohol abuse/dependence). Current comorbidities included panic disorder (*n*=1) agoraphobia (*n*=2), social phobia (*n*=6), specific phobia (*n*=8), obsessive–compulsive disorder (*n*=3), post-traumatic stress disorder (*n*=1), generalized anxiety disorder (*n* =6), hypochondriasis (*n* =1), pain disorder (*n*=1), and binge eating disorder (*n*=1).

The CTL group did not meet criteria for any current or lifetime Axis I disorder using the SCID-IV. CTL participants scored below cut-offs on the YMRS and IDS-C.

2.2. Measures of clinical functioning

2.2.1. Diagnostic Evaluation—Trained psychology doctoral candidates and postdoctoral fellows administered the SCID-IV (First et al., 1995). Fifteen randomly selected audiotapes were rated by an independent reviewer and ratings matched 100% (κ=1.00) of primary diagnoses.

2.2.2. Concurrent symptoms—The Young Mania Rating Scale (YMRS; Young et al., 1978) is a widely used, 11-item, clinician-rated measure of current manic symptoms. The Inventory of Depressive Symptomatology (IDS-C; Rush et al., 1996) is a 30-item, clinician-rated measure of current depressive symptoms. Intra-class correlations for absolute agreement between the interviewer and a second independent rater for a random subset (*n*=9) were strong for the IDS-C (ICC=0.98) and YMRS (ICC=0.99).

2.3. Measurement of emotional response

A multi-method approach was employed to measure emotion at experiential, behavioral, and physiological levels during the baseline periods (before the film or memory) and the film and memory tasks.

2.3.1. Self-reported positive and negative affect—Self-reported positive (PA) and negative (NA) affect were assessed using the short form of the Positive and Negative Affect Schedule (PANAS; Mackinnon et al., 1999), a 10-item self-report measure. Both PA (average α=0.89) and NA (average α=0.72) demonstrated good internal consistency in the present study.

2.3.2. Emotional behavior[1]—Participants' facial behavior was coded using the Emotion Facial Action Coding System (EMFACS; Ekman and Rosenberg, 1997). Two emotional displays coded reliably in previous BD research (Gruber et al., 2008) were coded; namely, happiness (AU6 [cheek raiser]+AU12 [lip corner puller]) and sadness (AU6 [cheek raiser], AU15 [lip corner depressor]). Following FACS scoring criteria, an emotional expression received an intensity score from 0 ("absent") and 1 ("trace") to 5 ("marked"). Three certified FACS coders blind to diagnostic status coded all emotion displays, exhibiting good ICC reliability values for a subset (*n*=28) of participants across happy (= 0.80) and sad (= 0.88) facial displays. Average values between coders were computed for this subset and remaining

[1]Given implications of anger in bipolar disorder, anger displays (AU 4 [eyebrow furrow], AU5 [upper lid raiser], and AU 23 [lip tightener] or AU24 [lip pressor]) were coded. However, the base rate across both tasks was too low to analyze (*n*=0).

participants were coded individually. Facial displays were coded during each baseline and film period and the average intensity was used in final analyses.

2.3.3. Physiology—Two measures were selected to allow for continuous measurement and sample both sympathetic (skin conductance response rate; SCR) and parasympathetic (heart rate variability; HRV) nervous system response. Data were analyzed and corrected for artifacts (<1.6% of data) offline using AcqKnowledge v.3.9.1 software.

2.3.4. Parasympathetic nervous system response—HRV was employed as an index of cardiac vagal tone, or parasympathetic nervous activity. Higher levels of cardiac vagal tone have been associated with greater positive emotion in healthy college (Oveis et al., 2009) and at-risk BD groups (Gruber et al., 2008) and so were used in the present study as an autonomic marker of positive emotion. ECG recordings were obtained with two pre-jelled Ag–AgCl snap disposable vinyl electrodes placed in a modified Lead II configuration using a Biopac ECG100C amplifier. HRV was quantified by performing a well-validated frequency domain analysis of the ECG recordings (e.g., Berntson et al., 1997). Specifically, a cubic spline interpolation was applied to generate a continuous time-domain representation of the interbeat (R-R) interval. A Welch periodogram was then used to generate the high frequency power spectral density (i.e., 0.15–0.40 Hz), used as an indicator of parasympathetic activity (e.g., Porges, 1991).

