



Exploring the mind's eye: Contents and characteristics of mental images in overweight individuals with binge eating behaviour



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A B S T R A C T

Mental images play a role in various mental disorders and are strongly associated with emotions. Negative emotions and their regulation are important in eating disorders. However, research on mental imagery in eating disorders is still scarce. We investigated mental images and their relation to distress and eating disorder psychopathology in individuals with binge eating behaviour. Content and characteristics of mental images and their relation to psychopathology of 21 individuals with binge eating behaviour, 19 mixed patient controls and 21 healthy controls have been assessed with a semi-structured interview. Occurrence and vividness of food-related images did not differ between groups. However they were experienced as more distressing and distracting and more difficult to control by eating disordered patients. Body-related mental images were less associated with desire to eat than expected. Mental images of social rejection were experienced as more vivid by both clinical groups and caused desire to eat in individuals with binge eating behaviour. Mental images are relevant in binge eating behaviour, but with different patterns regarding concomitant distress and eating disorder psychopathology. As transdiagnostic mental images of social rejection are relevant for individuals with binge eating behaviour, research on imagery based techniques in eating disorders seems promising.

1. Introduction

Episodes of binge eating are a key symptom of Binge eating disorder (BED) and Bulimia nervosa (BN). They are characterized by eating a larger amount of food than most people would eat in a similar period of time under similar circumstances, and by feelings of loss of control (American Psychiatric Association, 2013). The transdiagnostic model of eating disorders (Fairburn et al., 2003) and the cognitive model of bulimia nervosa (Cooper et al., 2004) highlight the role of negative automatic thoughts concerning the self as developmental and maintaining factors in binge eating. According to the models, binge eating is assumed to distract from distress and negative emotions that follow negative automatic thoughts concerning the self. These negative automatic thoughts develop, for example, because of negative self-evaluation concerning shape and weight and because of adverse childhood experiences. Negative self-evaluation occurs in BN as well as in BED (e.g. Grilo et al., 2010). Furthermore, these negative thoughts are often not only represented as verbal thoughts but also as mental images (Brewin et al., 2010; Somerville et al., 2007). Mental images are defined as non-verbal thoughts with sensory features (Berna et al., 2011). They can occur spontaneously or deliberately and consist

of retrieved memories or fantasized contents (Hackmann et al., 2011). Mental images are of particular interest in the context of eating disorders, as there is a strong connection between mental imagery and emotions (Holmes and Mathews, 2010). This connection is considered to be even stronger than that of verbal thoughts and emotions. For BED and BN, research on binge eating also highlights the role of negative affect as a precursor of binge eating behaviour as a dysfunctional affect regulation strategy (Fairburn et al., 2003; Hilbert and Tuschen-Caffier, 2007; Stein et al., 2007).

With this in mind, Cooper et al. (2007) as well as Tatham (2011) argued for more research on mental imagery in eating disorders. Tatham (2011) states that “there might be a relationship between content, frequency of negative self-imagery and the degree of pre-occupation, distress and overvaluation of weight and shape” (p. 1104). An interview study revealed mental images of negative life experiences and concomitant feelings of defectiveness, shame, failure and social isolation prior to self-induced vomiting in thirty individuals with bulimia nervosa (BN; Hinrichsen et al., 2007). Furthermore, Somerville et al. (2007) compared spontaneously occurring mental images during eating, shape or weight concerns of individuals with BN in dieting and non-dieting healthy controls. The mental images of

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individuals with BN were significantly more negative and associated with higher anxiety scores. These images were also more vivid and contained more sensory details than the mental images of controls. Vividness of images is considered to be an important characteristic of psychopathology (Hackmann and Holmes, 2004). A positive medium sized relationship between vividness of mental images of food and craving has been found in a sample consisting of dieters and non-dieters (Harvey et al., 2005). This relationship did not exist for the mental image of a positive event. Further studies with non-clinical samples showed similar results (McClelland et al., 2006; Tiggemann and Kemp, 2005). May et al. (2010) concluded that analogue to craving for addictive drugs, craving for food contains mental images of consumption.

Mental imagery has been explored with semi-structured interviews for various mental disorders including agoraphobia (Hirsch and Holmes, 2007), social phobia (Moscovitch et al., 2011), depression and PTSD (Reynolds and Brewin, 1999), body dysmorphic disorder (Osman et al., 2004), OCD (Speckens et al., 2007) and pelvic pain (Berna et al., 2011). Mental imagery seems to be both disorder-specific and related to general psychopathology (Brewin et al., 2010). As an example, contents of avoided situations in agoraphobia (Hirsch and Holmes, 2007) can be considered to be disorder-specific mental images. Mental images of distressing childhood memories (Reynolds and Brewin, 1999) can be considered to be transdiagnostic.

Research on disorder-specific or transdiagnostic mental images in eating disorders is scarce. As concerns about eating, shape, and weight are typical of eating disorders (Fairburn and Beglin, 1994) we assume these to be reflected in disorder-specific mental images. So far this has been supported by a few findings on mental images of food, body and weight. Concerning mental images of food, Harvey et al. (2005) detected an increase in desire to eat (DTE) when dieting participants were asked to imagine food. To our knowledge, there is no research specifically addressing mental images with the content of one's own body. However research on 'verbal' cognitions (in contrast to mental images as non-verbal cognitions) and external cues suggests it may be fruitful to explore body-related mental images. Hilbert and Tuschen-Caffier (2005) found negative body-related cognitions to be more frequent during mirror exposure in individuals with binge eating disorder (BED) and BN than in healthy controls. For BN negative body-related cognitions also had a stronger negative emotional valence. Relevant external cues (body-related film clips) increased DTE in individuals with binge eating (Svaldi et al., 2009). In another study, body related visual imagery was correlated with body dissatisfaction (Darling et al., 2015). However, this study was based on a non-clinical sample and did not explore idiosyncratic contents of imagery. There is no research on mental images of weight, but again only on 'verbal' cognitions of weight issues. Stein et al. (2007) conducted ecological momentary assessments of emotions and binge episodes. Before bingeing, negative mood was associated more strongly with both disorder-specific themes of weight/shape issues and with transdiagnostic themes such as relationship issues than during non-bingeing times.

