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Enhanced Detection of Emotional Facial Expressions in Borderline Personality Disorder

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Key Words

Borderline personality disorder · Emotion recognition · Faces · Labeling · Sensitivity

Abstract

Background: Borderline personality disorder (BPD) is commonly proposed to be characterized by an enhanced sensitivity for emotional stimuli. In the present study, we investigated whether BPD patients show a superior detection of emotional facial expressions relative to healthy controls. The detection of emotional information in the environment represents an important facet of emotional sensitivity. ***Sampling and Methods:*** Twenty patients with BPD were compared with 25 healthy controls. The participants were presented a rapid, continuous stream of neutral and randomly inserted emotional facial expressions and were asked to report the presentation of an emotional facial stimulus after each trial. Availability of cognitive resources was manipulated via two different task demands. ***Results:*** The participants with BPD performed significantly better in the detection of positive and negative facial expressions compared to the healthy controls. False alarm rates did not differ significantly between the two groups. ***Conclusions:*** The BPD participants showed an enhanced detection of emotional expressions that might be related to the emotional disturbances they experience. In particular, we will discuss the role of this superior emotion detection (in combination with previously reported deficits in the labeling of emotional states) for the understanding of emotional instability in BPD.

Introduction

Borderline personality disorder (BPD) is a severe mental disorder which affects approximately 2% of the general population in western societies [1, 2], with emotional instability being the most frequent and stable diagnostic criterion [3–5]. Thus, emotional instability is widely accepted to be 'at the core of borderline pathology' [6, p. 372] and was additionally shown to be directly related to many aspects of BPD psychopathology such as self-injurious behavior [7, 8], interpersonal problems, identity disturbances or feelings of chronic emptiness [9, 10].

Theoretical conceptualizations of BPD proposed three factors to underlie emotional instability: enhanced emotional sensitivity, stronger emotional responding and im-

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pairments in the ability to regulate negative emotions [11]. Studies available up to now provided evidence for more extreme emotional reactivity [12–16] as well as for deficits in the cognitive regulation of aversive emotions [17, 18]. With regard to emotional sensitivity, first experimental results by Frank and Hoffman [19] reinforced clinical observations that suggested BPD patients perceive emotional states in others more accurately [20]. Follow-up studies, in contrast, demonstrated either unaltered recognition of emotional states [21–23] or impairments in the accurate perception of emotions [24–29]. It needs to be stated that two studies also reported enhanced emotion recognition capabilities in BPD [30, 31]; however, subsequent studies using similar paradigms failed to replicate these results [21, 28, 32]. Impairments in the recognition of emotions were particularly evident when patients with BPD had to integrate facial and prosodic information [33], or were required to rapidly discriminate facial expressions [34]. Thus, in contrast to initial assumptions, most studies in BPD suggest decreased accuracy in the recognition of emotions. These alterations in the recognition and perception of social signals, along with biases to evaluate others more negatively and aggressively [35, 36] and a tendency to perceive facial expressions as more negative [21, 37, 38], might contribute to disturbances of the patients in social interactions [for review, see 39].

However, as illustrated by the preceding paragraph, the majority of studies investigated only one specific aspect of emotional sensitivity in BPD, i.e. emotion recognition. Findings regarding other aspects of emotional sensitivity, such as the detection of emotional information, for instance, are to date severely lacking [40]. Importantly, abnormalities in the detection of emotions were previously shown to be strongly related to emotional instability [for a review, see 41]. For instance, initial work by MacLeod et al. [42] illustrated experimentally induced biases in the detection of emotions to enhance the vulnerability of the participants for anxiety and negative mood, thereby supporting claims that sensitivity to emotional expressions represents an important aspect of emotional instability.

Consequently, in the present study we investigated a different facet of emotion sensitivity in BPD patients, i.e. emotion detection. In particular, we aimed to assess whether patients with BPD are characterized by a heightened detection of emotional facial expressions as predicted by theoretical models of BPD [11]. To this end, the participants were presented a rapid, continuous stream of neutral and randomly inserted emotional facial stimuli, while being asked to report the presence of an emotional stimulus after each trial. In addition, we aimed to explore the effects of the availability of cognitive resources on the detection of emotional stimuli by manipulating task demands.

Methods

Participants

Twenty-five healthy controls and 20 patients with a diagnosis of BPD were enrolled in the study. The healthy controls were recruited via public advertisements. The patients with BPD were recruited from two inpatient treatment facilities. All the patients were on a waiting list prior to treatment and none of them was admitted for acute psychiatric care. Only female participants were recruited to rule out possible effects of gender on the recognition of emotional stimuli [43] as well as differences in clinical symptoms between male and female patients with BPD [44].

