



# Affect and worry during a checking episode: A comparison of individuals with symptoms of obsessive-compulsive disorder, anorexia nervosa, bulimia nervosa, body dysmorphic disorder, illness anxiety disorder, and panic disorder



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## ABSTRACT

Checking behavior (CB) occurs in a variety of disorders such as obsessive-compulsive (OCD), body dysmorphic (BDD), illness anxiety (IA), and panic disorder (PD), as well as anorexia (AN) and bulimia nervosa (BN). Etiological models of these disorders – with the exception of those for PD – postulate that CB mainly occurs in situations characterized by negative affect and serves to regulate it. We aimed to test these assumptions:  $N = 386$  individuals with a self-reported diagnosis of one of the disorders rated their affect at baseline, directly before a remembered CB episode, during, immediately afterwards, and 15 and 60 minutes afterwards, and rated their endorsement of different functions of CB. The results show that transdiagnostically negative affect is significantly higher before CB compared to baseline, and is significantly reduced from before CB to all post-CB assessments. Reduction of negative affect and Attainment of certainty were the sole functions predicting the affective course during CB, and most prominently reported transdiagnostically. Assumptions of the etiological models were confirmed, suggesting that exposure and ritual prevention should be examined across disorders. As attainment of certainty seems to be predictive for the course of CB, this might be targeted in cognitive interventions.

## 1. Introduction

Checking behavior (CB) represents a core feature of various mental disorders such as obsessive-compulsive disorder (OCD; Carr, 1974; Hodgson and Rachman, 1977), eating disorders (EDs; Steinfeld et al., 2017), body dysmorphic disorder (BDD; Oakes et al., 2016), illness anxiety disorder (IA; Bleichhardt and Weck, 2015), and panic disorder (PD; Olatunji et al., 2009). Although the phenomenology of CB depends on the respective disorder, etiological models of the disorders (Rachman, 2002; Williamson et al., 2004; Rosen et al., 1995; Salkovskis and Warwick, 1986), with the exception of PD (Ehlers and Margraf, 1989; Salkovskis et al., 1996), consistently conceptualize CB as a behavior shown in situations characterized by negative affect (e.g., anxiety), and performed in order to reduce this negative affect or avoid feared outcomes or events (e.g., in the case of OCD, burning down the house by forgetting to turn off the stove; Rachman, 2002; Salkovskis, 1999). According to the models, the reduction of negative affect in turn

negatively reinforces the behavior. Moreover, CB is maintained by the lack of alternative experiences which might correct the assumption that negative affect cannot be tolerated without performing the behavior. Despite the fact that this functionality of CB is proposed in most of the theoretical models of the respective disorders, it has been empirically examined only by a small number of studies.

CB was investigated with respect to OCD early on (Carr, 1974; Hodgson and Rachman, 1977). In OCD, the behavior manifests itself in order to check, e. g., whether a door has been locked or whether one has accidentally injured somebody while on the way to work (Levy and Radomsky, 2016). There is first evidence that negative affect mediates the relationship between symptoms of OCD and CB of the body (e.g. checking one's looks in the mirror; Vartanian and Grisham, 2011), fully in women and only partially in men. Accordingly, one could tentatively assume that situations occurring prior to CB - also disorder-specific non body-related - in individuals with OCD might be characterized by increased negative affect. Two early experimental studies confirmed that

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CB immediately reduced self-reported discomfort induced by having to perform potentially “harmful” behaviors (Röper et al., 1973) or by confrontation with CB-provoking situations (Rachman et al., 1976). In sum, empirical findings support the assumption that CB seems to be a relevant perpetuating factor in OCD.

In EDs, CB usually manifests as the checking of one's own body with regard to body weight, shape, or body fat percentage, e.g., by weighing oneself, measuring body parts, or repeatedly looking in the mirror (Reas et al., 2002; Shafran et al., 2004; Vocks et al., 2008). While two observational and one interview study, primarily in anorexia nervosa (AN), have hinted at a more negative affect prior to CB (Engel et al., 2013; Espeset et al., 2012; Lavender et al., 2013), current experimental studies do not support the proposed mechanism of negative reinforcement of CB. An ecological momentary assessment study found that situations in which participants with AN and bulimia nervosa (BN) performed CB were not characterized by an increased negative affect, but rather by a low extent of positive affect. Moreover, immediately after CB, a reduction of positive affect, and an increase in negative affect was reported (Kraus et al., 2015). These findings were supported by an experimental laboratory study: Shafran et al. (2007) showed that the induction of CB in healthy women led to an increase rather than a decrease in body dissatisfaction, feeling of fatness, and negative self-referential thinking. In a more long-term experimental study, non-clinical female participants were asked to check their wrist size every 15 minutes for eight hours on one day and to not to check for the same time period one day, in randomized order (Bailey and Waller, 2017). While CB did not result in more negative general eating attitudes or body dissatisfaction, it did lead to a significant increase in the specific cognition of fear of weight gain. Thus, current evidence cannot confirm the etiological assumption regarding the negative reinforcement of CB put forward in etiological models; instead, the results even point to the reverse effect.

In BDD, CB is mostly performed using mirrors, but also includes behaviors such as touching the perceived flaw (Phillips et al., 2005). The postulated increased negative affect before CB and the reduction thereof by CB has so far not been empirically confirmed. In an experimental laboratory study by Windheim et al. (2011), the emotional burden of patients with BDD (but also of healthy control participants) did not decrease over the course of CB, but in fact increased. A more recent study confirmed this finding in young healthy female participants, and revealed that CB in the form of mirror gazing for two minutes led to increased body dissatisfaction, irrespective of whether participants adopted an external or an internal focus of attention (Veale et al., 2016). Additionally, in the conditions with heightened self-focus, an increase in sadness was observed. In line with these laboratory studies, a retrospective survey of patients with BDD confirmed a greater deterioration of mood from pre to post mirror gazing in comparison to healthy controls (Veale and Riley, 2001).

In IA, CB can occur, e.g., as visual inspection of birth marks for signs of skin cancer, performing eyesight tests to screen for brain tumors and other neurological diseases, or measurement of blood pressure or pulse as signs of cardiovascular diseases (Olatunji et al., 2011). In contrast to EDs and BDD, and in line with OCD, the proposed reduction of negative affect by CB was confirmed. In an experimental study in patients with hypochondria, Abramowitz and Moore (2007) showed that anxiety induced through confrontation with health-related stimuli was reduced by performing instructed CB. In another experimental study, healthy participants were instructed to perform a clinical extent of CB over the course of a week, which led to significant increases in health anxiety, hypochondriacal thoughts, contamination fears, and avoidance reactions. This finding was interpreted as a long-term increase in negative emotions (Olatunji et al., 2011). Thus, etiological models might be tentatively confirmed for IA.