2.3.5. Sympathetic nervous system response—SCR rate was assessed as a measure of sympathetic nervous system activity (Dawson et al., 2000). Greater sympathetic nervous system activity covaries with reports of increased negative emotion (Levenson, 1992). Electrodermal activity recordings were obtained using a Biopac GSR 100 C amplifier with constant voltage of 0.5v between two 10 mm Ag–AgCl electrodes. A 0.5% NaCl paste was applied on the palmar surface of the distal phalanges of the first and third fingers of the non-dominant hand. Using automatized AcqKnowledge software, SCRs were identified as increases in skin conductance level exceeding 0.05 μS from the participant's own baseline (Fowles et al., 1981).

2.4. 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 10 min completing demographic questionnaires. All questionnaires and stimuli were presented using computerized software (MediaLab, Inc., Atlanta, GA).

2.4.1. Normative happy film—At the beginning of the film task, a resting baseline (60 s) was acquired. After the baseline period, participants completed the PANAS. Next, they received the instructions: "We will now be showing you a short film clip. It is important that you watch the film clip carefully." These instructions were followed by one of two previously validated happy films (counterbalanced across participants): figure skater Sarah Hughes winning the Olympic gold medal (150 s) or Andy Roddick winning the US Open (181 s). At the end of the film, participants completed the PANAS.

2.4.2. Idiographic happy memory—Autobiographical memory tasks have been used in prior work as a valid elicitor of idiographic emotional content in healthy and BD groups (e.g. Eich et al., 1994; Holmes et al., 2008). Participants completed the happy memory task on the same day as the happy film task (54%) or at a separate experimental session (46%). At the beginning of the task, a resting baseline (60 s) was first acquired. After this baseline period ended, participants completed the PANAS. Next, participants listened to an audio-

recorded script orienting them to the task. Next, they identified an autobiographical experience in which they felt intense happiness (procedure adapted from Ayduk and Kross, 2009). Once they had identified a positive memory, they listened to pre-recorded audio recording as follows: "Go back to the time and place of the 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" and "As you continue to think about the happy memory, focus on the deepest thoughts and feelings you experienced as the situation unfolded." Participants were given 60 s to do this and completed the PANAS and rated memory vividness on a 1(not at all) to 7 (a lot) scale at the end. This paradigm has been used successfully in previous BD work (Gruber et al., 2009).

3. Results

3.1. Demographic and clinical characteristics

As evident in Table 1, BD and CTL participants did not significantly differ with respect to age, gender, education level, or ethnicity (*p*s>.05). Although both groups scored well below standardized cutoffs on the YMRS (≤7) and IDS-C (≤11), the BD group scored somewhat higher on both measures than CTL participants (*p*s<.05)[2].

3.2. Preliminary analyses

We first examined whether gender or order of task (i.e., whether memory and film task occurred on the same or different testing day) was related to emotional responding. No significant main effects or interactions for gender or order emerged for any of the three domains of emotional response (*p*s>.05) when entering either gender or order as the primary between-subjects variable using a multivariate analysis of variance (MANOVA) for each domain of emotional response (experience, behavior, and physiology).

Second, manipulation checks for the happy memory task revealed that BD and CTL groups did not differ in task engagement or memory vividness (*p*>.10).

Third, we examined whether there were significant differences in the content of the memories recalled. Two coders blind to diagnostic status coded brief one-sentence descriptions of the memory content provided verbally to the experimenter. Four categorical (yes or no) content variables were coded, including social interaction general, romantic or sexual interaction, outdoors, or vacation and three thematic codes rated on a 1 (not at all) to 5 (extremely) scale, including the degree to which the memory was goal-oriented, self-focused, or other-focused. Inter-rater reliability estimates were strong (κ_{mean} =0.80, ICC_{mean} =0.87) and an average score between both coders was thus computed. Results indicated no group differences for any of these codes (*p*s>.20).

Fourth, we examined whether medication variables were associated with diminished emotional responding within the bipolar group. Levels of each class of medication were recorded using the Somatotherapy Index (Bauer et al., 1997). Bivariate correlations conducted between intensity of medication dosage and our emotion responding variables were modest, inconsistent, and not indicative of a general blunting or amplification in emotional responding.

