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Electrocortical Reactivity During Self-referential Processing in Female Youth With Borderline Personality Disorder

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ABSTRACT

BACKGROUND: Borderline personality disorder (BPD) is debilitating, and theoretical models have postulated that cognitive-affective biases contribute to the onset and maintenance of BPD symptoms. Despite advances, our understanding of BPD pathophysiology in youth is limited. The present study used event-related potentials (ERPs) to identify cognitive-affective processes that underlie negative self-referential processing in BPD youth.

METHODS: Healthy females (n = 33) and females with BPD (n = 26) 13 to 22 years of age completed a self-referential encoding task while 128-channel electroencephalography data were recorded to examine early (i.e., P1 and P2) and late (late positive potential [LPP]) ERP components. Whole-brain standardized low-resolution electromagnetic tomography explored intracortical sources underlying significant scalp ERP effects.

RESULTS: Compared to healthy females, participants with BPD endorsed, recalled, and recognized fewer positive and more negative words. Moreover, unlike the healthy group, females with BPD had faster reaction times to endorse negative versus positive words. In the scalp ERP analyses, the BPD group had greater P2 and late LPP positivity to negative as opposed to positive words. For P2 and late LPP, whole-brain standardized low-resolution electromagnetic tomography analyses suggested that females with BPD overrecruit frontolimbic circuitry in response to negative stimuli.

CONCLUSIONS: Collectively, these findings show that females with BPD process negative self-relevant information differently than healthy females. Clinical implications and future directions are discussed.

Keywords: Borderline personality disorder, LPP, P1, P2, Self-referential processing, sLORETA

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The prevalence of borderline personality disorder (BPD) in adolescent community samples is approximately 1% (1–3). However, between 11% to 27% of outpatients (4,5) and 43% to 49% of inpatients (6) are believed to meet the diagnostic criteria for BPD during adolescence and young adulthood. Although BPD is more frequently diagnosed in females than males (7,8), epidemiologic data suggest that the lifetime prevalence of BPD among women and men is comparable (9). BPD in youth is characterized by greater nonsuicidal self-injury (10,11), and BPD severity has been found to predict suicide attempts (12). Although BPD has profound psychosocial and emotional consequences throughout the lifespan, research probing cognitive-affective processes underlying BPD in youth is limited.

Theoretical models in adult populations have postulated that cognitive biases contribute to the onset and maintenance of BPD symptoms (13–15), and these biases are particularly potent when processing negative self-relevant information. Indeed, BPD is marked by greater self-criticism (16), increased rejection sensitivity (17), more persistent shame (18), and negative emotion processing biases (19). Recently, Winter *et al.* (20) found that during a self-referential encoding task (SRET), adults with BPD judged positive and neutral self-relevant words as being more negative, and these negative self-referential processing biases—the tendency to appraise negative content as being related to one's own person—were correlated with a more dysfunctional attributional style. Converging evidence from neuroimaging studies has shown that BPD is characterized by potentiated activation to negative emotional information in paralimbic regions (21,22). To date, the majority of BPD research testing cognitive biases generally (and self-referential processing biases specifically) has been conducted in adults. Therefore, it is important to test whether self-referential processing biases are present in youth with BPD and to explore potential pathophysiologic mechanisms that may underlie these biases.

Event-related potentials (ERPs), which provide temporal resolution in the millisecond range, can offer a unique tool for probing brain mechanisms underlying self-referential biases. Early ERP components, such as the P1 and P2, are believed to reflect automatic processes, particularly to salient emotional information (23,24). The P1 (~100–200 ms post-stimulus) and P2 (~200–300 ms poststimulus) are maximal over parieto-occipital sites, and research has shown that there

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is differential activity after negative versus positive words among depressed individuals for the P1 (25) and P2 (26) components. These early effects suggest that lexical processing of emotional information occurs rapidly, and importantly, that these components are modulated by word valence (27–30).

The late positive potential (LPP), a slow-wave ERP component spanning several hundred milliseconds to seconds (31,32), indexes sustained engagement with emotional stimuli, including words (26,33) and images (34,35). Initially, the LPP is maximal over centroparietal sites (i.e., early LPP), but it also is evident in frontocentral sites later in the temporal course of the component (i.e., late LPP) (36). The frontal propagation may be particularly relevant to the current study in light of neuroimaging research implicating prefrontal cortex abnormalities during negative self-referential processing in patients with depression (25,37) and BPD (21,22,38,39). There is functional overlap between the early and late LPP; early LPP reflects encoding, retrieval, and processing of emotional information (40), and late LPP is thought to be more closely associated with memory storage and affective encoding (41).

