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ORIGINAL ARTICLE

Are Catastrophic Misinterpretations of Bodily Sensations Typical for Patients with Panic Disorder? An Experimental Study of Patients with Panic Disorder or Other Anxiety Disorders and Healthy Controls

Barnabas Ohst[1] · **Brunna Tuschen-Caffier**[1]

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Abstract

Background Research on catastrophic misinterpretations of bodily sensations in patients with a diagnosis of panic disorder has yielded inconsistent findings concerning the question of how typical these misinterpretations are and how this compares with other anxiety disorders. Limitations of assessment strategies concerning catastrophic misinterpretations have been discussed. We assessed catastrophic misinterpretations by activating participants' fear memory, as has been suggested.

Methods Participants in the experimental group (EG) were shown a suspenseful film clip to induce physiological arousal before completing a measure of catastrophic misinterpretation (BSIQ-FR). Skin conductance level (SCL) was used as marker for physiological arousal.

Results As expected, the film manipulation led to a significant increase in physiological arousal in the EG compared to the control group (CG) across all disorder groups. ANOVAs did not show significant interactions between factors Group (Panic Disorder, Other Anxiety Disorder, and Healthy Controls) and Condition (EG, CG). However, comparison of means indicated that participants with panic disorder showed more catastrophic misinterpretations of bodily sensations than patients with other anxiety disorders in the EG, but not in the CG.

Conclusions The findings indicate that the activation of fear memory via induction of physiological arousal facilitated the measurement of catastrophic misinterpretations, and provide further evidence that catastrophic misinterpretations of bodily sensations are typical for panic disorder.

Keywords Panic disorder · Anxiety disorder · Catastrophic misinterpretation · Experimental induction of physiological arousal · Fear memory

Introduction

Catastrophic misinterpretations of bodily sensations play a central role in the cognitive model of panic by Clark (1986). They are assumed to be mainly responsible for the emergence of panic during panic attacks, by leading from ambiguous bodily sensations to heightened apprehension and eventually to panic. Catastrophic misinterpretations have been found to occur in *patients with panic disorder* (e.g., Austin and Richards 2006; Clark et al. 1997; McNally and Foa 1987), *patients with other anxiety disorders* (e.g., social anxiety disorder: Austin and Kiropoulos 2008; Clark et al. 1997; Harvey et al. 1993; generalized anxiety disorder: Clark et al. 1997), and even in *people without a diagnosed mental disorder* (e.g., Clark et al. 1997; McNally and Foa 1987; Richards et al. 2001; for a systematic review and meta-analysis, see Ohst and Tuschen-Caffier 2018). Thus, catastrophic misinterpretations seem to be a transdiagnostic phenomenon that occurs even in healthy people. However, there have been no consistent findings concerning the question of how typical catastrophic misinterpretations of bodily sensations are for patients with panic disorder.

Following the cognitive model of panic (Clark 1986), one would assume catastrophic misinterpretations of bodily sensations to be more pronounced in patients with panic disorder (PD). Catastrophic misinterpretations of external events (e.g., ambiguous social situations and ambiguous situations in daily life), on the other hand, might be expected to be

✉ Barnabas Ohst
barnabas.ohst@psychologie.uni-freiburg.de

[1] Institut für Psychologie, Albert-Ludwigs-Universität Freiburg, 79085 Freiburg, Germany

more pronounced in patients with other anxiety disorders (AD), for example, social anxiety disorder (SAD) and generalized anxiety disorder (GAD). All studies to have investigated catastrophic misinterpretations in patients with PD and patients with other AD used one of the various versions of the Bodily Sensations Interpretation Questionnaire (BSIQ; Austin and Richards 2006; Clark et al. 1997; McNally and Foa 1987, see Table 1 for an overview including the version we used for the present study). All versions of the BSIQ have in common that their items measure bodily sensations and external events and that each item consists of two parts. In the first part, participants are presented with a situation (e.g., "You notice that your heart is beating quickly and pounding.") and are asked to provide an explanation ("Why?"; open response format). In the second part of each item, participants are presented with three potential explanations for the given situation (e.g., "Because you have been physically active.") and are asked to rank them in the order in which they would be most likely to come into their mind in the given situation (ranking format). One of these explanations is a catastrophic misinterpretation.

