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DOI
10.1016/j.jbtep.2018.11.005

Publication date
2020

Document Version
Final published version

Published in
Journal of Behavior Therapy and Experimental Psychiatry

License
Article 25fa Dutch Copyright Act

Journal of Behavior Therapy and Experimental Psychiatry 67 (2020) 101437

Contents lists available at ScienceDirect

Journal of Behavior Therapy and Experimental Psychiatry

journal homepage: www.elsevier.com/locate/jbtep

Patients with borderline personality disorder and comorbid PTSD show biased attention for threat in the facial dot-probe task

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ARTICLE INFO

Keywords:
Borderline personality disorder
Cluster-C personality disorder
Posttraumatic stress disorder
Attention
Facial expressions
Emotion
Facial dot-probe task

ABSTRACT

Background and objectives: Biased attention to threat is likely to play a crucial role in the dysfunctional emotion-related information processing in borderline personality disorder (BPD). However, the role of comorbid post-traumatic stress disorder (PTSD) has not yet been fully disentangled.
Methods: BPD patients with (n = 24) and without (n = 46) PTSD, 35 patients with Cluster-C personality disorder and 52 non-patients participated in the facial dot-probe task with angry, happy and neutral faces during automatic (100 ms), controlled (600 ms), and later (1200 ms) stages of information processing.
Results: BPD patients showed a greater congruency effect to angry faces during the controlled stage of processing than controls. Specifically, in BPD with PTSD compared to controls, this effect was due to difficulties disengaging from threat, indicated by slower reaction times to incongruent angry targets compared to neutral trials. Regarding automatic and later stages of information processing, there was no attentional bias (AB) in BPD. None of the groups revealed biased attention for happy faces at any stages of information processing.
Limitations: We did not include a control group of PTSD patients without BPD. Therefore, we cannot rule out that the present AB in BPD is mainly due to PTSD-specific psychopathology.
Conclusions: These findings provide first evidence for an AB towards angry faces and difficulties disengaging from these threat-related social cues in adult BPD patients. Although BPD patients in general demonstrated an AB when compared with controls, this effect was especially pronounced for BPD with PTSD, suggesting a significant effect of trauma-related psychopathology on social attention in BPD.

1. Introduction

Maladaptive emotion-related information processing is one of the core features of borderline personality disorder (BPD) psychopathology (Baer, Peters, Eisenlohr-Moul, Geiger, & Sauer, 2012). Biased attention towards emotional, especially threat-related stimuli is assumed to contribute to the onset, development and maintenance of emotional disorders (Mathews & MacLeod, 2005; Williams, Mathews, & MacLeod, 1996). Increased or biased attention towards threat-signaling stimuli may occur in the presence of acute threat or danger (Öhman & Mineka, 2001; Rosen & Schulkin, 1998). However, in absence of acute threat, biased attention can be maladaptive, interfering with the adequate processing of other relevant or even corrective information (e.g. signs of safety) (Cisler & Koster, 2010; Eysenck, Derakshan, Santos, & Calvo, 2007). There is clear evidence for a threat-related attentional bias (AB) in anxious individuals and in patients with anxiety disorders at both automatic and more elaborate, conscious stages of information processing (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007).

Studies investigating biased attention in BPD mainly employed three experimental paradigms: the emotional Stroop task (EST; Williams et al., 1996), the visual search task (VST; Treisman & Gelade, 1980) and the visual dot-probe task (VDPT; MacLeod, Mathews, & Tata, 1986). On the whole, EST studies using verbal stimuli revealed that

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https://doi.org/10.1016/j.jbtep.2018.11.005
Received 2 August 2018; Received in revised form 14 November 2018; Accepted 22 November 2018
Available online 26 November 2018

BPD patients demonstrate an AB towards general negative and BPD-associated negative words (Kaiser, Jacob, Domes, & Arntz, 2017). Findings from VST studies in BPD are inconclusive: There is evidence for intact detection (Hepp et al., 2016) as well as for enhanced detection of emotional faces (Schulze, Domes, Köppen, & Herpertz, 2013) – independent of the emotional valence, whereas other findings instead suggest impaired, more controlled attention demanding processing of positive facial expressions (Hagenhoff et al., 2013).

In contrast to the EST and the VST, the VDPT allows for the assessment of different aspects of visual attention: initial allocation towards emotional stimuli vs. difficulties disengaging (Cisler & Koster, 2010; Koster, Crombez, Verschuere, & De Houwer, 2004; Mogg et al., 2000). Faster reactions to a probe at the primed location of an emotional target have been assumed to indicate emotional vigilance, whereas slower reactions have been considered to represent avoidance of emotional information (MacLeod et al., 1986). Koster et al. (2004) argued that vigilance to emotional targets as well as difficulties disengaging from emotional cues might contribute to the attentional bias in the VDPT and proposed to include control trials to differentiate the relative contribution of both processes in attentional processes.

A possible starting point for an explanation of the previously inconsistent findings might be the observation that the AB depends on the duration of stimulus presentation and thus possibly depends on whether early vs. late stages of information processing are under study (Bradley, Mogg, Falla, & Hamilton, 1998; Calvo & Avero, 2005). However, there is little research on AB in BPD that utilizes the VDPT to examine the time course of attentional allocation. Only two studies examined automatic emotion-related attention allocation, i.e., at early, non-conscious stages of information processing, towards emotional faces in adolescents with BPD or BPD-features (Jovev et al., 2011; von Ceumern Lindenstjerna et al., 2010b). Jovev et al. (2011) found evidence for an AB at 30 ms (i.e., at early stage of information processing) towards threat-related faces in BPD compared to non-patients (NP), specified as difficulties in disengaging attention. In contrast, Ceumern-Lindenstjerna (2010b) reported the existence of higher vigilance towards threat in BPD. Regarding emotional information processing at conscious, more controlled stages of attention (presentation duration of 200–500 ms), there is preliminary evidence for biased attention towards happy, but not towards threat-related facial expressions (Kaiser et al., 2017). With respect to attention towards emotional faces at later stages of attention (presentation duration of 1000 ms), the only existing study revealed no evidence of biased attention in adolescents with BPD (von Ceumern Lindenstjerna et al., 2010a). Exploratory analyses yielded rather a state-dependent AB in adolescents with BPD, indicated by an inability to disengage attention from threatening faces when in negative or neutral mood, and by an avoidance of threat compared to NP and clinical controls when in positive mood.

