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Attentional Bias for Emotional Stimuli in Borderline Personality Disorder: A Meta-Analysis

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Key Words
Borderline personality disorder · Emotion regulation · Attentional bias · Threat · Visual dot-probe task · Emotional Stroop task · Meta-analysis

Abstract
Background: In borderline personality disorder (BPD), attentional bias (AB) to emotional stimuli may be a core component in disorder pathogenesis and maintenance. ***Sampling:*** 11 emotional Stroop task (EST) studies with 244 BPD patients, 255 nonpatients (NPs) and 95 clinical controls and 4 visual dot-probe task (VDPT) studies with 151 BPD patients or subjects with BPD features and 62 NPs were included. ***Methods:*** We conducted two separate meta-analyses for AB in BPD. One meta-analysis focused on the EST for generally negative and BPD-specific/personally relevant negative words. The other meta-analysis concentrated on the VDPT for negative and positive facial stimuli. ***Results:*** There is evidence for an AB towards generally negative emotional words compared to NPs (standardized mean difference, SMD = 0.311) and to other psychiatric disorders (SMD = 0.374) in the EST studies. Regarding BPD-specific/personally relevant negative words, BPD patients reveal an even stronger AB than NPs (SMD = 0.454). The VDPT studies indicate a tendency towards an AB to positive facial stimuli but not negative stimuli in BPD patients compared to NPs. ***Conclusions:*** The findings rather reflect an AB in BPD to generally negative and BPD-specific/personally relevant negative words rather than an AB in BPD towards facial stimuli, and/or a biased allocation of covert attentional resources to negative emotional stimuli in BPD and not a bias in focus of visual attention. Further research regarding the role of childhood traumatization and comorbid anxiety disorders may improve the understanding of these underlying processes.

Introduction

Borderline personality disorder (BPD) is characterized by instability in affect, self-image, and interpersonal relationships, and by impaired impulse control [1, 2]. In the last two decades, research on emotion regulation has been increasingly linked to BPD [3, 4], as maladaptive emotion-related cognitive processes have been shown to be related to the onset, development, and maintenance of various emotional disorders [5–7]. Studies in emotion-related cognitive processes show a BPD-specific memory bias towards generally negative and BPD-related mate-

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rial, and a BPD-specific cognitive bias towards distorted beliefs and schemata [4], whereas results regarding emotion responding are more mixed [3].

Another central emotion-related cognitive process is attention [8]. In this context, attentional bias (AB) reflects the tendency to preferentially focus or allocate attentional resources to certain types of emotional stimuli [7]. Moreover, AB has been studied in different mental disorders, particularly in anxiety disorders [9], but in other disorders also, such as depression [10] and eating disorders [11]. The results of a meta-analysis [9] reveal evidence of a threat-related AB both at the conscious (i.e. later) and nonconscious (i.e. early, automatic) stages of information processing in patients with anxiety disorders and in nonclinical highly anxious samples, but not in nonanxious subjects.

Regarding BPD, the review of Baer et al. [4] indicates mixed results concerning a BPD-specific AB. Their inconclusive results might be due to differences in experimental designs and paradigms that examine different underlying processes or different aspects of the same cognitive process. The emotional Stroop task (EST [12]) and visual dot-probe task (VDPT [13]) are the most prominent paradigms in AB assessment.

The EST assesses the ability to inhibit stimulus interference [14]. Emotional words in different colors are presented on a computer screen, and participants have to name the color of the word via button/keyboard (corresponding with the color) or verbally (a voice key detects response latency). Thus, two stimuli (i.e. emotional stimulus word vs. color of the word as the stimulus to be attended to) are presented simultaneously – spatially and temporally [15]. Stimuli can differ in their emotional valence and personal relevance to the corresponding psychopathology being examined. Interference is computed by subtracting reaction time (RT) to neutral words from RT to emotional words. Hence, in the EST the emotional stimulus words interfere with color naming in a different way compared to neutral stimuli by capturing attentional resources [16]. Three types of interference scores are distinguished: positive interference scores (attention allocation towards the emotional stimuli), negative interference scores (attention allocation away from the emotion stimuli) and interference scores around zero (no different attention allocation towards or away from emotional stimuli compared to neutral stimuli), indicating that such words capture covert attentional resources, causing deceleration in color-naming the words. Research shows that patients with emotional disorders react more slowly when naming the color when the words displayed are relevant to their psychopathology [14].

The VDPT assesses *visual* attention allocation. After the offset of a fixation cross, a pair of stimuli *(primes)*, typically emotional and neutral faces or words, appears briefly on the screen. The primes disappear, and a dot *(probe)* appears either on the former location of the neutral (incongruent trial) or the emotional (congruent trial) prime. The task is to identify the location of the dot by pushing a button as fast as possible. In this context, the so-called *congruency effect* is defined by faster RT to congruent than to incongruent primes [17]. Positive bias scores are interpreted as attention towards the emotional prime, i.e. persistent vigilance, negative scores as attention away from the prime, i.e. initial vigilance followed by avoidance [18]. Moreover, shorter presentation times of the primes detect hypervigilance towards emotional stimuli; longer presentation times detect difficulties in disengagement, or avoidance [19, 20]. Another variant of the dot-probe task uses an arrow pointing either up or down, whereby the arrows substitute the previously presented stimulus. Here, the task is to push one of two buttons to determine the arrow's direction as fast as possible. Still another dot-probe design compares RT on emotional primes with RT on exclusively neutral primes [17]. Vigilance, i.e. the facilitated detection of emotional (negative) information is reflected by faster RT to congruent trials compared with trials with two neutral stimuli. Difficulties in disengagement occur through slower RT to incongruent trials compared with trials with two neutral stimuli.

To sum up, the stimulus to be attended to (i.e. the dot-probe) in the VDPT is presented after the emotional stimulus. Consequently, all emotional and attended stimuli are presented in temporal separation, and half of the emotional and attended stimuli are presented in spatial separation [15]. Thus, the VDPT demands visual orientation and attention resources by scanning across different regions in the visual field [21].

To our knowledge, there has been no quantitative meta-analysis of AB studies in BPD yet. The present study aims to synthesize results from various studies on a quantitative basis, including a comparison between BPD and clinical controls (CCs). We can thus determine whether the AB found in BPD is specific to this disorder or due to psychopathology in general. Our meta-analysis includes experimental studies investigating AB in BPD with the EST [12, 14] or the dot-probe task [13] as they are most often used to examine AB in BPD, and enough studies were available to conduct separate meta-analyses for each design.