Concerning bodily sensations, only one study has found catastrophic misinterpretations to occur more frequently in patients with PD than in patients with other AD (i.e., SAD and GAD) or in healthy controls (HC) for both open responses and ranked responses (Clark et al. 1997). Several studies have found patients with PD to show more catastrophic misinterpretations of bodily sensations than healthy controls (Austin and Kiropoulos 2008; Austin and Richards 2006; Harvey et al. 1993; McNally and Foa 1987; Richards et al. 2001). However, in none of these studies was this difference found for all outcome variables. Comparing patients with PD and patients with SAD, only one study has found patients with PD to show more catastrophic misinterpretations of bodily sensations than patients with SAD for ranked responses (Harvey et al. 1993), while others have not found a difference (Austin and Kiropoulos 2008; Austin and Richards 2006). Concerning external events, some studies have found patients with PD to make more catastrophic misinterpretations than healthy controls (Clark et al. 1997; McNally and Foa 1987), while others have not (Austin and Kiropoulos 2008; Richards et al. 2001). Comparing patients with PD and patients with other AD, most studies have found no difference in the occurrence of catastrophic misinterpretations of external events (e.g., Austin and Richards 2006; Harvey et al. 1993).

Based on the structure of the BSIQ, Harvey et al. (1993) discussed the following explanation for the inconsistency of findings concerning research on catastrophic misinterpretations: In the ranking format, the provided response options might activate relevant threat-related cognitive schemata and thus facilitate the measurement of catastrophic misinterpretations. In the open response format, on the other hand, relevant cognitive schemata might not be sufficiently activated. This explanation is consistent with several studies to have observed that differences found in the ranking format could not be confirmed in the open response format (Harvey et al. 1993; McNally and Foa 1987; Richards et al. 2001).

To elaborate on this explanation, one can draw on the concept of fear memory (Foa and Kozak 1986). Fear memory is conceptualized as a network-like mental structure that holds information about feared stimuli, physiological and behavioral responses, and information about the meaning of stimuli (Lang 1977, 1979). Thus, it is plausible that feared bodily sensations and external events are stored in a fear memory along with associated catastrophic misinterpretations and their accompanying physiological and behavioral responses. The concept of a fear memory also assumes that this informational structure can be triggered by activating one of its components (Rauch and Foa 2006). This assumption is in line with and extends the aforementioned explanation by Harvey et al. (1993); if fear memory is successfully activated, the measurement of catastrophic misinterpretations might not only be facilitated in the ranked but also in the open response format.

In a previous experiment with an undergraduate sample without diagnosed mental disorder, we used a suspenseful film clip to induce physiological arousal to activate fear memory before administering an adapted German version of the BSIQ (Ohst and Tuschen-Caffier 2020). As a result, more participants in the experimental group (EG) reported at least one catastrophic misinterpretation.

Table 1 Characteristics of different versions of the BSIQ

Version of the BSIQ	Authors	Language	Items (BP, BO, SE, GE)
Interpretation Questionnaire (IQ)	McNally and Foa (1987)	English	14 (7, 0, 0, 7)
Bodily Sensations Interpretation Questionnaire (BSIQ)	Clark et al. (1997)	English	27 (7, 6, 8, 6)
Brief Bodily Sensations Interpretation Questionnaire (BBSIQ)	Clark et al. (1997)	English	14 (7, 0, 3, 4)
Bodily Sensations Interpretation Questionnaire-Modified (BSIQ-M)	Austin and Richards (2006)	English	18 (11, 0, 3, 4)
Bodily Sensations Interpretation Questionnaire-Freiburg (BSIQ-FR)	Ohst & Tuschen-Caffier, present study	German	18 (11, 0, 3, 4)

BP panic-related bodily sensations, *BO* other bodily symptoms, *SE* social events, *GE* general events

Furthermore, the increase in skin conductance level (SCL), which we used as an operationalization of physiological arousal, predicted the amount of catastrophic misinterpretations in the EG but not in the control group (CG).

In the present study, we used the same experimental setup to activate fear memory of patients with PD, patients with other AD (SAD, GAD, and specific phobia), and healthy controls to further investigate the question of how typical catastrophic misinterpretations of bodily sensations are for patients with panic disorder compared to other anxiety disorders. We included patients with specific phobia (SP) since they have been found to have trait anxiety in the range of patients with PD and SAD (Bieling et al. 1998). Therefore, they can be assumed to make more catastrophic misinterpretations of external events than healthy controls, as has been found for patients with SAD (Austin and Kiropoulos 2008; Austin and Richards 2006; Harvey et al. 1993). Based on our theoretical assumptions and on the findings of previous research, we formulated the following hypotheses:

(1) Patients in the EG with PD would score higher concerning catastrophic misinterpretations of bodily sensations than patients with other AD in both response formats (i.e., open and ranked responses). For open responses, this has only been found by Clark et al. (1997). For the ranking format, two studies have found this difference (Clark et al. 1997; Harvey et al. 1993).
(2) Patients in the EG with other AD would score higher concerning catastrophic misinterpretations of external events than patients with PD in both response formats. This difference has only been found for the ranking format by Austin and Kiropoulos (2008).
(3) Patients in the EG with PD would score higher concerning catastrophic misinterpretations of bodily sensations and external events than healthy controls in both response formats. For bodily sensations, this has been found for at least one response format in all studies using the BSIQ (Austin and Kiropoulos 2008; Austin and Richards 2006; Clark et al. 1997; Harvey et al. 1993; McNally and Foa 1987; Richards et al. 2001). For external events, this has been found for at least one response option in several studies (Austin and Richards 2006; Clark et al. 1997; Harvey et al. 1993; McNally and Foa 1987).
(4) Patients in the EG with other AD would score higher concerning catastrophic misinterpretations of external events than healthy controls in both response formats. This has been found for at least one response format in several studies (Austin and Kiropoulos 2008; Austin and Richards 2006; Harvey et al. 1993).