All the participants underwent diagnostic screening with the Structured Clinical Interview for DSM-IV and the International Personality Disorder Examination [45]. All diagnostic interviews were conducted by a trained and clinically experienced psychiatrist (D.K.). Healthy controls were included if they had no current or lifetime diagnosis of mental or neurological disorders and did not take any psychotropic medication. BPD patients were excluded if they had comorbid diagnoses of psychotic disorders, bipolar affective disorders or had a neurological disease. Patients were required to be free of psychotropic medication for at least 2 weeks.

Participants were additionally screened regarding their intellectual abilities as assessed by a short version of the Wechsler Adult Intelligence Scale. The severity of BPD symptoms was assessed by a German version of the Zanarini Rating Scale for BPD [46] and the Borderline Symptom List-23 [47]. In addition, participants completed the Brief Symptom Inventory [48] and the Beck Depression Inventory [49]. Demographic and clinical characteristics of BPD patients and healthy controls are presented in table 1.

The study design was approved by the ethics committee of the University of Rostock. All participants provided written informed consent after the procedures had been fully explained.

Experimental Design

The participants were presented a rapid, continuous stream of facial stimuli without interstimulus interval. Each trial lasted 1,750 ms and contained 15 stimuli presented for approximately 117 ms. Within each trial, a picture of flowers or mushrooms was presented (labeled T1 in the following) that appeared equally often in positions 2–7 of the trial sequence. In addition, some trials contained an emotional (angry or happy) facial stimulus that was always presented after the appearance of T1. The remaining stimuli were neutral facial expressions (see fig. 1). Facial stimuli were selected from a standardized set of photographs, Karolinska directed emotional faces [50], and balanced with regard to gender (half female and half male portraits). All pictures were converted to gray scales and an oval vignette was used to hide hair and ears of facial stimuli.

The participants followed two task instructions. In single-task trials, the participants were asked to ignore T1 and to report the appearance of an emotional facial stimulus at the end of each trial. They were not required to indicate the specific valence of the perceived emotion. Rather, they were only asked to confirm or deny the presentation of an emotional stimulus in the preceding

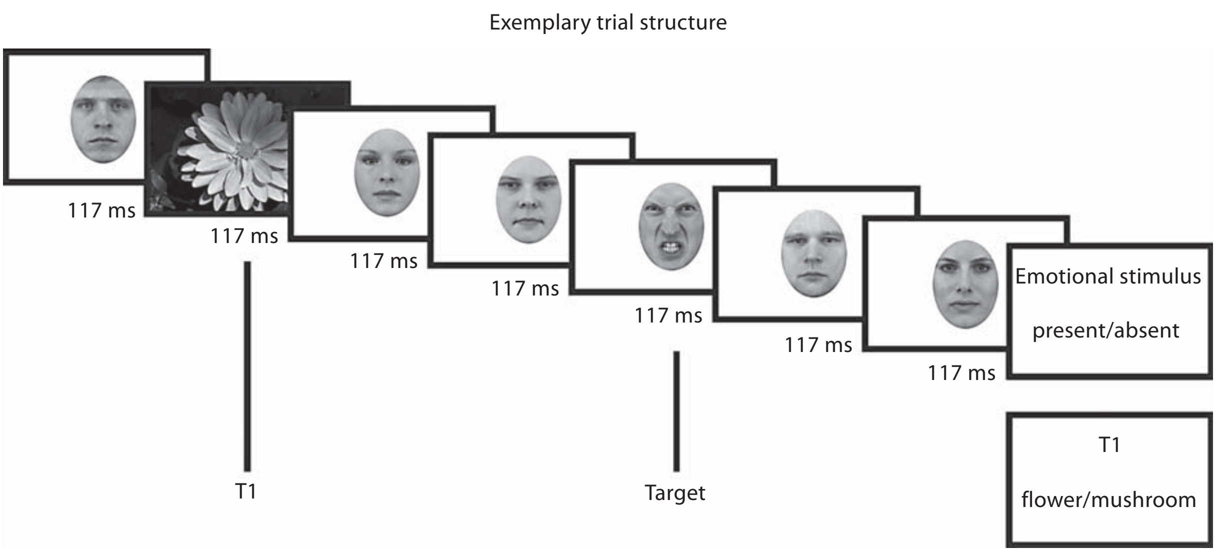

Fig. 1. Participants were presented a rapid stream of 15 stimuli per trial. Each trial contained a picture of flowers or mushrooms (T1) that appeared in positions 2–7 of the trial sequence. Furthermore, some trials contained an emotional (angry or happy) facial stimulus that was presented 2, 3 or 6 stimuli after T1. The remaining stimuli were neutral facial expressions. In single-task trials, the participants had to indicate whether an emotional stimulus was presented in the trial sequence, while ignoring T1. In dual-task trials, they were first asked to report the presence of an emotional stimulus and had then to report whether T1 was a picture of flowers or mushrooms.

