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Stress-Induced Body Dissatisfaction in Women With Binge Eating Disorder

Eva Naumann and Jennifer Svaldi
University of Tuebingen

Tanja Wyschka and Markus Heinrichs
University of Freiburg

Bernadette von Dawans
University of Trier

Stress is known to be a trigger for binge eating in individuals with binge eating disorder (BED). However, the influence of stressful situations on BED patients' body image is less understood. Our study objective was to gain insight into the effects of inducing psychosocial stress on body dissatisfaction in women with BED. Overweight women with BED ($n = 29$) and without an eating disorder (control group, CG; $n = 38$) underwent the Trier Social Stress Test for Groups (TSST-G stress) and a nonstressful control task (TSST-G no stress). Additionally, to test for the influence of body salience, participants were either exposed or not exposed to a mirror. Participants repeatedly rated their current body dissatisfaction and psychological distress. Simultaneously, biological stress reactivity was measured using salivary cortisol and alpha-amylase (sAA). Participants responded to TSST-G stress with significantly higher psychological and biological stress compared to the TSST-G control task. The psychological distress response was significantly greater in women with BED than the CG. As hypothesized, exposure to acute socioevaluative stress led to exacerbated body dissatisfaction in the BED group only. The findings of the present study suggest that acute socioevaluative stress may play an influential role in BED patients' body dissatisfaction. Body image programs might benefit from targeting stress management or coping skills in patients with BED.

General Scientific Summary
Stress is a commonly reported antecedent of binge eating in individuals with binge eating disorder (BED). This study supports the notion that body satisfaction of patients with BED is also negatively affected by the experience of stress.

Keywords: binge eating disorder, obesity, stress, TSST, body dissatisfaction

Binge eating disorder (BED) is a prevalent eating disorder characterized by recurrent binge eating in the absence of compensatory behavior (American Psychiatric Association, 2013). BED is a serious condition often associated with overweight and obesity (de Zwaan, 2001; Yanovski, 2003). Unlike anorexia nervosa and bulimia nervosa, body image problems have not been recognized as a diagnostic criterion for the diagnosis of BED. However, research continues to promote the clinical and prognostic significance of body image disturbances in BED (Grilo, 2013). Overvaluation of shape and weight, for example, has been shown to signal greater severity of BED (Grilo et al., 2008). Moreover, intervention studies suggest that body dissatisfaction is a salient predictor for poor BED treatment outcome (Hilbert, Saelens, et al., 2007; Sysko, Hildebrandt, Wilson, Wilfley, & Agras, 2010). Hence, research is warranted on the factors contributing to body-related pathology in BED. Cognitive maintenance models (e.g., Fairburn, Cooper, & Shafran, 2003; Heatherton & Baumeister, 1991) emphasize the role of stressors in the exacerbation of body image disturbances.

In general, stress is thought to play a central role in the pathogenesis and course of BED. Prospective studies suggest that stressful life events precede abnormal eating and weight control behavior in young girls as well as the onset of full-syndrome BED (Loth, van den Berg, Eisenberg, & Neumark-Sztainer, 2008; Pike et al., 2006; Striegel-Moore, Dohm, Pike, Wilfley, & Fairburn, 2002; Striegel-Moore et al., 2007). Furthermore, research provides evi-

Eva Naumann and Jennifer Svaldi, Department of Psychology, University of Tuebingen; Tanja Wyschka and Markus Heinrichs, Department of Psychology, University of Freiburg; Bernadette von Dawans, Department of Psychology, University of Trier.

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Correspondence concerning this article should be addressed to Eva Naumann, Department of Psychology, Clinical Psychology and Psychotherapy, University of Tuebingen, Schleichstr. 4, 72076 Tuebingen, Germany. E-mail: eva.naumann@uni-tuebingen.de

dence that women with BED display high stress vulnerability, with patients reporting higher acute levels of distress than healthy controls (Hilbert, Vögele, Tuschen-Caffier, & Hartmann, 2011). Gluck, Geliebter, and Lorence (2004) found some indication for a hyperactive hypothalamic–pituitary–adrenal (HPA) axis (as one of the main effector systems of stress) with exaggerated morning cortisol as well as a tendency toward greater cortisol responsivity following cold pressor stress in women with BED compared to obese nonbinge eaters. Group differences persisted even after a 6-week CBT treatment program (Gluck et al., 2004). In contrast to these findings, however, another experimental study on the effects of stress in obese individuals with and without BED failed to observe group differences in baseline cortisol concentration, and even found a blunted cortisol reaction to a psychosocial stressor for subjects with BED (Rosenberg et al., 2013). Conflicting results have also emerged with regard to the autonomic stress reactivity, with some researchers reporting differences between individuals who display binging behaviors and noneating disordered controls (Friederich et al., 2006; Messerli-Bürgy, Engesser, Lemmenmeier, Steptoe, & Laederach-Hofmann, 2010), while others do not find evidence for cardiac differences between these groups (Cattanach, Malley, & Rodin, 1988; Hilbert et al., 2011). These opposing results may be explained by variability in study designs, most importantly in the protocols used to induce stress. That is, personally relevant stressors (e.g., Hilbert et al., 2011) seem to produce a similar biological stress response in individuals with and without BED. Notably, most of the experimental approaches to BED mentioned made use of either a physical stressor or a cognitive stress task. However, research indicates that stress that stems from the social environment seems to be of distinct significance for the occurrence of BED pathology (Stein et al., 2007), just as social support was found to have a protective effect against binge eating (Freeman & Gil, 2004). Thus, it is particularly important to conduct research in BED exploring the effects of psychosocial stress—defined as stress perceived as a threat to the social status and social self-esteem.

