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Impulsivity in Borderline Personality Disorder: Impairment in Self-Report Measures, but Not Behavioral Inhibition

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Key Words

Impulsivity · Borderline personality disorder · Stroop test · Stop signal test · Antisaccades · State emotions

Abstract

Background: Impulsivity is a core feature of borderline personality disorder (BPD). However, previous clinical and experimental studies investigating impulsivity in BPD rendered mixed results. In this study, impulsivity was assessed by self-report scales and behavioral inhibition tasks to compare different data levels. ***Sampling and Methods:*** Fifteen women with BPD and 15 matched healthy control subjects (HC) completed the Barratt Impulsiveness Scale, Eysenck's Impulsivity Questionnaire and the UPPS (Urgency, Lack of Perseverance, Lack of Premeditation and Sensation Seeking) scale, and participated in a Stroop task, an antisaccade task and a stop signal task. ***Results:*** Patients with BPD scored significantly higher on self-report measures as compared to HC, but not in behavioral tests. In BPD patients, but not in HC, behavioral inhibition errors were correlated with more intense emotional state. ***Conclusion:*** We found a discrepancy between self-report and behavioral data. Further studies need to assess additional possible mechanisms underlying increased impulsivity, their relation to emotional instability, and their neurobiological underpinnings.

Introduction

Impulsivity, along with emotional dysregulation, is regarded as a core feature of borderline personality disorder (BPD) [1]. It is one of 9 diagnostic criteria (criterion 4) according to the DSM-IV [2] and is associated with factors contributing to the severity of the disorder, such as suicidal behavior [3] or an increased risk of substance dependency [4]. Typical expressions of impulsivity in BPD are behaviors like aggressive outbursts, buying or eating binges and substance abuse.

The common feature of these behaviors is disinhibition in behavioral domains that are usually highly restrained (aggression, money expense, sexuality, eating and alcohol or drug use). Correspondingly, the personality trait of impulsivity, which can be assessed by a variety of questionnaires, is characterized by a disinhibition of drive impulses and low levels of conscientiousness.

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Whiteside and Lynam [5] and Whiteside et al. [6] analyzed all commonly used impulsivity questionnaires and found the 4 following factors: (1) urgency, representing the inability to suppress strong behavioral impulses; (2) lack of premeditation, reflecting the inability to anticipate long-term consequences of one's own actions; (3) lack of perseverance, representing a lack of discipline in continuing boring or difficult behaviors, and (4) sensation seeking as a more functional facet of impulsivity, reflecting openness to new experiences and the capacity to take risks.

Impulsivity, however, does not only characterize a personality trait associated with complex behavioral patterns. With regard to (experimentally induced) behavioral reactions, impulse control describes the ability to interrupt ongoing reactions, or the ability to ignore irrelevant stimuli.

Studies of human psychology, psychiatry and animal behavior suggest that, psychologically, impulse control is not a unitary phenomenon, but may consist of several independent factors, each of which has several subcomponents [7, 8]. Behavioral inhibition in the narrow sense refers to withholding a channeled action or stopping an ongoing response. Cognitive inhibition refers to the inner processes foregoing behavioral (dis-)inhibition, such as orienting towards relevant stimuli and suppressing irrelevant stimuli, and to being geared to appropriate criteria.

Empirical Findings on Impulsivity in BPD

Concerning impulsivity as a personality trait as assessed by self-reports, there is ample evidence for increased impulsivity in BPD. Higher values on the Barratt Impulsiveness Scale (BIS) [9] were found for BPD as compared with healthy control subjects (HC) [10–12], with patients suffering from other personality disorders (PD) or bipolar II disorder [13], and with subjects suffering from damage to the orbitofrontal cortex [14]. Occurrence and severity of the BPD symptoms were shown to be correlated with impulsivity as measured by the BIS [15] and Eysenck's [16] Impulsivity Questionnaire (I-7) [17].