As in IA, PD is characterized by fears about health. However, the feared symptoms are those of a panic attack. PD is also characterized by various forms of CB, e.g., testing the vital functions to assure oneself of

the body's health and the absence of a panic attack (Kamphuis and Telch, 1998; Olatunji et al., 2009). According to existing etiological models (e.g., Ehlers and Margraf, 1989; Salkovskis et al., 1996), in individuals with PD, a sensitive perception of bodily functions and the misinterpretation thereof as a sign of an immediate health threat (e.g., a heart attack; see the construct of anxiety sensitivity by Reiss, 1991) can elicit strong fear reactions, which can in turn trigger panic attacks. Thus, in the long run, CB might maintain PD. However, studies examining both elevated negative mood prior to CB and the short-term consequences of CB in PD are lacking.

In sum, etiological models of OCD, EDs, BDD, and IA, but not PD (Rachman, 2002; Williamson et al., 2004; Rosen et al., 1995; Salkovskis and Warwick, 1986; Ehlers and Margraf, 1989; Salkovskis et al., 1996) include CB as a central aspect, and postulate that CB leads to a short-term reduction of negative emotions, thus reinforcing itself, and maintaining the respective disorder in the long term. While this assumption was confirmed for OCD and IA, the opposite effect was found for EDs and BDD and no studies on PD are found in this regard.

There are several possible explanations for the contradictory findings. First, diverging results might stem from different functions of CB across disorders or within different groups of individuals. While in OCD, IA and PD, CB may be intended to reduce negative emotions and to avoid feared outcomes, for some individuals, the behavior might also serve as a self-motivation strategy. This is suggested, e.g., by Kraus et al. (2015) with regard to EDs, i.e., a potentially scary impression of one's own weight or shape might foster dieting and excessive exercising. Further functions might include the attainment of certainty, given that studies show a greater intolerance of uncertainty in all of the disorders (OCD: Tolin et al., 2003, EDs: Kesby et al., 2017, BDD: Summers et al., 2016, IA: Boelen and Carleton, 2012, PD: Carleton et al., 2013). Second, findings of the various studies were based on data from different research settings, including field studies (e.g., Kraus et al., 2015), experimental laboratory studies (e.g., Abramowitz and Moore, 2007), and retrospective surveys (e.g., Veale and Riley, 2001), which might give rise to a systematic data variation. Third, the number and placement of measurement points varied across the studies, with only one single measurement after CB in some studies, and different follow-up points for the assessment of emotional consequences of CB. Fourth, the studies included various dependent measures to assess emotions, ranging from disorder-specific variables such as body dissatisfaction or health anxiety (e.g., Kraus et al., 2015; Olatunji et al., 2011) to broad assessments of affect (e.g., Kraus et al., 2015), even including measures of pathology (e.g. negative self-referential thinking, avoidance reactions; Abramowitz and Moore, 2007; Bailey and Waller, 2017), which might be related to a different extent to CB.

To improve transdiagnostic knowledge on CB, studies are needed in which diagnoses are directly compared using the same research paradigm and measures. Therefore, in the present study, six groups of individuals with the different disorders OCD, AN, BN, BDD, IA, and PD were examined in an online survey in which participants were asked to remember a disorder-specific idiosyncratic CB episode. Over the course of six measurement points (baseline, i.e., a situation not related to CB (t0), immediately before (t1), during (t2), immediately after (t3), 15 minutes after (t4) and one hour after the CB episode (t5)), participants had to indicate their experienced affect. Constructs assessed included Valence, Arousal, Worry that the feared event might come true, and Anxiety. The latter was incorporated due to its prominence in the phenomenology of all disorders included (APA, 2013), as well as the fact that anxiety is one of the main emotions to be reduced during a treatment with exposure and ritual prevention (i.e., a state-of-the-art treatment technique in most of the disorders; e.g. in OCD; Clark, 2004). Additionally, we assessed the possible functions of CB, i.e., (1) reduction of negative affect, (2) attainment of certainty, (3) motivation, and (4) avoidance of negative consequences. We investigated the self-reported functions served by CB in participating individuals, and

exploratively examined how these functions predicted courses of affect and worry.

We hypothesized that in accordance with etiological models, participants across all groups would report increased negative affect immediately before CB compared to the rating at baseline. In line with previous empirical studies, we also expected increases in negative affect and worry in AN, BN, and BDD, and decreases in OCD, IA and PD from immediately before to during CB and from immediately before to immediately after, 15 minutes, and one hour after CB. We further hypothesized that all symptom groups would mention reduction of negative affect and attainment of certainty as goals of their CB. Additionally, on an exploratory level, we examined the impact of the perceived CB goal on the course of negative affect during CB. Finally, we expected that participants with AN, BN, and BDD would be more likely to perform CB for purposes of self-motivation, and that participants with OCD, IA, and PD would be more likely to perform CB in order to avoid negative consequences.

## 2. Methods

### 2.1. Recruitment and sample

Participants were recruited through advertisements in disorder-related online forums, flyers handed out at on the University campus, and University press releases. Inclusion criteria were age 18 years or older, and having one of the disorders under investigation (i.e., OCD, AN, BN, BDD, IA, and PD in self-report). Of  $N = 1385$  individuals who started the survey,  $n = 547$  participants had to be excluded due to incomplete data sets,  $n = 388$  because the questionnaire responses revealed no experienced symptoms,  $n = 13$  because they did not perform any of the CBs, and  $n = 59$  because the imagined CB episode did not constitute an actual disorder-specific CB, i.e., not involving the performance of a behavioral ritual that involved a focus on the body, parts of it, bodily symptoms, and actions related to these (e. g., internet research of bodily symptoms in IA). Thus, the analyzed sample consisted of  $n = 378$  individuals (OCD:  $n = 90$ , AN:  $n = 50$ , BN:  $n = 46$ , BDD:  $n = 35$ , IA:  $n = 45$ , and PD:  $n = 112$ ).

### 2.2. Instruments

#### 2.2.1. Psychopathology

As diagnoses were only based on participants' self-reports, we included one measure for each diagnosis to quantitatively assess the severity level of symptoms. Furthermore, one instrument assessed trait anxiety across groups.

*Obsessive-Compulsive Inventory-Revised* (OCI-R; German-language version: Gönner et al., 2007). The OCI-R is an 18-item self-report scale that assesses obsessive-compulsive symptom severity within the last month. In the present study, only the global score was used, which has shown high internal consistency ( $\alpha = 0.86$ ; Gönner et al., 2007). For the German version, a sample of individuals with diagnosed OCD attained a mean score of  $M = 26.33$  (Gönner et al., 2007).

*Eating Disorder Examination-Questionnaire* (EDE-Q; German-language version: Hilbert and Tuschen-Caffier, 2016). The EDE-Q is a self-report instrument for the assessment of eating disorder psychopathology. The questionnaire focuses on the past 28 days and consists of 22 items. Six additional items assess the numerical frequencies of eating disorder behaviors. In the present study, the global score was used, which has shown excellent internal consistency ( $\alpha = 0.97$ ; Hilbert and Tuschen-Caffier, 2016). By applying an RCI methodology to the German EDE-Q scores reported by Hilbert and Tuschen-Caffier (2016), a cut-off score of  $c = 2.53$  was derived, which is very close to the score of  $c = 2.3$  calculated by Mond et al. (2004) in data from an Australian sample.