Some studies hint at the presence of transdiagnostic content of mental images in the context of bingeing. The two studies mentioned above predominantly found images related to core beliefs on social isolation prior to vomiting (Hinrichsen et al., 2007) and to negative childhood experiences while being concerned about eating, shape or weight (Somerville et al., 2007). The role of interpersonal problems in the maintenance of binge eating has been recognized (Fairburn et al., 2003; Tuschen-Caffier and Vögele, 1999) and shown in experimental studies (Hilbert et al., 2011). Villejo et al. (1997) showed that inducing mental images about one's family increased DTE in women with BED. Furthermore, typical core beliefs associated with eating disorders are often transdiagnostic as well. For example, Waller et al. (2000) found core beliefs on defectiveness and failure to play an important role in participants with BN.

In the present study we compared disorder-specific and transdiagnostic mental images in individuals with binge eating behaviour (BE), in patient controls with mixed mental disorders (mainly affective and anxiety disorders; PC) and in healthy controls (HC). It was hypothesized that BE participants would be more likely to experience disorder-specific mental images of food, weight and shape. Secondly, the relationship between specific contents of mental images and DTE was explored in order to find out what kind of mental images might be associated with binge eating episodes. Mental images of food, weight and shape were expected to cause greater DTE in BE than in controls. Thirdly, we investigated the characteristics and concomitant distress of both disorder-specific (food) and transdiagnostic (social rejection) imagery. More vivid and distressing mental images of food in BE and of social rejection in BE and PC were expected. Furthermore we expected that participants with more severe eating pathology would experience higher levels of distress related to negative mental images (both specific and non-specific).

2. Methods

2.1. Participants

We investigated individuals with binge eating behaviour, healthy participants and a mixed patient control group with mood and anxiety disorders. A priori power analysis for tests of difference (ANOVA) revealed the need of a sample size of $n=21$ in each group (large effect size, $\alpha=0.05$ and $1-\beta=0.80$). Twenty-one individuals with binge eating behaviour (BE) and 19 individuals with affective and anxiety disorders for PC were recruited from the inpatient clinic in Germany and from an outpatient health care centre at the University of Freiburg, Germany. Twenty-one healthy controls matched for gender were recruited through personal contacts. Exclusion criteria were psychotic disorders, acute mania, cluster B personality disorders, substance abuse and substantial difficulties in German language skills. Inclusion criteria were age 18–65 and a diagnosis of BED or BN (DSM-5: 307.51) with possible comorbidities for the BE group and accordingly any other mental disorder excluding eating disorders and the exclusion criteria for the PC group.

All participants were diagnosed using the Structured Clinical Interview for DSM-IV (SCID-I & -II), German version (Wittchen et al., 1997). Adaptations were made to assess BED according to current DSM-5 criteria (American Psychiatric Association, 2013). In the BE group 81% were diagnosed with BED and 19% with BN. Additionally, 81% had at least one affective disorder and 71.4% had one or more anxiety disorders as a comorbid diagnosis. Only one person did not have any psychiatric comorbidity. In the PC group, 84.2% had an affective disorder and 57.9% one or more anxiety disorders. BE and PC did not differ significantly on the proportion of affective ($p=0.559$) and anxiety disorders ($p=0.510$). None of the HC group met diagnostic criteria for any diagnosis on the SCID.

Groups did not differ significantly in gender representation (see Table 1). Participants in all three groups were on average overweight. Means of Body Mass Index (BMI) indicate adiposity I in BE and PC and preadiposity in HC. As expected, BE participants scored significantly higher on scales assessing severity of eating pathology as compared to PC and HC, while PC also scored significantly higher on the EDE-Q than HC. BE had on average $Mdn=7$ (range 1–28) objective binge episodes during the past 28 days, while PC and HC had none. Groups did not differ in their habitual use of imagery.

2.2. Procedure

Participants were contacted by phone, at admission or in nutritional counselling groups in the clinic. After giving written informed consent, participants were screened for their general mental health using the SCID I & II by a clinical psychologist and a trained research assistant.

Table 1
Group comparison on demographic and clinical measures.

	BE n=21		PC n=19		HC n=21		Statistics
	M	(SD)	M	(SD)	M	(SD)	
Women	76.2%		73.7%		66.7%		$\chi^2(2)$ =0.507, $p=0.825$
Age in years	43.38 ^a	(13.32)	52.32 ^b	(6.46)	46.38	(11.10)	$H(2)=6.24$, $p < 0.04$
BMI	33.67 ^c	(6.61)	35.14 ^c	(5.27)	28.19 ^d	(6.86)	$F(2,58)$ =6.85, $p < 0.002$
EDE-Q sum score	3.48 ^c	(0.99)	2.39 ^d	(1.32)	0.67 ^e	(0.95)	$F(2,58)$ =34.92, $p < 0.001$
BDI-V	57.38 ^c	(18.80)	40.53 ^d	(18.23)	17.19 ^e	(11.20)	$F(2,58)$ =31.87, $p < 0.001$
SUIS	40.10	(9.29)	40.37	(7.57)	37.24	(12.17)	$F(2,58)$ =0.63, $p=0.54$

BMI=body mass index (kg/m²); EDE-Q=Eating Disorder Examination Questionnaire; STAI Trait=State Anxiety Inventory Trait Version; BDI-V=simplified Becks-Depression-Inventory; SUIS=Spontaneous Use of Imagery Scale; BE=binge eating group; PC=patient control group; HC=healthy control group; $H(df)$ =Kruskal-Wallis-Test.