Methods

Participants

Participants in the clinical groups were patients seeking treatment at the outpatient clinic of the Department of Psychology, University of Freiburg, Germany. All participants were compensated with 20 Euro for their participation. Current diagnoses were determined using the German version (Wittchen et al. 1997) of the SCID-I (Edwards et al. 2011), diagnoses in the past were assessed in a verbal screening. Patients with PD were included if PD (with or without agoraphobia) was the primary diagnosis. Other anxiety disorders could be amongst comorbidities: Two patients with PD had comorbid GAD, seven had SAD, and one had SP. Patients with SAD, GAD, and SP were included if their respective anxiety disorder was their primary diagnosis and if they had no history of panic attacks in non-phobic situations. Patients were not included if comorbidities included psychotic disorders or symptoms. Healthy controls were included if they had no diagnosed mental disorder (past or present) and no history of panic attacks. The diagnostic interviews were conducted by the first author, a licensed clinical psychologist with experience in the treatment of patients with anxiety disorders, and by trained research assistants that were supervised by the first author. Two participants were excluded from analysis; one due to technical problems and one due to a schematic response pattern in the BSIQ-FR. The final sample consisted of 137 participants, consisting of 46 patients with PD (30 of which were diagnosed with PD with agoraphobia), 40 patients with other AD (20 SAD, 16 SP, and four GAD), and 51 healthy controls. For demographic and clinical characteristics, see Table 2. Since there were no significant differences between EG and CG in any group, values are reported separated by group and not by condition.

Instruments

Physiological Measure

A Varioport-II system (Becker Meditec GmbH, Karlsruhe, Germany) was used to measure electrodermal activity (EDA) at 400 Hz. Two 11-mm inner diameter Ag/AgCl electrodes were placed on the middle phalanx of the middle and ring fingers of the non-dominant hand to reflect electrodermal sympathetic activity (Boucsein 2012). An electrode paste (0.5% saline in a neutral lotion; TD-246, Mansfield Research and Development LLC, St. Albans, Vermont, USA) specifically formulated for measuring skin

Table 2 Demographic and clinical characteristics by group

	Patients with PD	Patients with other AD	Healthy controls
N	46	40	51
EG/CG	22/24	20/20	25/26
Demographic characteristics			
Age	36.30 (14.33)[a]	31.28 (10.25)[ab]	28.90 (10.70)[b]
Male (%)	35	33	41
General psychopathology			
BDI-II	16.07 (9.69)[a]	12.18 (8.85)[a]	6.08 (5.85)[b]
BSI (GSI)	.92 (.52)[a]	.79 (.54)[a]	.39 (.33)[b]
Anxiety-related characteristics			
ACQ	2.03 (.53)[a]	1.72 (.54)[b]	1.34 (.33)[c]
BSQ	2.70 (.68)[a]	2.18 (.74)[b]	1.75 (.62)[c]
ASI-3	33.17 (12.23)[a]	24.58 (12.23)[b]	14.37 (10.69)[c]
STAI-T	50.89 (10.55)[a]	48.30 (10.45)[a]	37.27 (7.27)[b]
STAI-S	44.37 (8.54)[a]	40.78 (9.04)[a]	34.57 (7.68)[b]
PAS	20.70 (7.95)	–	–

Different superscripts indicate significant differences between groups with at least $p < .05$ (*t*-tests)

BDI-II Beck Depression Inventory-II, *BSI* Brief Symptom Inventory, *GSI* Global Severity Index, *ACQ* Agoraphobic Cognitions Questionnaire, *BSQ* Body Sensations Questionnaire, *ASI-3* Anxiety Sensitivity Inventory-3, *STAI-T* State-Trait Anxiety Inventory-Trait, *STAI-S* State-Trait Anxiety Inventory-State, *PAS* Panic and Agoraphobia Scale

conductance and resistance was used. Skin conductance level (SCL) was used as a parameter of EDA. ANSLAB (Blechert et al. 2016) was used for data inspection and artifact corrections using version R2014b of MATLAB (The MathWorks, Inc., Natick, Massachusetts, USA).

