

## Instability of physical anxiety symptoms in daily life of patients with panic disorder and patients with posttraumatic stress disorder

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### ABSTRACT

The present study examined severity as well as degree and temporal pattern of instability of DSM-IV-based bodily symptoms of anxiety (BSA) in daily life of 26 panic disorder (PD) patients, 17 posttraumatic stress disorder (PTSD) patients, and 28 healthy controls (HC) during 1 week, using electronic diaries. The ecological momentary assessment around every 3 h during wake times was accepted well by patients. Compared to HC, patient groups exhibited elevated instability of BSA. BSA instability was more pronounced in PTSD than PD ( $p < 0.005$ ), even after controlling for mean symptom level. Numbers of symptomatic episodes were comparable in PTSD and PD, but the duration of symptom-free episodes was shorter in PTSD than PD. Results indicate that PTSD patients are particularly burdened by fluctuations in somatic symptoms of anxiety, implying perceived unpredictability and uncontrollability. Electronic diaries can be applied in innovative ways to provide novel insights into the phenomenology of anxiety disorders that may not be captured well by retrospective interviews and questionnaires.

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### 1. Introduction

Episodically occurring phases of intense anxiety are a defining feature of some anxiety disorders. In panic disorder (PD), recurrent panic attacks lie at the heart of the disorder (APA, 1994). To a large extent, these attacks are characterized by the presence of physical symptoms. According to DSM-IV, 10 out of 13 symptoms of panic attacks are of physical nature. Diagnostic criteria for posttraumatic stress disorder (PTSD) (APA, 1994) encompass episodic psychological distress and autonomic reactivity in response to trauma cues, which also implies the presence of physical symptoms. Thus, increased instability of physical anxiety symptoms must be, at least to a certain extent, characteristically inherent to both PD and PTSD. However, the focus of the disorders has been usually placed upon the severity rather than the instability of anxiety symptoms and physiological responses. In fact, very little is known about the temporal topography of symptoms.

Assessing instability in addition to severity may be of both theoretical and clinical relevance. For example, some patients may suffer from high and relatively stable levels of anxiety symptoms that hardly vary across time, while others may typically experience low levels of anxiety disrupted by bursts of intense anxiety, result-

ing in heightened symptom instability. Researchers and therapists often rely on single, retrospective patient reports when assessing emotional experiences. This would appear to be problematic for evaluation of PD and PTSD since both disorders are defined by a degree of temporal reactivity, and assessment of symptom instability, by definition, requires observing the object over time (Larsen, 1987). Moreover, traditional retrospective assessments of symptom variation are prone to error: various factors, including current mood, length of the recall interval, and primacy or recency of information can compromise the accuracy of retrospective reports (Hufford, Shiffman, Paty, & Stone, 2001). When asked to give retrospective accounts, PD patients, for instance, overestimate the frequency and severity of panic attacks (DeBeurs, Lange, & Van Dyck, 1992; Margraf, Taylor, Ehlers, Roth, & Agras, 1987).

These limitations have led to the use of patient diaries, which allow capturing symptoms close to their time of occurrence and thus reduce recall biases (Shiffman, Hufford, & Paty, 2001). Electronic diaries, i.e. diaries implemented on palmtop computers, are particularly suitable for data acquisition since they allow automatic registration of the time of patient entries. This is important as patients tend to complete several diary entries at once rather than at instructed time points, challenging the validity of paper-diaries (Stone, Shiffman, Schwartz, Broderick, & Hufford, 2003). Electronic diaries have been used productively in different areas, such as tracking smoking behavior and mood changes due to daily conflicts (Bolger, Davis, & Rafaeli, 2003). They are particularly suited to assess *instability* of symptoms (Ebner-Priemer & Trull, 2009) like the recurrent anxiety symptoms in PD and PTSD, as they allow

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capturing symptom fluctuations across various time points and situations, close to their occurrence.

Different methods have been established to quantify the degree of instability. The root mean squared successive differences (RMSSD) method has proven to be sensitive in detecting affective instability (Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009). This measure accounts for all three components of affective instability: temporal dependency of self-reports, amplitude of changes, and frequency of changes (Larsen, 1987). It has been successfully used to quantify affective instability in patients with mood and borderline personality disorders (Ebner-Priemer et al., 2007; Woysville, Lackamp, Eisengart, & Gilliland, 1999).