^{a,b} Different superscripts indicate significant group differences in Mann-Whitney post hoc test.

^{c,d,e} Different superscripts indicate significant group differences in Gabriel post-hoc test.

Questionnaires were handed out and recollected at the second appointment when the imagery interview was conducted. The interviews were audio-recorded. At the end of the interview participants were debriefed and help was offered in case of distress due to the interview. However, no participants experienced distress. To compensate participants for their time, raffles were held for gift certificates. The study design was approved by the ethics committee of the University of Freiburg.

2.3. Self-report measures

Severity of eating pathology was measured with the *Eating Disorder Examination Questionnaire* (EDE-Q; Fairburn and Beglin, 1994; Hilbert et al., 2007). Twenty-two items with reference to the last 28 days are rated from 0 "not at all" to 6 "every day/ very intensively" and 6 single items assessing behavioural features. It consists of a global score (mean scores between 0 and 23) and the four subscales 'restraint', 'eating concern', 'weight concern' (each mean scores between 0 and 6) and 'shape concern' (mean scores between 0 and 8). All scales show high internal consistency and good convergent and discriminant validity (Hilbert et al., 2007). The *Spontaneous Use of Imagery Scale* (SUIS; Reisberg et al., 2003) was used to measure a person's habitual use of imagery in everyday life with 12 items rated from 1 "never

appropriate" to 5 "always completely appropriate" (item example: "When I think about visiting a relative, I almost always have a clear mental picture of him or her"). The Score ranges from 12 to 60. The questionnaire has acceptable reliability and convergent validity (Nelis and Holmes, 2014). A simplified German version of the *Beck Depression Inventory* (BDI-V; original version by Beck et al., 1961; simplified version by Schmitt and Maes, 2000) was used to measure depressive mood. The BDI-V consists of 20 items based on the BDI original version excluding the item on weight loss due to poor discriminatory power. The answering format has been changed from four possible responses in the original version into a six point scale from 0 "never" to 5 "almost always". The score ranges from 0 to 100. Psychometric characteristics are comparable to those of the original BDI (Schmitt et al., 2003).

2.4. Imagery interview

Imagery interviews have often been used in mental imagery research (Hinrichsen et al., 2007; Osman et al., 2004; Pearson et al., 2013; Somerville et al., 2007). For this study, we adapted imagery interview procedures as described in Hackmann et al. (2000) and Holmes et al. (2007). The interview was conducted by the first author and three research assistants. For comparability, research assistants were trained by listening to audiotapes of the imagery interview conducted by the corresponding author. In return, the corresponding author was present during the research assistants' first interviews in order to make sure that questions concerning the definition of mental images were comparably answered. Participants were invited individually. They were introduced to the topic of mental imagery based on the standardized definition in the manuscript and asked about personal examples. We first confirmed that they understood the meaning of mental imagery. Subsequently they were asked twelve standardized questions about the occurrence of mental images prior to binge eating episodes and their frequency. Controls were asked the same questions regarding situations when eating more than they wanted. Answers were rated on a 100 mm visual analogue scale (VAS). The second part of the interview, the main part, consisted of the exploration of different contents of mental images. A mental image of a safe place was explored as a training session. Subsequently participants were asked whether they personally experience mental images with different contents (see Table 2) at any time, not specifically prior to binge eating, and to describe one striking example of each. If they indicated experiencing such an image, further characteristics of this image (content, valence, modality, vividness, distress and further emotions) were explored using VAS. The categories of contents were developed for this study based on studies of eating disorder-related cognitions (Cooper et al., 1997) and contents of stressful situations in general (Hilbert et al., 2011). The list of contents was standardized in an interview manuscript, as well as the ratings for each content. The manuscript in the German language may be obtained from the authors. The interview lasted approximately

Table 2
Occurrence of mental images of specific contents in the binge eating, patient control and healthy control groups.

Content	BE n=21%	PC n=19%	HC n=21%	$\chi^2_{(2)}$	p	Cramer's V
Food	67	32	67	6.528	$p < 0.05$	0.330
Shape	91	74	33	15.992	$p < 0.001$	0.510
Weight	24	16	24	0.502	$p=0.793$	0.091
Home alone	48	37	43	0.474	$p=0.767$	0.088
Achievement	48	32	48	1.376	$p=0.528$	0.150
Failure	33	42	24	1.519	$p=0.493$	0.158
Positive self	57	42	38	1.694	$p=0.524$	0.167
Negative self	71	53	5	20.212	$p < 0.001$	0.576
Positive social interaction	62	90	57	5.583	$p=0.062$	0.303
Social rejection	67	47	43	2.673	$p=0.358$	0.209

BE=binge eating group, PC=patient control group, HC=healthy control group; χ^2_0 =Chi-Square Analysis, Cramer's V=effect size for categorical data.