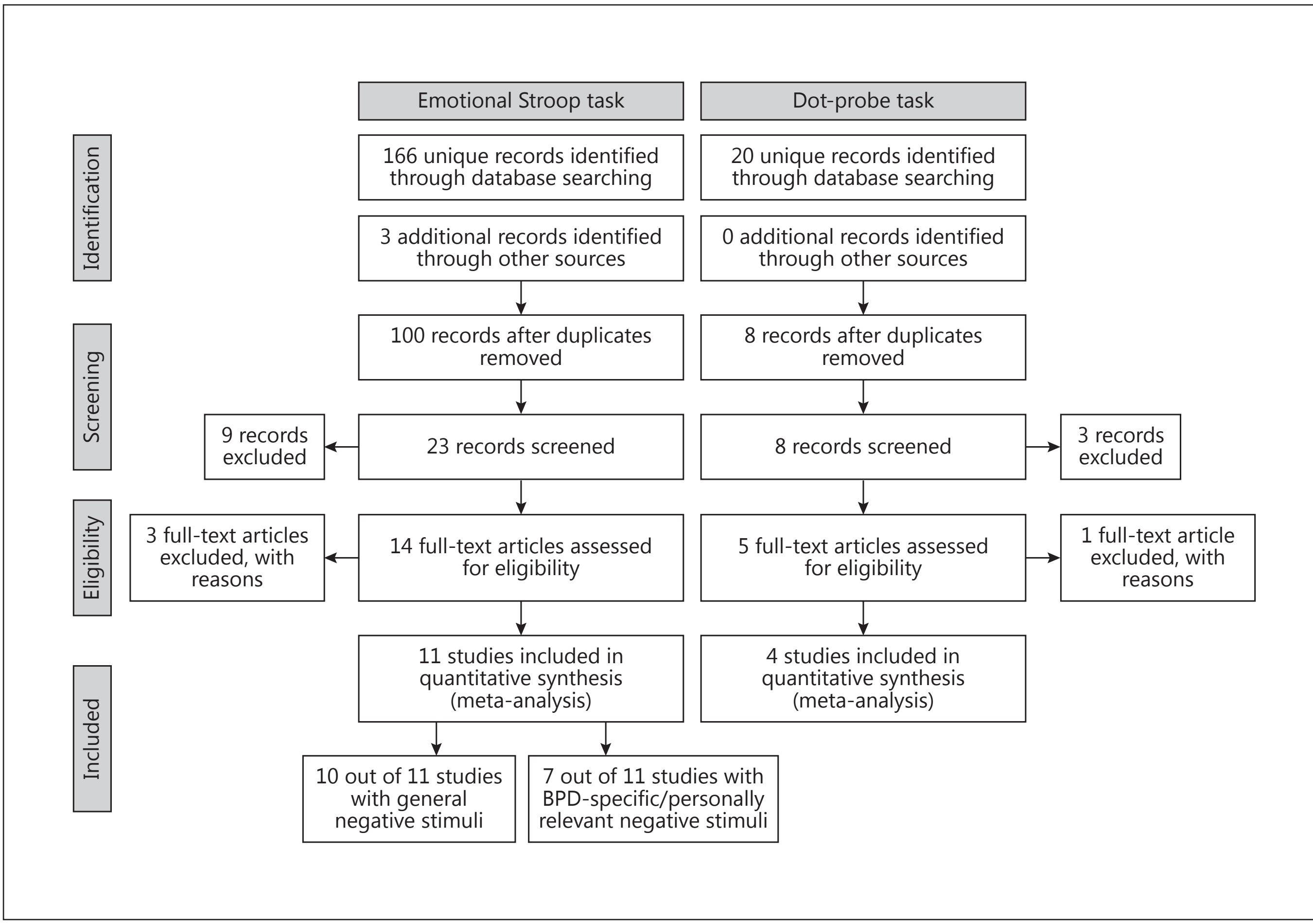

Fig. 1. Flowchart diagram for meta-analyses: summary of the literature search and study selection.

Methods

Study Selection

We followed PRISMA guidelines for reporting meta-analyses [22]. We searched published sources using the databases PubMed, Medline and PsychInfo until January 2016. Reference lists of relevant articles, previous reviews and Google scholar were studied to identify further relevant sources. Search strategies were adapted to different databases. Key words were: attention*, bias*, threat, Stroop, dot-probe, and borderline*.

We included studies that investigated AB in BPD patients or individuals with BPD symptoms, CCs and/or nonpatients (NPs) (DSM-III-R, DSM-IV or DSM-5 criteria) and used either an EST or a VDPT. We set the limit to a minimum of 4 studies to conduct a meta-analysis. We included studies that enabled the computation of an effect size for at least a between-group comparison in interference scores, i.e. the reported biases measured the differences between BPD participants and NP control participants. Journal articles published until January 2016 were included.

Corresponding authors were contacted if necessary. We received one unpublished study via personal communication [Button, postal delivery, September 21, 1999]. One non-English publication was translated. In total, we included 10 published and 1 unpublished EST involving 244 BPD patients (92% females), 255 NPs (89% females) and 95 CCs (94% females), and 4 VDPT studies involving 151 BPD patients or subjects with BPD features (83% females) and 62 NPs (84% females) (for flowchart, see fig. 1).

Statistical Analysis

Meta-Analysis of EST Studies

Study characteristics are provided in table 1. We meta-analyzed standardized mean differences (SMDs) of interference scores (table 2), i.e. the difference between groups in mean interference (defined as the difference between RT of the target word compared to that of the neutral word) divided by the pooled standard deviation of interference scores. SMD is also known as Hedges' *g* and is an unbiased alternative to Cohen's *d* [23]. SMDs were analyzed instead of RT differences, as not all studies presented the descriptive statistics (means and SD of interference scores per group), and studies varied widely in design, therefore meaning that raw RT could not be directly compared. If descriptive statistics were lacking, we derived SMDs from test statistics

Table 1. Cohort and study characteristics of all EST studies

First author	Group	n	Females, %	Mean age ± SD, years	In/out	Medication, %	Comorbidity	Inference scores	Presen-tation	Button
Arntz [30], 2000	BPD	16	100	29.8	out	n.a.	2.88_{AID}, 3.31_{PD}	neg.-neu.; neg. (BPD-spec.)-neu.	random	voice
	CPD	12		32.5			2.58_{AID}, 1.83_{PD}			
	NP	15		35.0						
Domes [57], 2006	BPD	28	100	24.93±5.85	in	–	–/–	neg.-neu.	random	button
	NP	30		23.9±5.88						
Portella [25], 2011	BPD	38	100	27.42±5.8	out	81.6	n.a.	neg.-neu.; neg. (BPD-spec.)-neu.	random	button
	NP	23		25.56±2.3						
Sieswerda [27], 2006	BPD	16	94	27±6.8	in/out	n.a.	1.63_{AID}, 1.56_{PD}	neg.-neu.; neg. (BPD-spec.)-neu.	random	voice
	CPD	18	89	29±9.2			1.67_{AID}, 1.06_{PD}			
	AID	16	75	30±9.2			1.81_{AID}			
	NP	16	88	26±5.4						
Sieswerda [58], 2007	BPD	24	88	29.6±7.2	out	n.a.	$71\%_{MD}$, $96\%_{AD}$, $42\%_{CPD}$, $25\%_{ASPD}$	neg.-neu.; neg. (BPD-spec.)-neu.	random	voice
	NP	23	91	34±11						
Sprock [33], 2000	BPD	18	100	37.6±5.3	out	+	$72.2\%_{DD}$, $27.8\%_{dysthymia}$	neg.-neu.	blocks	voice
	NP	16		30.3±5.9						
	DD	17		32.7±9.7						
Völker [26], 2009	BPD	24	100	23.17±4.74	in	–	n.a.	neg.-neu.	random	button
	DD	22		20.41±1.71						
	NP	24		22.21±4.69						
Waller [29], 1996	BPD	10	100	26.6±4.74	in	n.a.	n.a.	neg.-neu.	blocks	voice
	AID	10		28.5±10.8						
	NP	20		25.1±8.39						
Wingenfeld [31], 2009	BPD	20	70	29.75±13.2	in	60	$25\%_{PTSD}$, $25\%_{MD}$, $15\%_{ED}$, $5\%_{SP}$, $5\%_{SPD}$	neg.-neu.; neg. (pers.)-neu.	blocks	button
	NP	20	70	29.45±12.4						
Wingenfeld [32], 2009	BPD	31	67.74	28.2±11.1	in	n.a.	$83.88\%_{AID}$, $51.61\%_{PTSD}$	neg.-neu.; neg. (pers.)-neu.	blocks	button
	NP	49	61.22	32.4±11.8						
Winter [28], 2015	BPD	19	100	28.74±8.07	n.a.	–	$37\%_{PTSD}$, $11\%_{MD}$, $60\%_{AD}$	neg.-neu.	blocks	button
	NP	19		28.05±7.82						

F = Female; in/out = inpatients/outpatients; n.a. = not applicable; AID = axis I disorders; PD = personality disorder; neg. = negative; neu. = neutral; CPD = cluster C personality disorder; BPD-spec. = BPD-specific; MD = mood disorder; AD = anxiety disorder; ASPD = antisocial personality disorder; DD = depressive disorder; EgoThreat = Ego-threat words pooled; PTSD = posttraumatic stress disorder; ED = eating disorder; SP = social phobia; SPD = somatoform pain disorder; pers. = personal relevant words.

of the pertinent group contrasts. In one case a correlation between the bias score and BPD features was reported instead of a group difference [24]. Here we converted Pearson's *R* to Hedges' *g*.