The inconsistent findings so far may also be due to differences amongst studies regarding the computation of AB scores (e.g., only Jovev et al. (2011) pursued the approach of Koster et al. (2004)) and due to the high heterogeneity of symptom patterns observed in BPD (Tomko, Trull, Wood, & Sher, 2014). It should be noted that only one VDPT study investigated adults fulfilling the full diagnostic criteria of BPD and demonstrated that traumatic childhood experiences are associated with biased attention in adults with BPD (Brüne et al., 2013). This is especially relevant because BPD patients often report childhood abuse (Battle et al., 2004; Lobbestael, Arntz, & Bernstein, 2010). Furthermore, there are high rates (30–60%) of comorbid posttraumatic stress disorder (PTSD) in BPD (Pagura et al., 2010; Zanarini et al., 1998).

There is evidence for an AB regarding trauma-associated stimuli and threat-related facial expressions in PTSD (e.g., Bryant & Harvey, 1997; Dalgleish et al., 2003; Fani et al., 2012; McNally, Kaspi, Riemann, & Zeitlin, 1990; Pine et al., 2005; Schönenberg & Abdelrahman, 2013; Vythilingam et al., 2007). Hence, the question arises whether PTSD is one of the crucial factors potentially involved in the development or maintenance of observed biased attention towards threat in BPD patients. Accordingly, comorbid PTSD has been found to affect emotion-related processes in BPD (e.g., Brüne et al., 2013; Dyck et al., 2009; Unoka, Fogd, Füzy, & Csukly, 2011; Wingenfeld et al., 2009). Initial findings from EST studies suggest that BPD and PTSD interact to produce an AB towards negative information: Wingenfeld et al. (2009) observed an AB towards personally relevant negative words only in BPD patients with PTSD, but not in BPD patients without PTSD. In turn, biased attention towards body-related (e.g., 'face') words in PTSD patients was associated with comorbid BPD (Witthöft, Borgmann, White, & Dyer, 2015).

The present study focused on the hypothesis that patients with BPD show biased attention towards threat-related social stimuli using a VDPT. Angry facial expressions have been previously used as a prototypical social stimulus for investigating AB towards threat (Fox, Russo, & Dutton, 2002). From an evolutionary perspective, anger is considered as a salient sign for danger or threat (Öhman, Lundqvist, & Esteves, 2001; Shasteen, Sasson, & Pinkham, 2015). From a clinical perspective, BPD patients in particular tend to perceive the world and others as dangerous and malevolent in terms of a predominant cognitive schema (Arntz, Weertman, & Salet, 2011). We hypothesized that BPD patients exhibit biased attention towards angry facial expressions. We further assumed that this bias would be pronounced for stimuli presented long enough to be processed consciously. We thus varied the presentation duration of primes along the continuum from automatic to more elaborate processing. In addition, we aimed at exploring the underlying process involved, i.e. whether the presumed AB is mainly driven by either threat-related vigilance or difficulties disengaging from social threat cues. Moreover, to test for the specificity of biased attention in BPD we included a clinical control group (CC). Finally, we explored the effect of trauma-associated psychopathology by comparing subgroups of BPD patients exhibiting PTSD vs. those without comorbid PTSD.

2. Material and methods

2.1. Participants

One hundred and fifty-seven women were recruited at five centers in Maastricht (NL), Heerlen (NL) Lübeck (DE), Hamburg (DE) and Freiburg (DE). The study protocol was approved by the ethics committees at the respective local sites. Written-informed consent was obtained in all cases. The BPD group consisted of 24 patients with comorbid PTSD and 46 patients without PTSD, the CC group of 35 patients with Cluster-C personality disorder and the NP group of 52 participants. All BPD patients had a primary diagnosis of BPD (DSM-IV) and scored above 20 points on the BPD Severity Index (BPDSI; Giesen-Bloo, Wachters, Schouten, & Arntz, 2010). CC patients fulfilled criteria for at least one Cluster-C personality disorder, but did not fulfill more than two criteria of BPD and did not meet a full or sub-threshold Cluster-B personality disorder. NP had never been diagnosed with mental illness.

BPD patients were recruited within the context of a randomized controlled trial on group Schema therapy to treatment-*as*-usual (Wetzelaer et al., 2014). As BPD patients with and without PTSD were not specifically recruited for the study, the number of patients in the subgroups differed substantially. There is a considerable overlap between the present sample and the samples of three previous studies (Baczkowski et al., 2017; Kaiser et al., submitted for publication; van Zutphen et al., 2018). The CC group was recruited at the clinical sites at the treatment centers; NPs were recruited by an advertisement placed in the treatment centers and in the community.

Subjects were excluded if they had diagnoses of lifetime psychotic disorder, bipolar disorder type-1, attention deficit hyperactivity disorder, dissociative identity disorder, current substance dependence, a full or sub-threshold narcissistic or antisocial PD, or serious physical illness. Individuals with an IQ below 70 and/or insufficient language proficiency to understand the study instructions were also excluded. We excluded participants who were taking benzodiazepines and neuroleptics on a regular basis.

2.2. Diagnostic instruments

All subjects underwent the Structured Clinical Interview for DSM-IV axis I disorders (SCID-I; First, Spitzer, & Williams, 1997; Groenestijn, Akkerhuis, Kupka, Schneider, & Nolen, 1999; Wittchen, Wunderlich, Gruschwitz, & Zaudig, 1997), and axis II disorders (SCID-II; First, Gibbon, Spitzer, & Benjamin, 1997; Fydrich, Renneberg, Schmitz, & Wittchen, 1997; Weertman, Arntz, Dreessen, Velzen, & Vertommen, 2003) to assess DSM-IV diagnoses. Severity of BPD symptoms was assessed with the BPD-Checklist (Giesen-Bloo, Arntz, & Schouten, 2006). The BPDSI (Giesen-Bloo et al., 2010) was only conducted in the BPD group. General psychopathology was assessed with the Brief Symptom Inventory (BSI; Derogatis, 1993). The Wechsler Abbreviated Scale of Intelligence (WASI; The Psychological Corporation, 1999) was conducted to measure IQ. The Interview for Traumatic Events in Childhood (ITEC; Lobbestael, Arntz, Harkema-Schouten, & Bernstein, 2009) was used to assess traumatic experiences. Raters were clinically trained and experienced assessors.