1.5 h, which is similar to other imagery interviews in preliminary studies (e.g. Berna et al., 2011). DTE was computed as the mean of the questions ‘How strong is your craving for food when experiencing this image?’ and ‘How likely is it that you will be binge eating/ eating more than you want when experiencing this image?’, both answered on a 100 mm VAS anchored from “not at all” to “very much”. Similar items have been used in other studies (e.g. Naumann et al., 2014). A copy of the interview can be obtained from the authors. For all image contents internal consistency was high (Cronbach’s $\alpha=0.85-0.99$).

2.5. Data analyses

Analyses were carried out with the statistical software package IBM SPSS 22 for Windows. Group comparisons were run with chi-square tests for categorical data and covariance analysis with BMI as a covariate for continuous data. Effect sizes of the group differences and interactions are reported by partial eta squared (η_p^2), with values up to 0.01 referring to small, 0.06 to moderate, and 0.14 to large effect sizes (Cohen, 1988). As sample sizes varied for the variables DTE and characteristics Hedges g^* was chosen for effect size for post hoc tests with values up to 0.2 referring to small, 0.5 to moderate, and 0.8 to large effect sizes (Ellis, 2010; Field, 2009). Concerning the dependent variable DTE, some analyses could not be carried out due to the small sample size for some contents of mental images. Further characteristics (vividness, distraction, controllability, concomitant distress) were explored for food as an expected disorder-specific mental image and of contents of social rejection as a transdiagnostic mental image. In order to control for the severity of eating disorder symptomatology within the BE group, associations between EDE-Q means and all dependent variables were tested using Pearson’s correlation.

3. Results

3.1. Occurrence of mental images

Content exploration revealed that mental images involving food, shape, social rejection and negative self occurred in more than two thirds of BE (see Table 2). Mental images of food were also reported by two thirds of HC but by only one third of PC (BE=HC > PC, $p < 0.05$). Conversely, mental images of shape were also reported by more than two thirds of PC but only by one third of HC (BE=PC > HC, $p < 0.05$). According to Cramer’s V there is a medium-sized association between group and mental images of food and a large association between group and mental images of shape. Mental images of weight were rarely reported in any of the three groups. Furthermore, groups differed in the occurrence of mental images of a negative self (BE=PC > HC, $p < 0.001$). These associations have a medium and a large effect size. No group differences were found regarding the occurrence of mental images of being home alone, achievement, failure, social rejection or positive social interaction. Examples of different contents of mental images are: food: “I see myself sitting in the kitchen and eat and eat and eat; and I munch with my cheeks full [participant is demonstrating the munching]. I just gorge myself with everything.”, body: “I see myself as a kind of Michelin Man, do you know that? ...well it’s bulky, ugly, fat. I try to heave myself out of bed, but I can’t get up because I’m too fat.” and of social rejection: “I am being criticized for something; which I can’t help; the whole team is being called to the office of our supervisor and then, “you’ve done this and that”, while he’s saying that the supervisor is looking only at me.”

3.2. Desire to eat

The following contents were rated to be associated with an average DTE above 50 (VAS 0–100 mm) in BE: food, failure, negative self and social rejection. DTE, controlled for BMI, for each content of mental images is depicted in Table 3. Post hoc analysis revealed that BE

experienced significantly more DTE during mental images of food (BE vs. PC/ BE vs. HC: Hedge’s $g^*=1.12/0.94$), of shape (BE vs. PC/ BE vs. HC: Hedge’s $g^*=1.02/1.77$) and of social rejection (BE vs. PC/ BE vs. HC: Hedge’s $g^*=0.95/1.16$) than both control groups. BE had greater DTE than PC but not HC while experiencing mental images of being home alone (Hedge’s $g^*=1.42$) and of a negative self (Hedge’s $g^*=1.61$). BE had greater DTE than HC but not PC while experiencing mental images of achievement (Hedge’s $g^*=1.06$).

The covariate BMI was significant for mental images of food only: $F(1,30)=6.207$, $p < 0.05$, $\eta_p^2=0.171$. For the BE group, large-sized positive associations between DTE and EDE-Q were found for the following contents: shape, weight, home alone, positive self and negative self ($r =0.500-0.954$).

3.3. Characteristics and concomitant distress

Group comparisons with BMI as a covariate are displayed in Table 4. Post hoc analysis revealed that BE experienced significantly more distress during mental images of food than both control groups (BE vs. PC/ BE vs. HC: Hedge’s $g^*=1.62/2.13$). Additionally, BE felt more distracted by mental images food (BE vs. PC/ BE vs. HC: Hedge’s $g^*=1.73/1.45$) and less capable of controlling the occurrence of mental images of food than both control groups (BE vs. PC/ BE vs. HC: Hedge’s $g^*=0.42/1.28$). Concerning mental images of social rejection BE did not differ from PC but from HC concerning vividness (Hedge’s $g^*=1.32$). All three groups experienced relatively little control over the occurrence of mental images of social rejection.

For the BE group, distraction by and controllability of mental images of food were associated with EDE-Q mean score ($r =0.706$, $p < 0.01$ and $r =-0.568$, $p < 0.05$). No other correlation with characteristics of mental images of food or social rejection reached significance. The correlations between frequency of binge eating episodes and distress experienced during mental images of food and that during mental images of social rejection were not significant ($r =-0.418$, $p=0.136$ and $r =-0.083$, $p=0.788$).

4. Discussion

The aim of the present study was to investigate the importance of different mental images, their characteristics and concomitant distress in individuals with binge eating behaviour compared to mixed patients and healthy controls.