Research on symptom instability in anxiety disorders is rare and has used paper-diaries to assess depressed, high, and anxious mood. All previous studies found elevated instability of (low and high) mood in PTSD and patients with mixed anxiety disorders (Bowen, Baetz, Hawkes, & Bowen, 2006; Bowen, Clark, & Baetz, 2004; Golier, Yehuda, Schmeidler, & Siever, 2001). Anxiety instability was elevated in mixed anxiety disorders (Bowen et al., 2006), but not in PTSD (Golier et al., 2001). Yet, these studies have certain limitations, including issues regarding patient screening for anxiety disorders, imprecise time resolution of symptom recordings, and lack of assessment of bodily symptoms.

The present study assessed within-subject instability of bodily symptoms of anxiety (BSA) in the natural environment of PD and PTSD patients by means of electronic diaries. The aims of the study were twofold: first, we assessed whether electronic diaries are suited to capture clinically relevant phenomena like the recurrent BSA in PD and PTSD in the daily life of patients. The RMSSD approach was used to quantify instability and compare the two groups with one another and with healthy controls (HC) regarding instability of BSA. The 10 bodily symptoms of anxiety that are included in DSM-IV diagnostic criteria for panic attacks were assessed. Second, we assessed additional application possibilities of electronic diaries in research and clinical practice. Next to looking at individual patterns of BSA instability and the information they reveal for single patients, we were interested in the following questions: How often do symptomatic episodes (phases characterized by BSA) occur? Do PD and PTSD patients experience phases characterized by complete absence of BSA? How long do such phases last, and do the two patient groups differ regarding these aspects?

## 2. Method

### 2.1. Participants

26 PD patients, 17 PTSD patients, and 28 HC were recruited via local newspaper advertisements. The study was approved by the local ethics committee, and participants gave written consent before participating. Diagnoses were determined according to DSM-IV, using the Diagnostic Interview for Mental Disorders (DIPS; Schneider & Margraf, 2006). The DIPS is a well-validated structured interview for diagnosing DSM-IV disorders. It is a modified German version of the Anxiety Disorders Interview Schedule for DSM-IV – Lifetime version (ADIS-IV-L; DiNardo, Brown, & Barlow, 1994). HC had never qualified for an anxiety disorder and did not meet criteria for any current psychiatric disorder. Trauma types in the PTSD group were physical or sexual violence (8), traffic accidents (5), natural disasters (2), and other trauma (2). Out of the total of 24% (35%) of the PTSD (PD) patients who were taking psychotropic medications, 12% (34%) took selective serotonin or noradrenalin reuptake inhibitors, 6% (0%) took tricyclic antidepressants, 0% (12%) took benzodiazepines, and 6% (0%) were on hypnotics.

The present study was part of a comprehensive research project, during which additional symptoms of anxiety were assessed by the

electronic diary (data not published yet). Additionally, psychophysiological assessments were carried out during 2 days. Data of these assessments are reported elsewhere (Pfaltz, Michael, Grossman, Blechert, & Wilhelm, 2009; Pfaltz, Grossman, Michael, Margraf, & Wilhelm, 2010).

### 2.2. Psychometric measures

Psychometric assessment of the study groups included the German versions of the State-Trait Anxiety Inventory, STAI (Laux, Glanzmann, Schaffner, & Spielberger, 1981), the Beck Depression Inventory, BDI (Hautzinger, Bailer, Worall, & Keller, 1994), the Mobility Inventory, MI (Ehlers, Clark, & Chambless, 2001), and the Anxiety Sensitivity Index, ASI (Ehlers & Margraf, 1993). In PTSD patients, severity of symptoms was assessed with the Posttraumatic Diagnostic Scale (PDS; Ehlers, Steil, Winter, & Foa, 2001). In PD patients, severity of symptoms was assessed with the Panic Disorder Severity Scale (PDSS; Shear et al., 2001).

### 2.3. Electronic diary

A computerized questionnaire was developed to repeatedly assess various attributes of psychological well being and symptoms of anxiety. Items of the questionnaire covered the following areas: affective and bodily state (e.g., feeling anxious, tired, or tense), cognitive and bodily symptoms of panic attacks according to DSM-IV, triggers for symptoms of panic (e.g., unpleasant situations or thoughts), reactions to symptoms of panic (e.g., avoidance behaviors like leaving a situation or distracting oneself), symptoms of PTSD (e.g., hypervigilance, irritability, detachment from others, and re-experiencing symptoms), triggers for re-experiencing symptoms (e.g., mental images or unpleasant thoughts), symptoms of depression (e.g., feeling ashamed or guilty), environmental variables (activities pursued and people who are present), sleep (e.g., difficulties falling or staying asleep, ruminating in bed, nightly panic attacks and intrusions). Filling out the questionnaire took about 5 min. In few parts of the questionnaire, presentation of additional questions depended on the answer to the preceding question yet recording burden did not vary considerably by the presence or absence of symptoms. Items were either of a dichotomous format, requiring a yes or no response, or they comprised a computerized 0 (not at all) to 10 (very much) Likert-scale. The present study only reports scores regarding bodily symptoms of anxiety (BSA). BSA scores ranged from 0 to 10 and were calculated as the number of a total of 10 symptoms that participants rated as present (dichotomous items). For all study groups, the 10 symptoms referred to the DSM-IV bodily symptoms of panic attacks, which, according to DSM-IV, occur in both PD and PTSD patients [Exact items: “During the past 3 h (since waking up) I experienced the following symptoms: (1) palpitations, pounding heart or accelerated heart rate, (2) sensations of shortness of breath or smothering, (3) feeling of choking, (4) feeling dizzy or light-headed, (5) trembling or shaking, (6) chills or hot flushes, (7) sweating, (8) nausea or abdominal distress, (9) chest pain or discomfort, (10) tingling or numbness in parts of the body”].

