Personality Disorders: Theory, Research, and Treatment

EEG Asymmetry in Borderline Personality Disorder and Depression Following Rejection

Joseph E. Beeney, Kenneth N. Levy, Lisa M. Gatzke-Kopp, and Michael N. Hallquist

BRIEF REPORT

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Joseph E. Beeney
University of Pittsburgh School of Medicine and
The Pennsylvania State University

Kenneth N. Levy and Lisa M. Gatzke-Kopp
The Pennsylvania State University

Michael N. Hallquist
University of Pittsburgh

Borderline personality disorder (BPD) and major depressive disorder (MDD) share numerous features, including dysphoric affect, irritability, suicidality, and a heightened sensitivity to perceived interpersonal rejection. However, these disorders are associated with divergent profiles of reactivity to rejection: Individuals with MDD are more likely to respond with withdrawal and isolation, and those with BPD appear to respond with increased approach behaviors and greater hostility. Potential mechanisms underlying these divergent patterns of response have not been elaborated. The goal of the present study was to assess whether prefrontal cortical asymmetry is associated with these behavioral profiles. EEG alpha activity was recorded at baseline and after individuals with BPD, MDD and healthy controls (HCs) participated in a rejection task. Although no differences were found at baseline, results demonstrated that following rejection, individuals with BPD showed greater left cortical activation, consistent with approach motivation, whereas those with MDD showed greater right cortical activation, consistent with withdrawal motivation. HCs evidenced a more balanced cortical profile, as hypothesized. Although BPD and MDD are highly comorbid, are easily confused, and are phenomenologically similar in a number of ways, individuals with these two disorders respond in very different ways to perceived rejection.

Keywords: EEG asymmetry, borderline personality disorder, major depressive disorder, social rejection, approach motivation

Sensitivity to social rejection is adaptive when it works to allocate attention to the concerns of others and incorporate external feedback that shapes effective interpersonal behaviors. However, high rejection sensitivity (RS)—a tendency to anxiously expect rejection and readily perceive and overreact to rejection experiences (Downey & Feldman, 1996)—is thought to underlie vulnerability for a number of major psychiatric disorders, such as borderline personality disorder (BPD) and major depressive disorder (MDD). Although the heightened propensity to experience emotional distress in response to perceived rejection extends across both BPD and internalizing disorders such as MDD, these two domains of psychopathology differ markedly with respect to how individuals respond behaviorally to rejection. To date, the mechanisms that underlie this differential behavioral response to a common perceptual experience are poorly understood. Knowing more about the processes that, following rejection, promote hostile and aggressive behavior in BPD, and social withdrawal behavior in MDD,

could better inform therapeutic strategies for reducing these styles of reactivity.

Relation Between BPD and MDD

Symptoms of dysphoric affect, suicidality, irritability, and heightened anxiety are common in both BPD and MDD. The two disorders are highly comorbid (Widiger & Trull, 1993) and, in the absence of structured interviews or specialized training, are often confused (Hillman, Stricker, & Zweig, 1997). Heightened sensitivity to rejection is overrepresented in both populations relative to other forms of psychopathology (Ayduk, Downey, & Kim, 2001; Gunderson, 2007). However, the implications of RS for symptom manifestation differ markedly between MDD and BPD. Whereas individuals with MDD typically respond to interpersonal stressors, such as rejection, by withdrawing and isolating (Slavich, Thornton, Torres, Monroe, & Gotlib, 2009), BPD patients often react with anger and hostility. In response to social rejection, individuals with BPD experience odious affective states, such as aversive arousal and deep distress (Koslov, Mendes, Pajtas, & Pizzagalli, 2011), and these emotions are often followed by problematic behaviors such as aggression (Berenson, Downey, Rafaeli, Coifman, & Paquin, 2011), substance abuse (Kruedelbach, McCormick, Schulz, & Grueneich, 1993), and self-harm or suicidality (Brodsky, Groves, Oquendo, Mann, & Stanley, 2006). The destructive potential of these behaviors has led clinical scientists to focus on the importance of understanding RS in BPD (e.g., Berenson et al., 2011; Lawrence, Chanen, & Allen, 2011; Meyer, Ajchenbrenner, & Bowles, 2005; Selby, Ward, & Joiner, 2010; Staebler et al., 2011).