In total, 11 studies were included in this meta-analysis. All studies presented the stimuli words supraliminally. Five studies included besides a NP control group, also a CC group. SMDs could not be estimated in 2 studies [25, 26], but both first authors provided us with the necessary descriptive statistics [Portella, pers. commun., April 10, 2014; Völker, pers. commun., May 16, 2014]. For 1 study [27], we collapsed the two CC groups they used. In another study [28], one BPD subgroup underwent a dissociation induction before the EST. We did not include that BPD subgroup. We focused on interference scores for generally negative versus neutral and for BPD-specific negative/personally relevant versus neutral word comparisons. Ten of the 11 EST studies used generally negative words as stimuli (table 2a), and 7 studies used BPD-specific/personally relevant stimuli (table 2b). We merged the different categories of negative words from the Waller and Button [29] study into one category of generally negative stimuli. These stimulus words were being considered as generally negative words, since they had been used in a study on bulimia nervosa patients. The fourth author provided us with the descriptive data on the interference scores of generally negative-neutral words and the BPD-specific negative-neutral words, which had been merged in the original study [30]. The 2 studies by Wingenfeld et al. [31, 32] utilized individual personally negative words with and without current relevance. In our meta-analysis, we focused exclusively on the individual personal negative words with current relevance. Sprock et al. [33] stated that they used anger words as BPD-specific stimuli and sad stimuli as depression-specific stimuli. Therefore, we included only the interference scores of anger-neutral words in the meta-analysis of EST studies for BPD-specific/personal relevant words.

Positive words were only used in 3 of the 11 EST studies [25, 27, 28]. Since we had set our limit to a minimum of 4 studies to conduct a meta-analysis, no meta-analysis of EST studies with positive words was made. However, exploration suggests no evidence for an AB towards positive words (SMD = –0.301, SE = 0.259, p = 0.245, 95% CI = –0.810 to 0.207).

OpenMetaAnalyst was used for computations [34]. Given the large variations between study designs, random effects models (DerSimonian-Laird estimate) were used. We assessed the sensitivity of the results for finding by a particular study by leave-one-out

Table 2. Descriptive and statistical data of the meta-analysis of experimental studies using the EST

a With generally negative stimuli

First author	BPD group		CC group		SD pooled	SMD	95% CI	
	n	mean ± SD	n	mean ± SD			lower	upper
BPD versus NPs								
Arntz [30], 2000	16	40.46 ± 63.15	15	11.45 ± 38.79	54.22	0.535	–0.182	1.252
Domes [57], 2006	28	12.37 ± 52.88	30	19.29 ± 44.84	49.43	–0.140	–0.655	0.376
Portella [25], 2011	38	14.31 ± 63.57	23	17.06 ± 91.18	76.06	–0.036	–0.554	0.482
Sieswerda [27], 2006	16	32.4 ± 40.7	16	– 1.35 ± 18.2	32.33	1.044	0.305	1.782
Sieswerda [58], 2007	24	27.26 ± 40.85	23	3.82 ± 23.51	34.06	0.688	0.099	1.277
Völker [26], 2009	24	2.94 ± 25.59	24	– 2.46 ± 21.81	23.775	0.223	–0.344	0.791
Waller [29], 1996	10	13.3 ± 14.64	20	3.2 ± 7.81	10.79	0.936	0.141	1.731
Wingenfeld [31], 2009	20	17.6 ± 34.5	20	5.2 ± 34.5	35.23	0.352	–0.272	0.977
Wingenfeld [32], 2009	31	14 ± 44	49	15 ± 39	41.67	–0.024	–0.474	0.426
Winter [28], 2015	19	11.7 ± 29.68	19	4.00 ± 39.36	35.65	0.216	–0.421	0.854
BPD versus CCs								
Arntz [30], 2000	12	40.46 ± 63.15	12	29.44 ± 29.03	52.99	0.208	–0.543	0.958
Sieswerda [27], 2006	16	32.4 ± 40.7	34	17.5 ± 23.73	30.53	0.488	–0.114	1.089
Völker [26], 2009	24	2.94 ± 25.59	22	– 2.25 ± 23.72	24.194	0.206	–0.374	0.786
Waller[29], 1996	10	13.3 ± 14.64	10	4.467 ± 5.37	11.516	0.767	–0.141	1.676
CCs versus NPs								
Arntz [30], 2000	12	29.44 ± 29.03	15	11.45 ± 38.79	35.90	0.501	–0.270	1.272
Sieswerda [27], 2006	34	17.5 ± 23.73	16	–1.350 ± 18.20	22.49	0.838	0.221	1.454
Völker [26], 2009	22	–2.25 ± 23.72	24	– 2.46 ± 21.810	23.33	0.009	–0.569	0.588
Waller [29], 1996	10	4.467 ± 5.37	20	3.2 ± 7.81	7.32	0.173	–0.587	0.934

b With BPD-specific or personally relevant negative stimuli

First author	BPD group		CC group		SD pooled	SMD	95% CI	
	n	mean ± SD	n	mean ± SD			lower	upper
BPD versus NPs								
Arntz [30], 2000	16	28.45 ± 29.98	15	0.37 ± 27.84	29.75	0.944	0.202	1.687
Portella [25], 2011	38	13.04 ± 78.29	23	–4.494 ± 84.33	81.56	0.215	–0.304	0.734
Sieswerda [27], 2006	16	8.48 ± 50.7	16	–28.3 ± 22.2	40.16	0.916	0.188	1.644
Sieswerda [58], 2007	24	19.09 ± 37.24	23	0.1 ± 23.58	31.83	0.603	0.018	1.187
Sprock [33], 2000	18	–0.33 ± 6.03	16	0.75 ± 6.03	6.17	–0.175	–0.850	0.500
Wingenfeld [31], 2009	20	41.1 ± 31.5	20	29.6 ± 42.7	38.33	0.300	–0.323	0.924
Wingenfeld [32], 2009	31	67 ± 78	49	36 ± 39	57.84	0.536	0.079	0.994

analyses. Meta-regression analyses were conducted for verbal versus button-pressing response type and random versus nonrandom (presented in one block or card) word category presentation (blocked presentations have been criticized as potentially triggering processes other than AB, e.g. worrying). Meta-regression analyses were done for measures that had been reported by at least 8 studies.

From one study [26] valence of the emotional words, response type and word category presentation (random vs. nonrandom) was not clear. The first author provided us with this information [Völker, pers. commun., May 16, 2014].

