



Face and gaze perception in borderline personality disorder: An electrical neuroimaging study

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ABSTRACT

Humans are sensitive to gaze direction from early life, and gaze has social and affective values. Borderline personality disorder (BPD) is a clinical condition characterized by emotional dysregulation and enhanced sensitivity to affective and social cues.

In this study we wanted to investigate the temporal-spatial dynamics of spontaneous gaze processing in BPD. We used a 2-back-working-memory task, in which neutral faces with direct and averted gaze were presented. Gaze was used as an emotional modulator of event-related-potentials to faces. High density EEG data were acquired in 19 females with BPD and 19 healthy women, and analyzed with a spatio-temporal microstates analysis approach.

Independently of gaze direction, BPD patients showed altered N170 and P200 topographies for neutral faces. Source localization revealed that the anterior cingulate and other prefrontal regions were abnormally activated during the N170 component related to face encoding, while middle temporal deactivations were observed during the P200 component. Post-task affective ratings showed that BPD patients had difficulty to disambiguate neutral gaze.

This study provides first evidence for an early neural bias toward neutral faces in BPD independent of gaze direction and also suggests the importance of considering basic aspects of social cognition in identifying biological risk factors of BPD.

1. Introduction

Borderline personality disorder (BPD) is a mental illness characterized by emotional dysregulation and impaired social relationships. Affective dysregulation might be the consequence of an interaction between early life adversities and an inherited enhanced sensitivity to affective and social cues (Carpenter and Trull, 2013; Crowell et al., 2009; Gunderson and Lyons-Ruth, 2008; Linehan, 1993; Linehan and Wilks, 2015).

Several studies have found that BPD patients show a negative emotional bias in face recognition (Mitchell et al., 2014). Interestingly, the substantial impairment in identifying facial emotions is most pronounced during neutral face processing (Domes et al., 2008; Donegan et al., 2003; Dyck et al., 2009; Meyer et al., 2004; Mitchell et al., 2014;

Silbersweig et al., 2007). BPD patients exhibit a negativity bias in the appraisal of faces depicting neutral expressions (Domes et al., 2009); some studies, for example, demonstrated that they are inclined to identify anger (Domes et al., 2008), and fear (Wagner and Linehan, 1999) emotions. Functional magnetic resonance imaging (fMRI) studies indicate abnormal activation to neutral faces in the amygdala, and the anterior cingulate (Donegan et al., 2003; Minzenberg et al., 2007; Soloff et al., 2017).

Gaze direction conveys information about the emotional expression of a face (Itier and Batty, 2009) and humans are sensitive to it from birth (Farroni et al., 2002). Direct gaze prompts social stimulus processing (Mares et al., 2016; Senju and Johnson, 2009) and increases the perception of approach-related affective states such as anger and joy, while averted gaze increases the perception of avoidance-related

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affective states such as fear and sadness (Adams and Kleck, 2005, 2003). Some studies indicate that BPD patients judge the affective information conveyed by gaze differently than controls. These studies used the 'Reading Mind in the Eyes' test (RMET), in which subjects select the affective state that best describes the picture of the eyes presented (Baron-Cohen et al., 2001). A study by Fertuck et al. (2009) showed that BPD patients, relative to healthy subjects, have an increased ability to discriminate mental states based on the eye regions. This enhanced sensitivity has been proposed to be a precursor of their social impairments. However, Scott et al. (2011) showed that high BPD traits in healthy participants are associated with a negative bias to judge positive and neutral eyes in the RMET test. Evidence of abnormal gaze interactions comes also from behavioral studies that have investigated infants and mothers with BPD interactions (Apter et al., 2016; Crandell et al., 2003). On the other hand, Preißler et al. (2010) did not find any difference in the RMET scores between BPD patients and controls. Thus, while the negative bias in face perception of BPD patients is well established, it remains open whether this bias is related to a misinterpretation of the emotional expression conveyed by the gaze. The affective properties of direct and averted gaze have not been investigated systematically in BPD, and nothing is known about the brain correlates of gaze perception in this population.

Event-related potential (ERP) studies regarding face processing in BPD are sparse. The P100 is an early component mainly generated in visual areas associated with a posterior positive voltage distribution (Di Russo et al., 2002; Pascual-Marqui et al., 1994; Seki et al., 1996). Some studies reported modulation of this component by emotional stimuli (Pizzagalli et al., 1999; Pourtois et al., 2004). The N170 is a face-specific ERP component and is supposed to reflect the structural encoding of faces (Bentin et al., 1996). During facial emotion processing, Izurieta Hidalgo et al., (2016) found enhanced P100 amplitudes and reduced N170 amplitudes in BPD subjects. In a magnetoencephalography study by Merkl et al. (2010), BPD patients have reduced amplitude of the M170 (i.e., the N170 homologous component).