As far as eating disorder maintenance is concerned, psychosocial stress and interpersonal conflict are some of the most frequently reported triggers of loss-of-control and binge eating in individuals with BED (Hilbert et al., 2011; Laessle & Schulz, 2009; Schulz & Laessle, 2012; Smyth et al., 2007; Wolff, Crosby, Roberts, & Wittrock, 2000). From a theoretical point of view, it has been suggested that the triggering effects of stressors on binge eating are mediated through body image problems (Stice & Shaw, 2002; Williamson, White, York-Crowe, & Stewart, 2004). More precisely, acute stress, particularly that of a social nature (e.g., rejection from a group, being judged in front of an audience), has been theorized to activate appearance-schematic processing and promote dysfunctional body-related assumptions and body dissatisfaction in BED (i.e., "I am unlikable because I am unattractive"). In turn, body dissatisfaction has empirically been shown to foster unhealthy eating behavior (Stice & Shaw, 2002). However, in sharp contrast to the eating-related symptomatology, little is known about the effects of stress on the body image of patients with eating disorders.

A series of complementary studies has provided convergent empirical evidence for a close association between feelings of stress and body image problems (Johnson & Wardle, 2005; Kimmel & Mahalik, 2005; Mason & Lewis, 2016; Murray, Rieger, & Byrne, 2015; Ricciardelli & McCabe, 2001; Stice & Shaw, 2002). Longitudinal studies found that stress levels significantly predicted increases in body dissatisfaction after 1 year in nonclinical adolescent samples (Murray, Rieger, & Byrne, 2013; Presnell, Bearman, & Stice, 2004). Among minority women, body dissatisfaction and bulimic symptoms correlated significantly only in participants reporting high levels of acculturative stress (Perez, Voelz, Pettit, & Joiner, 2002). However, most of these studies on stress and body image were correlational, conducted in noneating disordered populations, or focused on chronic stress. To the best of our knowledge, no experimental study exists exploring the contributing role of acute psychosocial stress in the elicitation of body dissatisfaction in BED.

To address this paucity of information, the present study sought to experimentally investigate the effects of inducing acute psychosocial stress on self-reported body dissatisfaction in women with BED and weight-matched noneating disordered females. To this end, study participants underwent the Trier Social Stress Test for Groups (TSST-G), a reliable and ecologically valid method inducing socioevaluative stress, and an equivalent nonstressful control task (von Dawans, Kirschbaum, & Heinrichs, 2011). Furthermore, to test for effects of stress on body-related schemas, participants were additionally exposed to a 2-min mirror exposure or a comparable condition in which body schemas were not activated, respectively. Actual body dissatisfaction and distress levels were repeatedly rated by the participants. In addition, salivary cortisol and alpha-amylase (sAA) were assessed because both are considered as some of the most reliable biomarkers of stress, reflecting activity of the HPA axis and the sympathetic nervous system, respectively (Kirschbaum & Hellhammer, 1994; Nater & Rohleder, 2009).

Our main hypothesis was that the acute psychosocial stress provocation would lead to an increase in body dissatisfaction in women with BED, whereas women without BED were expected to exhibit greater body image resilience (i.e., stable body image despite feeling socioevaluative stress). With regard to mirror exposure, we anticipated that negative effects of stress on body dissatisfaction would be augmented when participants' body schema was activated. Furthermore, a multiple linear regression analysis was conducted to determine the association between stress responses and changes in state body dissatisfaction.

Method

Participants

Participants were recruited through announcements in local newspapers, TV, and radio. The study sample consisted of 29 overweight/obese women with a DSM-V diagnosis of BED and 38 control women without a current or lifetime eating disorder diagnosis (CG) of comparable weight. Eating disorder and comorbid diagnoses were established using the German versions of the Eating Disorder Examination Interview (Hilbert & Tuschen-Caffier, 2006) and the Structured Clinical Interview (SCID) for *DSM–IV* (Wittchen, Zaudig, & Fydrich, 1997). Participants' height and weight were measured during the diagnostic session.

Participants were excluded if they met any of the following criteria: (a) age below 18 years; (b) high risk of suicide; (c) co-occurring psychotic disorder, bipolar disorder, alcohol/sub-

stance dependence within the past 6 months, and/or borderline personality disorder; (d) acute or chronic medical illness that would affect weight and/or ability to participate; (e) insufficient German language skills; or (f) pregnancy.

The groups did not differ in age, marital status, educational level or body mass index (BMI). As expected, participants with BED had significantly higher scores on questionnaires assessing eating disorder severity, trait body dissatisfaction, depression, and general levels of stress over the past week, compared to the CG (see description of the questionnaires below). Means (*M*s), standard deviations (*SD*s) and statistics of the demographic characteristics and overall pathology are displayed in Table 1.

Participants with BED experienced a mean of 3.82 ($SD = 2.27$; range: 1–12) binges per week over the 3 months prior to testing. Regarding comorbidities, 55.17% ($n = 16$) of the BED sample had a lifetime diagnosis of an affective disorder and 13.79% ($n = 4$) a lifetime diagnosis of an anxiety disorder. The control group had fewer comorbidities, with 21.05% ($n = 8$) of participants having a lifetime affective disorder and 7.89% ($n = 3$) a lifetime anxiety disorder.

Questionnaires

As part of the diagnostic session, participants filled in questionnaires using an online research platform (Unipark, Globalpark AG, Hürth).

EDE-Q. The Eating Disorder Examination Questionnaire is a widely used and valid self-report questionnaire to assess eating disorder pathology (German version: Hilbert, Tuschen-Caffier, Karwautz, Niederhofer, & Munsch, 2007). It comprises a global score as well as four subscales (restraint, eating concern, weight concern, and shape concern). Cronbach's alphas for the present sample ranged between .82 and .96.