2.3. General procedures

Participants received general information about the study. After informed consent was obtained, a diagnostic phase followed including the SCID-I and −II interview, the BPDSI interview, and questionnaires on BPD-specific symptoms (BPD-Checklist), general psychiatric symptoms (BSI), and demographic and medical information. Afterwards, participants underwent the WASI and the ITEC. For the facial dot-probe task participants were seated in a comfortable chair in front of a PC running Presentation (Neurobehavioral Systems, Berkeley, CA, USA) for stimulus presentation and response recording.

2.4. Facial dot-probe task (FDPT)

Black-and-white angry, happy and neutral facial expressions (20 male/female actors) were selected from the Karolinska Directed Emotional Faces Database (Lundqvist, Flykt, & Öhman, 1998). Each trial started with a fixation cross with an average duration of 1250 ms (1000–1500 ms) (Fig. 1). After the offset, an emotional facial target prime (angry [A]/happy [H]) each paired with a neutral [N] distractor face of the same person or the control condition (two neutral facial primes [N−N]) appeared on a PC-screen in one of three presentation duration conditions (100 ms, 600 ms, 1200 ms). Then, a dot-probe was presented at the location of the previous emotional target (congruent location) or the neutral face (incongruent location). The participants' task was to indicate the probe's location by pressing one of two buttons as quickly and accurately as possible. Then, a blank screen appeared for 2000–3000 ms before the next trial started. The emotional target primes and dot-probes were presented equally often at the left and right position. Trial-order was randomized for each participant. The task included 18 conditions (three emotional target primes x three presentation time conditions x two probe locations) with 20 trials each, which resulted in 360 trials in total. The experiment was presented in four blocks (80 trials/block) with breaks of 30 s and lasted approximately 15–20 min in total.

2.5. Data preparation

AB scores were calculated by subtracting the mean reaction time (RT) when the probe was in the congruent location as the emotional primes (A/H face) from the mean RT when the probe was in the incongruent location as the emotional primes (A/H face). The congruency effect was indicated by faster RT to congruent primes than to incongruent primes. Subsequently, we inspected if the congruency effect was due to vigilance or difficulties in disengagement. Vigilance, i.e. heightened attention allocation to the emotional prime, was represented by faster mean RT to congruent emotional primes compared to mean RT to neutral primes. Difficulty in disengagement from the emotional prime was indicated by slower mean RT to incongruent emotional primes compared to neutral primes.

Behavioral data were excluded in cases of false-hits in the FDPT as well as responses with median RTs to probes < 300 and > 1500 ms to exclude potentially invalid responses (cf. Domes et al., 2013). Subjects with valid hits < 95% in one of the three presentation time conditions were excluded ($n_{total} = 12$ (7.1%), $n_{BPD} = 8$ (10.25%), $n_{CC} = 3$ (7.89%), $n_{NP} = 1$ (5.5%)). The mean number of excluded trials per participant was 4.62 ± 3.59 (1.28%). The mean number of removed RTs to probes per participant was 2.23 ± 2.45 (0.062%); the mean number of excluded false-hits per participant was 2.40 ± 2.57 (0.067%).

2.6. Statistical analysis

Demographic and clinical characteristics between all study groups were analyzed using univariate analyses of variance (ANOVA) and Student's *t*-test. To check for RT group differences irrespective of emotional primes, we inspected the mean RT to N-−N primes by conducting a 3 x 3 mixed design ANOVA, which included the between-factor group (BPD patients, CC, NP) and the within-factor presentation duration (100 ms, 600 ms, 1200 ms). The congruency effect was tested by using 3 x 2 x 3 mixed design ANOVA, which included the between-factor group (BPD patients, CC, NP) and the two within-subject factors emotional valence of the facial primes (angry, happy) and presentation duration (100 ms, 600 ms, 1200 ms). In the case of the presence of the congruency effect, we examined if it was due to vigilance towards or difficulties in disengagement from the emotional stimuli (Koster et al., 2004).

For this purpose, post-hoc ANOVAs and paired sample *t*-tests were conducted, which included the independent variable valence of prime

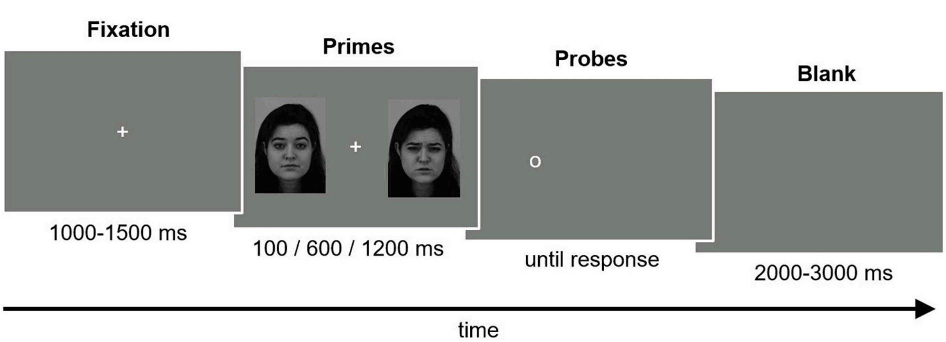

Fig. 1. Trial structure of the experiment. Participants viewed an instruction before each block. A single trial started with a fixation cross presented for 1000–1500 ms. Then, an emotional target prime (angry-neutral; happy-neutral) or control condition prime (neutral-neutral) appeared for 100 ms, 600 ms or 1200 ms. Thereafter, a dot-probe was presented at the location of the previous emotional target (congruent location) or the neutral face (incongruent location). Subjects were instructed to indicate the probe-location by pressing one of two buttons as quickly and accurately as possible using a response device. Then, a blank screen appeared for 2000–3000 ms.

(neutral primes [N-—N] versus congruent/incongruent emotional primes [e.g., A-N]).

To explore the role of comorbid PTSD regarding the assumed AB in BPD, we analyzed BPD subgroups, i.e. BPD patients with PTSD and without PTSD, with respect to the congruency effect by using a 4 x 2 x 3 mixed design ANOVA with the between-factor subgroup (BPD+, BPD-, CC, NP) and the two aforementioned within-subject factors. If the congruency effect emerged, we again used post-hoc ANOVAs and paired sample *t*-tests to analyze the underlying mechanism (vigilance versus difficulties in disengagement).