Affective impairments in BPD may be the result of an inability to control negative emotions (Perez et al., 2016; Silbersweig et al., 2007; Soloff et al., 2015). Working Memory (WM) load has a regulatory influence on emotional processing (Erk et al., 2007; Van Dillen et al., 2009). Many studies have described lower P300 amplitudes during action monitoring in patients with BPD (de Bruijn et al., 2006; Houston et al., 2005; Patrick, 2008; Ruchow et al., 2008), and it has been proposed that this suppression may reflect impulsivity and externalized symptoms in BPD (de Bruijn et al., 2006; Houston et al., 2005; Izurieta Hidalgo et al., 2016; Ruchow et al., 2006). However, it remains largely unclear whether social cue processing, such as gaze direction, may affect cognitive control at this latency.

In this study, we aimed to investigate the temporal dynamics of spontaneous gaze processing in BPD patients, and the influence of gaze perception on cognitive control. Gaze direction has emotional significance in faces with a neutral expression (Adams and Kleck, 2005), and BPD patients might be specifically sensitive to neutral faces (see Mitchell et al., 2014). Since emotional arousal has been proposed to impair cognitive control in BPD (Fertuck et al., 2009; Hurlmann et al., 2007; Skodol et al., 2002), we aimed to investigate the influence of gaze perception on WM. For this purpose, we used a 2-back WM paradigm, in which neutral faces with direct and averted gaze were presented (Berchio et al., 2016). High temporal resolution ERP data were acquired during the 2-back WM task, and to investigate the temporal properties of face perception in BD we used a spatio-temporal microstates approach (Michel and Murray, 2012).

2. Methods

2.1. Participants

Thirty-eight female participants took part in the study: 19 patients

Table 1

Demographic and clinical features of the two study groups.

Characteristics	Control participants (n = 19)	Patients with BPD (n = 19)	t value	p value
Age: M, SD	25 (5.38)	23.4 (6.0)	0.881	0.383
Gender: male, n	19	19	–	–
Handedness: right, n	18	19	χ^2	0.234
^a Education: M, SD	2.4 (0.60)	2.4 (0.59)	χ^2	0.984
University studies	9	9		
High school	9	9		
Working Memory (digit span): M, SD	9.66 (2.06)	8.891 (1.53)	–1.297	0.202
MADRS: M, SD	1.67 (2.38)	9.055 (5.50)	5.381	0.000
STAI-state: M, SD	26.45(10.89)	54.22 (12.06)	7.544	0.000
STAI-trait: M, SD	29.66 (11.30)	59.83 (7.33)	9.967	0.000
CTQ:				
Total score: M, SD	37.47 (19.08)	61.76(17.31)	4.100	0.000
Emotional Abuse: M, SD	6.65 (5.09)	17.16(5.14)	6.330	0.000
Physical Abuse: M, SD	5.59 (4.75)	9.05(4.22)	2.378	0.022
Sexual Abuse: M, SD	5.70 (4.97)	10.41(5.74)	2.699	0.010
Emotional Neglect: M, SD	12.52 (7.54)	14.22(5.75)	0.777	0.441
Physical Neglect: M, SD	7.00 (3.43)	9.55(3.73)	2.197	0.034

MADRS = Montgomery-Asberg Depression Rating Scale.

CTQ = Childhood Trauma Questionnaire.

^a Education levels were classified into three groups: 3 = university studies; 2 = high school; 1 = no high school.

diagnosed with BPD, according to the DSM-IV-R criteria, and 19 healthy controls. The mean age was 25.0 years ($SD = 5.385$) in the BPD group and 23.4 years ($SD = 6.001$) in the healthy control group. WM function was assessed with the digit memory span Wechsler sub-scale (Wechsler, 1997).

The two groups were matched in laterality, educational level, age, and WM digit span. Demographic and clinical characteristics are presented in Table 1.

Of the original 38 participants, two subjects were excluded (one BPD patient and one control) because of poor quality of the data. The complete sample was used only for the behavioral analyses (performance and affective rating).

All participants provided written informed consent, and the study was approved by the local ethical committee of the Geneva University Hospital.

2.2. Clinical assessment and symptom severity

BPD diagnosis as well as severity was assessed by the French version of the Structured Clinical Interview for DSM-IV Axis II Disorders BPD part (BPD severity index: $M: 6.777$, $SD = 1.506$). In addition, participants completed the State-Trait Anxiety Inventory (Spielberger, 1983). Depression was determined using the Hamilton Depression Rating Scale (Montgomery and Asberg, 1979). Participants were also assessed for history of childhood trauma (Childhood Trauma Questionnaire -CTQ- (Bernstein and Fink, 1998)). Groups differed in anxiety and depression scores. BPD patients reported more traumatic childhood experiences than controls (see Table 1). Affective disorders, schizophrenia, and related conditions in BPD patients and controls were assessed using the French version of the Diagnostic Interview for Genetic Studies (DIGS) (Preisig et al., 1999). BPD patients were free of any current axis 1 diagnoses, and current comorbidities included: eating disorders ($n = 7$), post-traumatic stress disorder ($n = 9$), anxiety disorder ($n = 3$), and attention-deficit-hyperactivity disorder ($n = 3$).

Healthy control subjects had no history of psychiatric illness as also assessed with the DIGS, and had not taken medications or substances by their own report.

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