Evidence suggests that individuals with BPD have a low threshold for detecting social rejection, reporting a greater sense of rejection in an ostracism task, even during conditions in which they were included (Staebler et al., 2011). Furthermore, recent research has suggested that the affective hyperarousal characteristic of BPD is specific to contexts of rejection rather than negative emotional stimuli generally (Limberg, Barnow, Freyberger, & Hamm, 2011).

Motivational Directions of Behavioral Responding

One basic way emotion influences behavior is to motivate an individual toward or away from a stimulus (Coan & Allen, 2004). For instance, fear and sadness are associated with a motivation to withdraw from a stimulus as a mechanism of self-protection (Coan & Allen, 2004). Motivational directions of behavior are not, however, synonymous with affective valence, as both happiness and anger promote approach behaviors, either to engage with a positive stimulus or to actively overcome an obstacle or challenge (e.g., Harmon-Jones, 2003). Frontal electroencephalography (EEG) alpha asymmetry has been employed in the study of motivated behavior for several decades, with extensive research supporting greater left frontal asymmetry as a marker of approach motivation and greater right frontal asymmetry as a marker of withdrawal motivation (Coan & Allen, 2004). Much of the research examining motivational tendencies with regard to psychopathology has focused on the association between greater withdrawal motivation, indicated by greater right frontal asymmetry, among individuals with MDD (Coan & Allen, 2004). To our knowledge, no studies

have assessed EEG frontal asymmetry among participants with BPD. Thus, it is unclear if this population would show a similar resting EEG profile of greater right asymmetry consistent with the tendency of both groups to experience high rates of negative affect defensive behaviors. In contrast to MDD however, BPD *could* be characterized by dysregulated approach motivation and thus should have a greater tendency toward left asymmetry. Among the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association, 2013) criteria for BPD, numerous symptoms are consistent with approach: excessive anger, suicidality, self-harm, substance abuse, binge eating, promiscuous sex, and excessive spending.

Although extensive research has examined the associations between resting EEG asymmetry and predisposition for psychopathology, Coan, Allen, and McKnight (2006) emphasized that assessing an individual's response to specific stressors provides more valid information about individual capability to react to affective challenges that may not be reflected in simple baseline assessments. Thus, EEG asymmetry may better elucidate behavioral tendencies when assessed in response to clinically relevant stimuli.

Rejection and EEG Asymmetry in Healthy Individuals

Extensive research has examined rejection-related brain function (e.g., Eisenberger, Lieberman, & Williams, 2003). However, fewer studies examining response to rejection attempted to elucidate differences in approach and avoidance motivation, which may moderate behavioral reactivity to rejection. The two studies that evaluated frontal asymmetry and rejection in healthy participants support an association between left frontal asymmetry and approach motivation. Peterson and colleagues (Peterson, Gravens, & Harmon-Jones, 2011) found that when individuals were rejected, relatively greater left frontal activation predicted reports of anger. Seemingly in contrast, Koslov and colleagues (Koslov et al., 2011) suggested that greater left frontal cortical activation in response to rejection buffers against threat. However, the authors note their physiological findings (left dorsolateral prefrontal cortex functioning related to increased cardiac output) could also be indicative of a physiological profile supporting anger (Harmon-Jones, 2003). Thus, evidence suggests healthy individuals tend to respond to rejection with no EEG asymmetry, demonstrating a balanced cortical alpha profile. At the same time, greater anger in response to rejection among HCs has been associated with greater approach-related neural activation. No EEG studies to date have evaluated groups marked by heightened RS. However, one study using fMRI provides preliminary support for left frontal activation in participants with BPD in response to an affective challenge. Hooley and colleagues (Hooley et al., 2010) found that BPD patients showed greater left frontal activation in response to comments depicting emotional overinvolvement (compared with neutral comments), suggesting an approach response to negative social stimuli.

