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ABSTRACT

According to Linehan (1993), emotion dysregulation is a central feature of borderline personality disorder (BPD). We hypothesized that patients with BPD are emotionally hyperresponsive. For BPD treatment, it is important to evaluate this hypothesis, because, if it is supported, therapeutic interventions could be designed to help patients to better manage hyperemotional reactions. We investigated the subjective reactions (in terms of valence and arousal) of patients with BPD to visual emotional stimuli of the International Affective Picture System (IAPS). We hypothesized that, compared to patients with Cluster-C personality disorders and non-patients, BPD patients would show higher scores on the arousal dimension and higher negative scores on the valence dimension when rating IAPS pictures with varying degrees of arousal and valence. Ratings of valence and arousal for 40 IAPS pictures were collected from 39 borderline personality disorder (BPD), 36 patients diagnosed with Cluster-C personality disorders (PD), and a group of 226 non-patients. Contrary to expectations, BPD patients did not differ from the non-patients. This indicates that their self-report scores do not reflect hypersensitivity. We found that patients with BPD showed lower scores on arousal than Cluster-C PD patients. The scores on valence suggested that Cluster-C PD patients also experienced more positive emotions than BPD patients.

1. Introduction

According to Linehan (1993), borderline personality disorder (BPD) results from emotion dysregulation. This emotional dysregulation is conceptualized as a combination of emotional vulnerability and an inability to modulate emotional responses. The key components of this vulnerability in BPD are hypothesized to be a greater emotional sensitivity (low threshold for recognition of emotional stimuli), greater emotional reactivity (high amplitude of emotional responses), and a slower return to baseline arousal (longer duration of emotional responses) (Glenn and Klonsky, 2009). The current study focuses on the second component and contrasts the general emotion hyperreactivity theory with theories that hypothesize that BPD is characterized by stronger emotional responsivity to specific stimuli, such as emotional, sexual, and physical abuse (Lobbestael and Arntz, 2015; Rosenthal et al., 2008). The results of previous studies on emotional reactivity vary across stimulus type (e.g., film clips, personalized scripts), emotional valence of the stimulus (i.e., neutral, positive, negative), comparisons groups (i.e., non-patients, other Axis I or II groups), and emotional outcomes (self-reported total negative affect vs. specific emotions).

Consistent with Linehan's (1993) theory of BPD, Lynch et al. (2006) found that BPD patients are more sensitive to identifying emotional expression in faces than non-patients are. Further, research using biological measures of emotion processing in BPD has also provided support for emotion hyperreactivity in BPD. Specifically, compared to controls, BPD patients have a heightened startle response to unpleasant stimuli (Ebner-Priemer et al., 2005; Glenn and Klonsky, 2009). Hazlett et al. (2007) reported that compared with healthy controls, BPD patients exhibited exaggerated affective startle modulation during un-

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pleasant, but not neutral words. Interestingly, compared with healthy control subjects, BPD patients rated the unpleasant words as significantly less unpleasant, whereas group ratings for the neutral words were similar. In our study, we also compared different groups, as we compared borderline patients to Cluster C personality patients and non-patients.

However, emotional hyperreactivity in BPD is not consistently reported in experimental studies. Several studies have failed to demonstrate that BPD patients exhibit increased psychophysiological responses to negative pictures (Domes et al., 2009; Herpertz et al., 1999, 2000), although there was also evidence of an enhanced amygdala activation to aversive stimulation (Herpertz et al., 2001). In a meta-analysis of 19 functional neuroimaging studies, BPD patients showed, compared to non-patients, relatively increased activation of the left amygdala and posterior cingulate cortex along with blunted responses of the bilateral dorsolateral prefrontal cortex during the processing of negative emotional stimuli (Schulze et al., 2016). These results appear to be consistent with results from most self-rating-based studies which did not find significant group effects in BPD (e.g., Niedtfeld et al., 2010; Schulze et al., 2011) or even blunted responses compared to non-patients (e.g., Hazlett et al., 2012). Several other studies (Elices et al., 2012; Jacob et al., 2010; Kuo et al., 2009, 2016;) illustrate that BPD patients do not exhibit greater self-reported emotional reactivity than non-patients.