Palm Tungsten E handheld computers were used as recording devices. Questions were programmed and displayed using Pendragon Forms software (Pendragon Software Corporation, Libertyville, IL, USA). All responses were automatically time-stamped by the program. Participant responses were assessed using time-contingent signalling (Stone & Shiffman, 1994). Participants retrospectively rated the presence of symptoms at fixed time intervals every 3 h. They were reminded of completing their recordings by means of Bob’s Alarm (rMOBILE software, Canada) and unneeded palmtop-applications were blocked (BPLaunch, rMOBILE software, Canada).

**Table 1**  
Means ( $\pm$ SD) of demographic and psychometric values and number (percentage) of additional diagnoses for patients with posttraumatic stress disorder (PTSD), patients with panic disorder (PD), and healthy control (HC) participants.

	PTSD	PD	HC	F(df) or $\chi^2$	Post hoc
Age (years)	43.8 $\pm$ 15.4	36.3 $\pm$ 11.6	38.6 $\pm$ 11.4	$F(2,68) = 1.9, p = 0.162$	
Education (years)	11.3 $\pm$ 1.7	10.8 $\pm$ 1.8	11.5 $\pm$ 1.6	$F(2,68) = 1.0, p = 0.358$	
Female (%)	47.1	73.1	64.3	$\chi^2 = 3.0, df = 2, p = 0.222$	
ASI	28.1 $\pm$ 12.9	25.6 $\pm$ 9.3	8.2 $\pm$ 5.5	$F(2,67) = 35.8, p < 0.001$	PTSD = PD > HC
MI	2.2 $\pm$ 0.8	2.3 $\pm$ 0.9	1.3 $\pm$ 0.4	$F(2,68) = 28.9, p < 0.001$	PTSD = PD > HC
STAI-Trait	52.5 $\pm$ 10.5	48.5 $\pm$ 10.3	32.3 $\pm$ 7.6	$F(2,65) = 28, p < 0.001$	PTSD = PD > HC
BDI	21.6 $\pm$ 10.7	12.9 $\pm$ 7.5	3.5 $\pm$ 4	$F(2,67) = 32.4, p < 0.001$	PTSD > PD > HC
PDS	32.2 $\pm$ 10.9	–	–		
PDSS	–	11.7 $\pm$ 4.9	–		
Agoraphobia	–	24 (92%)	–		
Major depression	5 (29%)	1 (4%)	–		
Social phobia	4 (24%)	3 (12%)	–		
GAS	1 (6%)	–	–		
Specific phobia	1 (6%)	–	–		
Primary insomnia	–	1 (4%)	–		
OCD	–	1 (4%)	–		
Hypochondriasis	–	1 (4%)	–		

Note: STAI-Trait, Spielberger State-Trait Anxiety Inventory; BDI, Beck Depression Inventory; ASI, Anxiety Sensitivity Index; MI, Mobility Inventory; PDS, Posttraumatic Diagnostic Scale; PDSS, Panic Disorder Severity Scale; GAS, Generalized Anxiety Disorder; and OCD, Obsessive Compulsive Disorder.

## 2.4. Procedure

After the diagnostic interview, participants received an individual appointment for a 30-min standardized session during which they were explained how to use the electronic diary. They were instructed to complete recordings during waking times every 3 h for 8 days, during which they pursued their daily life. The following five time points per day were chosen: 9am, 12pm, 3pm, 6pm, and 9pm. The 9am recording on day 8 was the last recording to be completed, resulting in a total of 36 recordings per participant. Each item was rated regarding the past 3 h except for items participants filled out in the morning, which referred to the time frame since waking up (approximately 2 h). For each item, participants indicated whether or not the according symptom had been present (at least one time) during the past 3 h. Intensity and duration of symptoms were not rated. To reduce subject burden, participants were allowed to fill in the questionnaires within 30 min prior to or after each scheduled signalling. Participants received a user's guide (unpublished, available from the authors) and the phone number of a contact person reachable in case of queries or technical problems.