Contrasting these self-report results, studies on impulsive behavior responses in BPD have rendered mixed results. First, studies focussing on behavioral inhibition as defined above mostly used stop signal tasks and go/no go tasks. In both kinds of tasks, subjects execute a behavioral reaction (button press) to a stimulus and have to suppress this reaction during the experimental phase after an alternate stimulus. While Leyton et al. [18] found significantly more errors in a go/no go task in a group of 13 BPD patients, and Rentrop et al. [19] found more commission errors in BPD patients as compared to HC, most studies have failed to find deficits in BPD samples. Two studies did not find a different performance in go/no go tasks in groups of 9 patients each [11, 20]. Similarly, other studies did not find differences between 24 BPD patients as compared to patients with major depression (MDD) and to HC in a stop signal task, a continuous performance task and a card sorting test [21], or did not report significant differences between BPD subjects and HC in a stop signal task [22]. And while Nigg et al. [23] found a significant correlation of r = 0.15 between BPD symptoms and the reaction time in a stop signal test even after controlling for other psychiatric disorders, intelligence was also correlated to BPD symptoms in this sample, which might explain the results as well.

Second, studies assessing aspects of cognitive inhibition typically use the Stroop paradigm, in which subjects are required to react to the content of a color name word, but not to the actual color of the letters. Thus, the Stroop paradigm measures the ability to suppress interfering stimuli. In Swirsky-Sacchetti et al. [24], the Stroop performance in 10 BPD subjects was compared with HC, and a significantly impaired performance was found in the BPD subjects; however, this BPD group showed decreased IQ levels as compared to HC as well. A study [25] investigating performance in the Stroop test in patients with PD according to the different DSM-IV clusters found an impaired Stroop performance in cluster B patients as compared to cluster A and C patients. In a study by de Bruijn et al. [26], the performance in a flanker task was investigated in 12 BPD patients, a task which also demands that subjects suppress irrelevant stimuli. They found significantly larger reaction time differences between correct and incorrect responses in BPD as compared to HC; however, these were mostly due to generally slower reactions in BPD patients. In two comparably large studies, Völker et al. [21] compared 24 BPD patients with 24 HC and 22 depressive patients, while Domes et al. [10] compared 28 BPD with 30 HC with a Stroop test using emotional stimuli; both studies did not find significant group differences. Similarly, in the study by Lampe et al. [22], no significant differences between BPD subjects and HC were found in the Stroop task.

In summary, increased impulsivity is clearly given on the level of self-reports in BPD. On the level of experimental tests, however, results are mixed; BPD patients seem to be less impaired in these tests than might be expected.

The present study used different self-report measures to assess impulsivity and used experimental setups to assess the ability of BPD patients and controls in cognitive and behavioral inhibition. For the first time, two tests of behavioral inhibition (antisaccade and stop signal tests) were directly compared to performance in cognitive inhibition, as measured by the Stroop test, and to a set of self-report measures. To exclude effects of age, education and intelligence, the BPD patients and control subjects were very carefully matched, and the patients had to be free of psychotropic medication with the exception of a stable selective serotonin reuptake inhibitor (SSRI) medication (in 1 patient) for at least 2 weeks.

Table 1. Subjects

	BPD (n = 15)	HC (n = 15)	p (two-sided)
Age, years	29 ± 5.5	29 ± 5.5	n.s.
Time in school, years	11.3 ± 1.7	11.3 ± 1.7	n.s.
BPDSI score	30.2 ± 8.9	–	–
BDI score	19.5 ± 10.5	2.1. ± 3.2	<0.001**
HAMD-21 score	7.7 ± 4.2	1.3 ± 2.0	<0.001**
Anger state	12.7 ± 3.6	10.5 ± 1.3	n.s.
Anxiety state	54.5 ± 10.8	35.7 ± 9.3	<0.001**
NEO scores			
Agreeableness	26.5 ± 7.1	33.9 ± 4.7	0.004**
Openness	29.4 ± 7.8	27.5 ± 7.3	n.s.
Neuroticism	35.8 ± 5.9	17.9 ± 7.0	0.001**
Conscientiousness	26.9 ± 5.0	35.8 ± 6.7	0.001**
Extraversion	19.0 ± 7.1	31.9 ± 5.3	0.001**
MWT-B score	27.7 ± 4.0	28.1 ± 3.7	n.s.
Operation span score	0.59 ± 0.17	0.60 ± 0.18	n.s.
Reading span score	0.55 ± 0.17	0.61 ± 0.16	n.s.