Film Clips

For the EG, we aimed to find a film clip that induces high arousal of negative valence to activate fear memory (Rauch and Foa 2006). From a database of 64 emotion-eliciting film clips (Schaefer et al. 2010), a scene from "Seven" (USA, 1995) with a length of 5:51 min was selected. In this scene, a detective threatens to shoot a criminal with a gun, after the criminal has revealed that he has killed the detective's pregnant wife. It is left open whether the detective eventually pulls the trigger or not. The selected film clip has an arousal rating of 5.69 (8th rank in the database, maximum: 6.12), an anger rating of .99 (9th rank, max: 2.19), and a fear rating of .47 (25th rank, max: 2.93). For the CG, a scene from a garden documentary about mulching ("Querbeet", Germany, 2016) with a comparable length (5:50 min) and no content that could be prone to elicit a phobic reaction (e.g., spiders) was selected. At the end of the experimental session, we assessed if participants had seen the movie or documentary the film clip they had been shown was taken from. Statistical analyses revealed no differences in the effects of the film clips or the outcome variables between participants who had seen the film clips before and those who had not.

Body Sensations Interpretation Questionnaire-Freiburg (BSIQ-FR)

The Body Sensations Interpretation Questionnaire-Freiburg (BSIQ-FR) is a modified and translated version of the BSIQ-M (Austin and Richards 2006). We translated the BSIQ-M into German and had a clinical expert with English as their first language retranslate it into English. Differences between the original and the retranslated version were discussed and adaptations were made accordingly. For the brief version of the BSIQ, satisfactory test–retest reliability has been reported for patients with PD for ranked responses (.73 for bodily sensations and .75 for external events; Clark et al. 1997). For the final version of the BSIQ-FR, we kept the 18 items of the BSIQ-M (i.e., 11 items concerning bodily sensations and 7 items concerning external events). External events are social situations ($n = 4$) and situations in daily life ($n = 3$). Each item comprises two parts: First, participants are asked to provide an explanation ("Why?") for an ambiguous situation (e.g., "You feel as if you are choking"). Then, three explanations (e.g., "Something is wrong with your digestive system.") are presented and participants are asked to rank them in the order in which "they would be most likely to come to mind in the given situation".

The BSIQ-M was the first version of the BSIQ to include an anxiety-related explanation in the ranking task. Since the meaning and thus the value of anxiety-related responses is debatable (Austin and Richards 2001; Clark et al. 1997), we decided to replace the anxiety-related explanations with benign explanations. For items 1, 6, 8, 9, and 13, we replaced the anxiety-related explanation with the benign explanation from the BSIQ (Clark et al. 1997) and for items 2, 4, 5, 11, 16, and 18, we created a new benign response option. Furthermore, Austin and Richards tried to investigate whether an initially anxiety-related open response (e.g., "I'm having a panic attack.") might be a precursor to an eventually expected catastrophic outcome. However, the follow-up question ("And then what might happen?") they included in the BSIQ-M did not yield the intended additional information (Austin and Kiropoulos 2008; Austin and Richards 2006). We therefore omitted this follow-up question in the BSIQ-FR.

For the open response format, responses concerning bodily sensations were coded as harm-related (e.g., "I am suffocating."), anxiety-related (e.g., "I am frightened."), or benign (e.g., "The air in the room is bad."), while the responses concerning external events were coded as either harm-related or benign. The responses were coded independently by the first author and a research assistant who were both blinded to the

group (i.e., PD, other AD, or healthy control) and condition (i.e., EG or CG) of participants. Divergent codes were discussed and consensus sought, inter-coder reliability was .98.

For ranked responses, the ranks each participant assigned to the harm-related explanations were summed (first rank = 3 points, second rank = 2 points, third rank = 1 points).

The software EFS Survey (Questback GmbH, Cologne, Germany) was used to implement the BSIQ-FR. The layout was closely matched with the layouts of previous versions of the BSIQ to ensure comparability of the results.

Positive and Negative Affect Schedule-Modified (PANAS-M)

A modified version of the Positive and Negative Affect Schedule (PANAS, Watson et al. 1988; German version: Krohne et al. 1996) was administered before and after the film clip to capture anxiety-inducing effects of the film clip and to measure changes in attentiveness. The original PANAS comprises 20 items with 10 positive and 10 negative emotional states. The German version of the PANAS has shown good internal consistency for both the positive affect scale (Cronbach's $\alpha = .85$) and the negative affect scale ($\alpha = .86$; Krohne et al. 1996). For our experiment, we used a modified version of the PANAS, consisting of its three anxiety-related negative affect items ("scared", "afraid", "nervous") and three positive affect items ("attentive", "interested", "alert") as a measure of attentiveness.