## 2.5. Compliance, reactivity and acceptability of the method

Compliance was assessed in two ways: (1) by computing the percentage of completed recordings out of the total number of required recordings, and (2) by computing the mean absolute temporal deviation of recordings from the scheduled alarms (in min) for the completed recordings for each participant. After study completion, participants filled in a paper-and-pencil postmonitoring questionnaire (PQ) assessing acceptability and subjective reactivity

to the diary by means of seven items to be rated on a scale from 0 (not at all) to 10 (very much). *Acceptability* was assessed by the following items: (1) Filling in the diary was disturbing to me. (2) Doing the self-assessment was helpful to me. (3) Others showed negative reactions to the method. (4) The reactions of others were unpleasant to me. *Subjective reactivity* was assessed by the following items: (1) The assessment method caused changes in my behavior. (2) I focused more on my mental state. (3) I paid more attention to bodily changes.

## 2.6. Mean symptom level, instability, symptomatic and symptom-free episodes

Mean symptom level was calculated by averaging BSA scores across the 36 data points for each participant. To assess symptom instability across the 36 data points RMSSD scores for BSA were calculated with the following formula:

$$\text{RMSSD} = \sqrt{\left(\frac{1}{n-1}\right) \cdot \left(\sum (\text{BSA}_i - \text{BSA}_{i-1})^2\right)},$$

where  $i$ , number of BSA at time  $i$  and  $n$ , number of data entries completed.

Symptomatic and symptom-free episodes were identified by visual inspection of the 36 data points for BSA per participant. A symptomatic (symptom-free episode) was defined as either a single data point or several consecutive data points at which participants reported at least one (no) BSA. We then calculated the number of symptomatic episodes and the average duration of symptom-free episodes (i.e. the number of consecutive hours without BSA) for each participant. For the analyses of symptomatic and symptom-

**Table 2**  
Mean feasibility ratings (SD) for the three study groups.

Ratings (0, not at all; 10, very much)	PTSD	PD	HC
<i>Acceptability</i>			
Filling in the diary was disturbing to me	3.0 (2.2)	2.0 (2.2)	1.6 (2.1)
Doing the self-assessment was helpful to me*	6.1 (2.5)	7.1 (2.9)	3.0 (3.3)
Others showed negative reactions to the method	1.1 (2.2)	0.5 (1.3)	0.4 (1.4)
The reactions of others were unpleasant to me	1.2 (2.4)	0.7 (1.5)	0.5 (1.3)
<i>Subjective reactivity</i>			
The assessment method caused changes in my behavior*	2.8 (2.9)	2.5 (2.6)	0.9 (1.6)
I focused more on my mental state*	6.2 (2.8)	5.7 (2.7)	2.2 (2.5)
I paid more attention to bodily changes*	5.8 (3.0)	5.4 (2.5)	1.8 (2.4)

\* PD = PTSD > HC,  $p$ 's < 0.015.

free episodes, the number of symptoms was estimated by linear interpolation between adjacent data points in case of missing data (2.1% of the data).

### 2.7. Statistical analyses

Due to not-normally distributed data in most variables in the HC group, we used the nonparametric Kruskal–Wallis test to assess group differences regarding the following variables: (1) compliance (percentage and temporal deviation of completed recordings), (2) feasibility (items of the PQ), (3) mean BSA scores, (4) RMSSD of BSA scores, (5) number of symptomatic episodes, (6) average duration of symptom-free episodes. Significant group effects were followed by pair-wise comparisons using two-tailed Mann–Whitney U-tests.

To examine the effect of illness severity on results, we calculated correlations between illness severity (as measured by the PDSS in PD patients and by the PDS in PTSD patients) and symptom instability within each patient group. In addition, correlations between illness severity and mean symptom levels were calculated within each patient group. For all statistical analyses,  $\alpha$  was set to 0.05.

## 3. Results

### 3.1. Psychometric measures

Table 1 provides demographic and psychometric measures for the three groups as well as additional diagnoses for the clinical groups. Groups did not differ in age, years of education, and gender distribution. Both patient groups scored higher on all clinical questionnaires than HC. While PTSD and PD patients had comparable scores on the ASI, MI, and STAI-Trait questionnaire, PTSD patients scored higher on the BDI than PD patients.