Meta-Analysis of VDPT Studies

Study characteristics and SMDs are provided in tables 3 and 4. In the meta-analysis of the VDPT studies, they were classified into 3 categories according to stimulus presentation time: subliminal (30 ms; 1 study) [35], medium (200–500 ms; 4 studies) [24, 35–37] and lengthy (≥1,250 ms; 2 studies) [24, 38], as early and later attentional processes often differ. Only the medium presentation category contained 4 studies that investigated AB for positive and negative faces, and thus enough studies to warrant a meta-analysis. Effect sizes were pooled when several classes of negative stimuli were studied [35]; one study already had collapsed data in this group [36]. SMDs of the AB index of the 4 studies were analyzed with OpenMetaAnalyst. Positive SMDs denote an AB towards emotional faces, negative SMDs an AB away from emotional faces (avoidance).

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Table 3. Cohort and study characteristics of all dot-probe studies

First author	Group	n	Females, %	Mean age ± SD, years	In/out	Medication, %	Comorbidity	Presentation time, ms	Emotional face	Examined AB
Berenson [24][1], 2009	BPD NP	43 44	79.31	22.75 ± 5.57	NP	–/–	–/–	500	threat pleasant	$RT_{incongruent}$ to $RT_{congruent}$
Brüne [37], 2013	BPD NP	13 13	61.54 76.92	26.8 ± 7.22 25.7 ± 6.79	in	+	n.a.	200 + 500[2]	angry happy	$RT_{incongruent}$ to $RT_{congruent}$
Von Ceumern-Lindenstjerna [36], 2010	BPD AID NP	30 29 30	100 100 100	16.13 ± 1.48 15.31 ± 1.11 15.73 ± 1.46	in/out	6.6 10.34	100% with $\geq 1_{\text{comorbid AID}}$ 100% with $\geq 1_{\text{comorbid AID}}$	500	negative positive	$RT_{incongruent}$ to $RT_{congruent}$
Jovev [35], 2012	BPD NP	21 20	85.71 60	18.90 ± 3.1 20.4 ± 2.72	out	+[3]	100% with $\geq 1_{\text{comorbid AID}}$	500	fear-angry pooled happy	$RT_{bias} = RT_{incongruent}$ to $RT_{congruent}$ $RT_{vigilance} = RT_{neutral}$ to $RT_{congruent}$ $RT_{adherence} = RT_{incongruent}$ to $RT_{neutral}$

F = Female; in/out = inpatients/outpatients; PT = psychotherapy; n.a. = not applicable; AID = axis I disorders. [1] Nonclinical adolescents with high and low features of BPD. [2] Data were pooled. [3] Antidepressives (n = 52), mood stabilizers (n = 10), and antipsychotics (n = 5).

Table 4. Descriptive and statistical data of the meta-analysis of experimental studies using the VDPT: BPD versus NPs

First author	BPD, n	NPs, n	SMDs	95% CI	
				lower	upper
Negative versus neutral faces					
Berenson [24][1], 2009	43	44	–0.140	–0.560	0.280
Brüne [37], 2013	13	13	–1.115	–1.884	–0.346
Von Ceumern-Lindenstjerna [36], 2010	30	30	0.539	–0.073	1.151
Jovev [35], 2012	21	30	0.058	–0.448	0.564
Positive versus neutral faces					
Berenson [24][1], 2009	43	44	0.181	–0.239	0.601
Brüne [37], 2013	13	13	0.247	–0.522	1.016
Von Ceumern-Lindenstjerna [36], 2010	30	30	0.448	0.090	0.806
Jovev [35], 2012	21	20	–0.054	–0.482	0.374

[1] Nonclinical adolescents with high and low features of BPD.

Results

Meta-Analysis of EST Studies

BPD versus NPs

The pooled effect size for generally negative words was in the small-to-medium range (SMD = 0.311, SE = 0.124, p = 0.001) and significantly favors the hypothesis that BPD is characterized by an AB towards generally negative stimuli (fig. 2a). The leave-one-out analysis did not cause the pooled EST to become nonsignificant and indicated robust results (fig. 2b). The meta-regression resulted in a nonsignificant effect of random versus blocked stimulus category presentation (p = 0.880); however, we observed a significant effect of response type (β = –0.713, SE = 0.21, p = 0.001). The 6 studies using button press responses failed to yield a significant pooled effect (pooled SMD = 0.07, 95% CI = –0.16 to 0.29), whereas the 4 studies using voice detection exhibited a significant pooled effect (SMD = 0.78, 95% CI = 0.43–1.13).

The pooled effect size for BPD-specific negative words was medium (SMD = 0.454, SE = 0.134, p < 0.001) and is significantly in line with the hypothesis that BPD is defined by an AB towards BPD-specific stimuli (fig. 3a). Again, the leave-one-out analysis did not cause the pooled ES to become nonsignificant and indicated robust results (fig. 3b). The meta-regression resulted in a nonsignificant effect of random versus blocked stimulus category presentation (β = –0.271, SE = 0.229, p = 0.236) and of response type (β = 0.017, SE = 0.230, p = 0.454).