In the current study, we explored whether a social rejection challenge—a context relevant to both BPD and MDD—had a differential effect on approach versus avoidance motivation in these groups. Specifically, we expected that individuals with BPD would show greater left frontal EEG asymmetry following social rejection (reflecting heightened approach), whereas those with MDD would have greater right frontal asymmetry postrejection

(reflecting greater avoidance motivation). We further anticipated the comparison group would evidence relatively balanced frontal cortical alpha activity. We anticipated that resting asymmetry would not significantly differentiate the groups from each other, but instead, group differences in EEG asymmetry would be evident after social rejection.

Method

Participants

Participants were 57 (BPD = 23, MDD = 13, HC = 21) right-handed females between the ages of 18 and 60 years (M = 30.78, SD = 9.98). Demographic characteristics are detailed in Table 1. In regard to Axis I comorbidity, among the BPD group, six (25%) had anxiety disorders, two (8%) had posttraumatic stress disorder (PTSD), five (20%) had substance-related disorders, and three (13%) had other disorders (somatoform or eating disorders). Among the MDD group, four (30%) had comorbid anxiety disorders and one (8%) had PTSD. BPD and MDD participants were recruited from a university-based community mental health clinic at The Pennsylvania State University. HC participants were identified among community residents.

Among all participants, individuals were excluded who were left-handed, had a significant medical illness, or who met diagnostic criteria at any point for psychotic disorders, bipolar I, delirium, dementia, history of brain injury, and/or mental retardation. For the BPD group, patients with a depressive episode within the last 6 months were excluded. MDD participants meeting more than two Cluster B personality disorder criteria were also excluded. For the HC group, participants were excluded with current or past Axis I or II diagnoses, as defined in the fourth edition of the *DSM* (text rev.; *DSM-IV-TR*; American Psychiatric Association, 2000), suicidal or self-injurious behaviors, or more than two Cluster B personality disorder criteria.

Table 1
Sample Characteristics

Characteristic	BPD (n = 23)	HC (n = 21)	MDD (n = 13)
Age (years)			
M	31.84	27.78	32.12
SD	9.10	11.74	8.80
Education, n (%)			
High school	8 (35%)	5 (23%)	3 (13%)
Some college	5 (22%)	11 (50%)	2 (15%)
College graduate	8 (35%)	4 (18%)	6 (46%)
Postgraduate	2 (8%)	2 (9%)	2 (15%)
Marital status, n (%)			
Single	13 (57%)	16 (73%)	5 (38%)
Married/cohabiting	4 (17%)	5 (23%)	5 (38%)
Divorced	6 (26%)	1 (5%)	3 (24%)
Ethnicity, n (%)			
Caucasian	17 (74%)	16 (72%)	11 (85%)
African American	5 (22%)	2 (9%)	1 (8%)
Latino/Latina	1 (4%)	1 (5%)	1 (8%)
Asian/Pacific Islander	0 (0%)	3 (14%)	0 (0%)

Note. BPD = borderline personality disorder; HC = healthy control; MDD = major depressive disorder.

Participants were evaluated using the Structural Clinical Interview for DSM–IV (SCID-I; First, Spitzer, & Williams, 1997) and the International Personality Disorder Examination (IPDE; Loranger, Janca, & Sartorius, 1997). Doctoral-level therapists, trained to reliability, conducted the clinical evaluations under the supervision of a licensed psychologist. Final diagnoses were established at an evaluation conference supervised by a licensed psychologist using the LEAD (longitudinal assessment, by expert diagnosticians, using all data) standard (Spitzer, 1983). This method involves using all available data (e.g., intake, treatment reports, clinician chart notes, and diagnostic interview data from the SCID and IPDE) in order to establish a "best estimate" diagnosis (Pilkonis, Heape, Ruddy, & Serrao, 1991). In previous studies, our interrater reliability was good (see Scott, Levy, & Granger, 2013). Kappas (κ) for SCID-I-CV Axis I diagnoses ranged from .64 to 1.0 and Kappas (κ) for IPDE personality disorder diagnoses ranged from .71 to 1.0 (κ = .88 for BPD diagnosis). Intraclass correlation coefficients were .94 for number of BPD criteria met and .98 for BPD dimensional scores.