### 3.2. Compliance and feasibility of the method

HC completed  $94 \pm 9\%$ , PD patients  $87 \pm 13\%$  and PTSD patients  $89 \pm 17\%$  of the required entries (Group:  $\chi^2(2) = 6.3$ ,  $p = 0.043$ ; HC > PD,  $U = 224$ ,  $p = 0.013$ ). HC (PD patients and PTSD patients) displayed an average absolute temporal deviation of  $21 \pm 17$  min ( $34 \pm 52$  min and  $35 \pm 40$  min). Temporal deviation did not differ significantly between groups. Table 2 shows the results of the PQ for the three groups. PTSD and PD patients displayed higher subjective reactivity to the method but also found the diary more helpful than HC. Groups did not differ regarding the remaining acceptability items.

### 3.3. Mean and instability of BSA scores

Mean BSA scores were  $0.05 \pm 0.12$  in HC,  $1.46 \pm 1.13$  in PTSD, and  $0.96 \pm 1.11$  in PD patients (Group:  $\chi^2(2) = 47$ ,  $p < 0.001$ ; PTSD > HC,  $U = 6$ ,  $p < 0.001$ ; PD > HC,  $U = 33.5$ ,  $p < 0.001$ ; PTSD > PD,  $U = 138$ ,  $p = 0.039$ ). Fig. 1 shows RMSSD  $\pm$  SE scores for the three groups. In PD patients, RMSSDs of BSA were significantly higher compared to HC and significantly lower compared to PTSD patients (Group:  $\chi^2(2) = 46.1$ ,  $p < 0.001$ ; PTSD vs. HC,  $U = 11$ ,  $p < 0.001$ ; PD vs. HC,  $U = 43.5$ ,  $p < 0.001$ ; PTSD vs. PD,  $U = 109.00$ ,  $p = 0.005$ ). Assuming that instability and mean level of symptoms are to a certain degree related with one another, one might wonder whether the elevated instability scores in PTSD compared to PD patients that follow the pattern of mean scores are merely reflecting elevated mean symptom levels in PTSD. As outlined by Ebner-Priemer et al. (2009), the effect of mean levels on the relationship between instability measures and diagnostic groups is an important matter and it is recommended to explore whether group differences in instability go beyond differences which might be attributed to differences in

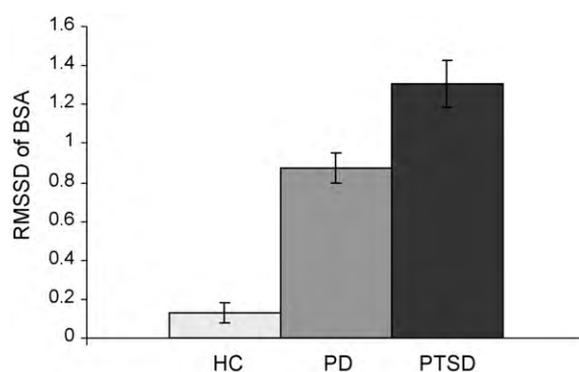


Fig. 1. Means (standard errors) for RMSSD values of BSA in HC, PD and PTSD.

mean scores. Therefore, we additionally compared RMSSD of BSA scores between PD and PTSD patients by analysis of covariance (ANCOVA) with mean BSA scores serving as covariate. HC were excluded from the ANCOVA due to not-normally distributed data in this group. Model assumptions were met, including equivalence of RMSSD-by-mean regression line slopes between patient groups ( $p = 0.98$ ). After covarying out mean BSA levels (using a linear as well as a quadratic polynome since the relationship between mean BSA levels and RMSSD of BSA proved to be curvilinear), RMSSD of BSA still differed significantly between PD and PTSD patients (adjusted means  $\pm$  SE:  $0.95 \pm 0.069$  (PD),  $1.19 \pm 0.087$  (PTSD);  $F(1,39) = 4.35$ ,  $p = 0.044$ ).

Correlations of symptom instability with PDSS symptom severity scores in PD patients and with PDS symptom severity scores in PTSD patients were not significant, regardless of whether mean symptom levels were partialled out ( $p$ 's > 0.34). Mean symptom levels were not correlated with PDSS symptom severity scores in PD patients or with PDS symptom severity scores in PTSD patients either ( $p$ 's > 0.45).

