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Sequences of emotions in patients with borderline personality disorder

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Objective: To investigate sequences of emotions (temporal dependence of emotions) to identify specific patterns of borderline personality disorder (BPD).
Method: The perceived emotions of 50 BPD patients and 50 healthy controls (HC) were monitored by using a hand-held computer system for a 24-h period in a daily life setting. Participants were prompted four times per hour to assess their current perceived emotions. Differences between BPD patients and HC in terms of activation, persistence and down-regulation of emotions were analyzed.
Results: Healthy controls in contrast to BPD patients more often activated joy and interest. BPD patients more often experienced persistence of anxiety and sadness. BPD patients more frequently switched from anxiety to sadness, from anxiety to anger and from sadness to anxiety. Anger was predominantly preceded by anxiety.
Conclusion: Persistence of sadness and anxiety, as well as emotional oscillating between anxiety, sadness and anger are important aspects of the emotional dysregulation in BPD patients.

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Key words: borderline personality disorder; ambulatory monitoring; emotion; affect regulation; psychotherapy

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Significant Outcomes

In comparison with healthy controls in daily life:

- Patients with borderline personality disorder (BPD) more often got stuck in anxiety and sadness.
- BPD patients more often oscillate between anxiety and sadness.
- In BPD patients, anger was predominantly preceded by anxiety.

Limitations

- The method of ambulatory monitoring (measuring in the field) may have influenced, and potentially distorted, data collection.
- The results may be partially dependent on the time interval between assessments (15 min).
- Results may not be specific for BPD; it cannot be excluded that patients suffering from other psychiatric disorders, specifically other personality or anxiety disorders, may have similar patterns of emotion sequences.
- The findings may be gender-specific; all study participants were female, hence results may not be replicable for a male sample.

Introduction

Emotional instability is a defining characteristic and a core symptom of borderline personality disorder (BPD) (1, 2). Therefore, emotion regulation is a main target in the treatment of BPD patients (3, 4). Emotional dysregulation of BPD patients is understood to be a pervasive phenomenon including all basic emotions (5, 6). In fact, Jones et al. (7) demonstrated that BPD patients show high scores on psychometric measurements of a wide range of emotions. Sadness as the central emotion of depression as well as the emotions anger and anxiety are (beside, e.g. shame and disgust) undoubtedly of clinical importance in the suffering of BPD patients. Parasuicidal behaviour

of BPD patients is closely related to these emotions and leads to temporary relief in the patient from these overpowering emotions (8). In accordance, Brezo et al. (9) claim that more research is necessary on the relation of anger and anxiety in BPD.

According to Linehan's biosocial theory (4), the defining pattern of BPD is emotional vulnerability characterized by heightened sensitivity and reactivity to stressors. Heightened sensitivity in BPD is manifested by a low threshold for emotional reactions, while heightened reactivity gives rise to immoderate reactions. To date, pertinent results from a number of studies on emotion dysregulation in BPD have been published. For example, when asked to imagine situations that could trigger off an emotional reaction, BPD patients demonstrated lower levels of emotional awareness, an impaired ability to cope with mixed valence feelings, as well as reduced accuracy in recognizing facial expressions of emotions, and more intense responses to negative emotions than non-borderline controls (10). In a further study, BPD patients exposed to induced frustration while gambling showed an aggression level three times that of controls (11). After assessing mood ratings for a 14-day period, Cowdry et al. (12) found that BPD patients exhibited higher mood variability when compared with other psychiatric groups. Stein (13) discovered that the diary entries made over 10 days by female BPD patients contained more unpleasant affect and greater short-term fluctuation of emotions than entries made by controls. Correspondingly, Herpertz et al. (14) found a lowered threshold for affective responses together with rapidly changing affects (affective hyperactivity) for this patient group. Hochhausen et al. (15) point out that disinhibition of emotions is a potentially important component characterizing BPD.

However, most of the published studies refer to highly stable traits which fluctuate in the degree of maladaptive expression (16, 17), but the definition of BPD also reflects the rapidly shifting emotional patterns emblematic of this disorder. So far, few studies focused this topic. Stiglmayr et al. (18) were able to demonstrate that symptoms (dissociation) of BPD patients were strongly related to stress, indicating that it is crucial to focus emotion states beside traits. In another study, Stiglmayr et al. (19) showed that BPD subjects experience more frequent and prolonged states of aversive tension. Koenigsberg et al. (20) found that both oscillation between depression and anger, as well as oscillation between anxiety and depression, seem to be key features of BPD.