Research Design

Participants were told that the study was designed to understand how the brain processes basic social interactions. EEG was continuously recorded throughout the experiment. Analyses are only presented from resting periods, consistent with previous research (e.g., Verona, Sadeh, & Curtin, 2009) and to insure analyses were not contaminated by motion artifact. An 8-min baseline was collected while participants sat quietly, alternating between 1-min epochs with eyes open and eyes closed. An additional 2-min epoch, alternating between eyes open and eyes closed, after the ostracism task, was collected.

Following baseline, participants engaged in the Cyberball task (Williams, Cheung, & Choi, 2000). Cyberball has successfully simulated rejection in a number of social psychological and clinical studies (e.g., Eisenberger et al., 2003). Participation in this task consistently heightens social distress and other negative socioemotional factors (Williams, Cheung, & Choi, 2000). Participants were asked to imagine the game as if they were throwing a ball with others in real life. Two avatars and pictures of supposed other participants were presented. An avatar representing the actual participant was presented in the bottom center of the screen with the participant's picture. Participants were told other players were in labs in the same building. The task was programmed so that participants were included for 21 throws, partially excluded for 21 throws (had a 25% chance of being thrown to on each trial), and were excluded for 21 throws.

Participants were carefully debriefed after study completion to assess their belief in the cover story. In addition, participants were asked questions following the rejection task, which subtly probed their beliefs about the task. Answers indicated participants believed the deception (M = 7.60, SD = 1.95 on a scale of 1 to 9) with no group differences in believability (p > .5). One BPD participant indicated she felt the other participants were not real and that she was excluded, which brought the total number of participants to 57.

EEG Data Collection and Analysis

EEG was recorded using a 128-channel electrical Geodesic Sensor Net (Electrical Geodesics, Inc., Eugene, OR) amplified 30,000 times by an EGI Netamps 200 system. Two electrooculogram (EOG) channels were recorded (vertical channels above and below the eye orbit and horizontal at the outer canthi). Data were digitized at 256 Hz. Impedances were kept below 50 K-Ohms. EEG data were acquired online with Cz as a reference site and were later referenced offline to the average of all EEG leads.

EEG was visually scored and edited to remove artifacts due to gross muscle activity and movement. Eyeblinks were removed using independent components analysis (ICA). The data were filtered using high-pass (.1 Hz), low-pass (100 Hz), and notch (60 Hz) filters. Data were segmented into 1-min blocks and further segmented into 1.024-s epochs (overlapped by 50%). Artifact-free epochs were extracted using a Hamming window. Data were subjected to a fast Fourier transform. Power density ($\mu V^2/Hz$) was computed for the alpha band in the range of 8 to 13 Hz. All power density values were natural log transformed in order to normalize the data distribution. Asymmetry scores were calculated by subtracting the natural log-transformed scores (ln[right]-ln[left]) for each of the following homologous left and right pairs: F1/F2, F3/F4, F5/F6, F7/F8, Fp1/Fp2, and abutting frontal electrodes. In total, analyses utilized 11 electrode pairs, representing coverage over most of the frontal lobe. EEG asymmetry studies have assumed alpha activity is the inverse of neural function, and thus invert the difference between right and left alpha activity to derive an EEG asymmetry score. Though this view is currently debated (Bazanova & Vernon, 2013), supporting evidence is available promoting this view as a viable possibility (e.g., Laufs et al., 2003).

Measures

Prior to fitting participants with EEG, they completed a packet of measures assessing depression, aggression, and RS. Participants completed questionnaires regarding positive and negative affect and hostility at baseline and after the rejection task.

Depression. The Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) is widely used as a self-report measure for screening depressive symptoms. Participants use a Likert scale (from 0 to 3) to indicate depression symptom severity in the past 2 weeks. The BDI-II has been used in thousands of studies and substantial evidence exists for its reliability and validity (Beck, Steer, Ball, & Ranieri, 1996).

Trait aggression. Participants self-reported trait aggression using the Buss-Perry Aggression Scale (Buss & Perry, 1992), a 29-item Likert-scale measure. The reliability and validity of this scale has been extensively demonstrated (e.g., Harris, 1997).

State affect. Participants completed the Positive and Negative Affect Schedule – Expanded Form (PANAS-X; Watson & Clark, 1999) at baseline and following the rejection task. All scales have excellent reliability and demonstrated external validity (Watson & Clark, 1999).