Table 1
Means and Standard Deviations (in Parentheses) of Demographic Characteristics

Characteristic	BED group ($n = 29$)	Control group ($n = 38$)	Statistics F or χ^2	p
Age	45.65 (11.19)	44.02 (14.98)	−.51	.612
Marital status			1.86	.393
single	4	10		
partner/married	19	23		
divorced/widowed	6	5		
Educational level			.51	.471
low/middle	14	15		
high	15	23		
BMI	33.96 (6.15)	33.66 (5.55)	−.21	.833
EDE-Q global	4.67 (.99)	1.83 (.87)	12.41	<.001
EDE-Q restraint	3.49 (1.30)	1.61 (.81)	6.77	<.001
EDE-Q eating concern	4.03 (1.32)	1.26 (.52)	10.63	<.001
EDE-Q weight concern	5.01 (1.06)	1.89 (1.00)	12.29	<.001
EDE-Q shape concern	5.37 (1.08)	2.18 (1.25)	10.92	<.001
BSQ	128.74 (30.47)	63.30 (23.45)	9.93	<.001
BDI-II	15.66 (8.61)	3.39 (3.37)	7.25	<.001
DASS stress	8.27 (4.96)	2.39 (2.66)	5.77	<.001

Note. BED = binge eating disorder; BMI = body-mass-index; EDE-Q = Eating Disorder Examination Questionnaire; BSQ = Body Shape Questionnaire; BDI-II = Beck Depression Inventory II; DASS = Depression Anxiety Stress Scales.

BSQ. The 34-item version of the Body Shape Questionnaire was administered to measure trait body dissatisfaction (German version: Pook, Tuschen-Caffier, & Stich, 2002). Despite its overlap with the EDE-Q subscales weight and shape concern, the BSQ was included because it measures the concept of body dissatisfaction in a broader sense than the EDE-Q and, for that matter, provides some additional information on the construct. Most importantly, the BSQ contains items that address aspects of body dissatisfaction deemed relevant in the study context such as body image avoidance. The BSQ uses Likert scoring on a 5-point scale, with higher scores reflecting greater body dissatisfaction. The BSQ has good psychometric values. Cronbach's alpha for the present sample was excellent with .98.

BDI-II. The Beck Depression Inventory II is a well-established self-report instrument to measure the severity of depression levels (German version: Hautzinger, Keller, & Kühner, 2006). The BDI-II consists of 21 items. It has demonstrated excellent reliability and validity. Cronbach's alpha for the present sample was excellent with .93.

DASS stress. The stress subscale of the Depression Anxiety and Stress Scale was used to assess participants' levels of perceived general stress over the past week (Lovibond & Lovibond, 1995). The stress subscale consists of seven items scored on a Likert-point scale ranging from 0 = *did not apply to me over the past week* to 3 = *applied to me very much or most of the time over the past week*. The DASS has demonstrated good psychometric properties. Internal consistency in the present sample was high (Cronbach's alpha = .92).

Stress Induction

The group version of the well-established TSST was used to induce acute socioevaluative stress (von Dawans et al., 2011). TSST-G sessions were held in groups of six. Participants stood next to one another, separated by partitions. The TSST committee (panel of two evaluators who were unfamiliar to the participants) sat at a desk on the opposite side of the test room.

The TSST-G consists of two stress phases. First, participants engaged in a 12-min public speaking task in the form of a mock job interview (first TSST-G stress phase). The second TSST-G stress phase involved an 8-min mental arithmetic task, in which participants had to perform serial subtractions. During both stress phases, participants were filmed by two clearly visible video cameras to enhance the effect of the stress induction.

The TSST-G no stress condition was designed by von Dawans et al. (2011) to guarantee specificity of the stress effects in a single-blind control condition containing all factors except for the psychosocially stressful components. That is, in the first TSST-G control phase participants simultaneously read a simple text, and in the second TSST-G control phase participants enumerated series of numbers in a low voice.

A detailed description of the procedure of the TSST-G stress and TSST-G no stress can be found in von Dawans et al. (2011).

Activation of Body-Related Schema

To test for the influence of body salience in the context of stress and body dissatisfaction, participants were asked to look either at themselves in a full-length mirror (mirror condition) or at a cov-

ered mirror (no-mirror condition) for 2 min after each TSST-G phase (mock job interview and arithmetic task, respectively). Participants wore a standard set of tight-fitting clothes during the mirror exposure to minimize avoidance behavior (see Procedures). The sequence of mirror versus no mirror condition was counterbalanced within the TSST-G session.

Stress Response Measures

Biological stress. Free cortisol levels and sAA activity were obtained using saliva samples with a commercially available sampling device (Salivette; Sarstedt, Nümbrecht-Rommelsdorf, Germany). All samples were stored at −20° C. For bio-chemical analyses of free cortisol concentration, saliva samples were thawed and spun at 3000 rpm for 10 min to obtain 0.5–1.0 ml clear saliva with low viscosity. Salivary cortisol concentrations were determined by a commercially available chemiluminescence immunoassay (CLIA; IBL Hamburg, Germany). Salivary alpha-amylase was measured by using a quantitative *enzyme kinetic* method (see Rohleder & Nater, 2009). Saliva samples of two participants (one per study group) could not be analyzed because of insufficient amounts of recovered saliva. Another participant from the BED group had to be excluded from sAA analyses because her sAA levels were not detectable in the TSST-G no stress condition. Inter- and intra-assay coefficients of variation were 8.4% and 4.6%, respectively.

Psychological distress. In the theoretical and empirical literature, a distinction has been made between psychological stress described as the recognition of a demanding circumstance and psychological distress as the negative emotional state that may result from a stressful situation (Hoffman & Hatch, 1996; Lazarus, 1993). In line with this definition, the following 100-mm visual analogue scales (VASs) were used to measure several aspects of the subjective distress response: (1) "How anxious do you feel at the moment?", (2) "How tense do you feel at the moment?", (3) "How distressed do you feel at the moment?", and (4) "How strong is your urge to leave this situation at the moment?" The VASs ranged from 0 (*not at all*) to 100 (*very much*) and were taken from those used by von Dawans et al. (2011). The internal consistency for the psychological distress scale was excellent, with Cronbach's alpha reaching from .84 to .97 (depending on the test interval).