*Body Dysmorphic Symptoms Inventory* (Fragebogen Körperdysmorpher Symptome; FKS; Buhlmann et al., 2009). The FKS consists of 18 items assessing BDD symptoms. In the present study, the total score was used, which has previously shown good internal consistency ( $\alpha = 0.88$ ;

Buhlmann et al., 2009). The authors suggest a cut-off of 14 to screen for BDD.

*Whiteley Index* (WI; German language version: Hiller and Rief, 2004). The Whiteley Index (WI, Hiller and Rief, 2004) is a widely used measure of hypochondriasis consisting of 14 items. The global scale of the WI shows good internal consistency ( $\alpha = 0.80$ ). For the German-language version, a cut-off score of  $\geq 8$  indicates threshold illness anxiety (Hinz et al., 2003).

*Questionnaire on Body-Related Anxieties, Cognitions and Avoidance* (AKV; Fragebogen zu körperbezogenen Ängsten, Kognitionen und Vermeidung; Ehlers et al., 2001). The AKV is used to measure the severity of panic disorder symptoms. It includes three questionnaires: The *Body Sensation Questionnaire* (BSQ), the *Agoraphobic Cognitions Questionnaire* (ACQ) and the *Mobility Inventory* (MI). In the present study, the BSQ (17 items) was implemented to assess the intensity of fear of bodily associations in situations in which respondents are highly aroused. It has shown good internal consistency ( $\alpha = 0.89$ ). Moreover, the ACQ (14 items) was used to assess the frequency of frightening or maladaptive thoughts about the consequences of panic and anxiety. It has shown good internal consistency ( $\alpha = 0.82$ ). Mean scores on the two questionnaires in the German validation sample of individuals with panic disorder were  $M = 2.74$  for the BSQ, and  $M = 2.19$  for the ACQ.

*State-Trait Anxiety Inventory Trait version* (STAI-T; German-language version: Laux et al., 1981). The STAI-T consists of 20 items, and assesses the level of trait anxiety. It has previously shown very good internal consistency ( $\alpha = 0.90$ ).

#### 2.2.2. State measures

To assess changes in affect and worry over the course of a CB episode, we used the following measures.

*Self-Assessment Manikin* (SAM, Bradley and Lang, 1994). The SAM is a non-verbal pictorial assessment technique that assesses valence and arousal. Participants have to choose one pictogram out of five that fits their emotion best. In the present study, verbally labeled anchor points were added ("positive" to "negative", "excited" to "calm").

*State-Trait Anxiety Inventory Short Version* (STAI-SKD, Englert et al., 2011). The German-language STAI-SKD is a 5-item version of the STAI to measure state anxiety. Items are rated on a 4-point Likert scale from 1 (= "not at all") to 4 (= "very much"). The total score has shown good internal consistency ( $\alpha = 0.81$ ).

*Worry item*. The worry item consisted of the question: "How much do you worry that your concern might become true at this moment?". It was answered on a Likert scale ranging from 1 (= "not at all") to 10 (= "very much").

*Functions of Checking Questionnaire*. To assess goals of CB in general, at  $t_0$ , participants rated the following items on a 5-point Likert scale ranging from 1 (= "not at all") to 4 (= "very much"): (1) "I check in order to calm myself down"; (2) "I check in order to further motivate myself"; (3) "I check in order to avoid negative consequences"; and (4) "I check in order to attain certainty". These functions were included as items based on an extensive literature search on CB, and an inspection of etiological models as well as their conceptualization of CB across all disorders included in the present study. A final selection was performed by an expert team including the first and last author and their teams. Correlation coefficients of functions are depicted in Table 1. They reveal that the functions seem to be sufficiently distinct to be included alongside one another in the mixed models. As analyses including the functions were conducted on an item-level, we cannot provide an internal consistency score.

### 2.3. Procedure

After providing informed consent on the landing page and learning about their option to stop participating by closing the browser window at any time, participants answered five questions about their age, gender, existing physical conditions, and current or past

**Table 1**  
Means, standard deviations, and correlations with confidence intervals of functions of CB.

Variable	<i>M</i>	<i>SD</i>	Reduction of neg. affect	Motivation	Avoidance of neg. conse-quences
Reduction of negative affect	3.10	1.00			
Motivation	1.91	1.01	0.03 [−0.07, 0.13]		
Avoidance of negative consequences	3.01	1.01	0.38** [0.29, 0.46]	0.07 [−0.03, 0.17]	
Attainment of certainty	3.30	0.88	0.55** [0.47, 0.61]	0.07 [−0.03, 0.17]	0.44** [0.36, 0.52]

Note. *M* and *SD* represent mean and standard deviation, respectively.

\*\* indicates  $p < 0.01$ .

psychotherapeutic treatment. Then, affect was rated for the first time ( $t_0$ ), which served as a baseline measurement (SAM Valence and Arousal, STAI-SKD), and functions of the CB in general were assessed. This was followed by short descriptions of the disorders OCD, AN, BN, BDD, IA, and PD in order to help the participants to indicate the disorder they experience. In the case of comorbid disorders, participants were instructed to choose the one associated with the highest severity and burden. Next, a definition of CB was displayed in order to ensure that each participant had the same mental representation of the construct under investigation. This was followed by a list of disorder-specific CBs which participants had to select and rate in terms of the frequency with which they are performed. Participants also had the option to add and rate the frequency of further CBs which were not included. Participants were then asked to select and remember a single typical recent CB episode, to describe what they checked and how they did so during this episode, and to rate their affect immediately before CB, as well as their level of worry that their concern could become true ( $t_1$ ; SAM Valence and Arousal, STAI-SKD, Worry item). Afterwards, participants were asked to think back to various time points over the course of the selected CB episode, i.e., during ( $t_2$ ), immediately after ( $t_3$ ), around 15 minutes after ( $t_4$ ) and one hour after ( $t_5$ ), and to rate their affect and their worry that their concern might become true (SAM Valence and Arousal, STAI-SKD, Worry item) at each of these time points. Finally, participants completed a set of measures assessing psychopathology (see above). Participants did not receive any reimbursement. The local ethics review board approved the study.