In BPD patients, hyperarousal and emotional reactivity do tend to occur when the attachment-safety system is threatened (Fonagy, 2000; Levy, 2005). Thus, images of interpersonal threat and interpersonal relations (e.g., the attachment projective, the eye in the mind test, and so on) tend to activate the amygdala-hippocampal systems (Hall et al., 2010; Schmahl et al., 2003). These tend to be shown clearly in imaging, but less so at the behavioral level.

In the present study, we aimed to further investigate the emotional reactivity of BPD by using the International Affective Picture set (IAPS: Lang et al., 1998). The IAPS is a well-known and widely used stimulus set of pictorial affective material. In neuroimaging research in BPD, the IAPS are among the most commonly used material to elicit emotional reactivity (Krause-Utz et al., 2014; Mauchnik and Schmahl, 2010; Van Zutphen et al., 2015). Findings from these studies show that limbic hyperreactivity and diminished recruitment of frontal brain regions may yield a link between disturbed emotion processing and other core features of BPD such as impulsivity and interpersonal disturbances. Koenigsberg et al. (2002, 2009) observed no differences in valence and arousal levels between a BPD group and non-patients, but did find different patterns of regional brain activation in BPD patients. This raises the possibility that, although borderline patients demonstrate a higher reactivity of mood and a higher sensitivity to emotional stimuli than non-patients, their subjective experience of emotional intensity does not differ from that of the non-patients. To clarify whether findings are specific to BPD, comparisons with other clinical groups are needed. In the present study, we expand upon this work by comparing the IAPS self-report evaluations by BPD patients, non-patients, and patients with Cluster-C PDs. We included Cluster-C PD patients as a comparison group because these patients tend to have high levels of Neuroticism (Saulsman and Page, 2004) and therefore should have emotionality-related problems as well.

To be able to draw meaningful conclusions on hyperreactivity specific to BPD patients, one must compare the findings with both patients with other personality disorders and non-patients. By doing this, we expected to find a unique pattern of hyperreactivity in BPD patients. Based on the theory of Linehan (1993), we expected BPD patients to have higher scores on the arousal dimension and more negative valence scores than Cluster-C PD patients and non-patients. Finally, we explored the association between the severity of BPD and hyperreactivity. We expected severe BPD to be associated with more hyperreactivity, thus to higher arousal and negative valence scores.

2. Methods

2.1. Participants

The patient group consisted of 39 patients (5 men and 34 women) diagnosed with BPD and 35 patients (12 men and 23 women) with Cluster-C PD (primary diagnoses: 17 avoidant personality disorder, 5 dependent personality disorder, and 13 obsessive personality disorder). Within the BPD group, 7 patients showed comorbidity with Cluster-C PD as they also met the criteria of a Cluster-C PD. The primary diagnosis was determined on the basis of the request for help and on what the primary focus of treatment should be to meet the demand for help. The patients were all waiting for outpatient treatment at the Mental Health Institute of Tilburg (GGZ Breburg). Acute and chronic psychotic disorders, as well as bipolar disorder, organic disorders, dissociative identity disorder, and mental retardation were exclusion criteria for both patients with BPD and Cluster-C PDs. Age for both patient groups ranged from 25 to 58 years (M_{age} = 36.3; SD = 8.8). The patient group in this study is a subsample of the sample that was investigated in an earlier study by Peter et al. (2013). That study focused on emotional intelligence and not on the IAPS.

For the non-patient group, data were used from another sample (N = 240). The non-patient group are healthy controls. All non-patients voluntarily participated in this study, after being approached by a data-collection agency (Center Data Tilburg). Although we did not have a formal assessment for the presence of psychopathology in the non-patient sample, an inclusion criterion was that participants had to report good mental health and no prior experience with mental health care. This inclusion was based on subjective reports. Specifically, we selected participants aged between 19 and 58 years in order to match the age range of the patient samples. The resulting non-patient group consisted of 226 individuals (M_{age} = 2.3 years; SD = 9.7).