Values denote means ± SD. BPDSI = Borderline Personality Disorder Severity Index; BDI = Beck Depression Inventory; HAMD-21 = 21-item Hamilton Depression Rating Scale; NEO = Neuroticism-Extraversion-Openness to Experience Five Factor Inventory; MWT-B = Mehrfachwahl-Wortschatz-Test, a linguistic intelligence test; n.s. = not significant. ** $p < 0.01$.

Methods

The following measures were used to characterize subjects in terms of psychopathology and personality traits (table 1).

The Beck Depression Inventory [27], German version [28], is a widely used instrument to assess the severity of self-rated depressive symptoms. It includes 1 scale consisting of 21 items scoring from 0 (not present) to 3 (strongly present). It was proved to be of high internal consistency (Cronbach's $\alpha = 0.88$) and high validity as shown by correlations with other depression self-ratings (r between 0.72 and 0.89 [28]).

In addition, depression was assessed by interviewer rating by the Hamilton Depression Scale [29], German version [30], which consists of 21 items measuring different depressive symptoms. The Hamilton Depression Scale shows good psychometric properties such as high interrater reliability (up to 0.98 depending upon the clinical experience of raters), high internal consistency (Cronbach's α between 0.73 and 0.88) and satisfying correlations with other observer ratings of depression.

The severity of BPD symptoms was assessed by the Borderline Personality Disorder Severity Index (BPDSI [31], German version [32]). This semistructured interview consists of 71 items assessing the frequency and severity of the 9 DSM-IV criteria for BPD. It shows high interrater reliability (r = 0.97), high internal consistency (Cronbach's $\alpha = 0.93$) and good construct validity [31].

Personality traits were assessed by the NEO (Neuroticism-Extraversion-Openness to Experience) Five Factor Inventory (NEO-FFI [33], German version [34]). The NEO-FFI is a well-established instrument for the assessment of individual differences on the scales for neuroticism, extraversion, openness, agreeableness and conscientiousness. Each scale comprises 12 items with 5-point Likert answer formats ranging from 0 (strongly disagree) to 4 (strongly agree). The NEO-FFI shows good internal consistency (Cronbach's α between 0.67 and 0.85 for different scales), retest reliability (r_{TT} between 0.65 and 0.81) and construct validity as measured by correlations with different related constructs.

As working memory capacity as well as intelligence can influence the performance in impulsivity tasks, these 2 parameters were tested as well. Working memory capacity was measured by reading span and operation span [35, 36]. In these tasks, subjects have to recall memory content while performing additional tasks calling for their attention. Thus, it is possible to estimate the subjects' ability to control their attention when distracted, to keep relevant information and to suppress irrelevant information. Operation span is tested by a parallel presentation of simple arithmetic problems and words [37]. Subjects have to decide whether the arithmetic problems are solved correctly, and at the same time memorize the words. Similarly, for assessing reading span, subjects are asked to decide whether simple sentences are true, and to memorize the last word of each sentence [38]. Operation and reading spans are operationalized by the mean number of correctly memorized words by test block [35]. This mode of calculation shows the best internal consistency (0.81 and 0.78, respectively).

Crystallized intelligence was estimated by a linguistic intelligence test, the Mehrfachwahl-Wortschatz-Test [39], which is commonly used in German-speaking countries. In each of the 37 test trials, 5 words are presented, of which 1 is a correct word, while the other 4 are fake words. Subjects have to mark the correct word, and their IQ can be estimated. The Mehrfachwahl-Wortschatz-Test is economical and shows high retest reliability ($r_{TT} = 0.87$) as well as high validity as measured by correlations with other global intelligence measures (median r = 0.72) [39].

Impulsivity Measures

Self-Report Measures

Three different questionnaires assessing impulsivity were administered.