[2]We opted not to covary for symptoms for two reasons: (American Psychiatric Association, 2000; Miller and Chapman, 2001) note that ANCOVAs are intended to minimize within group variability, not between group variability, especially when group is not randomly assigned; (Johnson et al., 2007) when correlations between symptoms and our primary dependent variables were conducted, no findings reached significance.

3.3. Emotional responding to idiographic and normative stimuli

Following prior research (e.g., Rottenberg et al., 2005) six separate 2 (Group: BD, CTL)×2 (Task: Film, Memory) repeated-measures analyses of covariance (ANCOVA) were conducted separately for each channel of emotion response (PA, NA, happy facial expressions, sad facial expressions, SCR, HRV), with respective scores from the 60 s baseline periods preceding the film and memory entered as covariates. A Greenhouse–Geisser correction was used when assumptions for sphericity were not met and adjusted *F* and *p* values 6 (two-tailed) are reported. Effect sizes are reported as partial eta squared (η_p^2). Raw means and standard deviations are presented in Table 2.

3.3.1. PA—For self-reported PA, there was a main effect of Task, $F(1, 45)=4.34$, $p<.05$, $\eta_p^2=0.09$, due to increased PA during the happy film ($M=16.63$, $SD=0.71$) compared to the happy memory ($M=15.23$, $SD=0.44$) across both groups.

3.3.2. Happy displays—A main effect of Task emerged, $F(1,44)=25.46$, $p<.001$, $\eta_p^2=0.37$, due to increased facial expressions of happiness in response to the film clip ($M=0.88$, $SD=0.15$) relative to the memory ($M=0.12$, $SD=0.05$) across both groups.

3.3.4. HRV—A main effect of Group emerged, $F(1,43)=5.51$, $p<.05$, $\eta_p^2=0.11$, reflecting greater HRV in BD ($M=1.29$, $SD=0.05$) compared to the CTL ($M=1.12$, $SD=0.05$) group.

No significant effects emerged for NA, sad displays, or SCR (*p*s>.05).

4. Discussion

BD has been associated with disturbances in positive emotion (Johnson et al., 2007), yet the precise types of stimuli that elicit these emotional responses are less clear. The present investigation examined whether individuals with BD differed from healthy controls in their emotional responses to normative and idiographic positive stimuli.

The first hypothesis was that both BD and CTL groups would be associated with greater emotional reactivity to idiographic compared to normative stimuli. Contrary to this hypothesis, both groups self-reported greater positive emotion and displayed more happy facial expressions in response to the normative stimuli. Although this is contrary to previous work suggesting that idiographic stimuli elicit stronger emotional responses (e.g., Dickerson et al., 2004; Rottenberg et al., 2005), these findings have similar significance insofar as they suggest that results from studies using different types of mood inductions cannot be readily compared.

The second hypothesis was that the BD group would exhibit greater positive emotional reactivity compared to the CTL group across both normative and idiographic stimuli. This hypothesis was partially supported insofar as the BD group exhibited greater HRV – a putative physiological marker of positive emotion – compared to the CTL group across both tasks. This is consistent with prior work reporting associations between HRV or vagal tone and positive mood (Oveis et al., 2009) and associations between increased HRV and bipolar disorder risk (Gruber et al., 2008). However, the BD group did not report greater positive emotion or exhibit more happy facial displays compared with the CTL group. This is contrary to previous findings that positive mood inductions are more effective in individuals with BD compared with controls (Roiser et al., 2009). Together, these findings stress the importance of a multi-method approach for a more comprehensive understanding of emotional reactivity in BD.

4.1. Limitations and future directions

Findings from the present study should be interpreted within the confines of several limitations. First, the impact of the idiographic memories might have been limited because some of the happy memories have been followed by loss or change (i.e., relationship termination). Second, in the BD group, decreased emotional responses to the idiographic relative to the normative induction may be accounted for by impairments in declarative memory (e.g., van Gorp et al., 1999), which may have diminished the clarity with which bipolar participants could recall the autobiographical event, thereby limiting the ability of the task to generate emotion. Another possibility is the fact that the memory task involved inward-focused attention, which may be less emotionally triggering compared to external stimuli in the environment, such as watching a film. Finally, we note that the order of the two procedures was not done in counterbalanced order (though a subset of participants complete the memory task at a separate visit) which may have influenced the obtained results.