#### 2.4. Data analysis

Participants' descriptive characteristics as well as disorder-specific clinical symptoms and trait anxiety were computed as *N* (%) or *M* (*SD*) and, if possible, compared across disorder groups using Chi-square tests or univariate analyses of variance (ANOVAs) with subsequent Bonferroni-corrected post-hoc tests. Differences between affect at baseline ( $t_0$ ) and immediately before CB ( $t_1$ ) were analyzed using three separate mixed models for the dependent variables (SAM Valence and Arousal, STAI-SKD). In these models, the value of the dependent variable was predicted by the fixed factors Time (i.e., baseline vs. immediately before checking), Group (using PD as the reference group), the interaction between these factors, and the random factor patient ID. The same procedure was performed for the time points  $t_1$  to  $t_2$  (during CB), to  $t_3$  (immediately after CB), to  $t_4$  (15 minutes after CB), and to  $t_5$  (one hour after CB), respectively, to determine the course of negative affect and worry over a CB episode. In order to exploratively analyze the impact of functions of CB on the course of affect, as measured by the SAM Valence and Arousal, STAI-SKD and the Worry item, mixed models were used to predict the different levels of affect before and after the CB episode. Specifically, Time, Group, and the Functions attainment of certainty, motivation, and avoidance of negative consequences, as well as their interactions with Time were used as fixed effects and patient ID was used as a random effect (random intercept

model). Group differences in self-reported general functions of CB were computed in a one-factor MANOVA with the factor Group (i.e., OCD, AN, BN, BDD, IA, PD) with subsequent ANOVAs and Bonferroni-corrected post-hoc tests over the four CB functions as dependent variables. To analyze the disorder-specific relevance of the functions of CB, we computed six repeated measures ANOVAs with the repeated measures factor Function, with subsequent Bonferroni-corrected post-hoc tests.

### 3. Results

#### 3.1. Sample characteristics

The demographic and clinical characteristics of the sample are displayed in Table 2. In the analyses of variance and the Chi-square test, groups did not differ in trait anxiety (STAI-T) but did differ regarding the percentage of female participants and regarding age. The AN, BN, and BDD groups were younger than the IA and PD groups. While there were more female participants in all groups, this difference was largest in AN and BN, followed by IA and PD, and most equal in OCD and BDD. All groups crossed cut-off scores or showed greater means than indicated for clinical levels of symptoms in the respective disorder-specific questionnaires. In OCD, 45 individuals (50.00%) exceeded the cut-off score. Forty-seven individuals with AN (94.0%) and 45 individuals with BN (97.83%) exceeded the cut-off score. In BDD, 31 individuals (88.57%) exceeded the cut-off score, and 35 participants with IA (77.78%) met the threshold for IA. A total of 71 (63.39%) and 59 participants with PD (52.68%), respectively, exceeded the cut-off scores of BSQ and ACQ.

#### 3.2. Differences in affect between baseline and immediately before the CB episode ( $t_0$ - $t_1$ )

The linear models for the three dependent variables STAI-SKD, SAM Arousal and Affect revealed significant effects of time (all  $b > 0.85$ ;  $p < 0.001$ ), indicating marked increases in negative affect from baseline ( $t_0$ ) to immediately before the CB episode ( $t_1$ ) in all groups. With regard to the STAI-SKD and SAM Arousal, this effect was also moderated by group, with OCD patients ( $b = 0.47$ ,  $p < 0.01$ ) and BDD patients ( $b = 0.47$ ,  $p < 0.01$ ) showing smaller increases in negative affect than PD patients. Furthermore, the increase in this variable over time was smaller in OCD patients ( $b = 0.47$ ,  $p < 0.01$ ) and BN patients ( $b = 0.47$ ,  $p < 0.01$ ) than in PD patients. With regard to group effects, we found overall higher values for AN ( $b = 0.67$ ,  $p < 0.05$ ) and BN ( $b = 0.96$ ,  $p < 0.01$ ) compared to PD patients in the variable SAM Valence.

#### 3.3. Course of affect and worry from immediately before to during and after the CB episode ( $t_1$ - $t_5$ )

Means and standard deviations of all dependent variables are depicted in Table 3 and Fig. 1. The linear models for all the dependent variables (STAI-SKD, SAM Arousal and Affect, and the Worry item)

**Table 2**  
Participants' demographic and clinical characteristics means (M) and standard deviations (SD) and group differences.

	OCD n = 90	AN n = 50	BN n = 45	BDD n = 35	IA n = 45	PD n = 112	F(5, 372)	χ <sup>2</sup> (df = 5)
Gender female n (%)	58 (64.44%)	49 (98.00%)	44 (97.78%)	24 (68.57%)	38 (84.44%)	97 (86.61%)		44.16***
Age	28.23 (0.92)	23.64 <sup>a</sup> (0.62)	26.09 (1.17)	27.09 (1.02)	32.51 <sup>b</sup> (1.68)	30.96 <sup>b</sup> (1.05)	7.01***	
Current Psychological Tx	12 (13.33)	25 (50.00)	21 (46.67)	13 (37.14)	14 (31.11)	45 (40.18)		27.67***
Past Psychological Tx	50 (55.56)	7 (14.00)	36 (80.00)	22 (62.86)	33 (73.33)	81 (72.32)		17.94**
STAI-T	53.27 (11.49)	59.54 (10.65)	56.37 (9.95)	54.41 (11.44)	54.98 (10.03)	55.21 (12.07)	2.14	
OCI-R	29.09 (11.87)							
EDE-Q		5.15 (0.19)	5.26 (0.16)					
FKS				25.35 (7.96)				
WI					14.00 (3.46)			
ACQ						2.42 (0.70)		
BSQ						2.91 (0.79)		

Notes. STAI-T = State-Trait Anxiety Inventory Trait Scale; EDE-Q = Eating Disorder Examination-Questionnaire; FKS = Fragebogen Körperdysmorpher Symptome (Body Dysmorphic Symptoms Inventory); OCI-R = Obsessive-Compulsive Inventory-Revised; ACQ = Agoraphobic Cognitions Questionnaire; BSQ = Body Sensations Questionnaire; WI = Whiteley Index; Tx, treatment.

Superscripts indicate significant Bonferroni-corrected post-hoc tests.

\*\*\*  $p < 0.001$ ;

\*\*  $p < 0.01$

revealed significant effects of time from t1 to t3 (all  $b \geq -0.29$ ;  $p < 0.001$ ), to t4 (all  $b \geq -0.30$ ;  $p < 0.001$ ), and to t5 (all  $b > -0.25$ ;  $p < 0.001$ ), but not to t2 (all  $b \leq |0.07|$ ;  $p \geq 0.37$ ). Thus, findings indicate no differences from immediately before to during the CB episode, but significant decreases across all groups from immediately before to immediately after, to 15 minutes after, and to one

**Table 3**

Means (M) and standard deviations (SD) of dependent variables across all symptom groups from baseline (t0), immediately before (t1), during (t2), to immediately after (t3), 15 minutes after (t4), and 60 minutes after CB (t5).