The BIS [9], German version [40], is widely used in clinical studies in general and has been recommended for use in studies on BPD [41, 42]. The BIS comprises 30 items measuring the following 3 scales: (a) attentional impulsiveness (8 items), defined as a tendency towards quick reactions and lack of attention and cognitive control; (b) motor impulsiveness (11 items), measuring behavioral spontaneousness such as buying things spontaneously, and (c) nonplanning impulsiveness (11 items), describing a lack of action planning on the level of a general attitude towards life, such as a low interest in one's future. Items are answered on a 4-point scale from 1 (rarely/never) to 4 (nearly always/always). The BIS shows high internal consistency (between 0.79 and 0.83 in different groups) [9], high retest reliability (r_{TT} = 0.89 [43]) and high construct validity as shown by the relationships to impulsive behaviors such as drug use, drunk driving and binge eating [43, 44].

Another commonly used self-rating of impulsivity is Eysenck's I-7 [16], German version [45]. It consists of 54 items with the 2 answering options 'yes' and 'no'. The questionnaire comprises scales for impulsiveness, venturesomeness and empathy. As only the first 2 scales are supposed to measure facets of impulsiveness, we report only on these. Impulsiveness (17 items) measures the tendency to act spontaneously, without planning and considering consequences, similar to motor impulsiveness and nonplanning impulsiveness as conceptualized in the BIS. Venturesomeness (17 items) describes a tendency to look for exciting new experiences, even if they are risky. A reliability of 0.80 is reported [46]; different studies have demonstrated the construct validity as shown by positive correlations with impulsive behaviors such as alcohol abuse, adolescent juvenile delinquency and pathological gambling [47–49].

The UPPS (Urgency, Lack of Perseverance, Lack of Premeditation and Sensation Seeking) impulsiveness scale [5], German version [50], comprises 45 items with 4-point Likert answering formats from 1 (strongly disagree) to 5 (strongly agree) measuring a total of 4 scales.

Urgency is characterized by a lack of control over one's action impulses. It covers the experience of strong impulses, often associated with negative emotions. Persons with high urgency scores show impulsive behavior in order to reduce negative emotions without regard to negative consequences.

Lack of premeditation describes a lack of anticipating the consequences of one's own actions. Persons with high scores on this scale typically act very spontaneously.

Lack of perseverance measures difficulties in continuing boring or difficult tasks.

Sensation seeking encompasses a tendency to enjoy and look for exciting activities as well as openness towards new experiences, even if they are risky. This scale resembles the construct of venturesomeness as defined by Eysenck's I-7.

The UPPS scale was constructed empirically on the basis of a factorial analysis of 20 different impulsivity scales. All scales show a high internal consistency between 0.82 and 0.91 [5]. Validity studies show differential correlations of UPPS scales with different variants of impulsive behavior and psychopathology [6, 51].

Experimental Studies

Three different tests were used to assess the ability of subjects in cognitive and behavioral inhibition [8, 52].

The Stroop test [53] measures the ability to control for interfering stimuli: the presented stimulus triggers competing (cognitions and) actions, one of which has to be suppressed. Therefore, the test can be regarded as specifically assessing cognitive inhibition, which is needed to sort out interfering irrelevant stimuli. Test stimuli are color words which are written in different colors. Subjects are asked to ignore the word content and identify the color of the word. In the incongruent condition (different word color and content), the word content has to be actively suppressed, which is more difficult for highly impulsive persons. The interference effect is calculated by subtracting the reaction time in the congruent condition from the reaction time in the incongruent condition [54]. The incongruent condition activates frontal brain regions [55]; patients with frontal brain lesions show a weaker Stroop test performance [56]. In addition, Stroop performance is associated with the activation of brain regions regulating attention, conflict monitoring and cognitive control [57–60]. It shows high retest reliability (incongruent condition: r_{TT} = 0.87; congruent condition: r_{TT} = 0.75) and excellent internal consistency (Cronbach's α = 0.88) [61].

The stop signal task (SST [62]) measures behavioral inhibition. Subjects specifically have to inhibit prepotent motor responses. In this task, subjects firstly build up a reaction tendency towards visual stimuli presented on a screen (categorize a word as quickly as possible as 'animal' or 'not animal' by left- or right-hand mouse click, respectively). After this reaction has been learned, it has to be suppressed when the visual target stimulus is combined with an auditory stimulus (stop trials). The dependent variable is the percentage of reactions in stop trials [63]. Successful inhibition is associated with activation of the prefrontal cortex and the nucleus subthalamicus [64–67], and stop task performance has been shown to correlate significantly with the questionnaires I-7 and BIS [63, 68].