In the case of heterogeneous variance, the Greenhouse-Geisser correction was applied. For all analyses, statistical significance was set at $p < .05$. Effect sizes are provided as explained variances (partial eta squared [η^2]). In the case of significant group effects, we used simple contrasts (contrast 1: BPD patients vs. CC; contrast 2: BPD patients vs. NP; contrast 3: BPD+ vs. BPD-; contrast 4: BPD+ vs. CC; contrast 5: BPD+ vs. NP). All calculations were done with SPSS for Windows (Version 22).

3. Results

3.1. Sample characteristics

Demographic and clinical characteristics of the study groups are depicted in Table 1. Participants were matched for age on group level ($p = .234$). First, we provide the sample characteristics for the whole BPD group, including both BPD patients with and without comorbid PTSD. The BPD group exhibited a lower IQ than the NP ($p = .013$) and a lower number of years of education than the control groups ($p < .001$). As expected, BPD patients revealed more general psychiatric symptoms in the BSI ($p < .001$) and more BPD symptoms in the BPD-Checklist ($p < .001$) than the control groups. BPD patients reported more severe traumatic experiences – assessed with the ITEC – than CC and NP ($ps \le .001$) aside from the physical neglect scale, ($p = .355$). With the exceptions of the sexual abuse scale ($p = .278$) and the physical neglect scale ($p = 1.000$), CC mentioned more severe traumatic experiences than NP ($ps \le .014$). BPD patients with PTSD and without PTSD did not differ regarding IQ, years of education general, psychiatric symptoms in the BSI, and BPD symptoms in the BPD-Checklist ($p > .05$). Regarding the ITEC, BPD subgroups differed in the scales regarding physical abuse, emotional abuse, and emotional neglect ($p < .05$). With regard to current co-morbidities and medication (see Table 2), patients with BPD had higher number of comorbid current axis-I mental disorders ($p = .028$) and higher rates of comorbid personality disorders ($p < .001$) than CC. Furthermore, patients with BPD did not differ in the number of medications compared to CC ($p = .127$).

3.2. Attentional bias ("congruency effect")

Regarding the average RT to neutral primes, no significant group differences emerged at the different presentation durations (all $F[2,154] < 1.00$, $ps > .50$, $\eta^2s < .01$) (for details see supplementary table 1).

In the three-way ANOVA on the AB, the *group* x *emotion* x *duration* interaction did not reach significance ($F[4,308] = 1.94$, $p = .103$, $\eta^2 = .025$) – Fig. 2a–c (for the different attentional bias scores see Table 3). To specifically test for the hypothesized AB for angry faces at different presentation durations, we calculated two-way ANOVAs for each presentation duration separately with the between-factor *group* and the within-factor *emotion* of the primes. With respect to the 600 ms presentation duration, a significant *group* × *emotion* interaction emerged ($F[2,154] = 3.24$, $p = .042$, $\eta^2 = .04$) – Fig. 2b. Post-hoc one-way ANOVA revealed that this interaction was mainly driven by a significant *group* effect for angry faces ($F[2,154] = 3.69$, $p = .027$, $\eta^2 = .046$). BPD patients demonstrated significantly higher AB scores than CC ($p = .011$), but did not differ from NP ($p = .079$). Furthermore, sample paired *t*-tests revealed significantly higher AB scores for 600 ms presented angry faces than in happy faces in the BPD group ($t[69] = 2.09$, $p = .04$). However, this was not the case for CC and NP. No significant group effect was demonstrated for happy faces ($F[2,154] = 0.61$, $p = .544$, $\eta^2 = .008$). Regarding the short and the long presentation durations (100 and 1200 ms), the main effects of group and the group × emotion interactions were not significant (all $p \ge .21$) – Fig. 2a and c.

Table 1
Demographics and clinical characteristics of the study groups.

	BPD total ($n = 70$)	BPD+ ($n = 24$)	BPD- ($n = 46$)	CC ($n = 35$)	NP ($n = 52$)	Statistics[a]			Statistic[b]		
	M ± *SD*	*M* ± *SD*	*M* ± *SD*	*M* ± *SD*	*M* ± *SD*	*F*	*df*[c]	*p*[d]	*F*	*df*[c]	*p*[d]
Age	31.5 ± 9.6	32.2 ± 11.3	31.2 ± 8.8	31.4 ± 11.1	28.6 ± 10.0	1.464	2,154	.234	1.029	3,153	.382
WASI	95.9 ± 8.0	95.1 ± 7.4	96.3 ± 8.4	98.4 ± 9.8	101.0 ± 10.8	4.429	2,154	.0131	3.023	3,153	.0325
Years of Education	12.0 ± 2.7	11.9 ± 2.5	12.1 ± 2.8	13.6 ± 2.4	13.8 ± 2.8	8.042	2,154	< .001[2]	5.345	3,153	< .01[5]
BSI	1.7 ± 0.6	1.8 ± 0.7	1.6 ± 0.5	1.0 ± 0.5	0.2 ± 0.3	144.0	2,153	< .001[3]	99.08	3,152	< .001[6]
BPD-Checklist	113.8 ± 24.2	113.3 ± 23.6	114.8 ± 25.8	74.9 ± 22.0	53.8 ± 9.7	139.5	2,151	< .001[3]	92.46	3,150	< .001[6]
ITEC											
Sexual abuse	9.2 ± 9.8	14.2 ± 11.8	6.6 ± 7.4	3.4 ± 7.2	0.1 ± 0.4	16.53	2,133	< .001[4]	17.67	3,132	< .001[7]
Physical abuse	16.7 ± 11.2	23.0 ± 11.6	13.4 ± 9.5	8.9 ± 12.3	1.7 ± 3.6	25.08	2,133	< .001[3]	23.72	3,132	< .001[8]
Emotional abuse	19.9 ± 8.1	23.6 ± 9.1	18.0 ± 6.8	13.8 ± 9.2	2.8 ± 4.6	55.28	2,133	< .001[3]	42.05	3,132	< .001[8]
Emotional neglect	10.7 ± 7.0	12.3 ± 6.7	9.9 ± 7.1	6.9 ± 6.8	0.9 ± 2.1	28.85	2,133	< .001[3]	20.26	3,132	< .001[8]
Physical neglect	0.2 ± 0.9	0.3 ± 1.0	0.2 ± 0.8	0.1 ± 0.6	0.0 ± 0.0	1.044	2,133	.355	0.935	3,132	.426

Note. BPD = borderline personality disorder. BPD+ = BPD with posttraumatic stress disorder (PTSD). BPD- = BPD without PTSD. CC = cluster C personality disorder. NP = non-patients. WASI = Wechsler abbreviated scale of intelligence. BSI = Brief Symptom Inventory. ITEC = Interview for traumatic events in childhood.