Body Dissatisfaction Measure

Actual body dissatisfaction was measured by using the following 100-mm VASs ranging from 0 (*not at all*) to 100 (*very much*): (1) "How satisfied are you with your body at the moment?" (reversed scoring), (2) "How satisfied are you with your weight at the moment?" (reversed scoring), (3) "How satisfied are you with your appearance at the moment?" (reversed scoring), (4) "How comfortable do you feel with your body at the moment?" (reversed scoring), (5) "How disgusted do you feel with your body at the moment?", 6) "How difficult is it for you to accept your body at the moment?", (7) "How distressful are your feelings toward your body at the moment?", (8) "How much do you wish you could change your body's appearance at the moment?", (9) "How worried are you about your body's appearance at the moment?", (10) "How scared of weight gain are you at the moment?", and (11) "How much do you dislike your body at the moment?" VASs were partly deduced from past research (Naumann, Tuschen-Caffier, Voderholzer, Schäfer, & Svaldi, 2016; Wade, George, & Atkinson, 2009) and partly self-developed to request additional information on the construct. The body dissatisfaction mean score revealed excellent internal consistency, with Cronbach's alpha reaching from .92 to .96 (depending on the test interval).

Procedures

This study received ethical approval from the Ethics Committee of the University of Freiburg (No.453/11). Participants provided informed consent before testing. This study used a mixed within- and between-subjects design: females of both study groups (BED vs. CG) participated in both TSST-G sessions, whereby the sequence of the TSST-G condition (stress vs. no stress) was counterbalanced. The TSST-G sessions were scheduled after the diagnostic phase and done within a 1-week interval. They took place in the late afternoon at 5 p.m. in order to control for diurnal variations in cortisol secretion. Furthermore, the participating women were either postmenopausal or they had to be in the luteal phase for both TSST-G sessions given that stress reactivity depends on the menstrual cycle status (Duchesne & Pruessner, 2013; Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999).

Upon arriving for the TSST-G session, participants were seated individually in the waiting room and instructed not to talk to each other for the study's duration. Baseline measures of saliva cortisol, sAA and psychometric variables were taken (baseline I). In the baseline phase, participants were already asked to put on the standard set of tight-fitting clothes underneath their clothing in separate changing rooms in order to save time during the mirror exposure task later. A second baseline assessment was then conducted (baseline II). After the baseline period, participants were introduced to the upcoming task and encouraged to prepare for the mock job interview for 10 min (anticipation phase). Then, participants were guided into the test room in which the two active TSST-G phases and the mirror/no mirror exposure took place. After the active TSST-G phase, participants were led back into the waiting room to rest for 25 min (follow-up phase).

Saliva cortisol, sAA, and ratings were assessed repeatedly after each phase in the TSST-G session. Please see Figure 1 for an illustration of the study design and timeline of assessments.

Statistics

Analyses were conducted using SPSS 24 (SPSS Inc., Chicago, IL). Preliminary analyses indicated no differences between the TSST phases (mock job interview and mental arithmetic task) with regard to stress and body dissatisfaction levels. Data were therefore collapsed across both TSST post-stressor phases (i.e., mean of assessments after the mock job interview and after the arithmetic task).

Psychological and biological data were analyzed by four-factor repeated measures analyses of variance (ANOVAs) with Group (BED vs. CG) as the between-factor and TSST-G condition (stress vs. no stress), Mirror condition (mirror exposure vs. no mirror) and Time (6 time points: baseline I, baseline II, anticipation, poststressor, postmirror, follow-up) as within-factors. We verified repeated measures results with Greenhouse-Geisser corrections where the Mauchly test of sphericity determined heterogeneity of covariance.

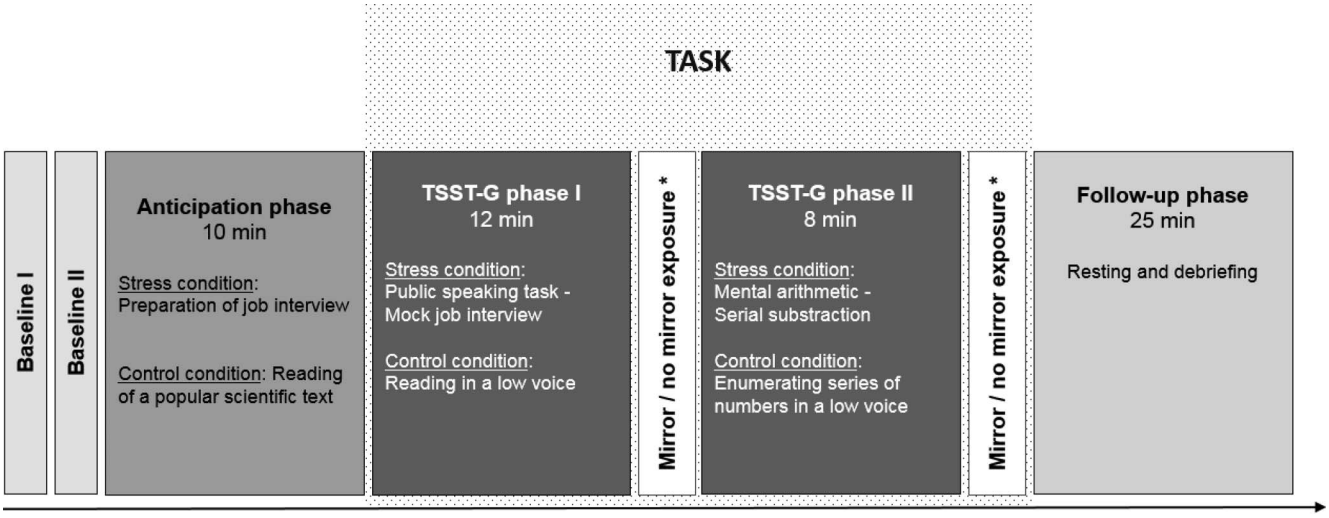

Figure 1. Study design: sequence of events and timeline. The shaded area represents the stressor phase.
* Mirror/no-mirror exposure were performed in randomized order within the TSST-G session.