Brief Symptom Inventory (BSI)

In order to compare the level of mental stress between groups and conditions, the Brief Symptom Inventory (BSI, Derogatis and Melisaratos 1983; German version: Franke 2000) was included in the post-experimental set of questionnaires. The BSI comprises 53 items, covering a variety of bodily, emotional, and cognitive symptoms. As an indicator of overall mental stress, the Global Severity Index (GSI; mean score of all responses) was used. The German version of the BSI has shown good internal consistency for the GSI ($\alpha = .96$; Geisheim et al. 2002).

Beck Depression Inventory (BDI-II)

The Beck Depression Inventory-II (BDI-II, Beck et al. 1996; German version: Hautzinger et al. 2006) was included in the post-experimental set of questionnaires to measure depressive symptomatology, a potential cause of negative interpretations (Voncken et al. 2007). The BDI-II comprises 21 items assessing the severity of various depressive symptoms. The German version of the BDI-II has shown satisfactory test–retest reliability ($r = .78$) and good internal consistency ($\alpha \geq .89$; Hautzinger et al. 2006).

Body Sensations Questionnaire (BSQ)

The Body Sensations Questionnaire (BSQ, Chambless et al. 1984; German version: Ehlers et al. 2001) assesses how afraid people are of bodily sensations that can occur when feeling anxious. Eleven of its 17 items correspond to panic symptoms. Thus, we included the BSQ in the post-experimental set of questionnaires as a measure of panic-specific anxiety sensitivity, which is a predictor of catastrophic misinterpretation (Richards et al. 2001). The German version of the BSQ has shown satisfactory test–retest reliability ($r \geq .63$) and good internal consistency ($\alpha \geq .80$; Ehlers et al. 2001).

Agoraphobic Cognitions Questionnaire (ACQ)

The Agoraphobic Cognitions Questionnaire (ACQ, Chambless et al. 1984; German version: Ehlers et al. 2001) comprises 14 items concerning thoughts that can occur when people feel anxious. Since agoraphobic cognitions have been shown to be predictive of catastrophic misinterpretations (Kamieniecki et al. 1997), we included the ACQ in the post-experimental set of questionnaires. The German version of the ACQ has shown satisfactory test–retest reliability ($r \geq .75$) and internal consistency ($\alpha \geq .74$; Ehlers et al. 2001).

State-Trait Anxiety Inventory (STAI)

The scale for trait anxiety (STAI-T) of the State-Trait Anxiety Inventory (STAI, Spielberger et al. 1983; German version: Laux et al. 1981) was included in the post-experimental set of questionnaires, since trait anxiety has been found to be predictive of catastrophic misinterpretations (Kamieniecki et al. 1997). At the beginning of the experiment, the scale for state anxiety (STAI-S) was administered to control for different levels of state anxiety that might have an effect on the experiment. Both scales comprise 20 items. The German version of the STAI has shown good internal consistency (STAI-S: $\alpha \geq .90$; STAI-T: $\alpha \geq .88$; Laux et al. 1981).

Anxiety Sensitivity Inventory (ASI-3)

Since anxiety sensitivity has been found to be a predictor of catastrophic misinterpretations (Richards et al. 2001), the Anxiety Sensitivity Inventory-3 (ASI-3, Taylor et al. 2007; German version: Kemper et al. 2009) was included in the post-experimental set of questionnaires. The ASI-3 comprises 18 items concerning fear of bodily and cognitive symptoms and social consequences of fear. The German version of the ASI-3 has shown good internal consistency ($\alpha \geq .86$; Kemper et al. 2009).

Panic and Agoraphobia Scale (PAS)

To assess the severity of agoraphobic and panic symptoms in patients with PD in the past seven days, the observer rating version of the Panic and Agoraphobia Scale (PAS, Bandelow 1999; German version: Bandelow 1997) was used. The PAS consists of 13 items covering panic (3) and agoraphobic (3) symptoms, anticipatory anxiety (2), disability in daily life due to symptoms (3), and panic-related worries/assumptions (2). The observer rating version of the PAS has shown good internal consistency ($\alpha = .89$) and satisfactory inter-rater ($r = .78$) and test–retest reliability ($r = .73$; Bandelow 1995).