2.2. Procedure

This study was approved by the institute's Medical Ethics Review Committee (METIGG Kamer Zuid). Written-informed consent was obtained from all participants. DSM-IV classifications of the patient group were based on the Structured Clinical Interview for DSM-IV (SCID-II: First et al., 1997; Dutch version by Weertman et al., 2000), which is part of the standard intake procedure at GGZ Breburg. After the intake, patients were invited to participate in this study. Patients were assessed at GGz Breburg where the IAPS pictures were presented on a 15-inch laptop. The non-patients completed the IAPS at home on their own computer. The IAPS pictures were presented in the same sequence to every participant, with each image displayed for 6 s.

2.3. Materials

As stimuli, 40 pictures were selected from the International Affective Picture System (IAPS; Lang et al., 1998). The IAPS is a collection of photographic images that have been shown to induce positive, negative, or neutral affective states. Picture ratings on the dimensions of valence and arousal were scored on a 9-point scale. The dimension of *valence* differentiates positive (pleasant) from negative (unpleasant) emotional states. The dimension of *arousal* distinguishes highly exciting, arousing states from calm, relaxed states. Four independent researchers rated the IAPS pictures in valence and arousal in the Dutch population. For every quadrant, we selected 10 photos with the highest loadings to evoke extreme emotional reactions in this study. For example, we selected pictures with domestic violence, group lynch/murder of a person, and a starving child. In this sense, we intended to trigger the attachment safety mechanism of participants. We made a selection of 10 pictures from each of the four quadrants, quadrant 1 (positive valence, high arousal), quadrant 2 (negative valence, high

arousal), quadrant 3 (negative valence, low arousal), and quadrant 4 (positive valence, low arousal). The selection was made keeping cultural aspects in mind. The value of this approach was supported by the fact that our ratings differed from those on published results with the IAPS pictures (see results section). In addition, we aimed to select IAPS pictures in such a way that our subjects would exhibit more extreme reactions to our experimental manipulation.

To assess the dimensions of pleasure and arousal, the Self-Assessment Manikin (SAM), an affective rating system devised by Lang (1980) is typically used. In this system, graphics depicting values along each of the two dimensions on a continuously varying scale are used to evaluate emotional reactions. However, instead of using the original SAM measure, we used the following four verbal items to operationalize the IAPS scales of valence (the rating of how pleasant/unpleasant a picture is, with higher scores indicating more positive valence) and arousal (how calm/excited participant feel when looking at a picture, with higher scores indicating more arousal): (1). To what extent are you touched by this picture?; (2) How much do you like this picture?; (3) To what extent does this picture make you feel relaxed?; and (4) To what extent does this picture arouse you? Items 2 and 3 both represent pleasant states and therefore are indicative of valence, whereas items 1 and 4 both address calmness/excitement and thus reflect the arousal dimension. Factor analyses supported this two-factor structure, as items 1 and 4 loaded on a first factor, and items 2 and 3 on a second one. The rationale for using the four verbal items instead of the original SAM score, is that we build our own software presenting the IAPS pictures to the participants. Building our own software was necessary to make the software compatible with the IT system of GGz Breburg. The software did not allow using the SAM measure.

The following pictures were selected from the IAPS and were presented in the following order:

- Negative valence/high arousal: 9040;6821;9300;9800;9921;6212;6360;9252;9570;6350.
- Negative valence/low arousal: 2271;1230;2280;2810;4002;4005;7700;9110;1945;2520.
- Positive valence/low arousal: 1810;2030;5250;5390;5875;7475;1900;2010;2560;2620.
- Positive valence/high arousal: 5621;8496;4572;8180;2216;5626;5629;8034;8185;8370.