RS. Participants were asked to rate the degree of concern and anxiety they would experience in nine hypothetical situations (Adult Rejection Sensitivity Questionnaire; Berenson et al., 2009). Reliability for the measure is good and external validity has been established (Berenson et al., 2009).

Results

Initial analyses compared groups on a number of baseline characteristics in order to examine differences in trait and state variables. In all cases reported, ANOVAs were followed by Tukey's honestly significant difference post hoc tests. EEG asymmetry was defined as the average of the 11 electrode pairs used in other analyses when using the variable in correlation analyses.

Self-Report

Table 1 details group differences on a number of variables. As expected, both the MDD and BPD groups scored higher on self-reported RS. In addition, individuals with BPD scored higher on self-report of trait anger.

To examine whether emotional reactivity was related to EEG asymmetry postrejection, correlations were computed with the entire sample. Self-reported hostility postrejection was associated with greater leftward asymmetry postrejection, $r(56) = .29$, $p < .05$. Baseline or postrejection EEG asymmetry was not associated with self-report of positive or negative emotion. Greater leftward EEG asymmetry at baseline and postrejection was associated with trait hostility reported on the Buss-Perry Aggression Questionnaire, $r(56) = .44$, $p < .001$, and $r(56) = .36$, $p < 001$, respectively.

Emotional Reactivity to the Rejection Task

To determine group differences in self-report of emotion, linear mixed-effects models were run on self-reports of negative affect, positive affect, and hostility scales from the PANAS-X across the two tasks (see Table 2). No group differences emerged for positive affect, though an effect of condition was present, with lower positive affect reported postrejection compared with baseline, $F(1, 54) = 15.59$, $p < .001$. Negative affect was different between groups $F(2, 54) = 5.41$, $p < .05$, and between conditions, $F(1, 54) = 5.94$, $p < .05$. Pairwise comparisons revealed that negative affect across all three groups decreased following rejection, $p < .05$, although, as expected, both clinical groups reported more negative affect compared with the HC group, $p < .005$, and did not differ from one another. There was an additional main effect of group for self-reported hostility, $F(1, 54) = 4.88$, $p > .05$. Again, the MDD and BPD groups reported more hostility compared with the HC group, but did not differ from one another. There was no effect of condition on hostility.

EEG Asymmetry

A factorial mixed linear model (Bosker & Snijders, 1999) was used to test the effects of group, electrode location, and condition on frontal EEG asymmetry. Group (HC, BPD, MDD) was a between subject variable, and condition (baseline or postrejection) and electrode location (medial or lateral) were within-subject variables. The dependent variable was frontal EEG asymmetry score from 11 frontal electrode pairs (including F4-F3, F8-F7, and abutting electrodes, representing coverage over the medial and dorsolateral frontal lobe), based on total 8- to 13-Hz alpha power.

Our key hypotheses focused on group differences in EEG asymmetry, particularly after rejection. Main effects manifested for both group, $F(2, 1253) = 48.15$, $p < .001$, $\eta_G^2 = .07$, and condition,

Table 2
Group Differences in Depression Symptoms, Rejection Sensitivity, Trait Aggression and State Emotions

Measure	BPD		HC		MDD	
	M	*SD*	*M*	*SD*	*M*	*SD*
BDI-II total	17.75*	11.12	2.87	2.78	18.5*	9.42
ARSQ	12.79*	5.65	7.93	3.51	11.19*	4.6
Buss-Perry Aggression	3.18**	0.75	2.28	0.48	2.24	0.62
PANAS-NA (Baseline)	17.27*	9.22	11.5	2.06	15.71*	8.42
PANAS-NA (Postrejection)	14.86*	6.63	10.7	4.71	14.00*	7.48
PANAS-PA (Baseline)	23.96	7.56	26.85	7.05	23.75	4.31
PANAS-PA (Postrejection)	20.52	8.58	21.65	10.79	19.58	7.91
PANAS-H (Baseline)	9.57*	5.14	6.25	.55	10.69*	5.39
PANAS-H (Postrejection)	9.65*	6.39	6.70	3.39	7.30*	3.71

Note. BPD = borderline personality disorder; HC = healthy control; MDD = major depressive disorder; BDI = Beck Depression Inventory; ARSQ = Adult Rejection Sensitivity Questionnaire; PANAS = Positive Affect and Negative Affect Scale; NA = negative affect; PA = positive affect; H = hostility.
* $p < .05$ compared with HC group. ** $p < .05$ compared with MDD and HC group.