trial. During dual-task trials the participants were, again, at first required to report whether an emotional facial expression was presented, but had furthermore to decide if T1 was a picture of flowers or mushrooms. In this way, the availability of cognitive resources was manipulated while assuring constant physical content for both task demands. Finally, we varied the temporal distance between T1 and emotional facial stimuli to explore whether cognitive processing of T1 interferes with the recognition of temporally closely presented emotional stimuli [51]. Emotional stimuli were presented 2, 3 or 6 stimuli after T1 (corresponding to a temporal distance of 233, 350 or 700 ms between T1 and facial expressions of emotions).

To summarize, we manipulated the valence of emotional stimuli (angry and happy), cognitive processing demands (single- and dual-task), and the temporal distance between T1 and facial expressions of emotions (233, 350 or 700 ms). The experiment consisted of 216 trials and was divided into 4 blocks (2 single-task and 2 dual-task blocks). Prior to each block, an instruction cue was given regarding the task demands in the following trials. A total of 144 trials contained emotional stimuli, while the remaining 72 trials contained only neutral facial expressions.

The experiment was conducted on a standard notebook with a 15-inch screen and a screen resolution of 800 × 600. The presentation of visual stimuli and the collection of behavioral data was realized using Cogent 2000. All the participants underwent a training session to ensure appropriate understanding of the task.

Table 1. Demographic and clinical characteristics of healthy controls and BPD patients

	HC (n = 25)	BPD (n = 20)	p
Demographics			
Age	26 ± 6	24 ± 6	0.132
Intelligence quotient	122 ± 14	113 ± 15	0.040
Clinical characteristics			
BDI			
Depression	3.28 ± 4.68	28.35 ± 10.27	<0.001
BSI			
Global severity	0.18 ± 0.17	1.60 ± 0.67	<0.001
Positive symptom distress index	1.17 ± 0.26	2.29 ± 0.46	<0.001
BSL-23			
BPD symptoms	2.28 ± 3.53	46.65 ± 23.12	<0.001
ZAN-BPD			
BPD symptoms		11.70 ± 4.92	

Values are presented as means ± SD. Group comparisons were conducted using Student's t tests. HC = Healthy controls; BDI = Beck Depression Inventory; BSI = Brief Symptom Inventory; BSL = Borderline Symptom List; ZAN-BPD = Zanarini Rating Scale for BPD.

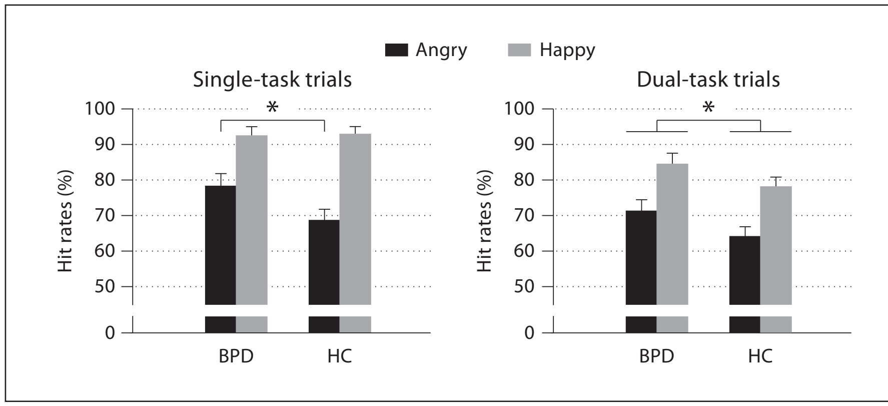

Fig. 2. Detection of emotional facial expressions as a function of task demands (single- and dual-task demands), valence (angry and happy) and group (BPD patients and healthy controls, HC). Error bars represent standard error of mean.

Statistical Analysis

The correct recognition of emotional stimuli, i.e. hit rates, were analyzed for single- and dual-task trials using separate mixed-design ANOVAs with the following factors, valence (angry and happy), temporal distance (233, 350 and 700 ms) and group (healthy controls and patients with BPD). To investigate the effects of manipulating cognitive resources available for the detection of emotional stimuli (dual-task demands), we only included trials with correct discrimination of T1 [51]. In addition, false alarm rates were analyzed for trials that contained exclusively neutral facial stimuli to determine whether BPD patients show a general response bias to more strongly affirm the presence of emotional stimuli.