The non-patients evaluated the IAPS pictures on 1–5 Likert scales with the same anchors as the 9-point scale. The ratings by the non-patients were transformed to a 9-point scale so that ratings could be compared between groups, using the transformation $y' = 2 * (y - 1) + 1$. Note that comparisons between non-patients and the two patient groups should still be interpreted with utmost caution.

BPD severity in the BPD patient group was measured using the Dutch version of the Borderline Personality Severity Index (BPDSI: Arntz et al., 2003; Giesen-Bloo et al., 2010), a semi-structured interview assessing the frequency and severity of manifestations of BPD during 3 months. The BPDSI is highly reliable (ICC = 0.93) and internally consistent (coefficient $\alpha = 0.85$ in BPD; 0.96 in mixed samples: Giesen-Bloo et al., 2010). Concurrent and construct validity is excellent (Arntz et al., 2003; Giesen-Bloo et al., 2010).

2.4. Statistical analysis

The scores on the four items of the IAPS were subjected to a principal component analysis (PCA) with varimax rotation, restricting the number of two factors, as an arousal and a valence dimension were expected, followed by varimax rotation. Internal consistencies of the scales based on this PCA were estimated by coefficient alphas. Associations were computed with Pearson correlations, except in case of non-normal distributions and a small total sample size ($n < 150$), in which case Spearman correlations were used (Schönbrodt and Perugini, 2013). The emotional hyperreactivity hypothesis was first tested by a Repeated Measures Multivariate Analysis of Covariance (MANCOVA), in which we included valence and arousal as dependent variables, a grouping variable to distinguish BPD, Cluster-C, and non-patients as independent variable, the four quadrants as repeated measures, and gender and age as covariates. If the first test yielded significant results, we would proceed with a follow-up MANCOVA to test between-group differences in valence and arousal for each quadrant. In these analyses, group was the between-person factor, gender and age were covariates, and the arousal and valence scores for each quadrant were the dependent variables (8 in total). We ran this analysis mainly to examine post-hoc tests on between-group differences in arousal and valence within each of the quadrants. We ran all analyses including the 7 BPD cases that also had a Cluster-C diagnosis, but repeated all analyses without these cases to examine whether the results were robust. Finally, we examined whether BPD severity was related to valence and arousal scores using Spearman correlations.

3. Results

Construction of arousal and valence scales. A principal component analysis with Varimax rotation and the number of factors restricted to two (as valence and arousal were expected as underlying dimensions) indicated that items 1 and 4 loaded on one component (loadings 0.836, 0.927), whereas items 2 and 3 loaded on the other component (loadings 0.933, 0.910; cross-loadings ≤ 0.396). The components were labeled arousal and valence. Subsequent internal consistency analyses yielded very high internal consistencies for scales constituted of items 1 and 4 (arousal) (coefficient alphas = 0.963) and 2 and 3 (valence) (coefficient alphas = 0.955). The two scales correlated 0.437, $p < 0.001$. The factor analysis, as well as the correlation between the scales and their internal consistencies, supported the hypothesis that valence and arousal to an important degree underlie the IAPS stimuli ratings.

3.1. Comparability of groups

Table 1 shows descriptive statistics of demographics. Groups differed significantly in age, $F(2, 300) = 13.85$, $p < 0.001$, and gender, $\chi 2 (1) = 23.25$, $p < 0.001$. Mean age was significantly higher in non-patients ($M = 42.2$ years) than in BPD patients ($M = 34.8$ years) and Cluster-C PD patients ($M = 36.3$ years), with patient groups not differing significantly. Regarding gender, the percentage of men was significantly different for each of the groups. In the BPD group, 12.8% were men, whereas the Cluster-C PD group and the non-patient group consisted of 34.3% and 52.7% of men, respectively. Age and gender were therefore included as covariates in subsequent analyses. Analyses of Variance (ANOVAs) showed non-significant differences between the two patient groups with regard to IQ and educational level (Table 2). Information on these variables was not available for non-patients.

Table 1
Group differences in gender, age, educational level, and IQ.