As eating, weight and shape concerns are primary symptoms of eating disorders with binge eating behaviour, the first step was to investigate these three contents as disorder-specific mental images, controlled for BMI. Mental images of food were experienced by BE and HC more often than by PC. However, BE experienced more DTE associated with mental images of food than both control groups. This is in line with the results of Harvey et al. (2005). All groups experienced mental images of food equally vividly, but BE felt significantly more distressed by mental images of food than PE and HC. Our findings confirm the assumption of Berry et al. (2010) that BE are more distracted by mental images of food. Consequently, BE were significantly less capable of controlling the occurrence of mental images of food than controls. Summarizing our findings on mental images of food, their importance is reflected not in their occurrence and DTE per se, but in their power to cause distress and to distract individuals with BE.

Mental images of shape were recalled by BE and PC more often than by HC. However, BE experienced significantly more DTE than the control groups when experiencing these images. Mental images with the content of weight were reported by an unexpectedly low percentage of participants with binge eating behaviour. Therefore a primary symptom of eating disorder, namely weight concern, is not commonly represented as a mental image. Group comparisons did not show significant differences in DTE associated with mental images of weight.

Table 3

Means (M), standard errors (SE) and group differences for desire to eat (DTE) of all explored contents of mental images.

Content	BE		PC		HC		ANCOVA	η_p^2
	M	(SE)	M	(SE)	M	(SE)		
Food	68.85 ^a	(7.65)	38.75 ^b	(11.38)	42.00 ^b	(8.10)	$F(2,30)=3.88, p < 0.05$	0.206
Shape	49.49 ^a	(6.59)	19.66 ^b	(8.00)	5.07 ^b	(11.69)	$F(2,37)=10.05, p < 0.001$	0.352
Weight ^c	43.79	(12.08)	18.79	(16.67)	6.573	(15.33)		
Home alone	49.87 ^a	(10.44)	1.71 ^b	(13.70)	31.93	(13.23)	$F(2,22)=4.46, p < 0.05$	0.289
Achievement	22.37 ^a	(5.73)	6.96	(8.15)	1.70 ^b	(6.53)	$F(2,22)=4.03, p < 0.05$	0.268
Failure ^c	65.27	(10.95)	9.67	(10.85)	30.99	(13.58)		
Positive self	11.72	(5.35)	0.15	(6.93)	10.18	(7.27)	$F(2,25)=0.97, p=0.392$	0.072
Negative self	67.47 ^a	(8.69)	13.39 ^b	(10.68)	6.07 ^c	(33.63)	$F(2,22)=8.35, p < 0.01$	0.432
Positive social interaction	11.69	(5.64)	8.06	(5.06)	6.80	(6.86)	$F(2,38)=0.18, p=0.834$	0.010
Social rejection	60.86 ^a	(10.39)	24.28 ^b	(11.25)	16.89 ^b	(10.93)	$F(2,29)=4.78, p < 0.05$	0.248

Means are adjusted for the covariate body mass index (weight/height²); BE=binge eating group; PC=patient control group; HC=healthy control group.^{a,b} different superscripts indicate significant group differences post hoc test.^c analyses could not be carried out due to the small sample sizes.**Table 4**

Means (M), standard errors (SE) and group differences for characteristics and concomitant distress of the mental images related to food and to social rejection.

	BE		PC		HC		ANCOVA	η_p^2
	M	(SE)	M	(SE)	M	(SE)		
Food								
Distress	69.92 ^a	(8.15)	20.91 ^b	(12.13)	3.98 ^b	(8.64)	$F(2,30)=15.29, p < 0.001$	0.505
Distraction	67.28 ^a	(7.69)	17.93 ^b	(11.45)	24.18 ^b	(8.15)	$F(2,30)=10.10, p < 0.001$	0.402
Vividness	72.60	(8.11)	75.95	(12.07)	74.21	(8.59)	$F(2,30)=0.03, p=0.970$	0.002
Controllability	25.50 ^a	(8.01)	67.06 ^b	(11.92)	64.97 ^b	(8.48)	$F(2,30)=7.20, p < 0.01$	0.324
Social rejection								
Distress	95.20	(4.03)	91.37	(5.16)	80.14	(5.57)	$F(2,27)=2.08, p=0.144$	0.134
Distraction	77.42	(8.55)	59.63	(10.96)	43.35	(11.82)	$F(2,27)=2.56, p=0.096$	0.160
Vividness	91.85 ^a	(7.47)	77.45	(9.57)	53.50 ^b	(10.33)	$F(2,27)=3.98, p < 0.05$	0.227
Controllability	28.03	(10.25)	32.03	(13.13)	34.15	(14.16)	$F(2,27)=0.06, p=0.938$	0.005

Means are adjusted for the covariate body mass index (weight/height²); BE = binge eating group; PC=patient control group; HC = healthy control group.^{a,b} different superscripts indicate significant group differences post hoc test with Sidák correction.

Thus our hypothesis that BE would experience mental images of food, shape and weight more frequently than controls was only partly supported. Although eating, shape, and weight concerns represent primary dysfunctional cognitions in eating disorders with binge eating behaviour (Hilbert et al., 2007), their occurrence in the form of mental images does not seem to be specific for BE only. However, mental images of food and shape are worth consideration in the context of binge eating behaviour, as they come along with higher levels of DTE.