Most studies investigating emotions in patients with BPD utilize standardized questionnaires to either measure focused emotions retrospectively or assess the instability of emotions. We are in agreement with Koenigsberg et al. (20) who assert that more finely grained methods are needed to investigate affective instability in BPD patients. In contrast to retrospective assessments, field studies can serve to investigate oscillations between emotional states directly and prospectively (21).

In this study, we focused on instability of self-reported perceived emotions. Using an ambulatory monitoring design (19, 22), participants were prompted to assess which of seven basic emotions (23) was present at a given moment. We investigated the temporal pattern (in the following called sequences of emotions) of basic emotions. Emotional sequences of BPD patients were compared with those of HC subjects.

When analyzing sequences of emotions, four types of emotion sequences can be differentiated:

> *Activation* (of an emotion): after having perceived no emotion, the subject perceives an emotion at the consecutive prompting.
> *Persistence* (of an emotion): the subject perceives the same emotion as before at the next prompting.
> *Switch* (of an emotion): the subject perceives a different emotion at the consecutive prompting.
> *Down-regulation*: the subject perceives no emotion after having perceived an emotion at the previous prompting.

Aims of the study

The goal of the study was to find BPD-specific emotion sequences (i.e. temporal series of emotions). We expect BPD subjects to experience the activation of angry, anxious or sad feelings more often than HCs; to persist in anxiety, anger and sadness; to show different patterns of emotional oscillations; and to down-regulate anxiety, anger and sadness less often.

Material and methods

Subjects

All patients met DSM-IV criteria for BPD, as determined by the section of the International Personality Disorder Examination (IPDE; 24). Axis I comorbidity was assessed using the Structured Clinical Interview for DSM-IV, Axis I Disorders (SCID-I; 25). Participants with a lifetime history of schizophrenia, bipolar disorder or

current alcohol/drug abuse were excluded. Trained psychologists (Freiburg) and masters-level clinical assessors (Seattle) administered all diagnostic instruments. All assessors were specifically trained to apply the mentioned diagnostic interviews. HCs were either randomly selected from the registry office of the City of Freiburg or recruited by means of advertisement in Seattle. Exclusion criteria for the control group included the diagnosis of BPD (IPDE), any current or past Axis-I disorder (SCID-I), current psychotherapy or current medication (based on verbal interview).

All patients were participants in psychotherapy programs. The Freiburg patient group was examined prior to dialectical behavioural therapy (DBT), while the Seattle patient group was examined during ongoing DBT treatment. All subjects were paid for participating in the study and each provided written informed consent. The study was approved by the ethical review committee affiliated with the University of Freiburg and by the human subject commission (University of Washington) in Seattle. Data referring to psycho-physiological correlates (22) and recall bias (26) were presented recently, analyzing different aspects of BPD pathology.

Assessment and data acquisition

Self-assessed emotions were recorded by a Psion minicomputer system, which was carried by the subjects for the duration of 24 h. Triggered by the software program MONITOR (University of Freiburg, Freiburg, Germany) (27), the hand-held computer emitted an acoustic signal every 15 min. At each measuring point, the display prompted subjects to answer the question 'How did you feel just before the beep?', select one of nine: 'happy', 'interested', 'anxious', 'angry', 'sad', 'ashamed', 'disgusted', 'emotion, but I cannot name it' and 'no emotion'. This list was derived from studies on basic emotions (4, 23). Subjects were also queried about the occurrence of any secondary emotion (same list as above, without the first reported emotion). This second query was omitted by the program if 'no emotion' was marked at the first request. The second emotion data were not considered in analyses to allow calculation of 'adjusted relative frequencies' (see below). Responses were automatically time-stamped by the software program. Prompting was effected by three signals, each with a duration of 5 s and an inter-signal interval of 40 s. If the subject failed to respond within 340 s, the trial was recorded as missing. Participants were trained in the use of the equipment beforehand and instructed how to turn off the device before sleeping.

To ensure ecological validity, participants were asked after concluding the procedure whether the device and monitoring had altered their behaviour in any way (e.g. altered their awareness of emotions, of body sensations, of extraordinary events during the day or altered their attitude towards the device, etc.). Minimal distress and reactivity to monitoring was reported for a few subjects in both groups. No group differences were found regarding the intensity of distress.

Data analysis

The given assessment method allows to record a sequence of emotional perceptions in each participant. Such data yield two types of information. First, the frequencies of perceived emotions can be described per patient and per group. Such time-independent frequencies of emotions have been covered in Ebner-Priemer et al. (22).