Procedure

All experimental sessions were conducted in a laboratory at the Department of Psychology, University of Freiburg, Germany. The window shutters were kept closed, the light turned on, and the thermostat set to a fixed temperature to keep context variables constant for the measurement of SCL. All parts of the experiment were conducted with a desktop PC. SCL was measured throughout the experimental session. No challenge tests to identify unmeasurable or non-responsive participants were conducted upon attachment of the electrodes. Before the experiment started, participants were informed about the conditions of their participation and their consent was obtained. Patients with PD were then administered the PAS. To have an SCL baseline, all participants were then presented with pictures of landscapes for five minutes. To assess the momentary level of anxiety and attentiveness before the presentation of the film clip, the STAI-S and the PANAS-M were administered. Participants in the EG were then shown a five minute film clip from the thriller "Seven" (USA, 1995), while participants in the CG were shown a five minute film clip from a garden documentary ("Querbeet", 2016, Germany). Both film clips were presented over headphones in German. Participants then again completed the PANAS-M to assess changes in their level of anxiety and attentiveness due to the presentation of the film clip. To ensure that the arousal-inducing effect of the film clip in the EG could carry over into the administration of the BSIQ-FR, the STAI-S was not administered again. At the end of the experiment, participants completed the BSIQ-FR. Overall, the experiment took between 70 and 90 min. Participants were offered the opportunity to ask questions after completing the experiment. Three days after the experiment, participants were sent a link via e-mail to the additional questionnaires (i.e., BSI, BDI-II, ACQ, BSQ, STAI-T, ASI-3) on the online platform EFS Survey (Questback GmbH, Cologne, Germany).

Statistical Analyses

To determine the effects of the film manipulation on levels of anxiety and attentiveness, and skin conductance level as a marker for physiological arousal, two-way ANOVAs with the factors *Condition* (EG vs. CG) and *Time* (pre- vs. post-film) with repeated measures on the last factor were calculated separately for the three groups (patients with PD, patients with other AD, and healthy controls) for the anxiety and the attentiveness scores of the PANAS-M and for SCL. Additionally, effect sizes (Cohen's *d*; Cohen 1988) were calculated for the differences in the increases from pre- to post-film between EG and CG. To determine the change in SCL, the difference between the last minute of the film-clip and the last minute of the baseline was computed. The last minutes were used instead of the average over the whole baseline and film clip to allow participants to come back to a neutral state after the potentially arousal-inducing start of the experiment (baseline) and to capture the climax of the suspenseful film clip. Different group sizes were considered when pooling standard deviations. To test the hypotheses, two-way ANOVAs with the factors *Group* (PD vs. AD vs. HC) and *Condition* (EG vs. CG) were calculated separately for bodily sensations and external events and separately for open responses and ranked response of the BSIQ-FR, resulting in four ANOVAs (bodily/open, bodily/ranked, external/open, external/ranked). For open responses, the dependent variable was the percentage of harm-related codes. For ranked responses, the dependent variable was the ranking score of the harm-related response options (see above). Post-hoc *t*-tests were computed to determine differences between pairs of groups. The required sample size was calculated using G-Power (Erdfelder et al. 2009; Faul et al. 2007). To test the hypotheses (two-way ANOVAs), the required total sample size was determined to be 128. Effect size was set to medium ($f = .25$), alpha error to .05, and power to .8. All statistical analyses were conducted with IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, New York, USA).

Results

Effects of the Film Manipulation

For anxiety (PANAS-M), a significant interaction between *Condition* and *Time* was found for all three groups, all $ps < .001$. Main effects for *Condition* and *Time* were also found for all three groups, all $ps < .05$. The effect sizes of the differences in the increase in anxiety between EG and CG ranged from $d = 1.4$ (healthy controls) to $d = 1.8$ (patients with PD). For attentiveness (PANAS-M), a significant interaction between *Condition* and *Time* was found for healthy

controls, $F(1, 49) = 7.52$, $p < .01$, but not for patients with PD or other AD, all $ps > .1$. No significant main effects were found. The effect size of the difference in the increase in attentiveness between EG and CG for healthy controls was $d = .8$. For SCL, a significant interaction between *Condition* and *Time* was found for all three groups, all $ps < .05$. Main effects for *Time* were also found for all three groups, all $ps < .01$, while no main effects for *Condition* were found. The effect sizes of the differences in the increase in SCL between EG and CG ranged from $d = .7$ (patients with other AD) to $d = 1.1$ (patients with PD).

Catastrophic Misinterpretations

For the catastrophic misinterpretation of bodily sensations, no interaction between *Group* (PD vs. AD vs. HC) and *Condition* (EG vs. CG; both $ps > .14$) but a main effect of *Group* (both $ps < .001$) was found for both open and ranked responses. Likewise, for external events, no interaction between *Group* and *Condition* (both $ps > .45$) but a main effect of *Group* (both $ps < .05$) was found for both response formats. Additionally, a main effect of *Condition* was found for open responses, $F(1, 131) = 6.37$, $p < .05$. Post-hoc *t*-tests were computed for harm-related scores between groups separately for EG and CG, see Tables 3 and 4. Since no significant interactions between *Group* and *Condition* were found for either bodily sensations or external events, their results have to be interpreted cautiously.