### 3.4. Individual patterns of BSA instability (patient examples)

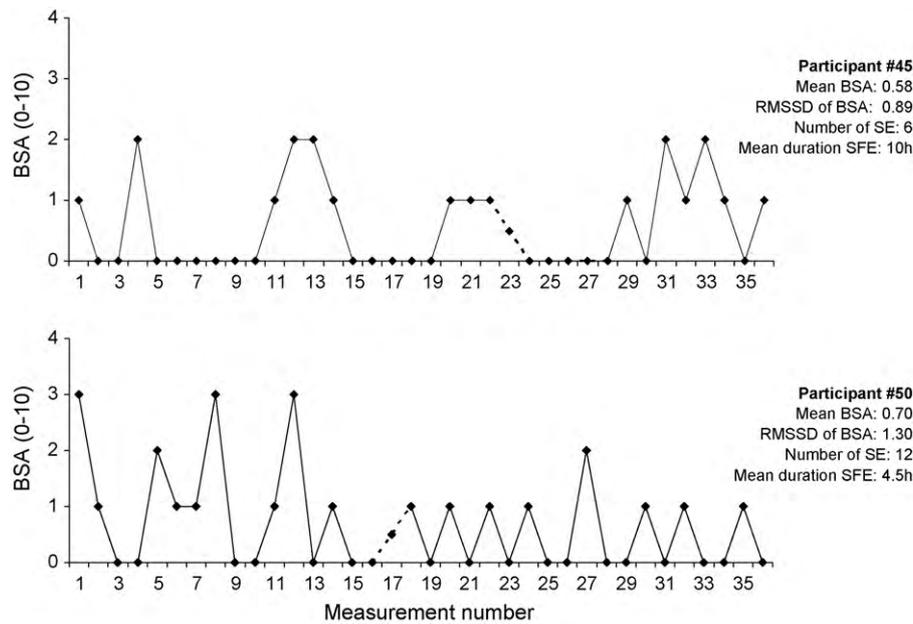
Fig. 2 shows the 36 consecutive BSA scores for two PD patients. The mean BSA score of these patients was comparable, yet RMSSD of BSA of the patient in the upper panel was smaller compared to the patient in the lower panel. In comparison to the patient in the lower panel, this patient showed less symptomatic episodes, and symptom-free episodes were of longer average duration.

### 3.5. Symptomatic and symptom-free episodes

As illustrated in Fig. 3, HC showed lower numbers of symptomatic episodes (Group:  $\chi^2(2) = 19.2$ ,  $p < 0.001$ ; PTSD vs. HC:  $U = 102.5$ ,  $p < 0.001$ ; PD vs. HC:  $U = 142$ ,  $p < 0.001$ ) and longer durations of symptom-free episodes than both patient groups (Group:  $\chi^2(2) = 40.4$ ,  $p < 0.001$ ; PTSD vs. HC:  $U = 21.5$ ,  $p < 0.001$ ; PD vs. HC:  $U = 58$ ,  $p < 0.001$ ). PD and PTSD patients were comparable regarding the number of symptomatic episodes ( $U = 214.5$ ,  $p = 0.871$ ) but the duration of symptom-free episodes was significantly lower in PTSD than in PD patients ( $U = 141.5$ ,  $p = 0.047$ ).

## 4. Discussion

This is the first study utilizing electronic diaries to examine in detail the temporal instability of physical anxiety symptoms in daily life of PD and PTSD patients. As predicted, both patient groups showed heightened instability of bodily symptoms. This is in line with diagnostic criteria of recurrent panic attacks in PD and recurrent psychological reactions to cues associated with the trauma in



**Fig. 2.** Time series of BSA for two PD patients. Note: dashed lines mark interpolated values. Note: SE, symptomatic episodes; SFE, symptom-free episodes.

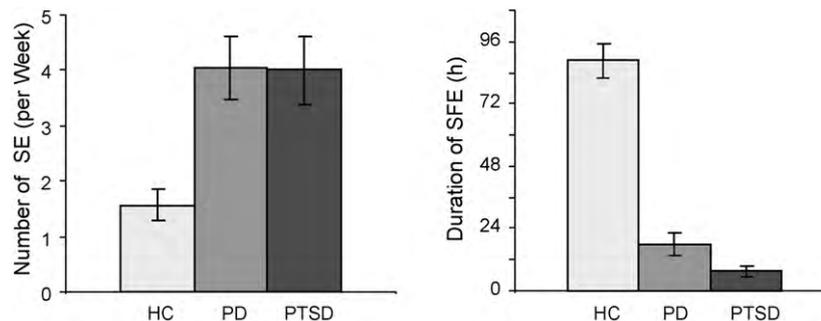
PTSD (DSM-IV; APA, 1994) that imply increased instability of bodily symptoms. It furthermore confirms that electronic diaries are suited to capture clinically relevant phenomena in the daily life of PD and PTSD patients.