Second, the data provide information on the frequencies of *emotion sequences*. Each such sequence consists of two assessment points (emotion E1 at assessment point t followed by emotion E2 at assessment point $t + 1$). Four different types of sequences were generally distinguished: 'Emotional activation' is defined as the sequence 'no emotion' followed by any emotion, 'persistence of an emotion' as emotion E1 followed by emotion E1, 'emotion switch' as emotion E1 followed by emotion E2, and emotion 'down-regulation' as emotion E1 followed by 'no emotion' at the next prompting.

Sequences can be counted directly from the data series but these counts will be biased in two respects: first, the frequency of any sequence depends on the frequencies of the contributing emotions. In other words, the frequency of emotion sequence E1 $\rightarrow$ E2 depends on the number of the subject's perception of both emotions E1 and E2 during the assessment period. The main goal of this study, however, was to analyze group-specific differences of emotion sequences independent of overall emotion frequencies. Since HCs and BPD subjects differ markedly with respect to the emotions they perceived (22), statistical analyses must be adjusted for such group differences. Second, the number of promptings differed between subjects. Therefore, the number of sequences was adjusted additionally for these individual numbers.

Adjusted relative frequency

To apply the two adjustments, the 'adjusted relative frequency' was calculated for each sequence E1 $\rightarrow$ E2 for each subject. The frequency of a specific sequence was counted for each subject.

This frequency was adjusted according to the following formula:

$$\mathrm{ARF}(\mathrm{E1} \rightarrow \mathrm{E2}) = \frac{f_S(\mathrm{E1} \rightarrow \mathrm{E2})}{f_G(\mathrm{E1}) \times f_G(\mathrm{E2})} \times \frac{f_G(\mathrm{Sequ})}{f_S(\mathrm{Sequ})},$$

with $\mathrm{ARF}(\mathrm{E1} \rightarrow \mathrm{E2})$, adjusted relative frequency (of the individual subject); $f_S(\mathrm{E1} \rightarrow \mathrm{E2})$, frequency of a sequence (of the individual subject); $f_G(\mathrm{E1}) \times f_G(\mathrm{E2})$, product of frequencies of emotions E1 and E2 [in the corresponding group (BPD or HC)]; $f_G(\mathrm{Sequ})$, total number of all sequences in the corresponding group; $f_S(\mathrm{Sequ})$, total number of all sequences of the individual subject.

In other words, to correct for the fact that the number of sequences $f_G(\mathrm{Sequ})$ differed between both groups, the number of individual sequences $f_S(\mathrm{E1} \rightarrow \mathrm{E2})$ was normalized by using the product of responses of both emotions (E1 or E2) that contributed to a specific sequence. In this procedure, the group level $f_G(\mathrm{E1}) \times f_G(\mathrm{E2})$was used to avoid missing values as a result of division by zero that would have resulted if using the individual levels (where some emotions were never perceived by some individuals).

Finally, the second adjustment $[\times \frac{f_G(\mathrm{Sequ})}{f_S(\mathrm{Sequ})}]$ corrects for the varying frequency of emotion responses in an individual subject in relation to the respective group frequency (BPD or HC).

The adjusted relative frequency ARF was calculated for each subject S and each sequence $(\mathrm{E1} \rightarrow \mathrm{E2})$. In several cases, ARFs were not distributed normally, hence BPD and HC were compared using non-parametric tests (Wilcoxon rank sum test) to identify group differences. The alpha level was set to 5% ($P < 0.05$). A Bonferroni correction on each type of emotion sequences (emotion activation, emotion perpetuation, emotion switch and down-regulation) was additionally carried out to compensate for multiple testing. Finally, odds ratios were computed for sequences that differed between groups to compare the absolute number of observed emotion sequences.

Additionally, the significant results of the ARF in the BPD sample were further tested to separately analyse potential influences of comorbid post-traumatic stress disorder (PTSD) and phobia as well as antidepressant medication using the same procedure. Bonferroni correction was again applied. Other comorbidities and other psychotropic medications were not considered owing to low occurrences and thus unacceptably low power of the analyses.

All analyses were carried out using JMP version 6.0 (SAS Institute, Cary, NC, USA) and SPSS version 11.5 (SPSS Inc., Chicago, IL, USA).

Results

Subjects

Fifty female patients meeting the criteria for BPD and a comparison group of 50 female HCs participated in this study. Forty-two per cent of the participants were assessed at the University of Washington, Seattle, USA (BPD, $n = 21$; HC, $n = 21$), and 58% were assessed at the University of Freiburg, Germany (BPD, $n = 29$; HC, $n = 29$).