[1] BPD differed significantly from NP, $p < .05$. [2] BPD differed significantly from controls, $p < .05$. [3]All groups differed significantly from each other, $p < .05$. [4] BPD differed significantly from controls, $p < .01$. [5] Both BPD subgroups differed significantly from NP, $p < .05$. [6] All groups differed significantly from each other except of BPD subgroups, $p < .001$. [8] BPD+ differed significantly from all others, $p < .01$; BPD-differed significantly from NP, $p < .01$. [8] All groups differed significantly from each other except of BPD- and CC, $p < .05$.

[a] BPD vs. CC vs. NP.

[b] BPD+ vs. BPD-vs. CC vs. NP.

[c] Degrees of freedom may vary because of missing data.

[d] All post-hoc single comparisons were carried out using *t*-tests with Bonferroni correction for multiple testing.

Table 2
Axis I and II diagnoses and medication in BPD and CC patients.

	BPD total (n = 70)		BPD+ (n = 24)		BPD-(n = 46)		CC (n = 35)	
	n	(%)	*n*	(%)	*n*	(%)	*n*	(%)
SCID-I								
Substance[a]	7	(10)	4	(16.7)	3	(6.5)	1	(3.5)
Mood[b]	44	(62.9)	17	(70.8)	27	(58.7)	14	(40.0)
Anxiety[c]	44	(62.9)	20	(83.3)	24	(52.2)	12	(34.3)
PTSD	24	(34.3)	24	(100)	0	(0)	3	(8.6)
Somatoform	5	(7.1)	2	(8.3)	3	(6.5)	6	(17.1)
Eating[d]	24	(34.3)	14	(58.2)	10	(21.7)	11	(31.4)
M ± SD # current disorders[e,f,1,2]	1.8	± 1.0	2.2	± 1.0	1.6	± 1.0	1.3	± 0.9
SCID-II								
Paranoid	17	(24.3)	8	(33.3)	9	(19.6)	1	(3.5)
Schizoid	1	(7)	1	(4.2)	0	(0)	0	(0)
Schizotypal	1	(7)	0	(0)	1	(2.2)	0	(0)
Avoidant	28	(40)	14	14		18	(51.4)	
Dependent	8	(11.4)	2	(8.3)	6	(13)	5	(14.3)
Obsessive-compulsive	14	(20)	6	(25)	8	(17.4)	12	(34.3)
M ± *SD* # PD[b,c,3,4]	1.99	± 1.2	2.3	± 1.2	1.8	± 1.1	1.0	± 0.6
Medication								
No medication	34	(48.6)	13	(54.2)	24	(52.2)	22	(62.9)
Number of medications n = 1	27	(38.6)	6	(25)	21	(45.7)	11	(31.4)
Number of medications n = 2	9	(12.9)	5	(20.8)	4	(8.7)	2	(5.7)
M ± *SD* # medication[b,5,6]	0.64	± 0.7	0.7	± 0.9	0.6	± 0.7	0.4	± 0.6
SSRI	18	(25.7)	4	(16.7)	14	(30.4)	7	(20)
SSNRI	13	(18.6)	6	(25)	7	(15.2)	2	(5.7)
TCAs	10	(14.3)	3	(12.5)	7	(15.2)	4	(11.4)
Melantonin	3	(4.3)	2	(8.3)	1	(2.2)	1	(2.9)
Stimulants	1	(1.4)	1	(4.2)	0	(0)	0	(0)

Note. BPD = borderline personality disorder. BPD+ = BPD with posttraumatic stress disorder (PTSD). BPD- = BPD without PTSD. CC = cluster C personality disorder. SSRI = selective serotonin reuptake inhibitors. SSNRI = selective serotonin noradrenalin reuptake inhibitors. TCAs = tricyclic antidepressants. [a] Cannabis, cocaine, opiates, alcohol, polysubstance. [b] Depressive disorders, and dysthymia. [c] Social phobia, agoraphobia, panic disorder, specific phobia, generalized anxiety disorder, hypochondria, obsessive compulsive disorder, and adjustment disorder. [d] Anorexia nervosa, bulimia nervosa, and eating disorder, not other specified. [e] PTSD not included. [f] All post-hoc single comparisons were carried out using *t*-tests with Bonferroni correction for multiple testing. [c] BPD included.
[1] BPD total vs. CC, $F[1103] = 4.969, p = .028$. [2] BPD + vs. BPD-vs. CC, $F[2102] = 5.887, p = .004$; BPD + differed significantly from BPD- and CC, $p < .05$. [3] BPD total vs. CC, $F[1103] = 21.595, p < .001$ [4] BPD + vs. BPD-vs. CC $F[2102] = 12.833, p < .001$; both BPD groups differed significantly from CC, $p < .01$. [5] BPD total vs. CC, $F[1103] = 2.366, p = .127$. [6] BPD + vs. BPD-vs. CC, $F[2102] = 1.195, p = .307$.

3.3. Exploratory analyses – BPD subgroups

To test whether the AB towards angry faces for the 600 ms presentation duration was associated with comorbid PTSD, subgroups of BPD+ and BPD- were compared to the two control groups regarding the 600 ms presentation duration condition – Fig. 2e. Although the *group* × *emotion* interaction for the 600 ms duration was not statistically significant ($F[3,153] = 2.41$, $p = .069$, $\eta^2 = .045$), we decided to calculate post-hoc one-way ANOVAs, which revealed that this interaction was mainly driven by a significant *group* effect for angry faces ($F[3,153] = 3.33$, $p = .021$, $\eta^2 = .061$), while no such effect occurred for happy faces ($F[3,153] = 0.44$, $p = .726$, $\eta^2 = .009$). BPD+ demonstrated higher AB scores for angry faces than NP ($p = .018$) and CC ($p = .003$), but not compared to BPD- ($p = .113$). Moreover, we found higher AB scores for angry faces than for happy faces only in BPD+ ($t[23] = 2.03$, $p = .054$), but not in BPD- ($t[45] = 1.16$, $p = .251$). Regarding the short and the long presentation durations (100 and 1200 ms), the main effects of group and the group × emotion interactions were not significant (all $p \geq .384$) – Fig. 2d and f.