		STAI-SKD	SAM Arousal	SAM Valence	Worry
OCD	t0	1.85 (0.07)	3.24 (0.11)	2.72 (0.10)	1.85 (0.07)
	t1	2.39 (0.08)	2.60 (0.12)	3.42 (0.10)	6.31 (0.30)
	t2	2.38 (0.09)	2.58 (0.12)	3.40 (0.11)	5.90 (0.29)
	t3	1.77 (0.08)	3.64 (0.12)	2.54 (0.13)	3.88 (0.28)
	t4	1.58 (0.08)	4.00 (0.11)	2.39 (0.12)	3.70 (0.28)
	t5	1.55 (0.08)	3.84 (0.12)	2.40 (0.12)	3.66 (0.30)
AN	t0	1.95 (0.10)	3.10 (0.15)	3.14 (0.13)	1.95 (0.10)
	t1	2.64 (0.11)	2.30 (0.14)	3.92 (0.14)	7.30 (0.32)
	t2	2.75 (0.11)	2.46 (0.16)	3.88 (0.14)	7.48 (0.29)
	t3	2.20 (0.10)	3.36 (0.13)	3.56 (0.15)	6.14 (0.39)
	t4	1.96 (0.10)	3.66 (0.13)	3.41 (0.15)	5.84 (0.40)
	t5	1.92 (0.11)	3.56 (0.13)	3.14 (0.13)	5.80 (0.34)
BN	t0	1.94 (0.01)	3.26 (0.16)	3.13 (0.13)	1.94 (0.01)
	t1	2.59 (0.11)	2.43 (0.15)	3.61 (0.14)	7.70 (0.27)
	t2	2.83 (0.12)	2.20 (0.16)	4.15 (0.13)	7.72 (0.29)
	t3	2.30 (0.11)	3.20 (0.19)	3.57 (0.20)	5.76 (0.36)
	t4	2.07 (0.11)	3.35 (0.17)	3.14 (0.13)	5.65 (0.32)
	t5	1.93 (0.10)	3.48 (0.16)	3.30 (0.12)	5.76 (0.35)
BDD	t0	1.94 (0.11)	3.34 (0.18)	2.77 (0.15)	1.94 (0.11)
	t1	2.36 (0.12)	2.83 (0.19)	3.60 (0.16)	7.34 (0.32)
	t2	2.33 (0.14)	3.03 (0.16)	3.49 (0.19)	7.03 (0.39)
	t3	2.07 (0.13)	3.40 (0.20)	3.40 (0.22)	5.74 (0.46)
	t4	1.92 (0.12)	3.54 (0.18)	3.09 (0.20)	6.09 (0.43)
	t5	1.91 (0.12)	3.51 (0.14)	3.17 (0.18)	5.91 (0.44)
IA	t0	2.08 (0.10)	3.27 (0.16)	3.00 (0.14)	2.08 (0.10)
	t1	2.80 (0.13)	2.22 (0.19)	4.04 (0.14)	7.36 (0.30)
	t2	2.77 (0.12)	2.38 (0.17)	3.78 (0.13)	7.36 (0.30)
	t3	2.21 (0.14)	3.07 (0.19)	3.16 (0.18)	6.27 (0.36)
	t4	1.95 (0.13)	3.53 (0.17)	2.91 (0.20)	5.44 (0.36)
	t5	1.90 (0.11)	3.64 (0.16)	2.76 (0.18)	5.29 (0.39)
PD	t0	1.91 (0.06)	3.28 (0.10)	2.83 (0.09)	1.91 (0.06)
	t1	2.76 (0.08)	2.16 (0.10)	3.97 (0.09)	7.41 (0.20)
	t2	2.81 (0.08)	2.18 (0.11)	3.90 (0.09)	7.24 (0.21)
	t3	2.18 (0.07)	3.12 (0.10)	2.98 (0.09)	5.43 (0.25)
	t4	1.87 (0.07)	3.44 (0.09)	2.70 (0.10)	4.93 (0.25)
	t5	1.75 (0.07)	3.63 (0.09)	2.58 (0.10)	4.69 (0.26)

hour after the CB episode. From t1 to t2 there is an interaction between Time and Group showing a further increase of negative affect (SAM Arousal;  $b = 0.61$ ,  $p < 0.001$ ) in BN compared to PD. With regard to t1 to t3 and to t4, respectively, the effect of Time is moderated by Group, with the BN and BDD groups showing less decrease in STAI SKD (all  $b \geq 0.12$ , all  $p < 0.05$ ) and with the AN, BN and BDD groups showing less decrease in SAM Valence (all  $b \geq 0.17$ , all  $p < 0.05$ ). Additionally, from t1 to t4 the effect of Time is moderated by Group in the variable Worry, yielding a smaller decrease in BDD ( $b = 0.19$ ,  $p < 0.05$ ). From t1 to t5, a moderation of the Time effect was found, showing a smaller decrease in STAI-SKD in BN and BDD, in SAM Valence in AN, BN and BDD, and in SAM Arousal in BN (all  $b \geq 0.09$ , all  $p < 0.05$ ). With regard to the Worry item, the effect of Time is moderated by Group from t1 to t3, to t4 and to t5, showing less strong decrease in AN and IA.

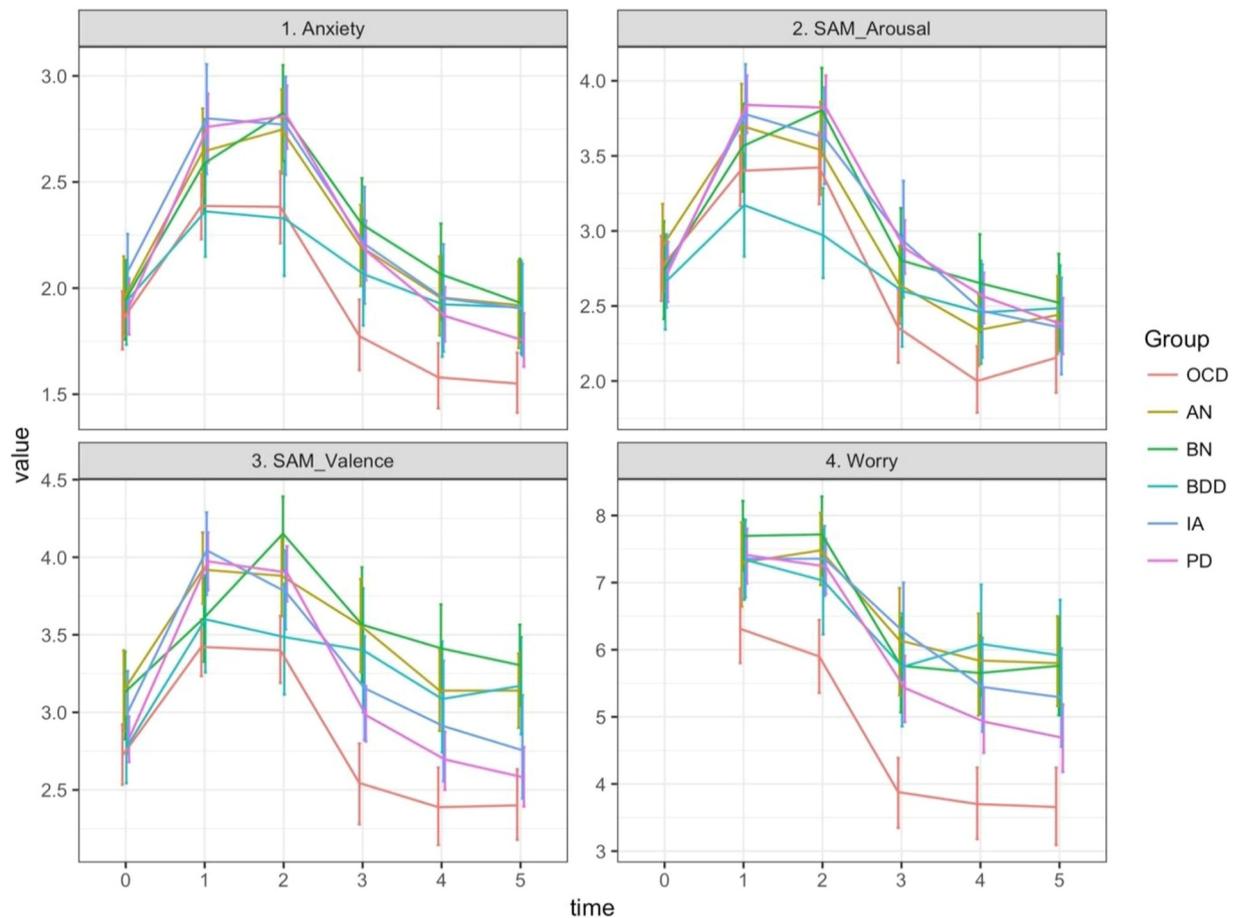
**3.4. Impact of functions of CB on the course of affect and worry from before to after the CB episode (t1-t3)**