Of the BPD patients, 20% were free of psychotropic medication. Of the 80% of patients on medication, 65% were receiving antidepressants, 32% antipsychotic medication and 30% hypnotics. Comorbid Axis I disorders of BPD patients were major depressive disorder (current, 36%), 60% suffered from other anxiety disorders (phobia: current, $n = 20/40\%$; obsessive–compulsive disorder: current, $n = 1/2\%$; agoraphobia: current, $n = 1/2\%$; panic disorder: $n = 12/24\%$), PTSD (current, 60%), eating disorders (past, 50%) and substance abuse (past, 60%). Comorbidity of other personality disorders (PD) was assessed only in the Freiburg sample (paranoid PD, $n = 6/20.7\%$; schizoid PD, $n = 7/24.1\%$; schizotypal PD, $n = 7/24.1\%$; antisocial PD, $n = 6/20.7\%$; histrionic PD, $n = 0$; narcicistic PD, $n = 1/3.4\%$; avoidant PD, $n = 13/44.8\%$; dependent PD, $n = 5/17.2\%$; obsessive–compulsive PD, $n = 7/24.1\%$).

The age of BPD patients (mean = 31.3, SD = 8.1) and HC (mean = 27.7, SD = 6.8) differed significantly ($t = -2.44$; $df = 98$; $P = 0.016$), otherwise no differences in sociodemographic variables existed between patients and controls.

Missing data (numbers of ignored requests) were not statistically different between groups (BPD: 5.36, SD 8.67; HC: 2.71, SD 4.16; Wilcoxon test, $P = 0.196$).

Frequency of emotions

Significant group differences were found regarding the absolute number of ratings for most of the seven basic emotions (see Table 1).

Adjusted relative frequency

The BPD group showed a number of specific emotion sequences that were significantly different from those found in HCs. Specifically, differences were found in emotion activation, repetition and emotion change, whereas no significant differences were found in emotion down-regulation (see Table 2).

Table 1. Frequencies of emotions

	BPD		HC		Wilcoxon test	
	Mean	SD	Mean	SD	*Z*	*P*
No emotion	6.6	9.1	12.9	12.4	2108	0.0039
Joy	4.8	5.2	12.0	7.0	1695	> 0.0001
Anxiety	8.9	7.4	1.6	2.1	1712	> 0.0001
Anger	4.5	5.0	2.5	3.0	2167	0.0124
Sadness	4.8	5.4	0.8	1.4	1784	> 0.0001
Shame	1.2	1.6	0.2	0.7	2023	> 0.0001
Disgust	1.0	1.7	0.3	0.8	2185	0.0047
Interest	6.5	6.1	12.5	7.3	1895	> 0.0001
Unspecific emotion	10.9	8.2	10.9	7.2	2489	n.s.

BPD, borderline personality disorder; HC, healthy controls.

Emotional activation: Group differences were only found for 'interest' and 'joy'. Both emotions were more often activated in the control group. No group differences were found for anxiety, anger or sadness.

Persistence: Positive autocorrelations of 'anxiety' and 'sadness' were found more often in the BPD group (odds ratio > 22). No persistence effect was found for anger.

Emotion switch: Compared with HC subjects, BPD subjects more often experienced changes from 'anxiety' to 'anger', from 'anxiety' to 'sadness' and from 'sadness' to 'anxiety'.

No statistically significant differences were found within the BPD group with respect to comorbidity (PTSD, phobias) and antidepressant medication, suggesting that comorbidity and antidepressant medication did not have an influence on the results. The resulting characteristic patterns are illustrated in Fig. 1.

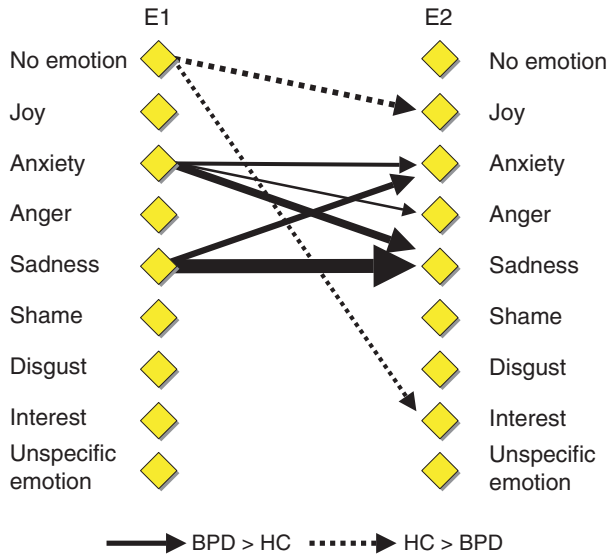

Fig. 1. Characteristic emotion sequences in borderline personality disorder patients and healthy controls. Thickness of arrows reflects significant odds ratios. BPD, borderline personality disorder; HC, healthy controls; E1, preceding emotion; E2, subsequent emotion.