$F(1, 1253) = 8.66$, $p = .003$, $\eta_G^2 = .007$. These main effects were qualified by a Group $\times$ Condition interaction, $F(2, 1253) = 12.82$, $p < .001$, $\eta_G^2 = .03$. Additional factorial mixed models run for baseline and postrejection conditions revealed that both the HC and BPD groups differed from the MDD group at baseline, $F(2, 624) = 6.80$, $p = .001$, but did not differ from each other. Qualitatively, both the BPD and HC groups showed left frontal asymmetry at baseline, whereas the MDD group showed slight right asymmetry (see Figure 1; more positive values signify greater left frontal activation). Following rejection, all groups differed, $F(2, 624) = 52.82$, $p < .001$, $\eta_G^2 = .19$; all pairwise comparisons, $p < .001$. The BPD group showed strong left frontal asymmetry after rejection, whereas the HC group evidenced slight left frontal asymmetry following rejection, and the MDD group had strong right frontal asymmetry following rejection (see Figure 1).
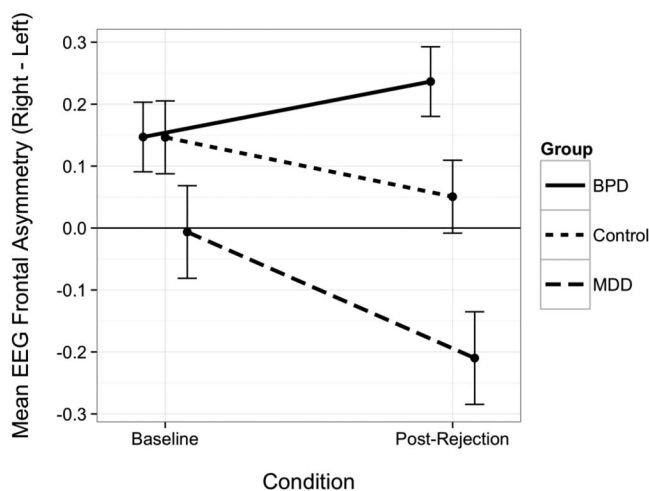

Figure 1. Group means for EEG asymmetry for baseline and postrejection. All groups differed from one another postrejection, but none significantly differed at baseline. Error bars denote the standard error of the mean. BPD = borderline personality disorder; HC = healthy control; MDD = major depressive disorder.

In order to determine the within-group effect of the rejection task on EEG asymmetry, linear contrasts of baseline versus postrejection were conducted. The significance of these contrasts was adjusted to maintain a Type I familywise error rate of .05 (using the method of Hothorn, Bretz, & Westfall, 2008). For all groups, EEG asymmetry changed significantly between baseline and postrejection, though the direction of change was different for the BPD group compared with the HC and MDD groups (HC: z = −3.26, $p = .003$, $d = −.51$; BPD: z = 2.78, $p = .02$, $d = .29$; MDD: z = −5.10, $p < .001$, $d = −.48$). Whereas asymmetry shifted toward more balanced cortical alpha activity in the HC group, and toward right frontal asymmetry in the MDD group, it shifted toward the left hemisphere in the BPD group.

Unrelated to the main hypotheses, a main effect of electrode location emerged, $F(1, 1253) = 13.13$, $p < .001$, $\eta_G^2 = .01$. Overall, medial electrode pairs tended toward greater leftward asymmetry. This effect was qualified by a Group $\times$ Location interaction, $F(2, 1253) = 3.93$, $p = .020$, $\eta_G^2 = .01$. Additional mixed models run for each group revealed significant differences between medial and lateral electrodes for both the HC and MDD groups, but not the BPD group. These electrode location effects were small, however. These results were almost identical when comparing all electrodes versus only lateral electrodes, causing us to retain the larger array.