Inspection of the mixed-model coefficients (see Table 4) revealed effects of the Functions reduction of negative affect and attainment of certainty, and interactions between these variables and Time. Specifically, the use of CB to reduce negative affect was associated with overall higher levels of all dependent variables, and modulated the change over time, with higher ratings being associated with a more pronounced decrease in all dependent variables. Similarly, the goal of attaining certainty was also associated with higher levels of all dependent variables, and with stronger decreases in STAI-SKD and SAM Arousal.

**3.5. Relative importance of general self-reported functions of CB (at t0)**

Fig. 2 illustrates group differences in mean endorsement rates for different functions of CB, MANOVA:  $F(20,1488) = 7.50$ ,  $p < 0.001$ ,  $\rho\eta^2 = 0.09$ . Subsequent ANOVAs revealed significant group differences in the CB functions reduction of negative affect, motivation, and avoidance of negative consequences, all  $p < 0.001$ ,  $0.08 \leq \rho\eta^2 \leq 0.19$ , but not for attainment of certainty,  $p = 0.08$ ,  $\rho\eta^2 = 0.03$ . Reduction of negative affect was a more prominent function in OCD and PD compared to BN and BDD, and motivation was more prominent in AN and BN compared to IA, OCD, and PD, and more prominent in BDD compared to OCD. Avoidance of negative consequences was generally less important in BN compared to IA, OCD, and PD, and in BDD compared to OCD and PD.

The rmANOVAs with the various functions included as within-group factors separately for each group with subsequent Bonferroni-corrected post-hoc tests ( $p < 0.0083$  for significance) revealed that attainment of



**Fig. 1.** Course of affect and worry over the course of the CB episode (t0-t5, or t1-t5 for worry, respectively). OCD, obsessive-compulsive disorder; AN, anorexia nervosa; BN, bulimia nervosa; BDD, body dysmorphic disorder; IA, illness anxiety disorder; PD, panic disorder; t0, Baseline (at onset of study); t1, immediately before CB-episode; t2, during CB-episode; t3, immediately after CB-episode; t4, 15 minutes after CB-episode; t5, 60 minutes after CB-episode.

certainty was the most important function in BN, and was a significantly more important function than motivation and avoidance of negative consequences in AN. In IA, attainment of certainty, avoidance of negative consequences and reduction of negative affect received higher ratings than did motivation, and attainment of certainty was even more important than reduction of negative affect. For OCD, reduction of negative affect, avoidance of negative consequences and attainment of certainty were more important than motivation but did not differ from each other. In BDD, attainment of certainty was more relevant than reduction of negative affect, motivation and the avoidance of negative consequences. Finally, for PD, reduction of negative affect, avoidance of negative consequences, and attainment of certainty were more important than motivation.

#### 4. Discussion

The present study aimed to transdiagnostically examine the course of affect over an episode of CB, with the goal of corroborating the mechanism of negative reinforcement of CB which is proposed in etiological models of AN, BN, BDD, OCD, and IA (Rachman, 2002; Williamson et al., 2004; Rosen et al., 1995; Salkovskis and Warwick, 1986). We were further interested in disorder-specific self-reported functions of CB and how these functions predict the course of affect.

The results indicate that in all of the disorders examined, negative affect was increased immediately before a CB episode compared to at baseline, i.e., in a situation at the very beginning of the study prior to all other measurements. This finding corroborates postulations in etiological models of OCD (Rachman, 2002; Salkovskis, 1999), EDs

(Williamson et al., 2004), BDD (Rosen et al., 1995; Stangier, 2002; Veale and Neziroglu, 2010; Wilhelm et al., 2013), and IA (Salkovskis and Warwick, 1986; Warwick and Salkovskis, 1990). It is also partially in line with a previous study in EDs, which indicated that situations immediately before CB are characterized by less strong positive affect (Kraus et al., 2015). When looking into the moderation of the increase by Group, findings remain somewhat inconclusive. Individuals with OCD and BDD showing smaller increases in arousal and anxiety than individuals with PD, while individuals with OCD and BN showed smaller increases in negative affect (Valence) than individuals with PD. One could assume that the arousal and negative affect level in individuals with PD might be generally higher (e.g., Doberenz et al., 2010). However, findings also reveal that the level of negative affect (Valence) was higher in AN and BN than in individuals with PD. Future studies, potentially incorporating other forms of measurement (e.g. psychophysiological measures), might shed light on these inconsistencies.

Etiological models of the disorders were not only confirmed with regard to increased negative affect prior to CB in comparison to baseline but also regarding the reduction of negative affect over the course of a CB episode. In all disorders, negative affect and worry were significantly reduced from immediately before to all after-CB time points. While in line with etiological models, it was only partially in line with our hypothesis that postulated a reduction in OCD, IA and PD, and an increase of negative affect in AN, BN and BDD. The difference to previous studies in the body-image related disorders might be due to differences in settings and measures. The only study that used a broad measure of affect (Kraus et al., 2015) was conducted as an EMA study in

**Table 4**

Coefficients and 95% confidence intervals (CI) of random intercept model for the four dependent variables STAI-SKD, SAM Arousal, SAM Valence, and Worry in the mixed models with the disorders, time (t1-t3) and functions as fixed parts.