Discussion

Sequence analyses showed that BPD patients in comparison with HCs get stuck in anxiety and sadness, pointing to the phenomenon that BPD subjects get trapped in theses emotions. These results are in line with Stiglmayr et al. (19) who found longer lasting emotional states in BPD subjects. It must be noted, that it was not possible to determine whether the perceived emotion was in fact related to the same (external or internal) event and hence a continuously perceived emotion.

Table 2. Adjusted relative frequencies (see Methods section) of emotion sequences

			BPD		HC				
Emotion 1		Emotion 2	Pattern present (%)	Pattern absent (%)	Pattern present (%)	Pattern absent (%)	*Z**	*P* (corrected)*	Odds ratio
Emotion activation									
No emotion	followed by	Joy	18	82	66	34	3.37	0.006	0.11
No emotion	followed by	Interest	24	76	68	32	3.45	0.005	0.15
Persistance of an emotion									
Anxiety	followed by	Anxiety	58	42	18	82	−3.25	0.010	6.29
Sadness	followed by	Sadness	48	52	4	96	−4.54	<0.001	22.15
Emotion switch									
Anxiety	followed by	Anger	26	74	8	92	−3.38	0.039	4.04
Anxiety	followed by	Sadness	44	56	6	94	−3.31	0.050	12.31
Sadness	followed by	Anxiety	46	54	8	92	−3.47	0.028	9.80
Emotion downregulation									
n.s.									

Results Bonferroni corrected.

BPD, borderline personality disorder; HC, healthy controls; n.s., not significant.

Conceivably, an identical emotion can be triggered by other stimuli, possibly at a lower threshold in BPD patients, particularly after subjects have felt anxious or sad. Our results may also be ascribable to a mixture of both effects. However, both of these effects are in line with Linehan's concept of emotional dysregulation, in which a slower return to the emotional baseline and a lower threshold for eliciting emotions in BPD patients is postulated. Inasmuch as we did not control for the stimulus itself, distinguishing these effects was not practicable.

The second important result yielded by sequence analyses indicates that BPD patients switch from anxiety to sadness and from sadness to anxiety, a finding that is in line with Koenigsberg et al. (20). The oscillation between anxiety and sadness is a specific aspect of emotional instability that has received little attention so far. It may be another emotional trap for a BPD patient leading to dysfunctional behaviour. A better understanding of this dynamic may enable the patient to discontinue the oscillation.

Third, anger seems to follow a dynamic different from anxiety or sadness. According to our results, BPD subjects perceive anger predominantly in succession to anxiety. This result leads to the conclusion that psychotherapists and patients need to analyze carefully situations evoking anger and to watch out for preceding situations evoking anxiety. Such an understanding of the emotional dynamic may help the individual patient to avoid anger-related dysfunctional behaviour.

Lastly, HCs, in comparison with BPD patients, more often activated joy and interest after having perceived no emotion. This result licences the conclusion that BPD subjects not only differ from HCs by the interaction of sadness, anger and fear, but also less often activate positive emotions. The data support the notion of Wöller (28) that refocusing on positive emotions and resource activation are important aspects in the psychotherapy of BPD subjects.

The following limitations of this study should be noted. A drawback in ambulatory monitoring is that the method potentially influences data collection. According to the postinterviews, however, this influence was minimal and did not differ between experimental and control group. Inasmuch as data collection spanned a 24-h period, it cannot be discounted that this particular time frame was not representative for all subjects. Furthermore, it could not be verified in this study whether the interval between promptings was optimal for assessing patterns of emotional processing. However, in another study, Ebner et al. (29) were able to demonstrate that sample rates of 15 min time intervals are within the range to assess emotional instability in borderline patients. Moreover, it cannot be completely ruled out that time intervals differing by a matter of minutes would have led to different results. Although we have not found results to be associated with the investigated comorbidities (PTSD and phobia) or antidepressant medication, it remains unclear whether the difference in emotional perception is BPD-specific and independent of any comorbidity or any other psychotropic medication. Additionally, the difference in age (BPD subjects were on average 3.6 years older than HC subjects) may have influenced the results. Lastly, we cannot exclude that the observed pattern may be related to general factors, such as neuroticism, that seem to be associated with all personality disorders (30).

In conclusion, the results of our study underscore the importance of learning to understand emotional processing in greater detail. Indeed, the process of understanding emotional patterns is an integral part of effective BPD therapy approaches, such as, for instance, dialectical behavioural therapy (31). Thus, further research is necessary to advance the understanding of the multidimensionality of emotional instability in BPD.

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