Previous research testing self-referential processing biases in youth has primarily been examined in the context of depression (25,42–44). As a whole, this research has shown that compared to healthy adolescents, depressed youth are more likely to endorse and recall negative self-relevant information. In addition, depressed youth have a faster reaction time (RT) when endorsing negative self-relevant words and a slower RT during endorsement of positive words. Capitalizing on the time resolution of ERPs, Auerbach *et al.* (25) examined depressotypic self-referential processing biases by evaluating ERP components. When probing the P1, which reflects semantic monitoring of emotional information (23,45), depressed youth had greater P1 amplitudes after negative words, and greater P1 positivity to negative words was correlated with greater self-criticism and a more depressogenic self-view. For the LPP, depressed youth showed sustained positivity for negative versus positive words, and healthy youth showed the opposite effect. Collectively, these findings suggest that ERP activity may reinforce and intensify debilitating symptoms. Earlier findings highlighted shared clinical, etiologic, and pathophysiologic features between depression and BPD (17,46), and we hypothesized that similar findings would emerge when testing ERP components in youths with BPD.

Although BPD is characterized by a negative evaluation bias, research investigating behavioral and neural mechanisms underlying these deficits in youths with BPD is sparse. Therefore, the goal of this study is to identify pathophysiologic mechanisms that differentiate healthy and BPD female youth. BPD is more readily diagnosed in females relative to males (1,47), and we therefore focused on female youth in this initial study and tested the following hypotheses. First, in line with past research in adults with BPD (20), relative to healthy female youth, BPD participants will endorse, recall, and recognize more negative and fewer positive self-relevant words during an SRET. Moreover, BPD youth will have a faster RT to negative words and slower RT to positive words. Second, compared to healthy youth, those with BPD will show greater P1 and P2 positivity to negative versus positive words. Similarly, the BPD group also will show sustained positivity to negative versus positive words in the early and late LPP. Finally, standardized low-resolution electromagnetic tomography (sLORETA) whole-brain analyses were used to evaluate the potential intracortical contributors of significant scalp findings. In light of earlier neuroimaging evidence (22), we hypothesized that scans of females with BPD would be characterized by paralimbic hyperresponsiveness to negative self-referential stimuli.

METHODS AND MATERIALS

Participants

Our sample included female youths (healthy controls [HCs] = 33; females with BPD = 26) 13 to 22 years of age. Demographic and clinical characteristics are presented in Tables 1 and 2. The HC and BPD participants did not differ in terms of age or race. However, BPD youth reported a higher family income; as a result, family income was included as a covariate in all analyses. No healthy female participants used psychiatric medications, but females with BPD reported the following medication use: 1) 69.2% (n = 18) antidepressants (e.g., selective serotonin reuptake inhibitors and serotonin–norepinephrine reuptake inhibitors); 2) 57.7% (n = 15) atypical antipsychotics; 3) 34.6% (n = 9) mood stabilizers; 4) 19.2% (n = 5) atypical antidepressants; 5) 19.2% (n = 5) benzodiazepines; 6) 11.5% (n = 3) stimulants; and 7) 7.7% (n = 2) naltrexone. Of the original 59 participants, electroencephalography (EEG) data from 3 HCs were excluded because of poor quality of the data. The complete sample was used for behavioral analyses (HC = 33, BPD = 26).

Procedure

The Partners Institutional Review Board provided approval for the study. Assent was obtained from females 13 to 17 years of age, and signed consent was provided by participants ≥18 years of age and from the legal guardians of all minors. HCs were recruited from the community, whereas BPD participants were recruited through an intensive Dialectical Behavior Therapy (DBT) clinical program. Inclusion criteria included English fluency, female, and right-handedness. Exclusion criteria for the HCs included any history of psychiatric illness, psychotropic medication use, organic brain syndrome, neurologic disorders, or seizures. BPD participants had the same exclusion criteria with the exception of psychiatric history and psychotropic medication use. The study procedures were completed over 2 separate days. On the first study visit, participants were administered diagnostic interviews probing Axis I and II psychopathology and completed self-report instruments regarding symptom severity. During the second study visit, EEG data were acquired while participants completed an SRET. The majority of study visits were completed within the same week (mean, 3.51 days [standard deviation, 4.09]), and participants were remunerated $50.

Instruments

Diagnostic Assessments. Participants were administered clinical interviews by bachelor's-level research assistants,