	STAI-SKD		SAM Arousal		SAM Valence		Worry	
	B	CI	B	CI	B	CI	B	CI
<b>Fixed Parts</b>								
(Intercept)	1.18***	0.52 – 1.85	2.32***	1.29 – 3.34	2.76***	1.74 – 3.78	3.46***	1.45 – 5.46
OCD <sup>1</sup>	-0.41**	-0.79 – -0.03	-0.40	-0.98 – 0.18	-0.74*	-1.32 – -0.16	-0.81	-1.95 – 0.33
AN	-0.05	-0.52 – 0.43	0.15	-0.58 – 0.88	-0.47	-1.19 – 0.26	-0.43	-1.85 – 1.00
BN	-0.16	-0.65 – 0.34	-0.13	-0.90 – 0.63	-0.98*	-1.74 – -0.22	1.03	-0.46 – 2.53
BDD	-0.34	-0.87 – 0.19	-0.67	-1.48 – 0.15	-0.80	-1.61 – 0.01	0.46	-1.13 – 2.06
IA	0.00	-0.46 – 0.47	-0.23	-0.95 – 0.48	-0.07	-0.78 – 0.63	-1.06	-2.45 – 0.34
Time	0.19	0.00 – 0.39	0.11	-0.20 – 0.42	0.14	-0.17 – 0.45	0.19	-0.38 – 0.77
Red. neg. Affect	0.31***	0.14 – 0.48	0.45***	0.19 – 0.71	0.33*	0.08 – 0.59	0.80***	0.29 – 1.31
Motivation	-0.04	-0.19 – 0.11	-0.06	-0.29 – 0.18	-0.04	-0.28 – 0.19	-0.01	-0.48 – 0.45
Avoid. neg. Cons.	0.04	-0.13 – 0.20	-0.15	-0.40 – 0.10	0.04	-0.20 – 0.29	0.20	-0.29 – 0.68
Attainment of certainty	0.33***	0.14 – 0.53	0.47***	0.17 – 0.77	0.32*	0.02 – 0.61	0.81*	0.23 – 1.40
OCD x time	0.01	-0.10 – 0.12	-0.04	-0.21 – 0.14	0.08	-0.10 – 0.26	-0.15	-0.48 – 0.17
AN x time	0.00	-0.14 – 0.14	-0.09	-0.31 – 0.13	0.25*	0.03 – 0.47	0.23	-0.18 – 0.64
BN x time	0.04	-0.10 – 0.19	0.02	-0.21 – 0.25	0.37**	0.14 – 0.60	-0.25	-0.68 – 0.18
BDD x time	0.04	-0.11 – 0.20	0.10	-0.14 – 0.35	0.28*	0.04 – 0.53	-0.08	-0.53 – 0.38
IA x time	0.01	-0.13 – 0.14	0.07	-0.14 – 0.29	0.06	-0.16 – 0.27	0.47*	0.07 – 0.87
Time x Red. neg. Affect	-0.10***	-0.15 – -0.05	-0.12***	-0.20 – -0.04	-0.12***	-0.20 – -0.05	-0.27***	-0.42 – -0.13
Time x Motivation	0.04	-0.01 – 0.08	0.02	-0.05 – 0.09	0.01	-0.06 – 0.08	0.10	-0.03 – 0.24
Time x Avoid. neg. Cons.	0.00	-0.05 – 0.05	0.07	-0.01 – 0.14	-0.01	-0.08 – 0.07	0.01	-0.13 – 0.15
Time x Attainment certainty	-0.07*	-0.13 – -0.01	-0.13***	-0.22 – -0.04	-0.07	-0.16 – 0.02	-0.16	-0.33 – 0.01
<b>Random Parts</b>								
σ <sup>2</sup>	0.311		0.788		0.788		2.745	
τ <sub>00, pid</sub>	0.284		0.391		0.332		2.872	
N <sub>pid</sub>	378		378		378		378	
ICC <sub>pid</sub>	0.477		0.332		0.297		0.511	
Observations	756		756		756		756	
R <sup>2</sup>	0.577		0.474		0.425		0.628	

Notes.

<sup>1</sup> The PD symptom group serves as the comparison group and is therefore not listed.

\* *p* < 0.05

\*\* *p* < 0.01

\*\*\* *p* < 0.001

individuals with AN and BN in daily life that might be closer to the real CB-experience and not distorted by memory biases compared to the present study. The other studies, both in EDs (Shafran et al., 2007) and BDD (Veale et al., 2016; Windheim et al., 2011) were performed in the laboratory and limited to CB in the mirror, while the range of CB in our sample was considerably wider.

Of all CB functions analyzed, only reduction of negative affect and attainment of certainty had a transdiagnostic impact on the course of affect over the CB episode. The more both functions were endorsed, the more negative affect and worry was present during the CB episode. Furthermore, high levels of endorsement of reduction of negative affect led to a stronger decrease of all dependent variables, and high endorsement of attainment of certainty resulted in stronger decrease of anxiety and arousal from before to after the CB episode.

In line with these findings are the results from the analyses of endorsement of functions of CB in general. Within the six diagnostic groups, the attainment of certainty was the most relevant function. This finding might be viewed in the context of previous research, which indicated a higher degree of intolerance of uncertainty in all six disorders (Tolin et al., 2003; Kesby et al., 2017; Summers et al., 2016; Boelen and Carleton, 2012; Carleton et al., 2013) compared to healthy control individuals, leading to a more pressing need for change in the individual and a consequent use of all kinds of (dysfunctional) techniques, e.g., CB. Furthermore, the results of CB revealed that participants in all symptom groups reported a reduction of negative affect as a goal of CB. However, this function was more prominent in OCD and PD than in BN and BDD. Regarding the other self-reported functions of CB, the hypotheses were partially confirmed: Participants with disorders which are associated with a negative body image, such as AN, BN, and BDD, were more likely to perform CB for purposes of self-motivation

compared to participants with IA, OCD and PD. This finding is in line with a previous suggestion by Kraus et al. (2015) that CB might be used in order to motivate oneself to further engage in compensatory behaviors (e.g., dieting) with the aim of regulating one's own body weight. The groups with OCD, IA, and PD more frequently used CB in order to avoid negative consequences compared to AN, BN, and BDD.