Intelligence was used as a covariate in all statistical analyses (see table 1). Greenhouse-Geisser corrections were applied if the assumption of sphericity was violated and significant interactions were followed by simple effects analyses. Analyses were performed using SPSS version 17. The significance level for all tests was $p < 0.05$.

Results

Single-Task Trials

Firstly, we analyzed the recognition of emotional stimuli in single-task trials. The results of a repeated-measures ANOVA revealed a significant main effect of emotion ($F_{1, 42} = 8.31$, $p = 0.006$, $\eta_p^2 = 0.165$) as healthy controls and patients with BPD showed an enhanced recognition of happy facial stimuli (see fig. 2). Importantly, the results also illustrated an interaction of group by emotion ($F_{1, 42} = 4.26$, $p = 0.045$, $\eta_p^2 = 0.092$). Follow-up analyses of simple effects suggested an enhanced recognition of angry facial stimuli in patients with BPD compared to healthy controls (angry: $F_{1, 42} = 4.11$, $p = 0.049$, $\eta_p^2 = 0.089$; happy: $F_{1, 42} = 0.02$, $p = 0.895$, $\eta_p^2 = 0.000$). No further significant main effects or interactions of the experimental factors were found (all $p > 0.10$).

Statistical analyses of false alarms in single-task trials without emotional stimuli yielded no significant differences between the healthy controls and patients with BPD ($F_{1, 42} = 2.54$, $p = 0.118$, $\eta_p^2 = 0.057$).

Dual-Task Trials

Following the single-task trials, the correct recognition of emotional facial expressions was analyzed during dual-task demands. As stated in the Methods section, only trials with correct discrimination of T1 were analyzed to ensure cognitive processing of the respective stimuli in all participants. Despite generally high accuracy scores in both groups (mean ± SD; BPD: 85.06 ± 9.83; healthy controls: 92.06 ± 9.78), the patients with BPD were found to be significantly worse in the discrimination of T1 compared to the healthy controls ($F_{1, 42} = 5.39$, $p = 0.025$, $\eta_p^2 = 0.114$). The impaired recognition of T1 in the BPD group was neither modulated by a specific valence nor the temporal distance between T1 and emotional facial expressions (all $p > 0.60$). Thus, as only trials with correct classification of T1 were analyzed and the BPD patients were found to be significantly worse in this regard, we included the mean accuracy rate in the discrimination of T1 as a covariate in the repeated-measures ANOVA.

The statistical analysis of hit rates during dual-task demands showed a significant main effect of group ($F_{1, 41} = 4.56$, $p = 0.039$, $\eta_p^2 = 0.100$), i.e. the patients with BPD showed a better recognition of emotional facial expressions in general compared to the healthy controls (see fig. 2). No further significant main effects or interactions were found (all $p > 0.25$). Again, the BPD patients and healthy controls did not significantly differ in false alarm rates ($F_{1, 41} = 2.47$, $p = 0.124$, $\eta_p^2 = 0.057$).

Discussion

The present study investigated whether patients with BPD are characterized by an enhanced detection of emotional facial expressions in a task with rapidly changing facial stimuli. Relative to the healthy controls, the BPD group showed a superior detection of emotional stimuli. In line with previous research that suggested a bias towards the perception of anger [21] as well as a tendency to interpret ambiguous stimuli more negatively in BPD patients [35, 37], we observed a heightened sensitivity for angry facial expressions in single-task trials. During dual-task demands, in contrast, the BPD patients showed an enhanced detection of angry but also of happy facial expressions. This dissociation in the detection of emotional stimuli might be attributable to an observed ceiling effect in the recognition of positive stimuli during single-task trials. Happy facial expressions are generally more easily detected or recognized than angry facial stimuli [52, 53], restricting the possibility to detect between-group differences. In our study, both groups showed an almost perfect detection of positive stimuli (>90%) during single-task conditions. For that reason, we propose our results to reflect a generally enhanced detection of emotional stimuli, which is in line with assumptions of an enhanced sensitivity for emotional stimuli in BPD patients.

It might be questioned whether the superior detection of emotional stimuli reflects a heightened sensitivity in BPD or is rather the result of a known bias to perceive neutral stimuli (that were predominantly presented in all trials) as more fearful [37] and less friendly [38]. This negativity bias in the evaluation of neutral expressions was also shown to be particularly pronounced when BPD patients were forced to rapidly discriminate emotional states of others [34]. However, analyses of false alarm rates in the present study yielded no significant differences between the two groups, i.e. the BPD patients did not show a significant response bias.