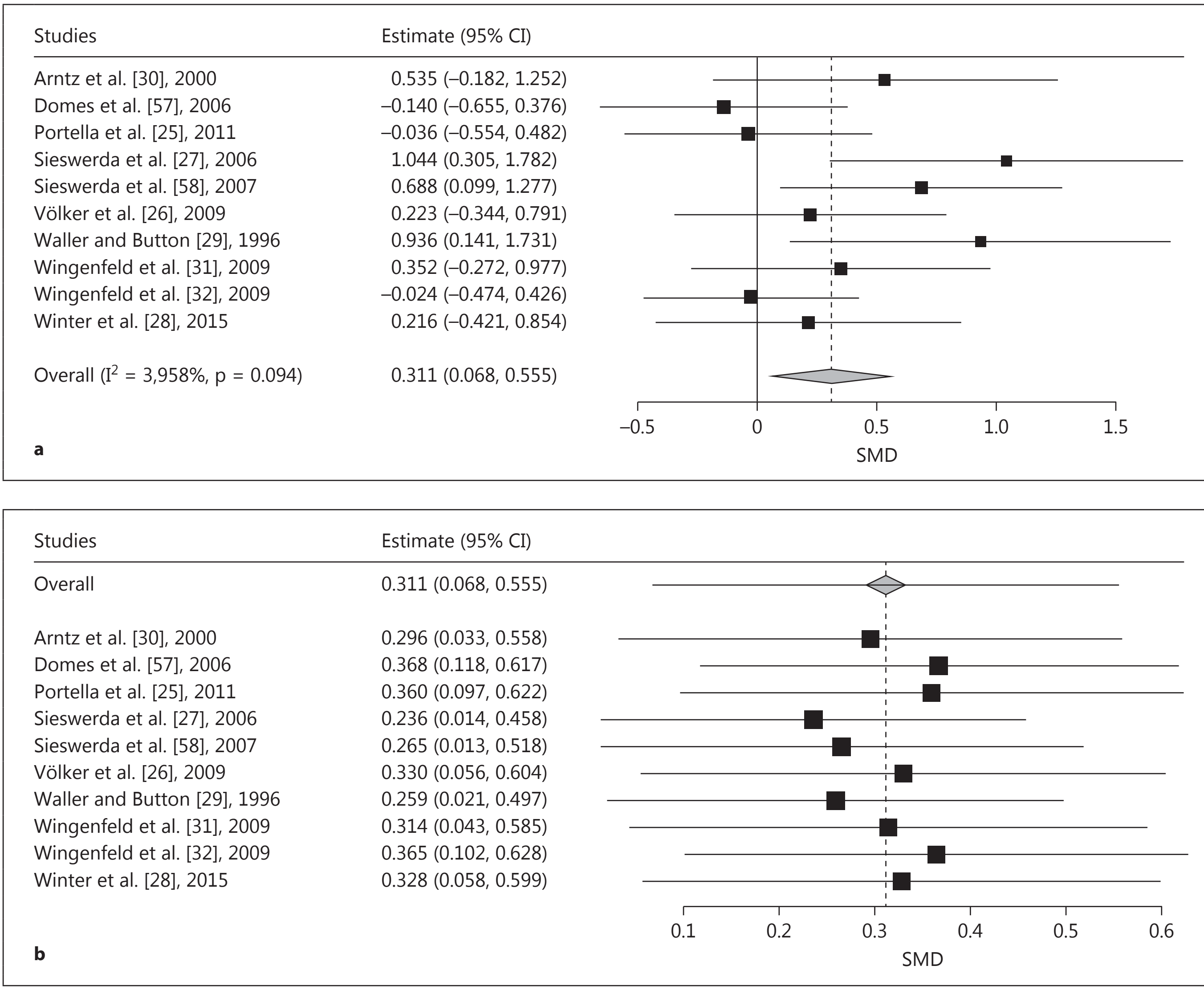

Fig. 2. a Forest plot of a meta-analysis of EST studies comparing patients with BPD with NPs. Positive effects denote stronger AB in BPD for generally negative emotional words. SMDs of interference scores were meta-analyzed. **b** Leave-one-out meta-analysis plot of the EST studies comparing patients with BPD with NPs and using generally negative emotional words as stimuli. The pooled SMDs prove to be quite stable when individual studies are omitted.

BPD versus CCs

Four studies using generally negative stimuli words reported BPD versus CC comparisons. The pooled effect size was in the small-to-medium domain (SMD = 0.374, SE = 0.173, p = 0.031; fig. 4a) and significantly favored a stronger AB in BPD than in CCs. The pooled SMD remained in the same domain with the leave-one-out analysis (–0.089 to 0.877), although 95% CIs covered zero when we omitted Sieswerda et al. [27] or Waller and Button [29] (fig. 4b). Given the low number of studies, a meta-regression was not conducted to explore further results. However, we found that omitting the study of Völker et al. [26] (which did not use a voice-based response) led to a greater effect (SMD = 0.460, SE = 0.213, p = 0.031). Due to the low number of studies that used BPD-specific or personally relevant negative stimuli and reported BPD versus CC comparisons, we did not conduct meta-analysis in this case.

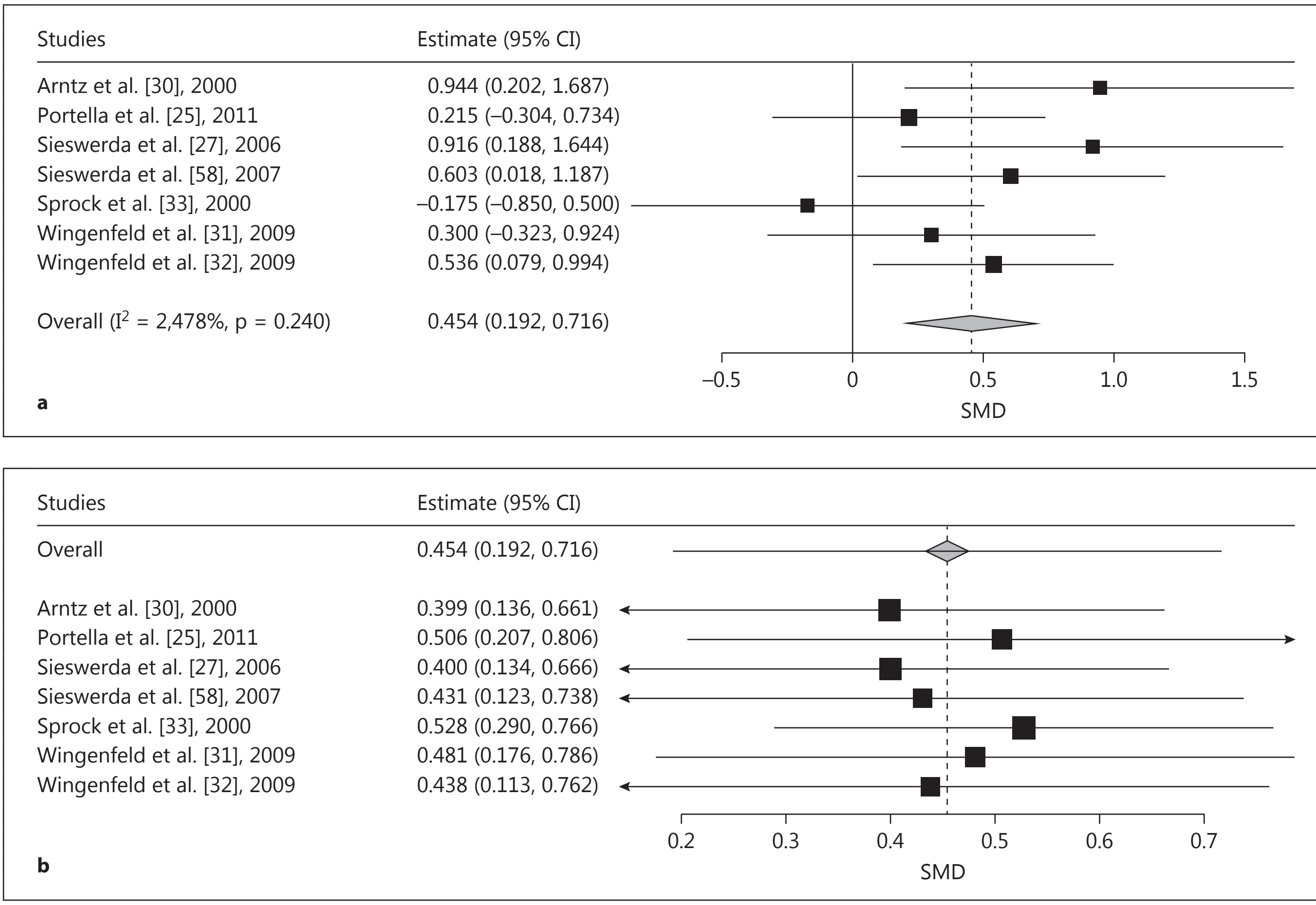

Fig. 3. a Forest plot of a meta-analysis of EST studies comparing patients with BPD with NPs. Positive effects denote stronger AB in BPD for BPD-specific and personally relevant negative emotional words. SMDs of interference scores were meta-analyzed. **b** Leave-one-out meta-analysis plot of the EST studies comparing patients with BPD with NPs and using BPD-specific and personally relevant negative emotional words as stimuli. The pooled SMDs prove to be quite stable when individual studies are omitted.

CCs versus NPs

The comparison of CCs with NPs revealed a trend towards a significant pooled effect size of a stronger AB in CCs than in NPs (SMD = 0.377, SE = 0.200, p = 0.059; fig. 5a). The leave-one-out analysis indicated wide variance in the pooled SMD from 0.183 (leaving out Sieswerda et al. [27]; fig. 5b) to 0.544 (leaving out Völker et al. [26]). Only omission of the study by Völker et al. [26] led to a significant effect (SMD = 0.554, SE = 208, p = 0.008).

Meta-Analysis of VDPT Studies

As to the negative versus neutral faces contrast, the meta-analysis revealed no evidence for a significant pooled effect (pooled SMD = –0.123, SE = 0.276, p = 0.66; fig. 6). Leaving individual studies out, the analysis yielded evidence for a significant effect.

Meta-analysis of the SMDs of the difference between BPD and NPs of the AB index towards positive faces (vs. neutral faces) demonstrated a positive pooled SMD (indicating AB towards positive faces), which almost reached significance (pooled SMD = 0.223, SE = 0.116, p = 0.055; fig. 7). Leaving the study of Jovev et al. [35] out of the analysis would lead to a significant AB towards positive faces (pooled SMD = 0.326, p < 0.05; fig. 8).