To examine the association between the stress response and the increase in body dissatisfaction due to the stress induction, a multiple regression analysis was performed on residual scores of poststressor body dissatisfaction while we controlled for baseline body dissatisfaction (Cohen, Cohen, West, & Aiken, 2013). All analyses were two-sided, with the level of significance set at $p < .050$.

Power analyses indicated that our sample size was sufficient to detect medium effect sizes at a 95% significance level and with a Type-II-error of 10%.

Results

TSST-Manipulation Check

Psychological distress. A four-factor repeated measures ANOVA (Group × TSST-G condition × Mirror condition × Time) on psychological distress yielded a significant main effect of Group, with higher distress ratings in patients with BED compared to the CG, $F(1, 65) = 43.10$, $p < .001$, $\eta_p^2 = 0.399$.

There was a significant two-way interaction of TSST-G condition × Time, $F(5, 61) = 23.56$, $p < .001$, $\eta_p^2 = 0.266$, and Group × Time, $F(5, 61) = 39.38$, $p < .001$, $\eta_p^2 = 0.377$, as well as a significant three-way interaction of Group × TSST-G condition × Time, $F(5, 61) = 3.75$, $p = .006$, $\eta_p^2 = 0.055$. Follow-up paired t tests comparing TSST-G stress and TSST-G control separately for the groups indicated that the stress manipulation was successful in both study groups. That is, psychological distress was significantly higher in the poststressor phase of the stress compared to the no-stress condition in both the BED group and CG, ts > 3.27, ps $< .002$, ds > 0.530. No significant differences between TSST-G stress and the no stress condition were detected at baseline or follow-up, again for both study groups, ts < 1.78. Only in the BED group, however, were distress ratings already significantly increased during the anticipation phase of the TSST-G stress, $t(28) = 4.92$, $p < .001$, $d = 0.914$. By contrast, in the CG, no significant differences in distress ratings between the stress and no-stress condition were found at this time point, $t = 1.87$. Furthermore, the difference between distress ratings in the stress and no-stress condition during the stressor phase was significantly higher in the BED group, $t(65) = -2.73$, $p = .008$, $d = -0.660$, suggesting a stronger psychological distress response in participants with BED relative to overweight controls (*M*s and *SE*s are shown in Figure 2a).

The four-factor repeated measures ANOVA further yielded a significant interaction of Group × Mirror condition, $F(1, 65) = 4.51$, $p = .037$, $\eta_p^2 = 0.065$, Time × Mirror condition, $F(2, 64) = 12.36$, $p < .001$, $\eta_p^2 = 0.160$, as well as Group × Mirror condition × Time, $F(2, 64) = 7.15$, $p = .001$, $\eta_p^2 = 0.099$. Follow-up paired t tests conducted separately for the groups revealed that mirror exposure led to a significant increase in psychological distress in patients with BED only, $t(28) = 4.41$, $p < .001$, $d = 0.819$. No significant differences in psychological distress between the mirror compared to the no-mirror condition were observed for the overweight CG, $t = 1.26$ (*M*s and *SE*s of the data on Mirror condition are shown in Figure 2b).

No other significant interaction emerged from the four-factor repeated measures ANOVA, Fs < 1.80.

Biological stress. Cortisol analysis revealed a significant main effect of TSST-G condition, $F(1, 63) = 6.65$, $p = .012$, $\eta_p^2 = 0.096$, and a significant interaction of TSST-G condition × Time, $F(5, 59) = 5.58$, $p = .010$, $\eta_p^2 = 0.081$. Follow-up paired t tests comparing the TSST-G stress and no stress over all participants showed that there were no cortisol differences at baseline or in the anticipation phase between the TSST-G conditions, ts < 0.81. In the poststressor and follow-up phase, cortisol was significantly higher in the stress compared to the no-stress condition, ts > 3.76, ps $< .001$, ds > 0.534 (*M*s and *SE*s are shown in Figure 3a). No other significant effects regarding cortisol responses were found, Fs < 1.81.

The analysis of sAA activity revealed a significant effect of TSST-G condition, $F(1, 62) = 6.95$, $p = .011$, $\eta_p^2 = 0.101$, a significant effect of Time, $F(5, 58) = 14.45$, $p < .001$, $\eta_p^2 = 0.189$,