Effects of this study must be interpreted cautiously, as sample size was quite small. Power limitations are unlikely to explain the failure to demonstrate more positive affect or positive facial expressions in the BD compared to CTL group. As seen in Table 2, effect sizes were small for non-significant Group Main Effects ($\eta_p^2 < .04$) and Group X Task Interactions ($\eta_p^2 < .08$). If anything, the BD group demonstrated equivalent or diminished reports and expressions of positive emotion after the happy film. After the happy memory, any group differences on affect or expression were quite small.

Despite these limitations, this study represents one of the first glimpses of the relative strength of idiographic vs. normative stimuli. Surprisingly, for both groups, normative stimuli appeared to be more powerful than idiographic. This provides important methodological considerations for future experimental research in positive emotion elicitation. The present study also provides additional insight regarding the profile of positive emotion in BD. Consistent with prior work, people with BD were characterized by elevated vagal tone. Prospective studies are needed to test the extent to which processing of emotional material contributes to the development of symptoms in BD.

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Table 1

Demographic and clinical characteristics of BD and CTL Groups.

	BD	CTL	Statistic
Age	36.68 (11.96)	36.65 (10.65)	F=0.00
Female (%)	74%	62%	χ^2=1.05
Caucasian (%)	65%	77%	χ^2=1.04
Education	15.81 (2.09)	15.58 (2.73)	F=0.13
YMRS	2.76 (2.13)	1.14 (1.29)	F=11.07*
IDS-C	7.68 (3.76)	3.74 (2.61)	F=20.24*

Note: BD = Bipolar disorder group; CTL = Healthy control group; YMRS = Young Mania Rating Scale; IDS-C = Inventory to Diagnose Depression. Mean values are displayed with standard deviations in parentheses where applicable.

* p<.05.

Table 2

Descriptives and effect sizes for emotion responses to happy film and happy memory.

	Raw Mean (M) and Standard Deviations (SD) by group		Effect sizes (η^2_P)		
	BD	**CTL**	**Group Main Effect**	**Task Main Effect**	**Group X Task Interaction**
Happy film					
PA	16.38 (5.11)	16.687(4.84)	–	–	–
NA	6.58 (2.32)	5.35 (0.88)	–	–	–
Happy display	0.72 (1.08)	1.04 (1.00)	–	–	–
Sad display	0.09 (0.48)	0.00 (0.00)	–	–	–
HRV	0.82 (0.41) [b]	0.82 (0.54) [b]	–	–	–
HR	74.81 (13.27)	73.93 (10.57)	–	–	–
SCR	1.09 (1.11)	1.42 (1.28)	–	–	–
Happy Memory					
PA	15.31 (4.21)	15.13 (2.97)	–	–	–
NA	5.85 (1.35)	5.52 (0.79)	–	–	–
Happy display	0.14 (0.37) [a]	0.10 (0.30) [a]	–	–	–
Sad display	0.00 (0.00)	0.00 (0.00)	–	–	–
HRV	1.75 (0.83) [b]	1.43 (0.48) [b]	–	–	–
HR	73.00 (12.49) [b]	75.57 (10.56) [b]	–	–	–
SCR	0.45 (0.94)	0.46 (0.74)	–	–	–
Happy film vs. Happy Memory comparison					
PA	–	–	.00	.09	.00
NA	–	–	.04	.00	.02
Happy display	–	–	.00	.37	.03
Sad display	–	–	.02	.02	.02
HRV	–	–	.11	.05	.08
HR	–	–	.03	.00	.09
SCR	–	–	.00	.03	.04

Note: BD = Bipolar disorder group; CTL = Healthy control group; η_p^2=Partial etq squared effect size estimate. PA = Positive affect; HRV = Heart rate variability; SCR = Skin conductance response rate. PA rated on a 1 (very slightly or not at all) to 5 (extremely) scale, with summed scores for the 5 positive and 5 negative items reported. Facial displays coded on a 1 (very slightly) to 5 (extremely scale), with a score of '0' if no expression was coded.

[a] $p<.05$ for Happy film vs. Happy memory (for all participants).

[b] $p<.05$ for BD vs. CTL group.

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