	Borderline patients ($N = 39$)	Cluster-C patients ($N = 35$)	Non-patients ($N = 226$)	p-value
N male (%)	5 (12.80%)[a]	12 (34.30%)[b]	119 (52.70%)[c]	<0.001
Age	34.85[a]	36.34[a]	42.25[b]	<0.001
IQ	101.59	104.26	N.A.	0.332
Educational level	5.51	5.18	N.A.	0.418

Note. Percentages and group means with different superscripts are significantly different from each other ($p < 0.05$). Gender differences were determined with a chi-square test, whereas differences in age, educational level (measured on a scale from 1 (lowest level) to 9 (highest level)), and IQ were determined with ANOVA-tests. There was no information available on the educational level and IQ of non-patients.

Table 2
Estimated marginal means and standard errors of arousal and valence ratings in borderline patients ($N = 39$), cluster-C patients ($N = 35$), and non-patients ($N = 226$) across four quadrants controlled for age and gender.

Quadrant	Arousal			Valence		
	BPD	Cluster-C	Non-patients	BPD	Cluster-C	Non-patients
1High A - Pos V	3.59 (0.23)[a]	4.56 (0.24)[b]	3.91 (0.09)[a]	4.50 (0.23)[a]	5.82 (0.23)[b]	4.75 (0.09)[a]
2High A - Neg V	3.42 (0.18)[ab]	3.93 (0.18)[b]	3.25 (0.07)[a]	3.97 (0.14)[a]	4.46 (0.14)[b]	3.86 (0.06)[a]
3Low A - Neg V	2.84 (0.18)[a]	3.60 (0.18)[b]	3.10 (0.07)[a]	3.41 (0.17)[a]	4.15 (0.18)[b]	3.77 (0.07)[a,b]
4Low A - Pos V	3.73 (0.21)[a]	4.62 (0.21)[b]	4.00 (0.08)[a]	4.64 (0.20)[a]	5.57 (0.21)[b]	4.75 (0.08)[a]

Note. Group means with different superscripts within a quadrant are significantly different from each other ($p < 0.05$).

To answer our central research question, we examined differences in reported arousal and valence between BPD patients, Cluster-C patients, and non-patients for each of the four IAPS Quadrants. For both arousal and valence, we found no significant main effects of the covariate age, but the main effects for the covariate gender were significant for arousal ($F(1295) = 7.574$, $p = 0.006$, partial $\eta^2 = 0.025$) and valence ($F(1295) = 9.077$, $p = 0.003$, partial $\eta^2 = 0.030$). The between-subjects factor group significantly predicted differences in arousal ($F(2295) = 6.204$, $p = 0.002$, partial $\eta^2 = 0.040$) and valence ($F(2295) = 9.573$, $p < 0.001$, partial $\eta^2 = 0.061$). Follow-up pairwise comparisons showed that this was due to Cluster-C patients reporting higher levels of arousal and a more positive valence across conditions.

The within-subject effects of quadrant were also significant for both arousal ($F(2.452, 723.368) = 3.436$, $p = 0.024$, partial $\eta^2 = 0.012$) and valence ($F(2.512, 704.897) = 10.563$, $p < 0.001$, partial $\eta^2 = 0.035$). These effects indicated that levels of arousal and positive valence were the highest in quadrant 1 high arousal/positive valence and 4 low arousal/positive valence, followed by quadrant 2 high arousal/negative valence. Levels of both positive valence and arousal were the lowest in quadrant 3 low arousal/negative valence.