With regard to transdiagnostic images we found the following results. Mental images of social rejection were recalled equally in all three groups, but concomitant DTE was significantly higher in BE. Core beliefs regarding social isolation have been found to be related to mental images in BN (Hinrichsen et al., 2007). Furthermore, interpersonal problems are recognized as a precursor of binge eating (Fairburn et al., 2003). Therefore the exploration of social contents of mental images in BE was a further interest of this study. Mental images of positive and negative social interactions occurred frequently in BE. However BE did not report significantly more mental images of social rejection as levels of occurrence were high in all three groups. This indicates that these mental images are transdiagnostic rather than specific for BE. Furthermore, BE experienced mental images of social rejection more vividly than HC. This is in accordance with the findings of Somerville et al. (2007), who found mental images of negative social experiences during childhood to be more vivid and scary in a sample of BN than in controls. It should be noted that PC experienced mental images of social rejection as just as vivid, distracting and distressing as BE. This is in accordance with findings on mental imagery in affective (Weßlau and Steil, 2014) and anxiety disorders (Hirsch and Holmes, 2007). Thus mental images of social rejection are not specific for binge

eating, but still lead to DTE. This idea of transdiagnostic contents of mental images that still lead to disorder-specific symptoms should be explored in future research. Furthermore, the findings on mental images of negative social interaction in BE are in accordance with Tuschen-Caffier and Vögele (1999). They found interpersonal conflicts to be more relevant for individuals with BN than achievement challenges in the elicitation of symptoms.

In the current study, only images preceding binge episodes were explored. As negative affect can be even higher after episodes of binges (Stein et al., 2007), mental images in the course of binge episodes should be explored in future studies. Furthermore, this study examined a heterogeneous group of individuals with binge eating behaviour, and did not compare BN and BES. Differences between the two diagnoses, for example impulsivity, might be reflected in imagery. The study can therefore only be considered to be a starting point for more basic research that should include comparisons between BES and BN. We did not control for neglect of images due to avoidance, as we simply asked for the usual occurrence of mental images. Therefore our results on the occurrences of mental images must be interpreted with caution. A further limitation is the retrospective data collection, and that the accuracy of these recollections could not be determined. This issue could be addressed by using ecological momentary assessment in future studies. However, individuals have a good understanding of their own mental images (Pearson et al., 2011). The power of this study was limited to the detection of large effects, and therefore larger group sizes are necessary in future studies comparing contents of mental images in order to detect small to medium effects. The current study is relevant within the clinical context, and has high external validity given the inclusion of both a patient and a healthy control sample, and both

genders. Often samples are limited to women (e.g. Svaldi et al., 2014). The sample was well diagnosed with the SCID interview.

Our study is the first to investigate different contents of mental images in binge eating behaviour. Replication and investigation of the potential use of mental images in psychotherapy of BED and BN is needed. Knäuper et al. (2011) demonstrated that applying the technique of positive imagery reduced craving. Creating vivid positive mental imagery is a growing interest in transdiagnostic research (Blackwell et al., 2013). Also, mental images of food and body could directly be addressed by cognitive bias modification, as has been done with external cues (Brooks et al., 2011; Smeets et al., 2011) by adding an imagery component (Holmes et al., 2009). More research on addressing mental images of social rejection in psychotherapy is needed. Initial attempts using imagery rescripting (Cooper et al., 2007; Ohanian, 2002) seem promising in eating disordered patients, but research involving larger sample sizes and control groups is lacking.

In conclusion, the present study is the first attempt to investigate mental imagery related to binge eating behaviour in detail. Mental images of food and shape, as well as mental images of social rejection, should be considered in individuals suffering from binge eating because of their concomitant DTE and distress.

Disclosure

No potential conflicts of interest.