3.4. Vigilance versus difficulties in disengagement

We inspected whether the observed congruency effect towards angry faces in BPD patients regarding the 600 ms presentation duration condition was due to vigilance or difficulties disengaging using a two-way ANOVA – Fig. 3a. The *group* x *vigilance vs. difficulties in disengagement* interaction did not yield a significance effect ($F[2,154] = 0.261$, $p = .771$, $\eta^2 = .003$). Using separate exploratory one-way ANOVAs to test the underlying mechanism for the congruency effect, we did not find a main effect neither for vigilance ($F[2,154] = 2.231$, $p = .111$, $\eta^2 = .028$) nor for difficulties in disengagement ($F[2,154] = 0.703$, $p = .497.$, $\eta^2 = .009$). Apparently, both attentional mechanisms (vigilance and difficulties disengaging) contributed to the observed congruency effect towards angry faces in BPD patients when inspecting group differences. Furthermore, we explored potentially underlying mechanisms regarding the observed biased attention within the groups by calculating two separate paired sample *t*-tests. BPD patients did not reveal faster RT to congruent angry primes ($M = 527.55$, $SD = 98.20$) compared to neutral control primes ($M = 533.24$, $SD = 105.07$; $t[69] = -1.79$, $p = .077$). However, BPD patients demonstrated significant slower RT to incongruent angry primes ($M = 544.19$, $SD = 99.09$) compared to neutral control primes ($t[69] = 2.62$, $p = .011$), which supports the difficulties in disengagement hypothesis. CC did not demonstrate significant RT differences when comparing neutral primes ($M = 551.53$, $SD = 114.65$) to congruent primes ($M = 558.00$, $SD = 127.44$) ($t[34] = 1.28$, $p = .210$) or incongruent primes ($M = 556.51$, $SD = 117.66$) ($t[34] = 0.91$, $p = .367$). The same was true for NP regarding the differences between neutral primes ($M = 526.25$, $SD = 86.41$) and congruent ($M = 525.50$, $SD = 91.08$; $t[51] = -0.19$, $p = .848$) or incongruent primes ($M = 531.11$, $SD = 91.81$; $t[51] = 1.33$, $p = .190$).

For the BPD subgroups, we further explored whether the AB towards angry faces in BPD+ patients was due to vigilance or difficulties in disengagement by using a two-way ANOVA – Fig. 3b. Again, the *group* x *vigilance vs. difficulties in disengagement* interaction was not significant ($F[3,153] = 0.224$, $p = .880$, $\eta^2 = .004$). When calculating two separate exploratory ANOVAs, we did not find a significant main effect for vigilance ($F[3,153] = 1.609$, $p = .190$, $\eta^2 = .031$) nor for difficulties in disengagement ($F[3,153] = 0.915$, $p = .435.$, $\eta^2 = .018$). In addition,

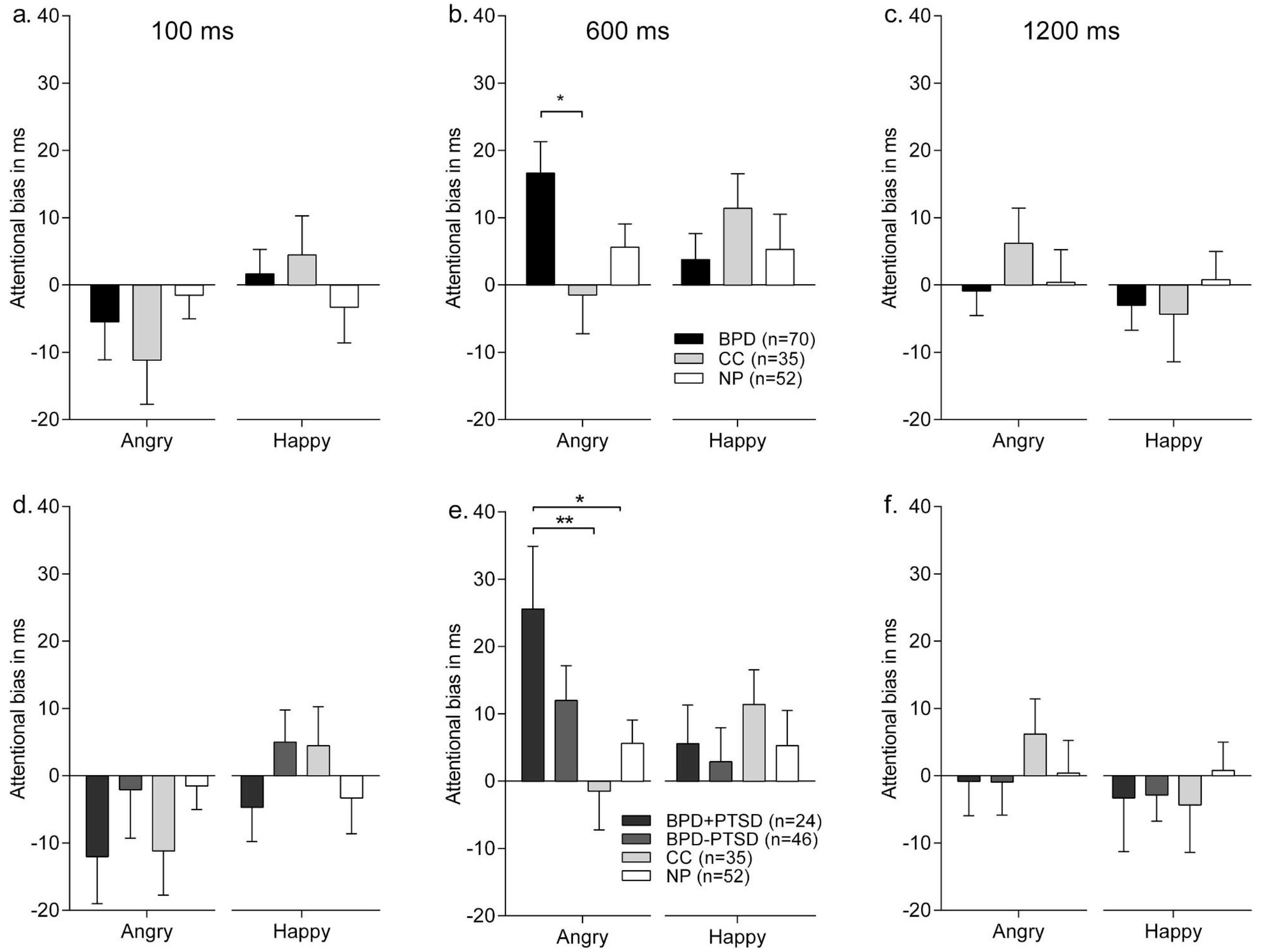

Figure 2. Attentional bias (AB) – congruency effect in the facial dot-probe task at different presentation durations. Upper row: Borderline personality disorder (BPD) patients compared to clinical control (CC) patient with Cluster-C personality disorders and non-patients(NP) control group. Lower row: BPD with posttraumatic stress disorder (PTSD) compared to BPD without PTSD and the two control groups.