Interactions effects of the covariate gender with quadrant were significant for both arousal ($F(2.452, 723.368) = 9.844$, $p < 0.001$, partial $\eta^2 = 0.032$) and valence ($F(2.512, 704.897) = 10.509$, $p < 0.001$, partial $\eta^2 = 0.034$). The interaction effect of the covariate age by quadrant was not significant for arousal ($p = 0.062$), but was significant for valence ($F(2.512, 740.68) = 2.811$, $p = 0.048$, partial $\eta^2 = 0.009$). Finally, group significantly interacted with quadrant in predicting valence ($F(5.023, 740.897) = 4.206$, $p = 0.001$, partial $\eta^2 = 0.028$), but not arousal ($p = 0.108$). These interactions indicated that gender differences, age differences, and between-group differences in valence were larger in some quadrants than in others. In addition, gender differences in arousal were also larger in some groups than in others. We further explored this interaction effect by examining posthoc between-group comparisons in a follow-up MANCOVA with group as between-subjects factor, age and gender as covariates, and the arousal and valence scores for each of the four quadrants (i.e., 8 variables in total) as dependent variables.

Univariate tests for gender showed that there were no significant gender effects for arousal or valence in Quadrant 3 low arousal/negative valence. However, there were significant gender differences in arousal in Quadrant 1 high arousal/positive valence ($F(1295) = 13.774$, $p < 0.001$, partial $\eta^2 = 0.045$), Quadrant 2 high arousal/negative valence ($F(1295) = 11.014$, $p = 0.001$, partial $\eta^2 = 0.036$), and Quadrant 4 high arousal/negative valence ($F(1295) = 4.976$, $p = 0.026$, partial $\eta^2 = 0.017$). Similarly, gender differences for valence were significant in Quadrant 1 high arousal/positive valence ($F(1295) = 15.649$, $p < 0.001$, partial $\eta^2 = 0.050$), Quadrant 2 high arousal/negative valence ($F(1295) = 11.206$, $p = 0.001$, partial $\eta^2 = 0.037$), and Quadrant 4 ($F(1295) = 7.894$, $p = 0.005$, partial $\eta^2 = 0.026$). These significant differences indicated that in quadrants 1, 2, and 4, women scored consistently higher on both arousal and positive valence. For age, univariate tests were only significant for arousal in Quadrant 3 low arousal/negative valence ($F(1295) = 7.129$, $p = 0.008$, partial $\eta^2 = 0.024$). This result indicated that older participants were less aroused in Quadrant 3.

Results of the follow-up tests for the between-subject factor group are presented in Table 2. This table shows that Cluster-C patients typically scored higher on both positive valence and arousal when compared to the BPD patients and non-patients ($p \leq 0.038$), whereas BPD patients and non-patients typically did not significantly differ from each other. However, there were two exceptions to this general rule. First, in quadrant 2 high arousal/negative valence, the arousal scores for BPD patients did not significantly differ from those of the Cluster-C patients. Second, in quadrant 3 low arousal/negative valence, valence scores were not significantly different for Cluster-C patients when compared to non-patients.

As a first robustness check, we reran our analyses without the covariates gender and age. These analyses produced highly similar results, as the main effects and interaction effects that were significant in the analyses with covariates were also significant in the analyses without covariates, and the non-significant effects were still non-significant. As an additional robustness check, we reran our analyses excluding the 7 BPD patients who also had a Cluster-C diagnosis. These analyses also produced results that were identical to the results including comorbid cases in the sense that significant effects remained significant and non-significant effects remained non-significant.

As a follow-up test for examining possible associations with BPD severity, we calculated the bivariate correlations of arousal and valence in each of the Quadrants with the severity index of BPD (BPDSI). BDPSI scores were only available for the BPD group, and therefore the sample size for these analyses was rather small ($N = 37$). Therefore, we used non-parametric (i.e., Spearman) correlations. Table 3 shows that none of the correlations of the severity of BPD with valence and arousal scores reached statistical significance, regardless of whether or not we included the 7 BPD patients who also had a Cluster-C diagnosis.

4. Discussion

The present study aimed to investigate the reactions of BPD patients to IAPS pictures. We hypothesized that BPD patients would show higher scores on arousal and negative valence compared with Cluster-C PD patients and non-patients. Studies with the IAPS and BPD (Sauer et al., 2016; Sloan et al., 2010; Soloff et al., 2015) typically show higher

Table 3
Spearman correlations of the total severity index, ($N = 37$) with IAPS arousal and valence scores.