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References

- American Psychiatric Association. 2013. Diagnostic and statistical manual of mental disorders 5th ed.. American Psychiatric Association, Washington, DC. <http://dx.doi.org/10.1176/appi.books.9780890425596.744053>.
- Beck, A.T., Ward, C.H., Mendelson, M., Mock, J., Erbaugh, J., 1961. An inventory for measuring depression. *Arch. Gen. Psychiatry* 4, 561–571. <http://dx.doi.org/10.1001/archpsyc.1961.01710120031004>.
- Berna, C., Vincent, K., Moore, J., Tracey, I., Goodwin, G.M., Holmes, E.A., 2011. Presence of mental imagery associated with chronic pelvic pain: a pilot study. *Pain Med.* 12, 1086–1093. <http://dx.doi.org/10.1111/j.1526-4637.2011.01152.x>.
- Berry, L.-M., May, J., Andrade, J., Kavanagh, D., 2010. Emotional and behavioral reaction to intrusive thoughts. *Assessment* 17, 126–137. <http://dx.doi.org/10.1177/1073191109344694>.
- Blackwell, S.E., Rius-Ottenheim, N., Schulte-van Maaren, Y.W.M., Carlier, I.V.E., Middelkoop, V.D., Zitman, F.G., Spinoven, P., Holmes, E. a., Giltay, E.J., 2013. Optimism and mental imagery: a possible cognitive marker to promote well-being? *Psychiatry Res.* 206, 56–61. <http://dx.doi.org/10.1016/j.psychres.2012.09.047>.
- Brewin, C.R., Gregory, J.D., Lipton, M., Burgess, N., 2010. Intrusive images in psychological disorders: characteristics, neural mechanisms, and treatment implications. *Psychol. Rev.* 117, 210–232. <http://dx.doi.org/10.1037/a0018113>.
- Brooks, S., Prince, A., Stahl, D., Campbell, I.C., Treasure, J., 2011. A systematic review and meta-analysis of cognitive bias to food stimuli in people with disordered eating behaviour. *Clin. Psychol. Rev.* 31, 37–51. <http://dx.doi.org/10.1016/j.cpr.2010.09.006>.
- Cohen, J., 1988. *Statistical Power Analysis for the Behavioral Sciences*. Lawrence Erlbaum, Hillsdale, NJ.
- Cooper, M.J., Cohen-Tovée, E., Todd, G., Wells, A., Tovée, M., 1997. The eating disorder belief questionnaire: Preliminary development. *Behav. Res. Ther.* 35, 381–388.
- Cooper, M.J., Todd, G., Turner, H., 2007. The effects of using imagery to modify core emotional beliefs in bulimia nervosa: an experimental pilot study. *J. Cogn. Psychother.* 21, 117–122. <http://dx.doi.org/10.1891/088983907780851577>.
- Cooper, M.J., Wells, A., Todd, G., 2004. A cognitive model of bulimia nervosa. *Br. J. Clin. Psychol.* 43, 1–16. <http://dx.doi.org/10.1348/014466504772812931>.
- Darling, S., Uytman, C., Allen, R.J., Havelka, J., Pearson, D.G., 2015. Body image, visual working memory and visual mental imagery. *PeerJ* 3, e775. <http://dx.doi.org/10.7717/peerj.775>.
- Ellis, P.D., 2010. *The Essential Guide to Effect Sizes: Statistical Power, Meta-analysis, and the Interpretation of Research Results*. Cambridge University Press, Cambridge, New York.
- Fairburn, C.G., Beglin, S.J., 1994. Assessment of eating disorders: interview or self-report questionnaire? *Int. J. Eat. Disord.* 16, 363–370.
- Fairburn, C.G., Cooper, Z., Shafran, R., 2003. Cognitive behaviour therapy for eating disorders: a “transdiagnostic” theory and treatment. *Behav. Res. Ther.* 41, 509–528. [http://dx.doi.org/10.1016/S0005-7967\(02\)00088-8](http://dx.doi.org/10.1016/S0005-7967(02)00088-8).
- Field, A., 2009. *Discovering Statistics using SPSS*. Sage Publications, London, England.
- Grilo, C.M., Masheb, R.M., White, M.A., 2010. Significance of overvaluation of shape/weight in binge-eating disorder: comparative study with overweight and bulimia nervosa. *Obes. (Silver Spring)* 18, 499–504. <http://dx.doi.org/10.1038/oby.2009.280>.
- Hackmann, A., Bennett-Levy, J., Holmes, E.A., 2011. *Oxford guide to imagery in cognitive therapy*. Oxford University Press, New York.
- Hackmann, A., Clark, D.M., McManus, F., 2000. Recurrent images and early memories in social phobia. *Behav. Res. Ther.* 38, 601–610.
- Hackmann, A., Holmes, E.A., 2004. Reflecting on imagery: a clinical perspective and overview of the special issue of memory on mental imagery and memory in psychopathology. *Memory* 12, 389–402. <http://dx.doi.org/10.1080/09658210444000133>.
- Harvey, K., Kemps, E., Tiggemann, M., 2005. The nature of imagery processes underlying food cravings. *Br. J. Health Psychol.* 10, 49–56. <http://dx.doi.org/10.1348/135910704x14249>.
- Hilbert, A., Tuschen-Caffier, B., 2007. Maintenance of binge eating through negative mood: a naturalistic comparison of binge eating disorder and bulimia nervosa. *Int. J. Eat. Disord.* 40, 521–530. <http://dx.doi.org/10.1002/eat>.
- Hilbert, A., Tuschen-Caffier, B., 2005. Body-related cognitions in binge-eating disorder and bulimia nervosa. *J. Soc. Clin. Psychol.* 24, 561–579. <http://dx.doi.org/10.1521/jscp.2005.24.4.561>.
- Hilbert, A., Tuschen-Caffier, B., Karwautz, A., Niederhofer, H., Munsch, S., 2007. Eating Disorder Examination-Questionnaire: Evaluation der deutschsprachigen Übersetzung [Eating Disorder Examination-Questionnaire: psychometric properties of the German version]. *Diagnostica* 53, 144–154. <http://dx.doi.org/10.1026/0012-1924.53.3.144>.
- Hilbert, A., Vögele, C., Tuschen-Caffier, B., Hartmann, A.S., 2011. Psychophysiological responses to idiosyncratic stress in bulimia nervosa and binge eating disorder. *Physiol. Behav.* 104, 770–777. <http://dx.doi.org/10.1016/j.physbeh.2011.07.013>.
- Hinrichsen, H., Morrison, T., Waller, G., Schmidt, U., 2007. Triggers of self-induced vomiting in bulimic disorders: the roles of core beliefs and imagery. *J. Cogn. Psychother.* 21, 261–272. <http://dx.doi.org/10.1891/088983907781494528>.
- Hirsch, C.R., Holmes, E.A., 2007. Mental imagery in anxiety disorders. *Psychiatry* 6, 161–165. <http://dx.doi.org/10.1016/j.mppsy.2007.01.005>.
- Holmes, E.A., Crane, C., Fennell, M.J.V., Williams, J.M.G., 2007. Imagery about suicide in depression—“Flash-forwards”? *J. Behav. Ther. Exp. Psychiatry* 38, 423–434. <http://dx.doi.org/10.1016/j.jbtep.2007.10.004>.
- Holmes, E.A., Lang, T.J., Shah, D.M., 2009. Developing interpretation bias modification as a “cognitive vaccine” for depressed mood: imagining positive events makes you feel better than thinking about them verbally. *J. Abnorm. Psychol.* 118, 76–88. <http://dx.doi.org/10.1037/a0012590>.
- Holmes, E.A., Mathews, A., 2010. Mental imagery in emotion and emotional disorders. *Clin. Psychol. Rev.* 30, 349–362. <http://dx.doi.org/10.1016/j.cpr.2010.01.001>.
- Knäuper, B., Pillay, R., Lacaillie, J., McCollam, A., Kelson, E., 2011. Replacing craving imagery with alternative pleasant imagery reduces craving intensity. *Appetite* 57, 173–178. <http://dx.doi.org/10.1016/j.appet.2011.04.021>.
- May, J., Andrade, J., Batey, H., Berry, L.-M., Kavanagh, D.J., 2010. Less food for thought. Impact of attentional instructions on binge thoughts about snack foods. *Appetite* 55, 279–287. <http://dx.doi.org/10.1016/j.appet.2010.06.014>.
- McClelland, A., Kemps, E., Tiggemann, M., 2006. Reduction of vividness and associated craving in personalized food imagery. *J. Clin. Psychol.* 62, 355–365.
- Moscovitch, D.A., Gavric, D.L., Merrifield, C., Bielak, T., Moscovitch, M., 2011. Retrieval properties of negative vs. positive mental images and autobiographical memories in social anxiety: outcomes with a new measure. *Behav. Res. Ther.* 49, 505–517. <http://dx.doi.org/10.1016/j.brat.2011.05.009>.
- Naumann, E., Tuschen-Caffier, B., Voderholzer, U., Svaldi, J., 2014. On the role of sadness in the psychopathology of anorexia nervosa. *Psychiatry Res.* 215, 711–717. <http://dx.doi.org/10.1016/j.psychres.2013.12.043>.
- Nelis, S., Holmes, E.A., 2014. Mental imagery during daily life: Psychometric evaluation of the spontaneous use of imagery scale (SUIS). *Psychol. Belg.* 54, 19–32. <http://dx.doi.org/10.5334/pb.ag>.
- Ohanian, V., 2002. Imagery rescripting within cognitive behavior therapy for bulimia nervosa: an illustrative case report. *Int. J. Eat. Disord.* 31, 352–357. <http://dx.doi.org/10.1002/eat.10044>.
- Osman, S., Cooper, M.J., Hackmann, A., Veale, D., 2004. Spontaneously occurring images and early memories in people with body dysmorphic disorder. *Memory* 12, 428–436. <http://dx.doi.org/10.1080/09658210444000043>.
- Pearson, D.G., Deepprose, C., Wallace-Hadrill, S.M.A., Burnett, S., Holmes, E.A., 2013. Assessing mental imagery in clinical psychology: a review of imagery measures and a guiding framework. *Clin. Psychol. Rev.* 33, 1–23.
- Pearson, J., Rademaker, R.L., Tong, F., 2011. Evaluating the mind’s eye: the metacognition of visual imagery. *Psychol. Sci.* 22, 1535–1542. <http://dx.doi.org/10.1177/0956797611417134>.
- Reisberg, D., Pearson, D.G., Kosslyn, S.M., 2003. Intuitions and introspections about imagery: the role of imagery experience in shaping an investigator’s theoretical views. *Appl. Cogn. Psychol.* 17, 147–160. <http://dx.doi.org/10.1002/acp.858>.
- Reynolds, M., Brewin, C.R., 1999. Intrusive memories in depression and posttraumatic stress disorder. *Behav. Res. Ther.* 37, 201–215.
- Schmitt, M., Beckmann, M., Dusi, D., Maes, J., Schiller, A., Schonauer, K., 2003. Messgüte des vereinfachten Beck-Depressions-Inventars (BDI-V). *Diagnostica* 49, 147–156. <http://dx.doi.org/10.1026/0012-1924.49.4.147>.
- Schmitt, M., Maes, J., 2000. Vorschlag zur Vereinfachung des Beck-Depressions-