Discussion

The role of approach and withdrawal motivation, indexed by EEG asymmetry, was examined as a potential mechanism by which two groups characterized by greater RS are also characterized by different maladaptive reactions to rejection. Our primary prediction was that in response to rejection, individuals with BPD would evidence greater left frontal EEG asymmetry, reflecting approach motivation, whereas individuals with MDD would evidence greater right frontal asymmetry, reflecting withdrawal tendencies. EEG asymmetry measures supported the proposition that motivational direction differentiates responses to rejection in BPD and MDD. Importantly, greater leftward asymmetry after rejection was associated with greater trait and state hostility.

In line with previous findings, the MDD group did show greater resting right asymmetry at the pretask baseline, and differed significantly from both the nonpsychiatric comparisons and the group with BPD. Interestingly, individuals with BPD did not show a different pattern of resting EEG asymmetry at baseline compared with nonpsychiatric controls, suggesting that heightened RS shared between these two diagnostic groups is not associated with the biomarker of resting right asymmetry that has been frequently reported for individuals with MDD (e.g., Stewart, Bismark, Towers, Coan, & Allen, 2010).

However, evidence for group differences in EEG asymmetry was found following a salient stressor. Postrejection, all three groups demonstrated change in asymmetry, consistent with the capability model that proposes that psychophysiological indices are maximally valid when assessed in theoretically grounded contexts (Coan et al., 2006). As predicted, the BPD group showed greater left asymmetry postrejection, whereas the MDD group showed greater right asymmetry. The HC group moved toward balance in terms of cortical alpha. Researchers have consistently found that sadness and depression are associated with relatively higher right frontal activation (e.g., Stewart et al., 2010). Depressed patients are likely to turn inward in response to social stress, personalize it, and withdrawal behaviorally (Nezlek, Kowalski, Leary, Blevins, & Holgate, 1997). In contrast, BPD patients tend to become angry in response to rejection (Berenson et al., 2011), a state supported by approach motivation (Harmon-Jones, 2003).

In addition to the general withdrawal and approach tendencies of these clinical groups, there is some indication in the literature of support for approach-oriented tendencies in BPD and withdrawal tendencies among individuals with MDD, specifically following rejection (Berenson et al., 2011; Selby et al., 2010). However, the current study is the first to test this hypothesis with EEG asymmetry as a biomarker for these motivational dispositions. The groups diverged in terms of EEG asymmetry, suggesting divergence in approach and withdrawal motivation following rejection, consistent with differences found in trait hostility between the two groups. For the BPD group, the finding of an approach orientation following rejection helps organize and explain a great number of behaviors characteristic of the disorder. Furthermore, this may be a useful biomarker to employ in treatment outcome research to examine the effects of clinical strategies aimed at engaging in different motivational tendencies (e.g., inhibition, withdrawal, cautious approach). These results also suggest that clinical strategies for individuals with MDD may involve promoting approach behaviors following rejection. This recommendation is consistent with the literature supporting behavioral activation as a useful treatment for depression (Lejuez, Hopko, & Hopko, 2001). Additionally, facilitating approach behaviors allows for the possibility of expression of feelings, repairs, and/or new interpersonal successes that are not possible with withdrawal. In contrast, our findings suggest that, for those with BPD, the clinical need is to inhibit additional harm to the relationship by inhibiting destructive approach behaviors (e.g., stalking, hostility) and allow for the possibility of repair and relationship successes.

Both the MDD group and the HC group evidence a rightward shift of comparable effect size in EEG asymmetry following rejection. However, where the two groups end up in terms of EEG asymmetry following rejection is clearly distinct and reflective of

much different motivational tendencies. Consistent with accounts of healthy reactions to rejection as taking the form of cautious approach (Maner, DeWall, Baumeister, & Schaller, 2007), the HC group shows a slight left frontal asymmetry after the rejection task. The neural state of the MDD group, however, is strongly right frontal following rejection, indicative of withdrawal. Thus, though both groups change in the same direction and magnitude in terms of EEG asymmetry postrejection, they follow rejection with different motivational states—states likely to promote discrepant behaviors.