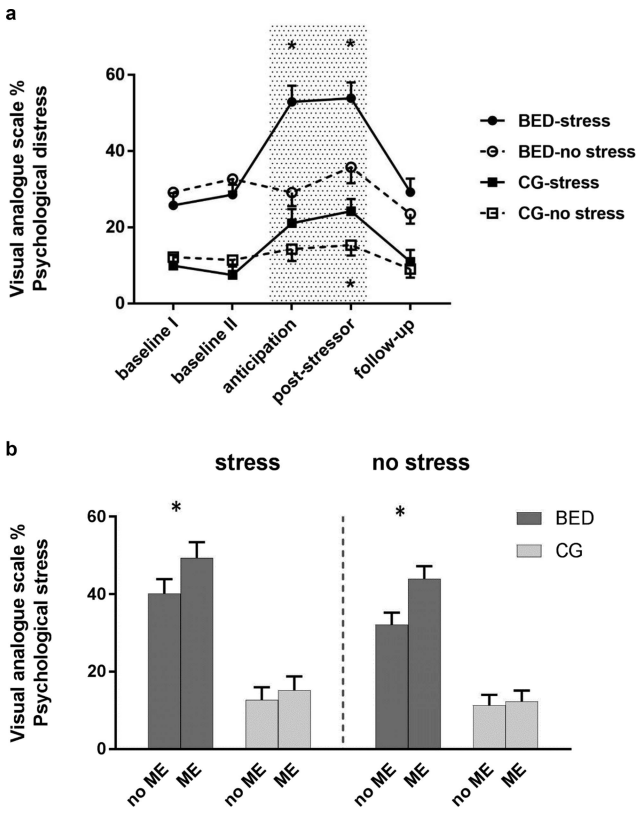

Figure 2. Psychological distress in the binge eating disorder (BED) group and control group (CG) in the stress and no-stress condition. Figure 2a shows data at baseline, in the anticipation phase, after the stressor, and at follow-up. The shaded area represents the stressor phase. The asterisks indicate statistical significance ($p < .050$). Between-group comparisons indicate significantly higher distress levels in BED than CG. Within-group comparisons indicate significant differences between the stress and no-stress condition in the anticipation phase in BED and after the stressor in BED and CG. Figure 2b shows data after the no-mirror exposure (no ME) and after the mirror exposure (ME). Within-group comparisons indicate a significant difference between ME and no ME in BED but not CG.

and a significant interaction of TSST-G condition × Time, $F(5, 58) = 6.03$, $p < .001$, $\eta_p^2 = 0.089$. Follow-up paired t tests comparing the TSST-G stress and no stress over all participants showed that there was no sAA difference at baseline between the TSST-G conditions, ts < 0.753. In the anticipation, poststressor, and follow-up phases, both groups' sAA levels were significantly higher in the stress than in the no-stress condition, ts > 2.06, ps $< .043$, ds > 0.283 (Ms and SEs are shown in Figure 3b). No other significant effects emerged from the ANOVA conducted on sAA, $F < 1.45$.

Primary Analyses

Body dissatisfaction. A four-factor repeated measures ANOVA (Group × TSST-G condition × Mirror condition × Time) on body dissatisfaction yielded a significant main effect of Group, with state body dissatisfaction being significantly higher in the BED group compared to the CG, $F(1, 65) = 80.50$, $p < .001$, $\eta_p^2 = 0.553$.

There was a significant two-way interaction of TSST-G condition × Time, $F(5, 61) = 5.21$, $p = .001$, $\eta_p^2 = 0.074$, and a significant three-way interaction of Group × TSST-G condition × Time, $F(5, 61) = 3.08$, $p = .021$, $\eta_p^2 = 0.045$. Follow-up paired t tests conducted separately for the groups revealed that in the BED group, body dissatisfaction was significantly higher during the anticipation and poststressor phases of the stress than during the no-stress condition, ts > 3.11, ps $< .004$, ds > 0.578, whereas no significant differences were found at baseline and follow-up, ts < 1.91. In the CG, body dissatisfaction did not differ significantly between the stress and no-stress condition at any time point, ts < 1.85 (Ms and SEs are shown in Figure 4a).

The ANOVA further revealed a significant two-way interaction of Group × Mirror condition, $F(1, 65) = 11.49$, $p = .001$, $\eta_p^2 = 0.150$, and Time × Mirror condition, $F(2, 64) = 47.30$, $p < .001$, $\eta_p^2 = 0.421$, as well as a significant three-way interaction of Group × Mirror condition × Time, $F(2, 64) = 8.83$, $p = .001$, $\eta_p^2 = 0.120$. Follow-up paired t tests conducted separately for the groups showed that body dissatisfaction was significantly higher

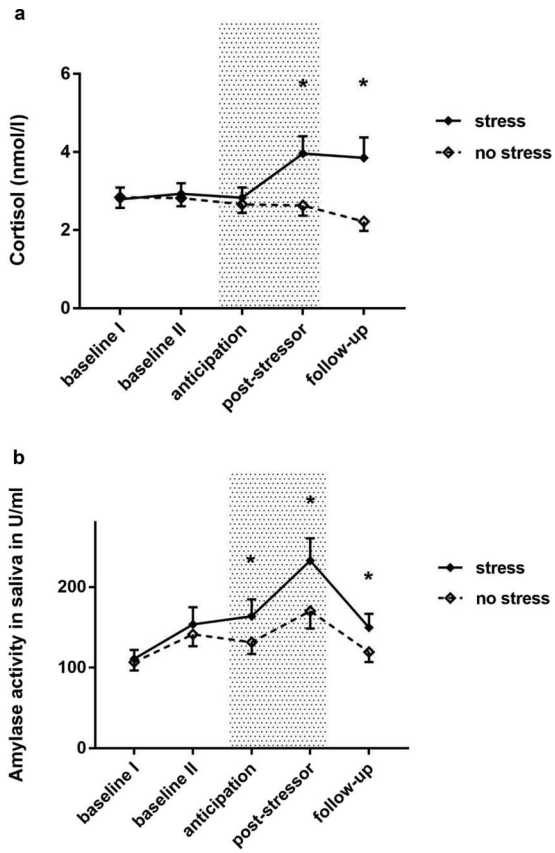

Figure 3. Cortisol (Figure 3a) and alpha-amylase (Figure 3b) in the stress and no-stress condition in all participants at baseline, in the anticipation phase, after the stressor, and at follow-up. The shaded area represents the stressor phase. The asterisks indicate statistical significance ($p < .050$). Within-group comparisons indicate significant differences between the stress and no-stress condition in the anticipation phase for alpha-amylase levels as well as after the stressor and at follow-up for cortisol and alpha-amylase levels. Between-group comparisons indicate no significant difference between binge eating disorder (BED) group and control group (CG).