Discussion

The present study is the first meta-analysis investigating AB in BPD. We conducted two separate meta-analyses focusing on AB in BPD assessed with either the EST or with the VDPT.

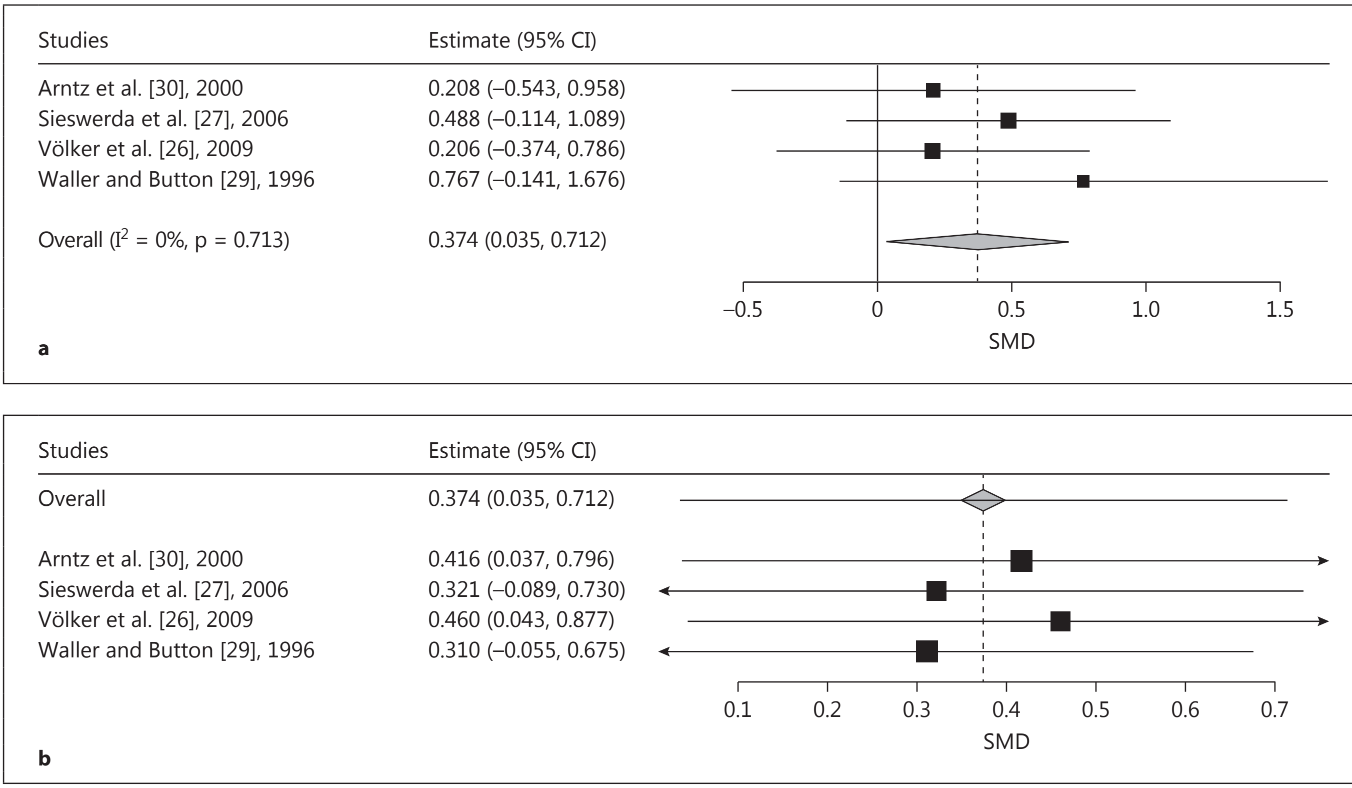

Fig. 4. a Forest plot of a meta-analysis of EST studies comparing patients with BPD with CCs. Positive effects denote stronger AB in BPD for generally negative emotional words. SMDs of interference scores were meta-analyzed. **b** Leave-one-out meta-analysis plot of the EST studies comparing patients with BPD with CCs and using generally negative words as stimuli. The effect remains in the range from –0.09 to 0.88, though leaving out the study of Sieswerda et al. [27] or of Waller and Button [29] leads to the 95% CI covering zero.

Our meta-analysis of the EST studies revealed evidence for the existence of an AB to generally negative stimuli in BPD compared to NPs and CCs. Compared to NPs, AB in BPD became stronger when we excluded studies using button press rather than oral response. Thus, the increased AB for generally negative stimuli seems to be specific to BPD. In addition, we observed clear and relatively stronger evidence of an AB towards BPD-specific/personally relevant negative stimuli in BPD patients compared to NPs. These results therefore suggest the existence of a threat-related AB in BPD patients which becomes stronger when the negative stimulus words are BPD schema congruent. The AB towards BPD-schema-congruent stimulus words in BPD is comparable to that seen in anxiety disorders [9]. Furthermore, we noted a trend towards evidence of an AB to generally negative words in CCs compared to NPs.

Cisler and Koster [39] claimed there is evidence for the AB effect's equal magnitude in all anxiety disorders and that threat-related AB in anxiety disorders can be observed in several different paradigms. Indeed, an AB for threat is commonly observed across anxiety disorders [9, 14, 39]. Anxiety disorders were represented in CCs of the EST studies, either as the primary diagnosis or (probably) a secondary diagnosis (e.g. many cluster C personality disorder patients have comorbid anxiety disorders). However, the CC groups' heterogeneity might explain the smaller effect size in CCs in the present study, and comparisons between BPD and anxiety disorder groups might be worth pursuing.

Interestingly, verbal responses yielded much stronger AB effects to generally negative stimuli than button pressing. This is in line with findings indicating that the response type influences the magnitude of the Stroop effect, or, to be more precise, using verbal responses exhibited higher interference scores than using button responses [40, 41]. This was also found regarding the EST in a clinical sample of people who stutter [42]. The EST effect