The antisaccade task is used to assess the intentional control of reflectory reactions via ophthalmic motor inhibition [69]. In this task, the presented visual stimulus moves towards one side of the screen, and subjects are instructed either to follow the visual stimulus with their gaze (prosaccade trials) or to move their gaze towards the other side of the screen (antisaccade trials). Eye movements are recorded by eye tracking. The dependent variable is the percentage of mistakes in antisaccade trials [70]. The antisaccade task shows high retest reliability (r_{TT} = 0.89) and internal consistency (Cronbach's α = 0.87) [71]. Antisaccade performance correlates significantly with impulsiveness as measured with the BIS [68], and patients with attention deficit and hyperactivity disorder as well as patients with orbitofrontal cortex lesions show a weaker antisaccade performance [8, 72]. Neuroimaging shows an activation of frontostriatal regions during antisaccades [69, 73].

Strategies of Data Analysis

All statistics were calculated by SPSS (Statistical Packages for the Social Sciences®, version 14.0). Means and SD were calculated for all variables. Group differences were calculated with paired t tests, as the subjects were matched for age and education with a pairwise matching procedure. To test for interrelations, Pearson's correlations were calculated. All p values were two-sided.

Results

Subjects

Fifteen women with BPD and 15 female HC, matched for age and years of education in a pairwise matching procedure, participated in the study. Patients were recruited from the Department of Psychiatry and Psychotherapy, University Medical Center Freiburg, Germany, and from the Rehaklinik Glotterbad, Glottertal, Germany. Healthy participants were recruited from the surroundings of the authors and via bulletin board appeals. Psychiatric diagnoses of axis I and II were made by the Structured Clinical Interview for DSM-IV axis I disorders (SCID-I) [74], German version [75], and the SCID-II [76], German version [77], by trained interviewers who were also clinicians experienced in BPD. State anxiety and state anger was assessed by the state scales of the State-Trait Anxiety Inventory [78], German version [79], and the State-Trait Anger Expression Inventory [78], German version [30], respectively.

The inclusion criteria for BPD were a current diagnosis of BPD according to DSM-IV, female gender and age between 18 and 40 years. Exclusion criteria were lifetime diagnoses of schizophrenia or bipolar I disorder, a current diagnosis of psychotic disorder, MDD or any bipolar disorder, and psychotropic medication other than SSRI. Only 1 subject was medicated with an SSRI. Patients had to be free of all other psychotropic medications for at least 2 weeks.

HC were matched with BPD subjects in terms of age, years of education and intelligence. Exclusion criteria for HC were any current or lifetime psychiatric disorder as assessed by SCID-I and -II. All participants were informed in detail of the study's purpose before giving their written informed consent. The study was approved by the local ethical board of the University of Freiburg. A description of the sample in terms of age, level of education, psychopathology, personality, intelligence and working memory span is given in table 1. The BPD subjects showed significantly higher values in psychopathology measures and neuroticism, and significantly lower values in agreeableness, conscientiousness and extraversion. No differences were found in intelligence and working memory span.

On axis II, 7 patients reported a comorbid avoidant PD, and 1 patient a comorbid obsessive-compulsive PD. On axis I, only 3 patients reported a current binge eating disorder. However, all but 1 of the patients reported additional lifetime diagnoses, mostly MDD (n = 12), eating disorders (n = 6), substance use disorders (n = 4), post-traumatic stress disorder (n = 3), obsessive-compulsive disorder (n = 3) and anxiety disorders (n = 3). Current axis I comorbidity was relatively low due to the fact that current MDD and current substance use disorders were exclusion criteria.