Table 3
Attentional bias ("congruency effect") scores for angry and happy faces at 100, 600, and 1200 ms presentation duration.

	BPD total (n = 70)	BPD+ (n = 24)	BPD-(n = 46)	CC (n = 35)	NP (n = 52)
	$M \pm SD$	$M \pm SD$	$M \pm SD$	$M \pm SD$	$M \pm SD$
100 ms					
Angry	−5.5 ± 47.2	−12.0 ± 43.4	−2.1 ± 49.1	−11.2 ± 39.0	−1.5 ± 25.3
Happy	1.7 ± 30.3	−4.7 ± 25.0	5.0 ± 32.5	4.5 ± 34.4	−3.3 ± 38.2
600 ms					
Angry	16.6 ± 39.3	25.6 ± 45.7	12.0 ± 35.0	−1.5 ± 34.7	5.6 ± 25.2
Happy	3.8 ± 32.2	5.6 ± 28.1	2.9 ± 34.5	11.4 ± 30.3	5.3 ± 37.7
1200 ms					
Angry	−0.9 ± 30.6	−0.8 ± 25.0	−0.9 ± 33.4	6.2 ± 31.1	0.4 ± 35.0
Happy	−3.0 ± 30.9	−3.3 ± 39.0	−2.9 ± 26.3	−4.3 ± 41.9	0.8 ± 30.2

Note. BPD = borderline personality disorder. BPD+ = BPD with posttraumatic stress disorder (PTSD). BPD- = BPD without PTSD. CC = cluster C personality disorder. NP = non-patients. A = angry. H = happy.

we also explored potentially underlying mechanisms regarding the observed biased attention within the groups by calculating two separate paired sample t-tests. The results are in favor of the difficulties in disengagement hypothesis, as BPD+ had significant slower RT to incongruent angry primes (M = 544.19, SD = 99.09) compared to neutral primes (M = 533.24, SD = 105.07) (t[23] = 2.14, p = .043). Against the vigilance hypothesis, BPD+ did not demonstrate faster RT to congruent angry primes (M = 527.55, SD = 98.20) compared to neutral primes (t[23] = −1.68, p = .106). However, the BPD- did not reveal significant RT differences when comparing neutral primes (M = 521.98, SD = 100.73) to congruent (M = 513.42, SD = 99.53) (t[45] = −1.04, p = .306) or incongruent primes (M = 538.98, SD = 94.21) (t[45] = 0.1.62, p = .113).

3.5. Potential covariates – IQ, trauma, and depressive symptoms

BPD patients had a significant lower IQ than NP. Therefore, we inspected the association of IQ and the AB towards angry faces for the 600 ms presentation duration. We also examined the association between IQ and difficulties disengaging from angry faces for the 600 ms

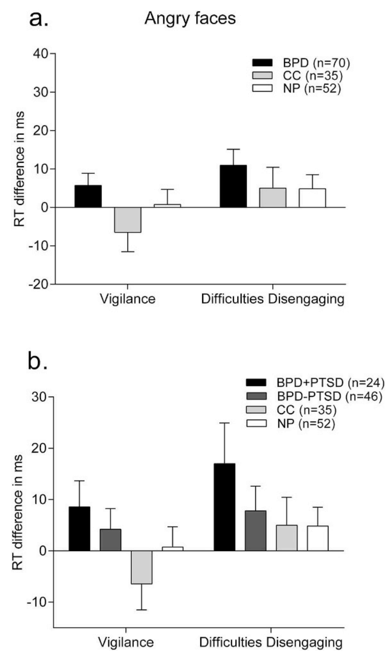

Figure 3. Vigilance vs. difficulties in disengaging calculated for angry faces for the 600 ms presentation duration. a. reaction time (RT) (non-target) minus RT(congruent); b. RT(incongruent) minus RT(non-target). BPD = borderline personality disorder; PTSD = posttraumatic stress disorder; CC = clinical controls with Cluster-C personality disorders; NP = non-patients.

presentation duration. We did not find a significant correlation between IQ and the tested variables, neither within the entire group of BPD patients nor within the BPD+ (all $r \leq 0.081$, all $p \geq .519$). Furthermore, we inspected the association between the severity of traumatization (measured with the ITEC) and the AB towards angry faces for 600 ms presentation duration and difficulties in disengaging from angry faces. ITEC scales did not correlate substantially with the AB or difficulties disengaging scores (all $r \leq 0.167$, all $p \geq .167$) with the exception of the significant positive correlation between the ITEC subscale 'physical neglect' and the AB towards angry faces for 600 ms presentation duration ($r = 0.438$, $p = .032$). In addition, more than 60% of the BPD patients had a comorbid mood disorder. We inspected the association between the severity of depressive symptoms (measured with the BSI subscale 'depression') and the AB towards angry faces for 600 ms presentation duration and difficulties in disengaging from angry faces. The BSI subscale 'depression' did not correlate substantially with the AB or difficulties disengaging scores (all $r \leq 0.111$, all $p \geq .360$).

4. Discussion

The present study investigated attention towards social cues in adult female BPD patients and hypothesized that BPD patients demonstrate biased attention towards threat-related stimuli presented long enough to be processed consciously. In addition, we examined which subprocess – vigilance or difficulties in disengaging – might underlie the assumed AB using a modified facial dot-probe task. Furthermore, we explored the potential effect of comorbid PTSD on threat-related attention in BPD.