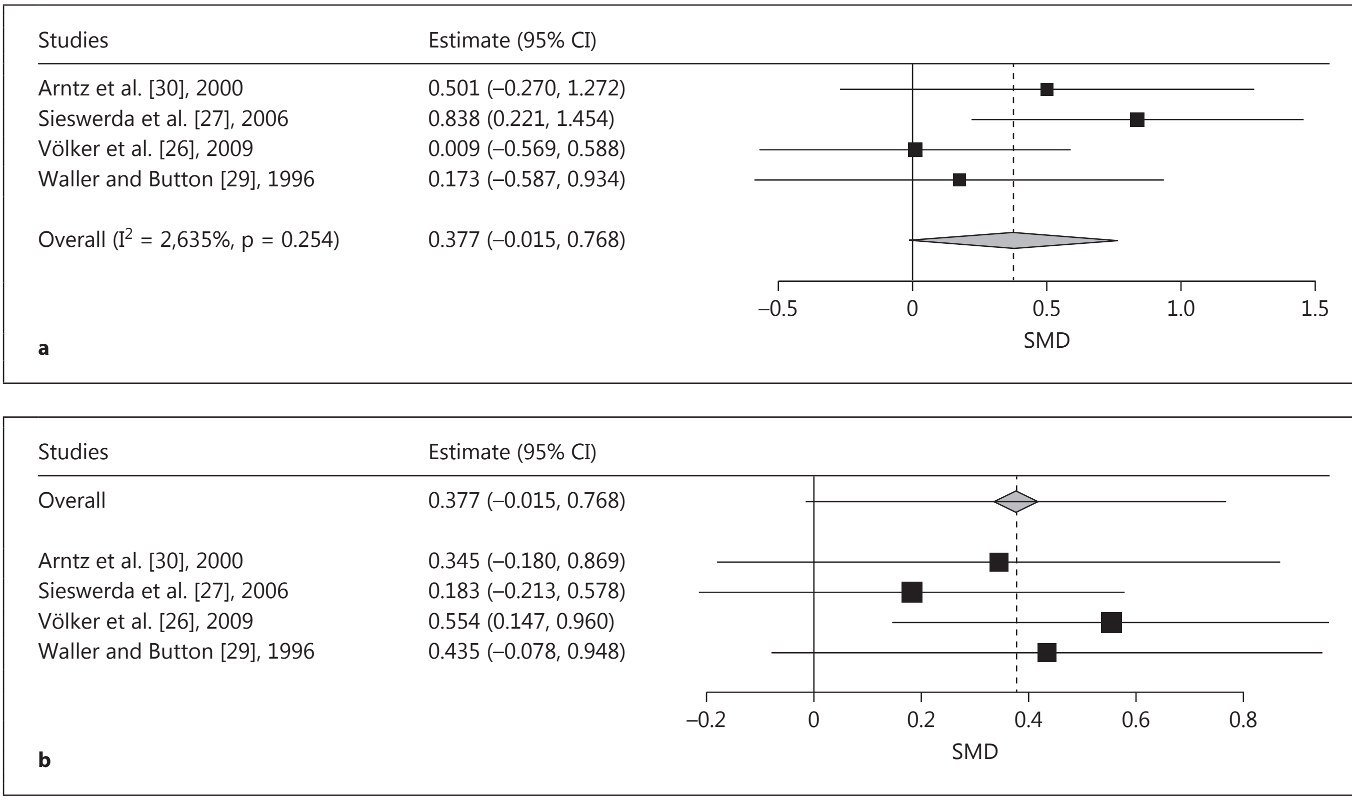

Fig. 5. **a** Forest plot of a meta-analysis of EST studies comparing CCs with NPs. Positive effects denote a trend towards a stronger AB for generally negative emotional words in CCs. SMDs of interference scores were meta-analyzed. **b** Leave-one-out meta-analysis plot of the EST studies comparing CCs with NPs and using generally negative words as stimuli. The leave-one-out analysis indicated a wide variance in the pooled SMD from 0.183 (leaving out the study of Völker et al. [26]) to 0.544 (leaving out the study of Sieswerda et al. [27]).

might thus arise mainly with verbal responses, probably because reading and speaking are intrinsically related (reading automatically leading to the preparation of speaking), which is not the case for reading and pressing a button. Perhaps the Stroop effect's underlying cognitive process is masked by the variance in reaction times arising from manual responses (i.e. like button pressing) due to the additionally required motoric involvement, unlike the EST effect with voice detection [43]. The EST involving the verbal response type might therefore yield a more pure and reliable estimate of interference by word content. However, verbal responses yielded no stronger AB effects towards BPD-specific/personally relevant negative stimuli. This might be due to the lower number of studies using button response and BPD-specific/personally relevant negative stimuli.

Not all EST studies included in the present meta-analysis reported details on design and statistical outcomes. Word contents were often not reported, as were attempts to control for word length and word use in the general population. Lacking information on these details makes it impossible to assess to what degree the AB in BPD is dependent on the relevance of the words' content for BPD.

Our meta-analysis of the VDPT studies revealed inconclusive findings. There was no evidence for an AB in BPD for negative emotional faces in conjunction with medium presentation times (200–500 ms), but there was initial evidence for an AB for positive emotional faces in BPD compared to NPs – but not in the study of Jovev et al. [35]. These results contradict Linehan's [44] postulation of hypersensitivity to any emotional stimuli in BPD patients. We cannot take a position as to whether the AB in BPD is borderline specific, since only 1 study included a patient control group [36]. These inconclusive results could be due to different patient cohorts (e.g. NPs [24] vs. adolescents not meeting the full threshold of BPD criteria [35, 36] vs. adults fulfilling all the BPD criteria [37]).

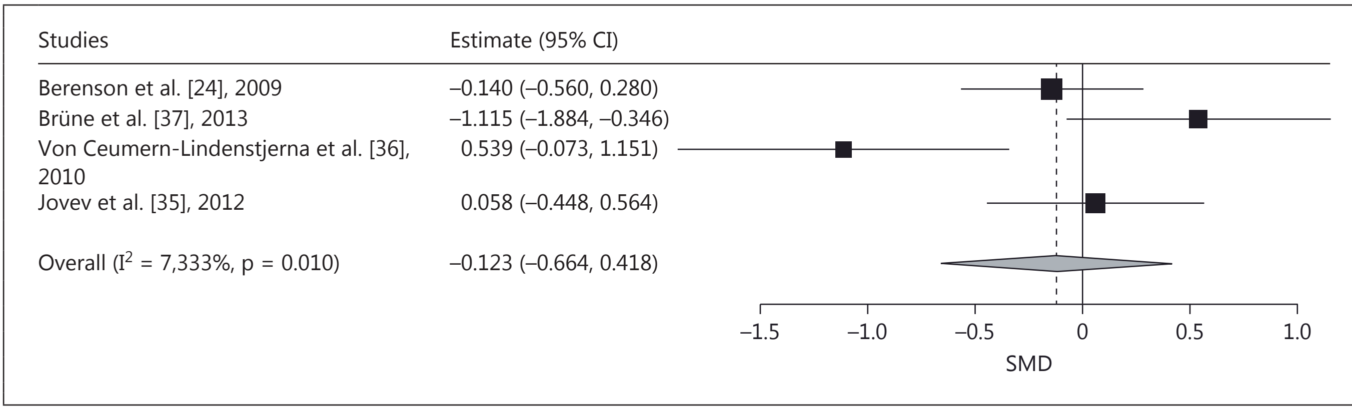

Fig. 6. Forest plot of a meta-analysis of the dot-probe studies with negative versus neutral faces and with medium presentation time (200–500 ms) comparing patients with BPD with NPs. SMDs denote AB toward, negative SMDs AB away from negative faces (avoidance).

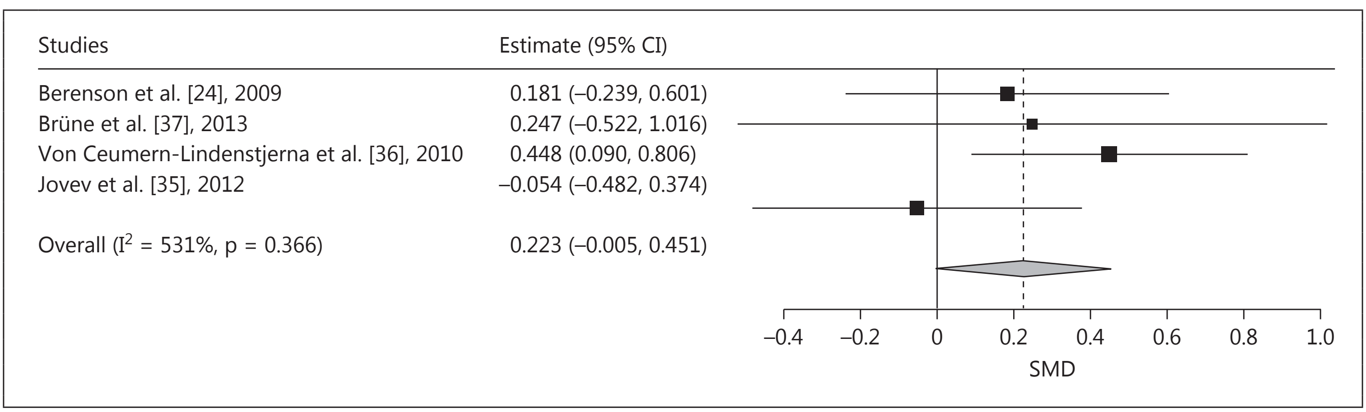

Fig. 7. Forest plot of a meta-analysis of the dot-probe studies with positive versus neutral faces and with medium presentation time (200–500 ms) comparing patients with BPD with NPs. Positive SMDs denote AB toward positive faces, negative SMDs AB away from positive faces.