Table 2. Group differences in clinical impulsivity measures

	BPD (n = 15)	HC (n = 15)	p
Self-report measures			
BIS scores			
Behavioral	2.5 ± 0.4	1.9 ± 0.3	<0.001**
Attentional	2.9 ± 1.0	1.8 ± 0.4	0.002*
Nonplanning	2.7 ± 0.4	2.1 ± 0.4	0.003*
I-7 scores			
Venturesomeness	6.9 ± 3.9	7.7 ± 3.8	0.559
Impulsivity	11.4 ± 3.5	5.6 ± 3.8	0.003*
UPPS scores			
Urgency	47.7 ± 6.3	28.8 ± 7.9	<0.001**
Lack of premeditation	35.5 ± 7.5	28.3 ± 5.1	0.016
Lack of perseverance	30.1 ± 7.8	20.3 ± 3.6	0.001*
Sensation seeking	30.8 ± 11.9	34.5 ± 8.7	0.335
Behavioral measures			
Stroop interference effect	202 ± 80	151 ± 84	0.033
SST reactions in stop trials	0.20 ± 0.13	0.17 ± 0.07	0.352
Antisaccade error rate	0.15 ± 0.17	0.14 ± 0.08	0.522

Values denote means ± SD. * $p < 0.05/12$; ** $p < 0.01/12$.

Group Differences

The means ± SD and p values of all impulsivity measures are listed in table 2. To control for multiple comparisons, $p < 0.05/12$ are marked as significant.

The patients with BPD showed significantly higher values in most of the self-report measures. On all 3 BIS scales, Eysenck's I-7 impulsiveness, and the UPPS urgency and lack of perseverance scales, they showed remarkably higher values than the HC. Only the scales for venturesomeness (I-7) and sensation seeking (UPPS), which overlap in content, as well as lack of premeditation (UPPS) did not differ between the BPD subjects and the HC.

The behavioral tests rendered divergent results. Only in the Stroop test did the BPD patients show a tendency towards difficulties in cognitive inhibition as compared to the HC. However, the effect was rather minimal (d = 0.6) as compared to self-ratings, and with Bonferroni correction, it was not significant. Neither the SST nor antisaccades showed significant group differences.

Table 3. Correlations between different measures of impulsivity in patients with BPD (n = 15) and matched HC subjects (n =15)

	UPPS lack of premeditation	UPPS lack of perseverance	UPPS sensation seeking	BIS attentional impulsivity	BIS behavioral impulsivity	BIS non-planning impulsivity	I-7 impulsivity	I-7 venturesomeness	Stroop interference effect	Antisaccade error rate	SST reactions in stop trials	BPDSI impulsivity (n = 15)
UPPS												
Urgency	0.56**	0.55**	–0.08	0.55**	0.70**	0.69**	0.78**	0.02	0.27	0.14	0.21	0.63*
Lack of premeditation		0.47**	0.14	0.45*	0.55**	0.74**	0.68**	0.10	0.34	0.52**	0.30	0.57
Lack of perseverance			–0.22	0.54**	0.46*	0.60**	0.52**	–0.26	0.41*	0.36	0.31	0.05
Sensation seeking				0.13	0.13	0.04	0.08	0.71**	–0.35	–0.28	–0.16	0.02
BIS												
Attentional impulsivity					0.58**	0.48**	0.61**	0.26	0.24	0.01	0.06	0.47
Behavioral impulsivity						0.76**	0.85**	0.23	0.14	0.08	0.06	0.45
Nonplanning impulsivity							0.85**	0.20	0.32	0.41*	0.22	0.62*
I-7												
Impulsivity								0.34	0.18	0.19	0.12	0.68*
Venturesomeness									–0.39*	–0.25	–0.03	0.18
Stroop interference effect										0.44*	0.27	0.18
Antisaccade error rate											0.30	0.48
SST reactions in stop trials												0.23

* $p < 0.05$, two-sided; ** $p < 0.01$, two-sided. Correlations in the last column refer to the 15 BPD subjects only, as the BPDSI was not assessed in the HC subjects.

Table 4. Correlations between behavioral impulsivity measures and emotions

	Stroop interference effect	Antisaccade error rate	SST reactions in stop trials
State anger			
BPD	0.237	0.071	0.595*
HC	0.013	0.237	0.175
Trait anger			
BPD	0.234	0.117	0.389
HC	0.070	–0.051	0.081
State anxiety			
BPD	0.561*	0.202	0.413
HC	–0.176	0.325	0.159
Trait anxiety			
BPD	0.434	0.281	0.168
HC	0.169	0.512	0.256

* $p < 0.05$, two-sided.