Remarkably, the BPD group also showed a diminished accuracy in the discrimination of T1. Impaired discrimination of T1 might reflect a prioritized attentional orienting towards emotional stimuli in BPD patients that is at the expense of further cognitive processing requirements. Alterations in the distribution of attentional resources, although in the spatial domain, were previously found in BPD patients [54]. In particular, the authors reported that patients with BPD are characterized by an impaired ability to disengage attention from negative facial stimuli. The investigation of attentional processes as well as the role of emotional stimuli with attentional processes might consequently represent a promising avenue to study emotional sensitivity in greater depth.

Although the paradigm is quite different from previous studies on emotional sensitivity in BPD, and theoretical distinctions between facial emotion recognition and emotion detection have to be made, the results seemingly support two isolated findings indicating enhanced emotional sensitivity in patients with BPD [30, 31]. For instance, the results by Fertuck et al. [30] illustrated that BPD patients might be better at mental state discrimination based only on the eye region of individuals. Importantly, the authors observed this effect not only for negative expressions but also for positive ones.

Nevertheless, considering the findings presented in the Introduction, the overwhelming majority of studies in BPD rather point to subtle impairments in the recognition of emotion. Trying to merge this general line of research in emotion recognition with the results presented in this manuscript, we want to carefully propose a mechanism that might help to combine these seemingly contradictory findings, i.e. emotion labeling. Up to now, studies investigating the recognition of emotional states relied exclusively on the use of verbal labels to measure the accuracy of emotion recognition. However, the necessity to label emotions might come into conflict with assessments of a heightened sensitivity in patients with BPD. This proposed confound seems particularly plausible considering the marked differences of BPD patients in the semantic representation of emotional labels compared healthy controls [55], as well as their pronounced difficulties in using emotional labels to describe their own emotional states [11, 56]. Recent work further supported this argument by illustrating that difficulties in the ability of BPD patients to identify and label emotional states are indeed a significant predictor for the performance in emotion recognition tasks [57]. In contrast, the participants in our study were only asked to indicate the presence of an emotional stimulus without the need to label the emotional state. Quite similarly, a recent study without labeling requirements found stronger initial attentional orienting of BPD patients to emotional stimuli, which suggests an enhanced sensitivity towards emotional information in BPD [40]. Consequently, we do suggest that BPD patients might be characterized by an enhanced detection of emotional expressions by others, while also showing difficulties in accurately describing the depicted emotions at the same time. Intriguingly, the labeling of emotions was found to attenuate self-reported emotional experiences [58] and to diminish limbic activity [59]. Impairments in the labeling of emotional responses might thus contribute to emotional instability in patients with BPD.

Accordingly, our results are proposed to be consistent with the emotional instability phenotype as a central feature of BPD. In addition, enhanced detection of emotional expressions in the faces of others may also be related to the interpersonal hypersensitivity phenotype [60]. Our results may reflect that BPD patients are hypersensitive to emotional states perceived in other's faces as they have learnt to expose high attention to the emotional states of others in an unpredictable or even threatening environment. Our paradigm does not allow for differentiating between emotional and interpersonal hypersensitivity in patients with BPD, which might anyhow strongly interact in the social context.

The present study has some limitations that need to be acknowledged and might be addressed in future studies to broaden the understanding of emotional sensitivity in BPD patients. First, we proposed the superior detection of emotional stimuli in the BPD group to be related to the response format as the participants were not required to indicate the specific valence. Although this interpretation seems plausible regarding the current state of research in BPD, the experimental paradigm chosen did not allow for directly comparing accuracy scores with and without the need to label the specific emotional state. Thus, further research is needed to determine whether BPD patients show an initially heightened detection of emotional facial expressions but are characterized by impairments in the subsequent labeling of these emotional states. In addition, future research is needed to investigate the specificity of these results for BPD (e.g. by including a psychopathological control group) and whether the presented results are also applicable to male patients with BPD. Third, while the temporal distance between T1 and the presented emotional stimuli was experimentally manipulated, there was no significant evidence for a decline in performance accuracy when T1 and emotional stimuli were presented in close temporal succession [54].

The results of this study demonstrate an enhanced emotional sensitivity – in the sense of a superior detection of emotional stimuli – in patients with BPD. More specifically, we argued that a higher detection of emotional information along with deficits in the labeling of emotions might contribute to the characteristic pattern of emotional instability. In addition, the superior detection of emotional stimuli during dual-task demands was found to be at the expense of further cognitive processing requirements.

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Disclosure Statement

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