While instability of bodily symptoms of anxiety has not been examined to date, two previous studies assessed instability of anxious mood in patients with anxiety disorders. Bowen et al. (2006) found heightened anxiety instability in patients with mixed anxiety disorders compared to HC. This finding is in accordance with our results of elevated physical anxiety symptoms in PD and PTSD, which are likely to be related to anxious mood. Golier et al. (2001) found no difference between PTSD patients, healthy controls and patients with major depression regarding anxiety instability. Yet unlike Bowen et al. and us, they used range, standard deviation (SD), and coefficient of variation (SD/mean) as measures of instability. These measures are less sensitive in quantifying instability than RMSSD, which might explain discrepant results.

Our approach proved feasible to not only quantify the instability of anxiety symptoms but also to distinguish between different anxiety disorders, as indicated by the more pronounced instability of bodily symptoms in PTSD compared to PD. As outlined by Ebner-Priemer et al. (2009), the effect of mean levels on the relationship between instability measures and diagnostic groups is an important issue, yet research to date has not typically controlled for mean levels when comparing groups regarding instability measures.

In this study, when statistically controlling for mean symptom levels, the difference in symptom instability between patient groups remained significant, implying that elevated instability scores in PTSD compared to PD are not simply a by-product of particularly pronounced mean symptom levels in PTSD. Also, in the correlational analyses, results did not seem to be influenced by illness severity.

The higher symptom instability in PTSD compared to PD patients is in accordance with clinical observations of frequently occurring re-experiencing symptoms (e.g., Michael, Ehlers, Halligan, & Clark, 2005) and with the diagnostic criterion of heightened physiologic reactivity to trauma reminders in PTSD. While it is likely that recurrent bodily symptoms in PTSD represent re-experiencing symptoms, their occurrence might as well be linked to other aspects of the disorder. Recurrent anxiety symptoms might, for example, be related to ruminative thinking, i.e. repetitive negative thinking about aspects of the traumatic event and its sequelae. For example, it has been shown that “rumination” is common in PTSD and that it triggers feelings of anxiety (Michael, Halligan, Clark, & Ehlers, 2007). Future studies are needed to assess which situations or events are related to symptomatic episodes in daily life. In addition, it seems important to identify the specific aspects of instability that are crucial for different anxiety disorders. High levels of symptom instability might for example be associated with low levels of perceived predictability and controllability of symptoms.



**Fig. 3.** Means (standard errors) for number of symptomatic episodes and average duration of symptom-free episodes in HC, PD, and PTSD. Note: SE, symptomatic episodes; SFE, symptom-free episodes.

These two concepts play an important role in the development and maintenance of anxiety disorders and, in particular, of PTSD (Mineka & Oehlberg, 2008; Mineka & Zinbarg, 2006). Uncontrollable and unpredictable stress is associated with heightened anxiety and arousal. As such, patients who cannot predict when symptoms are occurring and perceive symptoms as uncontrollable are likely to be particularly distressed by them. Future research should capture these concepts to further clarify the relationship between them and the occurrence of BSA.

#### 4.1. Individual pattern of BSA instability

The electronic diary approach presented here may also be useful for detailed assessment of symptomatology in clinical practice. It may provide valuable information for better diagnosis and treatment of individual patients with anxiety disorders. Fig. 2 shows how complex symptom patterns are in daily life and that valuable information can be gained by capturing symptom fluctuations by ambulatory self-monitoring. The two patients in Fig. 2 display comparable mean symptom scores but show quite different symptom patterns across time. This clinically meaningful difference might not be detected when asking patients to summarize their symptoms. Patient #45 experienced several relatively long-lasting symptom-free episodes. It might be helpful to evaluate what might have contributed to these phases. On the other hand, patient #50 showed frequent sudden fluctuations of BSA and it might be of importance to discover triggers for sudden bursts or to identify a circadian pattern, since elevated BSA scores seem to accumulate in the morning and afternoon for this patient.

#### 4.2. Symptomatic and symptom-free episodes

The number of symptomatic episodes was equally elevated in the two patient groups relative to healthy controls. Yet, in PD patients, symptom-free episodes lasted on average 18 h whereas in PTSD patients, they lasted on average 8 h only. Together with the particularly elevated instability and mean levels of bodily symptoms in PTSD, this finding suggests that PTSD patients are heavily burdened by somatic symptoms such as heart pounding or shortness of breath, underlining the need to address these symptoms and potential maintaining factors in the treatment of PTSD.

In future studies, it might be of interest to apply our analysis of symptomatic and symptom-free episodes to other disorders such as somatisation disorder or hypochondriasis that are characterized by recurrent physical symptoms as well. Another interesting extension is to examine the temporal stability of the patterning of individual symptoms within and between participants which may provide further insights into the phenomenology of anxiety disorders in daily life. Further, the symptoms we assessed imply changes in the autonomic nervous system. It would be clinically informative to additionally measure the instability of psychophysiological parameters such as heart rate and skin conductance to provide an additional perspective on the severity of the disorders (Wilhelm & Grossman, 2010; Wilhelm & Roth, 2001).