		Severity index BPD BPDSI score
1High A - Pos V	Arousal	−0.321
	Valence	−0.183
2High A - Neg V	Arousal	−0.020
	Valence	0.008
3Low A - Neg V	Arousal	−0.127
	Valence	−0.168
4Low A - Pos V	Arousal	−0.194
	Valence	−0.171

Note. None of the correlations was statistically significant.

physiological activity in BPD patients compared to non-patients. However, such studies typically show a pattern in which (self-report) ratings of BPD patients and non-patients are not different from each other (Koenigsberg et al., 2002, 2009: Van Zutphen et al., 2015).

Contrary to our expectations, we found that patients with BPD showed lower scores on arousal than Cluster-C PD patients. The scores on valence suggested that Cluster-C PD patients also experienced more positive emotions than BPD patients. The scores on arousal and valence of BPD patients did not differ significantly from non-patients. The results of this study partly replicated the results of Koeningsberg et al. (2002, 2009) and Zutphen et al. (2015), as we also found no differences in self-report scores between borderline patients and non-patients. However, whereas Koeningsberg et al. (2002) did not find differences in subjective affective intensity between borderline patients and patients with other personality disorder, our results do suggest that Cluster-C personality disorder patients score higher than BPD patients on both arousal and (positive) valence. These findings are not in line with the core idea of general emotional hyperreactivity in BPD as stated in Linehan's (1993) theory. However, previous studies on emotional hyperreactivity in BPD show inconsistent findings (Domes et al., 2009; Herpertz et al., 1999, 2000; Lobbestael and Arntz, 2015), and Koenigsberg et al. (2009) also found no differences in the IAPS scores on valence and arousal levels between a group of BPD patients and healthy control group.

How can these findings be explained? First, evidence for the hyperreactivity theory has been mixed, and it remains to be proven that BPD is characterized by a general emotional hyperreactivity. Second, emotional hyperreactivity might be present on other levels than the subjective experience. One of the sources of inconsistency between self-report and physiological emotional responses in BPD (Daros et al., 2013; Ruocco et al., 2013; Schulze et al., 2016) may be problems in understanding emotions. Previous research found that BPD patients have more problems in this regard than Cluster-C patients and non-patients (Peter et al., 2013). Third, our IAPS stimuli might not have been capable of triggering the hyperemotional reactions that characterize BPD. Perhaps stimuli should have a specific personal meaning (e.g., depicting childhood abuse for BPD patients that experienced this as a child) in order to be capable of triggering hyperemotional responses (Herpertz et al., 1997). Fourth, statistical power might have been too small to detect differences, though the present study had 82% power to detect a medium effect size ($d = 0.50$) at a significance level of 0.05, and at least medium size effects would be expected for a phenomenon so central in several theories about BPD. Fifth, ambiguity might be needed to elicit biased interpretation processes that lead to relatively extreme emotional responses one does not see in a non-patient group (e.g., Arntz et al., 2011). The IAPS pictures might have been too straightforward to elicit different responses in BPD and non-patients. Sixth, BPD patients might have been successful in blocking hyperemotional reactions as an emotion regulation strategy. This hypothesized form of blocking could reflect a way of protecting against threat, as the IAPS pictures included pictures of war scenes, gender interactions, illness and domestic violence.

In line with the evidence-based therapies of BPD, our findings suggest that it may be essential to know if the patient is blocking their emotions during therapy. Therapists should create a therapeutic climate that helps patients to achieve more contact with their inner emotional state instead of avoiding/blocking emotions. Blocking emotions in BPD is a problem because this mechanism interferes with therapeutic interventions. Also, it can lead to prolonged treatment and more mental health care costs (Van Asselt et al., 2007). Thus, additional research directly examining blocking of emotions is warranted.

Interestingly, in this study, Cluster-C PD patients seem to show hyperresponsive reactions. We have currently no explanation for this unexpected finding, which will need to be replicated in future studies. The finding might imply that addressing emotional hyperreactivity is required for the treatment of Cluster-C PDs.