Correlational Analyses

Correlational analyses revealed strong interrelations among all self-report scales, with the exception of sensation seeking and venturesomeness (table 3). In addition, most of these scales correlated with the impulsivity scale of the BPDSI, which reflects the severity of impulsive symptoms in BPD. By contrast, the behavioral tests did not show a clear pattern of interrelations or relations to self-report measures (table 3).

To test for the influence of state and trait emotion on behavioral impulsivity, additional correlational analyses were performed with state and trait anger and anxiety for both groups separately (table 4). We found significant correlations between state anxiety and Stroop interference effect as well as between state anger and SST reactions in the BPD subjects, but not in the HC.

Discussion

In this study, several facets of impulsivity were assessed in BPD patients as compared to HC. Most self-report scales showed large group differences, with BPD subjects showing stronger impulsivity. Higher values for BPD patients on these scales are in line with many other studies using self-report measures in BPD [10–15, 17]. High overall interrelations between different self-report scales indicate that, in general, they measure rather similar constructs. By contrast, apart from a nonsignificant

tendency in the Stroop test, none of the experimental tests revealed a significant group difference.

This discrepancy between self-report measures and behavioral data is in line with mixed findings in the previously published literature, which, in general, found few differences in behavioral tests and large differences in self-reports on impulsivity in BPD subjects [9–26]. Adding to this, it is in parallel with the conclusion of Rosenberg et al. [80] in their review on emotional dysregulation in BPD. The review shows, overall, strongly elevated self-reports of negative state and trait emotions in BPD subjects. However, objective data on emotion regulation such as psychophysiological data or fMRI results are mixed and do not show a general hyperarousal in BPD as might be expected from self-ratings, clinical impression and clinical models of BPD such as the model of Linehan [81] stating emotional hypersensitivity as a main factor for BPD.

However, concerning the complex construct of impulsivity, the missing connection between self-report and behavioral data is not limited to BPD. Although not many studies on impulsivity have so far investigated the relation between different data levels, and studies on this issue have been methodologically heterogeneous, similar results have already been reported for healthy male volunteers [82], undergraduate students [83], a mixed sample of PD and healthy participants [84], alcoholics with comorbid cluster B PD [85], patients with traumatic brain injury [86] and violent offenders with schizophrenia [87].

The correlations we found between test performance and state emotions may be an interesting finding, as they hint at a relationship between emotions and impulsivity specific to BPD. Regarding the influence of emotions on impulsivity in BPD, previous findings hint at differential effects. Both Domes et al. [10] and Völker et al. [21] failed to find group differences in a so-called emotional Stroop test, which employs emotional words as test stimuli. However, Silbersweig et al. [88] found behavioral differences in a go/no go task using BPD-specific negative words as stimuli. Thus, the mere negative valence of test stimuli may not influence test performance, while BPD-specific negative stimuli may have such an effect. In addition, while Domes et al. [10] did not find group differences in the Stroop test in general, they found significant correlations between state anxiety and state anger regarding reaction time in the emotional Stroop. As in our study, this effect was present only in BPD subjects, but not in HC. In a study investigating a passive avoidance learning task in healthy subjects, who were stratified into severe and mild BPD groups according to the intensity of their borderline features, it was found that negative state emotions increased the number of avoidance errors in persons with severe BDP features, but not in participants with mild BDP [89].

Understanding disinhibition in BPD in more detail may require investigations on broader and more complex levels, covering situational and emotional factors as well. Further research should aim to understand the connection between emotions and impulsivity in BPD in more detail and to investigate the neurobiological underpinnings of such processes.

This study has several limitations, mainly its small sample size. In particular, the fine-grained comparison between different facets of behavioral disinhibition, such as cognitive, behavioral or motivational disinhibition, requires larger sample sizes. In addition, findings can only be generalized to women, as we only included female subjects; however, gender differences have been found concerning psychopathology and temperament, for example [90, 91].

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