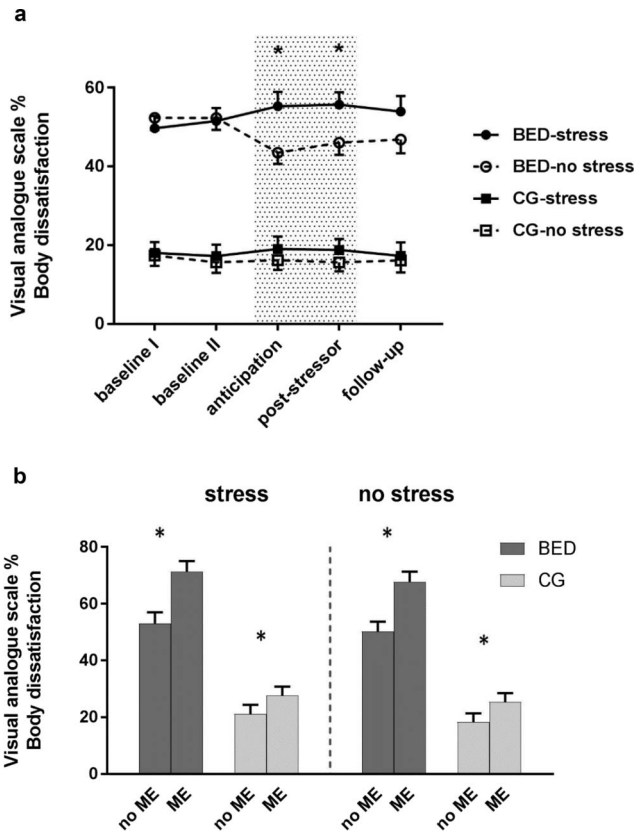

Figure 4. Body dissatisfaction in the binge eating disorder (BED) group and control group (CG) in the stress and no-stress condition. Figure 4a shows data at baseline, in the anticipation phase, after the stressor, and at follow-up. The shaded area represents the stressor phase. The asterisks indicate statistical significance ($p < .050$). Between-group comparisons indicate significantly higher body dissatisfaction in BED than CG. Within-group comparisons indicate significant differences between the stress and no-stress condition in the anticipation phase and after the stressor in BED. Figure 4b shows data after the no-mirror exposure (no ME) and after the mirror exposure (ME). Within-group comparisons indicate a significant difference between ME and no ME in BED and CG.

after participants looked in the mirror compared to the no-mirror condition in both study groups, $ts > 4.03$, $ps < .001$, $ds > 0.653$. However, the increase in body dissatisfaction in response to mirror confrontation was significantly higher in the BED group compared to the CG, $t(65) = -3.42$, $p = .001$, $d = -0.839$ (*M*s and *SE*s of the data on Mirror condition are shown in Figure 4b).

Regression analysis. A multiple linear regression analysis on residual scores of poststressor body dissatisfaction in the TSST-G stress condition controlling for baseline body dissatisfaction and the stress response measures as predictor variables revealed a significant multiple regression coefficient of $R = 0.479$, $F(3, 61) = 6.04$, $p = .001$, $f^2 = 0.297$. The psychological distress response to the TSST-G was the only significant predictor for poststressor body dissatisfaction, $\beta = 0.482$, $t(61) = 4.24$, $p < .001$. Beta-coefficients of the cortisol response and sAA response were not significant, $\beta s < -0.030$, $ts < -0.249$, $p > .804$, suggesting that the experience of psychological distress has greater influence on state body dissatisfaction than biological stress responses.

Discussion

Stress has received considerable theoretical attention in the context of binge eating and body image problems (Fairburn et al., 2003; Stice & Shaw, 2002). To the best of our knowledge, the present study is the first to investigate the influence of acute psychosocial stress on body dissatisfaction in overweight women with and without BED. The group version of the TSST (von Dawans et al., 2011), which involves performing public speaking and mental arithmetic tasks in front of a committee, was used to induce psychosocial stress.

In accordance with our hypothesis, we found that BED patients' body dissatisfaction was significantly higher after the stress provocation compared to the nonstressful control condition. In overweight control women without an eating disorder, no influence from the psychosocial stressor on self-rated body satisfaction was found. Consequently, this study's results suggest that acute psychosocial stress has a deleterious effect on the body image of women with BED, whereas overweight women without BED may be more resilient against the negative impact of stress on body dissatisfaction. Thus, our findings corroborate theoretical models that implicate the experience of stress, particularly of a psychosocial nature, in the etiology and maintenance of BED (Fairburn et al., 2003; Hagan et al., 2002; Stice & Shaw, 2002). Current clinical options for treating negative body image in BED might benefit from incorporating modules on stress prevention and management that help patients to become more resistant to social conflict as well as daily life stressors. Furthermore, in line with an abundance of other work demonstrating greater body image problems in BED than in overweight individuals without an eating disorder (Lewer, Nasrawi, Schroeder, & Vocks, 2016), the results of the present study are in keeping with the notion that body image disturbances are an important factor in BED.

Interestingly, our stress manipulation revealed no effect on body image ratings after the 2-min mirror exposure. That is, mirror exposure led to higher body dissatisfaction compared to the no-mirror control task in both the stress and control conditions. Thus, it seems that the formative influence of psychosocial stress on body dissatisfaction in BED disappears when patients are in a state of heightened body awareness. This result may likely reflect a ceiling effect in BED individuals during mirror exposure. In fact, the confrontation with one's own body is known to evoke powerful negative thoughts and feelings toward the body in females with eating disorders, which may not be exacerbated by the stress experience (Hilbert, Tuschen-Caffier, & Vögele, 2002; Vocks, Legenbauer, Wächter, Wucherer, & Kosfelder, 2007). Regarding the mirror exposure, it is further noteworthy that the BED group responded with a greater increase in body dissatisfaction and psychological distress than the CG. Taken together with our main results on the stress-induced body dissatisfaction specifically in BED, this indicates that overweight individuals with BED relative to those without an eating disorder are associated with both a poorer and more unstable body image that appears to be more negatively affected by acute stressors.

Consistent with previous research (Hilbert et al., 2011; Hansel & Wittrock, 1997), our results suggest higher self-reported distress

at baseline and over the last 4 weeks (i.e., DASS scores) as well as greater psychological distress reactivity to the psychosocial stress induction in women with BED compared to overweight controls. It is noteworthy that the anticipation of the TSST stress test alone seems to have caused a rise in subjective distress in participants with BED but not in the CG, which serves as another indication for heightened psychological distress vulnerability in BED.