#### 4.3. Compliance and feasibility of the method

Overall, compliance with the method was relatively high. On average, the least compliant group (PD patients) completed 87% of the required entries. Although PD patients completed significantly fewer questionnaires than HC, their compliance can still be considered satisfying and is comparable to previous clinical research using electronic diaries (Stone et al., 2003; Taylor, Fried, & Kenardy, 1990).

According to the postmonitoring questionnaire, self-reported reactivity to the method was moderate but nevertheless more pro-

nounced in the clinical groups compared to HC. We thus cannot rule out that our method altered the frequency or intensity of symptoms in the patient samples, although according to self-reports, such unwanted effects would be positioned within an acceptable range. However, the impact an electronic diary might have on participants' everyday life is a problem inherent to the method we used, which is unfortunately hard to eliminate.

We observed high levels of acceptance of the electronic diary method. Neither HC nor patient groups perceived it as disturbing or reported mentionable negative reactions of others to the method. On the contrary, on average, both patient groups indicated that doing the self-assessment was relatively helpful to them.

#### 4.4. Limitations and conclusions

The present study has certain limitations. A first critical aspect concerns the method of data collection. Event-based sampling methods allow capturing each occurrence of a particular symptom as participants complete a recording each time the symptom occurs (Shiffman, Stone, & Hufford, 2008). On the other hand, time-based sampling methods like the one we used require participants to complete recordings on a time schedule. When using this approach, the fit of the lengths of time intervals between self-reports with the process of interest is of major importance, in particular when assessing instability (Ebner-Priemer & Sawitzki, 2007; Rapp et al., 2007). That is, results depend on the combination of the recording interval relative to incidence and bout duration of the clinical phenomenon of interest. We opted for 3-h intervals to keep participant burden as low as possible while still being able to detect important fluctuations occurring across the day. This allowed us to capture data across 1 week, which covers a relatively representative time interval, while not interfering too much with participants' daily routine. However, we might have missed symptom fluctuations occurring over shorter time periods, thereby underestimating symptom instability. Results however show that even when selecting a relatively large sampling period symptom instability in anxiety disorders is captured reliably. Second, to provide a relatively representative cross-sectional view of a patient's day participants rated their symptoms referring to the past 3 h, rather than to how they felt at the moment. Therefore, retrospective distortions cannot be ruled out completely but should be reduced strongly in comparison to clinical interviews and questionnaires that typically require retrospective judgments referring to whole weeks or even months. Third, to minimize participant burden, we used constant 3 h intervals rather than randomly varying recording lengths, which might have induced potential expectation effects (Chen, 2006). That is, the anticipation of symptom ratings at fixed time points might have increased participants' focus on their symptoms, leading to heightened symptom reports.

Despite these limitations, our approach proved feasible to assess symptom instability in the daily life of patients with anxiety disorders. Heightened instability of BSA in PTSD and PD was clearly supported by our data. Disorder-specific and nonspecific characteristics of symptomatic and symptom-free episodes further showed that PTSD and PD share certain features but are distinct regarding other aspects of the disorders. This finding is of particular interest regarding PTSD, since the classification of PTSD as an anxiety disorder has been questioned due to insufficient predominance of anxiety (O'Donohue & Elliott, 1992). The PTSD diagnosis has further been criticized by arguing that symptoms like intense psychological distress and physiological reactivity in response to trauma-related cues are normal human reactions to adversity (see Spitzer, First, & Wakefield, 2007). Our results provide clear evidence for clinically relevant anxiety symptoms in PTSD and suggest that in PTSD, physical symptoms of anxiety are even more prominent and changeable compared to PD. Enhanced symptom instability in PTSD patients

is a clinically relevant phenomenon, which we would not have been able to capture by traditional psychometric approaches. As discussed by Fava and Belaise (2005), clinimetric approaches are needed to capture clinical phenomena that are sensitive to change and thus not adequately captured by most questionnaires or other traditional measurement approaches. Ambulatory assessment of symptom instability by means of electronic diaries seems a valuable addition to clinimetric approaches when assessing phenomena like the sequence of symptoms, the rate of progression of illness, severity of comorbidity, and other aspects of daily life that are subject to change across time. Hopefully, the use of new technologies such as ecological momentary assessment will not only be beneficial in the area of research but also in therapeutic settings, for monitoring symptoms in the natural environment of patients and assessing responses to treatment (see Alpers, 2009; Maheu, Pulier, Wilhelm, McMenamin, & Brown-Connolly, 2005; Wilhelm & Grossman, 2010).

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