This study has some limitations. One of them is the online study design, which might have led to a selection bias. Furthermore, due to the assessment via the internet, we had to rely on self-identification as having one of the disorders, which might threaten the validity of the groups. However, the sample showed relatively high scores in the disorder-specific questionnaires and results of the course of negative affect and worry from before to during and after CB did not change when a re-analysis with those participants crossing disorder-specific cut-offs for full syndromes was performed. As cut-off scores are not fully reliable and in order to not lose power, we decided in favor of analyzing the full samples. As participants only completed psychopathology measures related to the disorder they self-identified with, we cannot rule out that in fact participants suffered from one of the other disorders, misinterpreting their symptoms. We tried to avoid this complication by providing description of typical symptoms of all the disorders and by checking the short description of the CB episodes participants remembered for fit to the disorder. Additionally, the study employed a retrospective design, asking participants to recall a typical recent CB episode and rate their affect and attainment of goals of CB over different points of the episode. Therefore, we cannot exclude the possibility of memory biases, and strongly suggest that future studies include the examination of affective states during an actual CB episode in daily life using ecological momentary assessment procedures. Furthermore, as participants were not asked to report how long ago the episode they

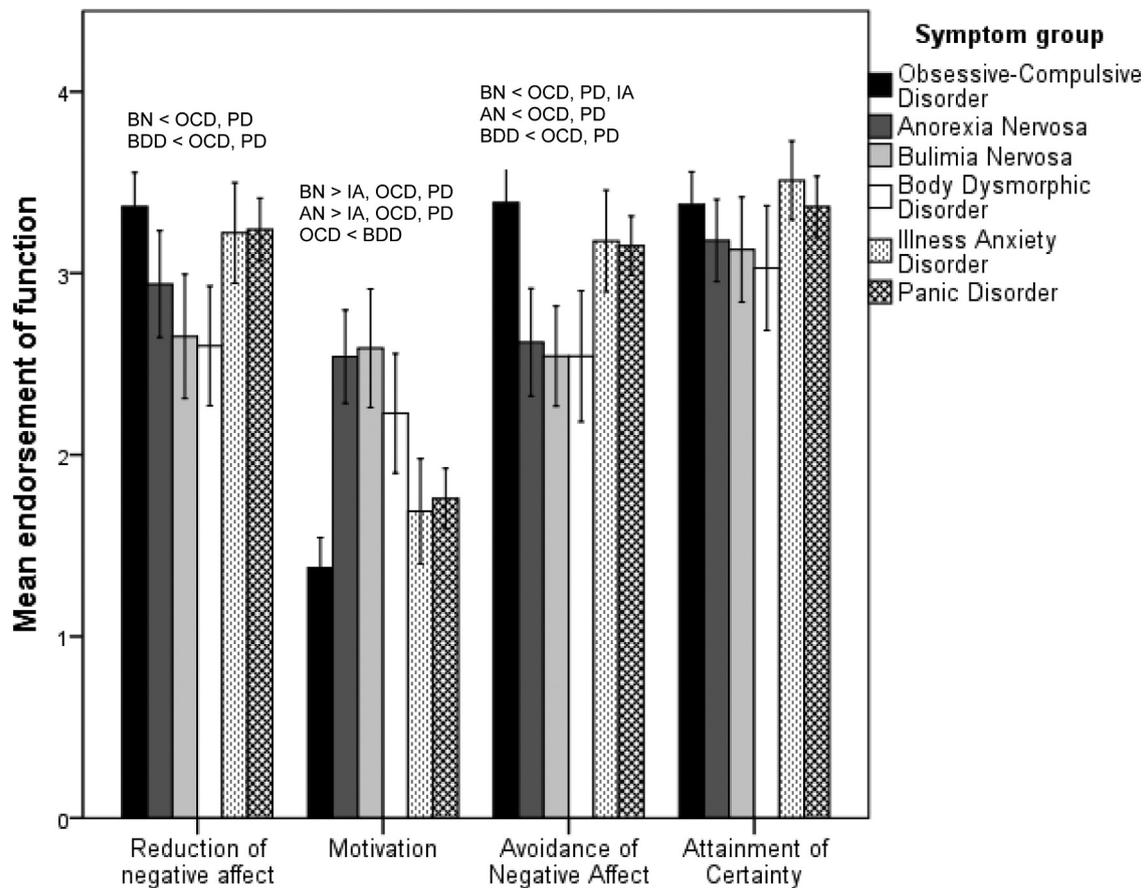


Fig. 2. Group Differences between Obsessive-Compulsive Disorder (OCD), Anorexia Nervosa (AN), Bulimia Nervosa (BN), Body Dysmorphic Disorder (BDD), Illness Anxiety Disorder (IA), and Panic Disorder (PD) in General Mean Endorsement Rates of Functions of CB. Error bars denote + /- 2 standard errors.

remembered was, we cannot rule out the impact of different memory spans. Linked to this limitation of the design, it is of note, that the current study cannot answer the question, whether CB might rather provide a negative intermittent reinforcement, thus whether only a few CB episodes rather than all lead to a decrease in negative affect. Lastly, we suggest that future studies counter the limitation of pure self-report by additionally using other, more objective assessments such as peripheral-physiological measures to assess emotional activation (Kaholokula et al., 2009; Kreibig, 2010). Nevertheless, the present study was the first to place a transdiagnostic focus on central disorder-maintaining mechanisms proposed by etiological models of almost all disorders included. Moreover, the multi-measurement design of the study further allowed for the analysis of different time frames within the process of CB and the inclusion of different disorders enabled direct comparisons. Furthermore, to our knowledge, this was the first study to examine different functions of CB beyond reduction of negative affect. Moreover, the study was adequately powered and employed validated self-report measures.

In sum, across all symptom groups – with the exception of PD – the course of affect postulated in etiological models (Rachman, 2002; Williamson et al., 2004; Rosen et al., 1995; Salkovskis and Warwick, 1986) was confirmed. In particular, reduction of negative affect and attainment of certainty were found to influence the course of negative affect and worry from a transdiagnostic perspective. As a first clinical implication, the study findings support the psychoeducational explanation that CB acts as a possible disorder-maintaining mechanism due to its negatively reinforcing effect. Second, therapeutic techniques might be indicated which aim to reduce negative affect – without making use of CB. These include exposure and response prevention, which is an established and well-researched cognitive-behavioral

treatment component for OCD (for an overview, Abramowitz et al., 2018). However, the clearly transdiagnostically valid mechanism of CB does not automatically imply transdiagnostic treatment strategies. Therefore, future studies should examine whether mechanisms of action and outcomes of treatment are comparable across different disorders, and whether the substantial findings from OCD treatment research regarding exposure and ritual prevention could be transferred to the other disorders. This might be of particular interest given the relevance of attainment of certainty as a function of CB, as research in OCD indicates that exposure does not result in unlearning or in the correction of fear-based associations, but rather in the facilitation of new safety-based associations (Abramowitz et al., 2018). Furthermore, the function of attainment of certainty, which, potentially due to an underlying intolerance of uncertainty, appears to be important across the disorders, should be targeted more directly in interventions. Thus, it might be promising to employ cognitive techniques which aim to question the striving for certainty, to illustrate the lack of attainability of certainty (e.g., Grayson, 2010), or to foster a willingness to experience and respond flexibly to obsessions, anxiety and uncertainty (Twohig and Levin, 2017).

**Conflict of interest**

The authors do not report any conflict of interest.

**Disclosure**

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