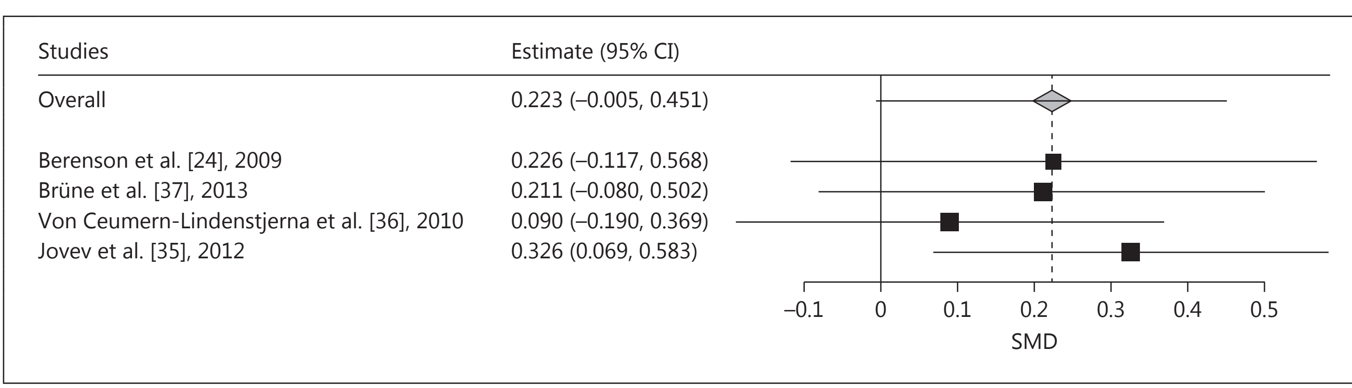

Fig. 8. Leave-one-out meta-analysis plot of the dot-probe studies with positive versus neutral faces and with medium presentation time (200–500 ms) comparing patients with BPD with NPs. Positive SMDs denote AB toward positive faces, negative SMDs AB away from positive faces.

Moreover, findings from the dot-probe studies are limited as our meta-analysis was only feasible for stimuli presented at a medium range of 200–500 ms. For stimuli presented in a shorter or longer time range, a meta-analysis was impossible due to the paucity of studies. Further research is needed to investigate the association between different attentional stages, the valence of facial stimuli, and their effects on the AB in BPD via the VDPT. In addition, some studies reported very poor reliability estimates of the dot-probe task [45, 46], which might explain the inconsistent findings in the literature. To improve the facial dot-probe task's sensitivity to detect subtle group differences in visual attention, a greater effort is needed to increase its reliability [47].

Another possible reason why our meta-analysis supports AB in BPD as assessed with the EST, but not the VDPT, has to do with the fact that the two paradigms assess different underlying mechanisms or different aspects of the same cognitive process. The EST assesses the degree to which processing resources are captured by a word's emotional content. Since the emotional and attended stimuli in the EST are presented spatially and temporally simultaneously, it is not visual but rather covert attention that is involved. In contrast, the dot-probe task assesses the focus of visual attention by requiring that the field of view be scanned for the attended stimuli that do not coincide with the emotional stimuli. Furthermore, the EST usually uses verbal stimuli rather than pictures. Those words covered very different domains in the studies we included, while the pictures in the dot-probe tasks were always emotional human faces. On the other hand, words might represent more accurately the typical stimuli for which BPD patients might be vigilant for (like abuse, abandonment, rejection) than emotional faces. Moreover, BPD patients might find neutral faces ambiguous [48] and difficult to tolerate; they might be as attention-getting as emotional faces (e.g. in creating anxiety [49]), making the control stimulus category ineffective in the studies so far. One conceivable approach to test whether BPD reveals an AB to any face could be to compare faces and nonfacial stimuli [50].

Thus, the evidence for EST effects and the absence of dot-probe effects in BPD might indicate that it is not the focus of visual attention that is biased in BPD, but rather the processing of emotional material. However, whether such differences are due to the different processes or stimuli involved cannot be judged from our analyses. Further research is needed to clarify this issue.

The present study has some limitations. Conclusions have been drawn from studies applying very different methods and experimental designs. We only partly reached our goal to specifically focus on the comparison between BPD and CCs because of the scarcity of studies that include CCs – a problem that continues to frustrate our field and that hinders us from properly assessing the degree to which AB is specific to BPD. Other disorders (e.g. anxiety or depression) are known to be characterized by AB. Although CCs of the studies we meta-analyzed included patients with these disorders, it is not possible at the moment to clarify whether the AB in BPD assessed via the EST is comparable to or stronger than the AB in other CCs, or whether stimulus specificity plays a role. Moreover, we need to disentangle the influence of BPD and traumatic experiences/posttraumatic stress disorder on bias attention processes, since traumatic experiences are very common in BPD subjects; nearly all of them report some kind of abuse [51], and up to 70% report having suffered childhood sexual abuse [52]. Thirty to 60% of BPD patients reveal comorbid posttraumatic stress disorder [53, 54].

Finally, the severity of BPD and of comorbid disorders, as well as medications, should be taken into account. The majority of the studies we analyzed had patient cohorts consisting of mainly or entirely females. Research is needed to draw conclusions from results on male patients also. Concerning the divergent results of the meta-analysis of the VDPT and EST studies, note that only 4 studies could be included in the meta-analysis of the VDPT studies whereas the meta-analysis of the EST studies included 11.

Moreover, both the EST and VDPT studies reported on cohorts with either inpatients or outpatients or in- and outpatients. Some studies did not inform whether their samples consisted of in- or outpatients [28], or if inpatients had just begun treatment or had already recovered in response to (inpatient) treatment [37]. All in all, the potential influence of the in- versus the outpatient setting cannot be excluded.

It should be noted that paradigms other than EST and VDPT have been used to examine attentional preferences and biases in BPD, such as the 'attentional blink paradigm' [55] and visual search tasks [56]. We could not include those studies in this meta-analysis because of the low number of published studies.

Conclusion

Our results from this meta-analysis of the EST studies display evidence of an AB for generally negative words and even stronger AB effects for BPD-specific/personally relevant words in BPD patients, an effect that seems to be specific for BPD and not for its psychopathology in general. The results of our meta-analysis of the VDPT studies do not confirm an AB for visual attentional focus for negative and/or threatening faces. Interestingly, the present results from the VDPT meta-analysis indicate a tendency towards an AB to positive facial stimuli in BPD. In sum, we can assume that not visual attentional, but rather covert attentional resources are drawn by threat signals in BPD patients. Alternatively, words better represent the specific threats that are relevant for BPD than do emotional faces. Further research into the impact of childhood traumatization and/or comorbid diagnoses like anxiety disorders and posttraumatic stress disorder will help to shed light onto (threat-related) AB in BPD.

Acknowledgment

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Erratum

In the paper by Kaiser et al. entitled 'Attentional bias for emotional stimuli in borderline personality disorder: a meta-analysis' [Psychopathology 2016;49:383–396, DOI:10.1159/000448624], the correct affiliations should read as follows:

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