Patients with PD scored higher concerning catastrophic misinterpretations of bodily sensations than patients with other AD in both response formats (i.e., open and ranked responses) in the EG ($d = .81$ and $d = .83$ for open and ranked responses, respectively), but not in the CG. Compared with healthy controls, they also scored higher in both response formats in the EG for catastrophic misinterpretations of both bodily sensations and external events. The same pattern was found for the CG except for open responses concerning external events. Patients with other AD did not score higher concerning catastrophic misinterpretations of external events than patients with PD in either response format in the EG or the CG. However, compared with healthy controls, they scored higher concerning catastrophic misinterpretations of external events in both response formats in the EG.

Table 3 Harm-related scores by group for the EG

	Patients with PD	Patients with other AD	Healthy controls
Experimental group	$n = 22$	$n = 20$	$n = 25$
Bodily sensations			
Open responses	.21 (.26)[a]	.05 (.09)[b]	.05 (.07)[b]
Ranked responses	1.79 (.48)[a]	1.45 (.31)[b]	1.40 (.28)[b]
External events			
Open responses	.19 (.19)[a]	.17 (.19)[a]	.07 (.09)[b]
Ranked responses	1.78 (.58)[a]	1.56 (.50)[a]	1.31 (.22)[b]

Range for open responses: 0–1; range for ranked responses 1–3; different superscripts indicate significant differences between groups with at least $p < .05$ (*t*-tests)

Table 4 Harm-related scores by group for the CG

	Patients with PD	Patients with other AD	Healthy controls
Control group	$n = 24$	$n = 20$	$n = 26$
Bodily sensations			
Open responses	.11 (.18)[a]	.08 (.14)[ab]	.04 (.06)[b]
Ranked responses	1.69 (.34)[a]	1.51 (.31)[ab]	1.38 (.25)[b]
External events			
Open responses	.11 (.15)	.09 (.13)	.05 (.09)
Ranked responses	1.64 (.49)[a]	1.46 (.46)[ab]	1.35 (.29)[b]

Range for open responses: 0–1; range for ranked responses 1–3; different superscripts indicate significant differences between groups with at least $p < .05$ (*t*-tests)

Discussion

The present experiment aimed to investigate the question of how typical catastrophic misinterpretations of bodily sensations are for patients with panic disorder. Furthermore, we tried to facilitate the measurement of catastrophic misinterpretations using an experimental design that we had successfully implemented in a previous experiment investigating the relationship between physiological arousal and catastrophic misinterpretations with a non-clinical sample (Ohst and Tuschen-Caffier 2020).

As in our previous experiment (Ohst and Tuschen-Caffier 2020), the film clips proved to be an effective method to selectively induce physiological arousal (operationalized as SCL) in the EG in all groups, with medium to large effects compared to the increase in SCL in the CG ($.7 \leq d \leq 1.1$). The same pattern was found for anxiety with even larger effect sizes ($1.4 \leq d \leq 1.8$). The correlation between the increase in SCL and the increase in anxiety in the EG across all groups ($n = 67$, $r = .07$, $p = .58$) shows that the increase in SCL was not merely the physiological epiphenomenon to the increase in anxiety, but a discrete effect of the experimental manipulation. The pattern found for attentiveness is difficult to interpret, as the expected interaction between *Condition* and *Time* was only found for healthy controls ($d = .8$), while for patients with other AD no interaction was found, and

attentiveness even descriptively decreased in both conditions for patients with PD. Taken together, a valid conclusion cannot be drawn for attentiveness, as measured by the three selected PANAS items.

Concerning our hypotheses, no interaction between *Group* and *Condition* was found for any combination of ambiguous situation (i.e., bodily sensations/external events) and response format (i.e., open responses/ranking). In the following, the results of post-hoc *t*-tests will be interpreted to draw cautious conclusions from our data that may form the basis for further research.

In line with Hypothesis 1, patients with PD scored higher concerning catastrophic misinterpretations of bodily sensations than patients with other AD in both response formats in the EG, but not in the CG. This pattern indicates that the effects of the film clip facilitated the measurement of catastrophic misinterpretations. Considering the results of our previous study, in which an increase in SCL but not in anxiety predicted catastrophic misinterpretations (Ohst and Tuschen-Caffier 2020), it is likely that the induction of physiological arousal (rather than of anxiety) was responsible for this effect. Furthermore, the facilitation of the measurement of catastrophic misinterpretations indicates that fear memory (Foa and Kozak 1986) was successfully activated via the induction of physiological arousal (Rauch and Foa 2006). Finally, the results in the EG support the idea that catastrophic misinterpretations of bodily sensations are typical for panic disorder. For open responses, our study is the first to replicate this finding by Clark et al. (1997).