Although we selected stimuli to reflect the four quadrants of valence and arousal, this is not reflected in the actual ratings. The mean arousal ratings of quadrant 1, 3, and 4 are more or less the same. This indicates that our manipulation seems to have worked less successfully, but it should be noted that there were still some notable between-group differences in the reported levels of valence and arousal. This raises the question if the IAPS pictures can be divided into the four quadrants and if the pictures differentiate enough. Herpertz et al. (1999) reported a dissociation between psychophysiological and self-report measures of arousal in BPD patients—lower-than-normal physiological arousal (skin conductance) during neutral pictures yet higher-than-normal self-report of their arousal experiences. There are several interpretations of our reported findings. One is that BPD patients suppress their hyperresponsive reactions. Alternatively, these findings could suggest that BPD subjects have a dissociation between their physiological response and their self-report.

4.1. Limitations and future directions

This study has several limitations in addition to the aforementioned. The present study did not include Cluster-A personality disorders and Cluster-B personality disorders other than BPD, limiting the range of PDs that could be compared. The current study was restricted to assessment of the impact of evocative stimuli on self-reported emotions. Future studies on emotional hyperactivity in BPD should continue to use different emotional evoking stimuli. Such research would also facilate a better understanding of the presumed blocking of emotional reactions in BPD patients and the conditions under which it may occur.

Another limitation of this study is the scoring system. We did not use the Self-Assessment Manikin scoring system (SAM; Bradley and Lang, 1994). The SAM scoring is a nine-point scale with figures. Instead of the SAM scoring, we used four questions on a 9-point scale in the patient group and a 5-point scale in the non-patient group. Further studies with the IAPS might consider using the original SAM scoring.

A limitation is that we did not test the non-patient control group for mental disorders. On the other hand, these were not patients and in that sense an adequate representation of the non-patient sample. For instance, even if participants of this sample would have had elevated psychopathology symptoms, they were not decompensated to the degree that they sought treatment for these symptoms. Note that some level of symptoms is common in the general population, including among non-patients (Bijl et al., 1998).

Except for levels of psychopathology, the non-patients were also not assessed for IQ and educational level. This limits the comparability and interpretation of between-group differences. Another limitation is that the non-patients completed the IAPS at home on their own computer, whereas the patients completed it at the mental health care institution. This unstandardized assessment might have influenced the results. However, all patients were out-patients. Thus, all participants lived in their own homes, and did not reside in a ward.

Another limitation is that the BPD group has fewer men than the Cluster C PD group. While we controlled for gender by adding it as a covariate, equal proportions of men and women in the samples would have been preferable.

Lastly, third variables might play a role, like the use of medication, which is more prevalent in the BPD patients with more symptoms, and might interfere with their emotional reactions. Future research should control for medication.

5. Conclusions

In the current study, we assessed BPD patients' reactions to IAPS pictures and compared these responses to the reactions observed in both a Cluster C PD and a non-patient group. Our findings are not in line with the hypothesis of a general emotional hyperactivity in BPD but suggest that BPD patients might effectively block their feelings.

Although further studies are needed to confirm this blocking hypothesis, studies like the current one can potentially assist in specifying treatment focus of this profoundly challenged patient group. According to the literature on several forms of therapy, patients are known to be detached from their emotions. This detachment is a dissociative symptom that can lead to underreporting on one's emotions. This is why it remains unclear whether or not dissociative experiences during testing had an impact on general psychophysiological response in BPD patients. Another reason for these unexpected findings could be that dissociative symptoms have not been considered in these studies. Especially in BPD patients, dissociative symptoms are highly present and may influence psychophysiological reactions to emotional stimuli (Barnow et al., 2010; Korzekwa et al., 2009; Stiglmayr et al., 2003).The present study supports these previous research findings and suggests that therapists should stimulate patients to show more emotions during therapeutic sessions.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2019.01.105.

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