BPD patients revealed an AB towards angry facial expressions at a more controlled stage of information processing when compared to a non-patient control group as well as compared to a CC group with Cluster-C personality disorders. Thus, the present results extends previous findings as the AB to social threat appeared to be specific for BPD patients rather than being related to general psychopathology (Berenson et al., 2009; Brüne et al., 2013; von Ceumern Lindenstjerna et al., 2010b). Both BPD patients and patients with Cluster-C personality disorders are characterized by strong expectations of rejection or threat in social relationships, and by beliefs of being inferior or unattractive (Arntz et al., 2011; Arntz & Veen, 2001). However, BPD patients did not show an AB towards angry facial stimuli at automatic, i.e. uncontrolled, and at later, more elaborate stages of information processing. This is in line with Jovev et al. (2012), who did not find that adolescents with BPD features demonstrated an AB towards angry facial expressions at automatic stages of attention. However, the results of Jovev et al. (2012) indicate that adolescents with BPD features have an AB towards fear at automatic stages of attention, which suggests that angry and fearful facial expressions are processed differently in spite of the common categorization as threat-related stimuli.

Notably, difficulties disengaging from the threat-related information seemed to contribute to the overall AB to a greater extent than a tendency to initially allocate attention (vigilance). According to the model of Cisler and Koster (2010), vigilance related initial threat detection might be mostly automatic and thus observable at very short presentation times. In contrast, effortful threat avoidance may be mostly a strategic and controlled process and thus prominent at relatively long presentation times. Difficulties in disengaging from threat-related social information may be based on both automatic and strategic processes and might thus contribute to an overall AB mainly at medium presentation times as in the present study. Future studies are needed to further explore the association between the presumed processes involved in attention allocation and emotion processing in BPD and (comorbid) anxiety disorders.

Regarding positive facial expressions, BPD patients did not reveal any attentional abnormalities when compared with CC or NP at all stages of information processing examined. This is in contrast to findings from a recent meta-analysis summarizing the preliminary literature, providing the first aggregated evidence for an AB towards positive stimuli in BPD (Kaiser et al., 2017). Differences in patient samples might explain the divergent findings, since these findings are mainly based on samples with adolescents who did not fulfil the full diagnosis of BPD (Berenson et al., 2009; von Ceumern Lindenstjerna et al., 2010b). Furthermore, differences regarding the experimental paradigms (e.g., only one study included N-–N trials; varying presentation durations for examining the same stage of processing) employed and thus the specific process under study might explain the inconsistent findings.

Although BPD patients in general demonstrated a threat-related AB when compared with CC and NP, this effect was especially pronounced for the group of BPD with comorbid PTSD. Taking this into consideration, the question arises whether the observed threat-related AB in BPD is rather a PTSD-specific phenomenon than a specific maladaptive emotion-related cognitive process in BPD patients. Indeed, there is evidence for a threat-related attentional bias in PTSD patients which has been associated with trauma-related anxiety and hypervigilance (Bryant & Harvey, 1997; Felmingham, Rennie, Manor, & Bryant, 2011; Kimble, Fleming, Bandy, Kim, & Zambetti, 2010). From another perspective, both BPD and PTSD patients have maladaptive self- and other-focused beliefs, which might result from (early childhood) traumatic experiences, emotional or physical abuse and neglect. These dysfunctional beliefs might play a significant role in the development and maintenance of the respective disorder and might explain in part a cognitive bias towards potentially threatening social cues. From a clinical perspective, changes in posttraumatic cognitions and PTSD severity are assumed to be crucial with regard to improvements in functional outcomes in patients with BPD and PTSD (Harned, Rizvi, & Linehan, 2010; Harned, Wilks, Schmidt, & Coyle, 2018). Further research is needed to elucidate the role of trauma-related anxiety on affective or social attention in BPD patients.

The present study has some limitations: First, we cannot rule out a possible gender-specific effect of the threatening stimuli (male vs. female faces), although this could be an interesting question for future studies (; Öhman, Juth, & Lundqvist, 2010; Wieser, Pauli, Alpers, &

Mühlberger, 2009). In addition, the present findings are restricted to women with BPD. As BPD symptoms differ between men and women (Grant et al., 2008; Zanarini et al., 2011), future studies could include men with BPD to directly compare alterations in social information processing with those observed in women. To further investigate the role of trauma and PTSD on social attention, future studies could include – in an *a priori* approach – a clinical control group of patients with the primary diagnosis of PTSD and a subgroup of BPD patients with PTSD with a higher sample size than in the present study. Moreover, we did not differentiate between traumatic experiences during childhood and later traumatization with respect to threat-related AB. Approximately 76% of the present BPD patients did not have a comorbid PTSD, while 74.3% had experienced sexual and 94.3% physical abuse during childhood. Furthermore, no state measures of emotional arousal, fear or acute dissociative symptoms were obtained in the present study. Thus, we cannot rule out that the biased attention to angry facial expressions in BPD patients – especially with comorbid PTSD – was due to altered state-arousal, fear or acute symptoms of dissociation during stimulus presentation. Also, BPD patients were recruited within the context of a psychotherapy study, whereas CC patients were recruited at the clinical sites of the treatment centers, which might have resulted in biased samples with respect to both patient groups. Finally, we included patients who were treated with psychoactive medication. Although there was no overall effect of drug treatment on reaction times, we cannot rule out subtle effects of medication on performance in the dot-probe task, especially when it comes to differences between medication classes. However, pharmacological treatment is rather the rule than the exception in BPD, thus the present sample seems to be representative for the BPD population in clinical settings.

In sum, the present facial dot-probe study extends previous findings regarding biased information processing in BPD by providing the first evidence for difficulties disengaging from angry facial stimuli, mainly in female BPD patients with comorbid PTSD. This finding contradicts the assumption of a general AB in BPD, but rather is in line with findings of previous studies on social information processing (e.g. EST studies) suggesting a significant effect of comorbid PTSD on social attention in BPD (Wingenfeld et al., 2009; Witthöft et al., 2015).

Conflicts of interest

None.

Acknowledgements

This work has been conducted in the program "Open Research Area in the Social Sciences", funded by the Netherlands' Organization for Scientific Research (NWO) to A.A. [464-10-080] and the German Research Foundation to G.A.J., B.T-C. and G.D. [JA1785/3-1]. We thank Dr. Gerhard Zarbock for his support at the study center Hamburg.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jbtep.2018.11.005.

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