Our finding that individuals with BPD evidenced asymmetry differences in response to rejection is also consistent with research suggesting that rejection is particularly difficult for individuals with BPD (e.g., Berenson et al., 2011; Limberg et al., 2011). The current findings extend this literature, suggesting that rejection prompts a motivational state in BPD with the potential to support various approach behaviors that, accompanied by severe negative affect, are more likely to be expressed in aggressive, impulsive, and generally maladaptive ways. The findings that each group evidences neural changes in response to rejection may suggest that the emotional challenge of rejection is similar for each group, whereas the method of dealing with the challenge is distinct. Brain imaging studies detail how rejection tends to activate brain areas related to processing physical pain, even in healthy individuals (Eisenberger et al., 2003). Although social pain is distressing to most people, individuals differ in their capacity and style of coping with this pain. Perhaps speaking to this issue, we did not find a relationship between RS and the absolute value of EEG asymmetry. Though both clinical groups reported greater RS and imbalanced asymmetry profiles compared with the HC group, RS has not related to more unbalanced asymmetry, despite being correlated to indices of anger and hostility. This finding was unexpected and may suggest that reactions to rejection are distinct from self-report of RS. However, further research using physiological measures is needed to determine whether BPD is associated greater reactivity to rejection or simply a more maladaptive emotional response.

BPD participants did not self-report greater hostility following rejection, contrary to our hypothesis. Both the BPD and MDD groups reported more hostility overall compared with the HC group. In addition, participants reported lower positive affect and negative affect following rejection, though the clinical groups reported more negative affect overall. However, self-report of emotion may be problematic in this context, given reports that BPD is characterized by difficulties reading emotions in oneself and others (for review, see Domes, Schulze, & Herpertz, 2009). Physiological measures may be particularly useful in assessing covert processes that are difficult to assess with self-report.

Several studies appear to have had similar difficulty detecting group differences based on self-report. Comparable with our study, following rejection, Lawrence and colleagues (Lawrence et al., 2011) found no difference in the pattern of emotional responding between a BPD and HC group on self-report of 13 mood states, though the BPD group reported more intense emotions. These results are broadly consistent with the present results. No differences were found in the pattern of responding between groups, only differences in intensity. Using socioemotional self-report metrics, Staebler and colleagues (Staebler et al., 2011) found BPD participants reported fewer positive emotions and more self-

focused negative emotions overall compared with controls, but not as a function of the rejection condition. Other-focused negative emotions, however, increased as a function of condition for the BPD group only. These findings may suggest that the use of socioemotional metrics may be more sensitive in detecting emotional responses in BPD. Asking about a target of anger may be more appropriate than querying about general hostility in this context. In addition, though a decrease in negative affect may appear odd following rejection, a meta-analysis (Blackhart, Nelson, Knowles, & Baumeister, 2009) revealed that rejection is characteristically followed by both low positive and negative affect. Thus, the lack of group differentiation in self-report of emotion is consistent with research using similar metrics, whereas group differences may have been more evident if queries focused on feelings about others, rather than on internal experience.

This study has a number of strengths. First, methods were utilized that provided balance between ecological validity and laboratory control. Second, two clinical groups were included. The inclusion of a patient control allowed for comparison with past research and control in terms patient status, negative affect, and RS, allowing us to uncover some specificity in motivational direction between the groups. Third, using diagnostic interviews insured that all participants were well defined, including the HC group.

Still, some limitations deserve consideration. Results should be appraised in the context of the limited sample size of our MDD group. More research including larger samples of MDD patients would be helpful in verifying these findings. However, despite a smaller sample size, our results are consistent with previous research on MDD and EEG asymmetry. Our sample included only women and, as a result, may not generalize to men. The inclusion of only women participants was because previous recruiting efforts yielded only 10% men, making analyses of differential affects among men and women likely unhelpful.

Conclusions

Although BPD and MDD are highly comorbid, are easily confused, and are phenomenologically similar in a number of ways, most centrally in terms of sensitivity to rejection, individuals with these two disorders respond in very different ways to perceived rejection. The present research demonstrated that these two groups differed in frontal EEG asymmetry following rejection, which likely reflects differences in approach and withdrawal motivation. These findings open up questions about the influence of motivation in response to social stresses such as rejection among individuals with BPD and MDD, including what contexts may prompt approach or withdrawal motivation.

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