Contrary to Hypothesis 2, patients with other AD did not score higher concerning catastrophic misinterpretations of external events than patients with PD in either response format in the EG or the CG. This finding is, however, in line with most existing research (Austin and Kiropoulos 2008; Austin and Richards 2006; Clark et al. 1997). A possible explanation is the suitability of the BSIQ-FR for different anxiety disorders and the composition of our group of other anxiety disorders. While eleven of the 18 BSIQ-FR items are perfectly applicable to panic disorder, covering all bodily symptoms as defined in the DSM-5 (American Psychiatric Association 2013), only seven items are suitable for other anxiety disorders. Four of these cover social situations and are thus suitable for patients with SAD, and three cover general situations and might be applicable to patients with GAD. For patients with SP, which constituted 40% of our group of other anxiety disorders, none of the specific items are suitable.

In line with Hypothesis 3, patients with PD scored higher concerning catastrophic misinterpretations of bodily sensations and external events than healthy controls in both response formats in the EG. The same pattern was found for the CG except for open responses concerning external events. These findings are in line with existing research concerning bodily sensations (Austin and Kiropoulos 2008; Austin and Richards 2006; Clark et al. 1997; Harvey et al. 1993; McNally and Foa 1987; Richards et al. 2001) and external events (Austin and Richards 2006; Clark et al. 1997; Harvey et al. 1993; McNally and Foa 1987). The fact that a difference for open responses concerning external events was found in the EG but not in the CG can be interpreted as further evidence that the experimental manipulation successfully facilitated the measurement of catastrophic misinterpretations.

In accordance with Hypothesis 4, patients with other AD scored higher concerning catastrophic misinterpretations of external events than healthy controls in both response formats in the EG, which is in line with existing research (Austin and Kiropoulos 2008; Austin and Richards 2006; Harvey et al. 1993). Since no difference was found for external events for either response format in the CG, this provides further evidence for the facilitation of the measurement of catastrophic misinterpretations via the induction of physiological arousal. The finding that no differences were found for bodily sensations either in the EG or in the CG is as expected, since patients with SAD, GAD, or SP would not be assumed to make catastrophic misinterpretations of bodily sensations.

Taken together, the results provide further evidence that catastrophic misinterpretations in different domains (i.e., bodily sensations and external events) vary in their occurrence in different anxiety disorders. Specifically, catastrophic misinterpretations of bodily sensations are more pronounced in panic disorder than in other anxiety disorders. For external events, the expected difference between panic disorder and other anxiety disorders was not found, which might be due to the item pool of the BSIQ-FR and the composition of the group of other anxiety disorders, as discussed above. Furthermore, the results support and extend the idea that the measurement of catastrophic misinterpretations depends on the activation of threat-related cognitive schemata (Harvey et al. 1993). Specifically, by activating fear memory (Foa and Kozak 1986) via the induction of physiological arousal (Rauch and Foa 2006), we successfully facilitated the measurement of catastrophic misinterpretations both for patients with panic disorder and patients with other anxiety disorders.

Limitations

There are some limitations to our study. Diagnostic assessment was partly done by research assistants. Though trained and supervised, this might have reduced the validity of the diagnostic assessment. Patients with PD were included with SAD, GAD, or SP as comorbidity. This could partly explain why some of the expected differences

between patients with PD and patients with AD were not observed. Concerning SCL, no challenge tests to identify unmeasurable or non-responsive participants were conducted. An uneven distribution of such participants might have influenced the observed differences in the increase in SCL between EG and CG. We did not determine the psychometric quality of our measures of anxiety and attention (both selected PANAS items). Therefore, the findings concerning the effects of the film clips on anxiety and attention and the relationship between both constructs and SCL have to be interpreted with caution. Finally, the items of the BSIQ-FR are more suitable for patients with PD as for patients with AD, as discussed above. This might partly explain why some of the expected differences between patients with PD and patients with AD were not observed.

Conclusions

The present experiment is, to the best of our knowledge, the first to induce physiological arousal before the measurement of catastrophic misinterpretations in a clinical sample. Furthermore, this experimental manipulation facilitated the measurement of catastrophic misinterpretations in panic disorder and other anxiety disorders (SAD, GAD, and SP). As a result, catastrophic misinterpretations of bodily sensations were found to be more typical for panic disorder than for other anxiety disorders. Having shown this for both response formats of the BSIQ-FR, the present experiment is the first replication of the findings of Clark et al. (1997).

Further research is required on methods of facilitating the measurement of catastrophic misinterpretations and on the question of which catastrophic misinterpretations are typical for which anxiety disorders. Specifically, future experiments should investigate other methods of inducing physiological arousal and study each anxiety disorder separately. Finally, this area of research would greatly benefit from the development of an instrument to measure catastrophic misinterpretations that is suitable for all anxiety disorders.

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Data Availability The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Compliance with Ethical Standards

Conflict of Interest Barnabas Ohst and Brunna Tuschen-Caffier declare that they have no conflict of interest.

Ethical Approval The research was approved by the ethics committee of the University of Freiburg with application number 415/16.

Animal Rights No animal studies were carried out by the authors for this article.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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