Similar to other studies, subjects of the present study displayed elevated salivary cortisol and sAA activity in response to the stress induction compared to the nonstressful control task (Engert, Smallwood, & Singer, 2014; Nater & Rohleder, 2009). Moreover, in line with other research, the autonomic nervous system revealed a faster response curve (relative to the HPA axis as represented by cortisol) with increased sAA levels in the anticipation phase of the TSST-G stress condition (Engert et al., 2014; Gordis, Granger, Susman, & Trickett, 2006). It is noteworthy, however, that the stress-induced cortisol increase in our study sample was relatively low compared to cortisol reactivity reported in other TSST studies (Childs, Vicini, & De Wit, 2006; von Dawans et al., 2011). Demographic differences may likely account for this effect because results of higher endocrine stress reactivity are mostly based on younger, normal-weight, and gender-mixed samples. In fact, in line with the "wear and tear" hypothesis of aging, empirical evidence points to a diminished HPA stress reactivity in older populations and individuals with more lifetime exposure to stress (Elzinga et al., 2008; Nicolson, Storms, Ponds, & Sulon, 1997).

Contrary to Gluck et al., (2004), we observed no significant differences between overweight/obese women with and without BED with regard to basal and stress-responsive cortisol and sAA. However, our findings are in line with recent studies also reporting no evidence of increased cortisol stress response in obese women with BED compared to obese non-BED groups (Rosenberg et al., 2013; Schulz, Laessle, & Hellhammer, 2011). It is unclear why results conflict regarding the cortisol stress response of overweight individuals with and without BED, but it may be best explained by dissimilar study designs, including differences in time period of assessments (e.g., morning vs. evening), sampling methods (e.g., serum vs. salivary cortisol), and stressors that were used. As for the latter, overweight individuals with and without BED may display a more similar biological stress reaction during psychological challenges with a high socioevaluative component (such as the TSST in a group setting) given their similar experience with frequent weight-based stigmatization in social interactions (Puhl & Heuer, 2010).

As a matter of fact, psychological stressors recruit more brain resources and have been shown to provoke different stress response patterns than physical stressors (Dickerson & Kemeny, 2004). Thus, it is essential that our results are interpreted in light of the context-specific nature of the TSST-G, especially regarding our multiple regression analysis data that suggest a significant correlation between body dissatisfaction and psychological distress measures but not cortisol or the activation of salivary alpha amylase. While this finding corresponds with current models that place special emphasis on psychological factors as the primary cause for body image disturbances (Stice & Shaw, 2002; Williamson et al., 2004), it is important to bear in mind that the relationship between body dissatisfaction and biological stress markers might have been stronger had other stressors (e.g., with a stronger physical component) or parameters (e.g., cardiac biomarkers, skin conductance) been used. For future research, it will be beneficial to compare a broad array of different stressful scenarios (e.g., environmental, academic, interpersonal conflict) to attain deeper understanding of the specifics of the effects that stress has on BED patients' eating pathology and body image.

Just as much as the stressor's characteristics, it is important to take our participants' personal characteristics into account when interpreting our data, as only overweight and obese individuals were tested in the present study. Overweight and obesity, however, have each been associated with body image problems, stress dysregulation, and general endocrine and metabolic abnormalities (Furukawa et al., 2004; Laederach-Hofmann, Mussgay, & Ruddel, 2000; Lo Sauro, Ravaldi, Cabras, Faravelli, & Ricca, 2008; Sarwer, Wadden, & Foster, 1998; Valensi, Thi, Lormeau, Pariès, & Attali, 1995). Thus, it will be necessary for future studies to additionally include a normal-weight control group to better determine the role that excess weight plays in the damaging influence of stress on body satisfaction.

In addition to the lack of a normal-weight control group, other limitations of the current study must be considered. While the TSST is regarded as a relatively ecologically valid method to induce psychosocial stress because of its recreation of a realistic scenario, it is conducted in a laboratory-controlled environment that provides high internal validity but is still by nature artificial. In the future, it will be necessary to examine psychosocial stress and body image in BED using more naturalistic study designs (e.g., ecological momentary assessment), and for that matter to gain more information on stress that is idiosyncratically relevant to participants.

Another limiting factor of the present study is that we observed only the short-term effects of acute stress. There is evidence that acute stressors can exert long carry-over effects. For instance, Koo-Loeb, Costello, Light, and Girdler (2000) found higher 24-h urinary cortisol in females with bulimia nervosa compared to controls on the day following an interpersonal speech task. Furthermore, research provides compelling evidence for the harmful influence of prolonged chronic stress (especially early life stress) on subjective well-being and physiological states (Zandstra et al., 2015), and even body dissatisfaction in adolescents (Murray et al., 2013). Thus, it will be interesting for future studies to investigate stress-stimulated body dissatisfaction over longer periods of time, and to conduct prospective studies on the relationship between body image and chronic stress in BED.

Another issue of the present study is that only self-reported body dissatisfaction was assessed. In light of the many facets of body image disturbances (Cash & Deagle, 1997; Svaldi, Caffier, & Tuschen-Caffier, 2011, 2012), research on other BED-relevant components of body image (e.g., body distortion, overvaluation of shape and weight, body avoidance) and stress is warranted. Last but not least, it is of note that our results do not apply to males with BED. It will be interesting to replicate this study with male patients, as empirical data point to gender-specific body image problems as well as stress functioning (Matud, 2004; Miller et al., 2000), and because almost half of those suffering from BED are men (Striegel-Moore & Franko, 2003).

Apart from these limitations, this is the first study to provide empirical support that acute socioevaluative stress negatively affects satisfaction with one's own body in women with BED. More research on stress and body image in BED is needed to continue to

inform theoretical models and to optimize current treatment programs addressing body image problems.

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