- Inventars (BDI). *Diagnostica* 46, 38–46. <http://dx.doi.org/10.1026//0012-1924.46.1.38>.
- Smeets, E., Jansen, A., Roefs, A., 2011. Bias for the (un)attractive self: on the role of attention in causing body (dis)satisfaction. *Health Psychol.* 30, 360–367. <http://dx.doi.org/10.1037/a0022095>.
- Somerville, K., Cooper, M.J., Hackmann, A., 2007. Spontaneous imagery in women with bulimia nervosa: an investigation into content, characteristics and links to childhood memories. *J. Behav. Ther. Exp. Psychiatry* 38, 435–446. <http://dx.doi.org/10.1016/j.jbtep.2007.09.003>.
- Speckens, A.E.M., Hackmann, A., Ehlers, A., Cuthbert, B., 2007. Imagery special issue: intrusive images and memories of earlier adverse events in patients with obsessive compulsive disorder. *J. Behav. Ther. Exp. Psychiatry* 38, 411–422. <http://dx.doi.org/10.1016/j.jbtep.2007.09.004>.
- Stein, R.I., Kenardy, J., Wiseman, C.V., Dounchis, J.Z., Arnow, B.A., Wilfley, D.E., 2007. What's driving the binge in binge eating disorder? A prospective examination of precursors and consequences. *Int. J. Eat. Disord.* 40, 195–203. <http://dx.doi.org/10.1002/eat>.
- Svaldi, J., Caffier, D., Blechert, J., Tuschen-Caffier, B., 2009. Body-related film clip triggers desire to binge in women with binge eating disorder. *Behav. Res. Ther.* 47, 790–796. <http://dx.doi.org/10.1016/j.brat.2009.06.005>.
- Svaldi, J., Tuschen-Caffier, B., Trentowska, M., Caffier, D., Naumann, E., 2014. Differential caloric intake in overweight females with and without binge eating: effects of a laboratory-based emotion-regulation training. *Behav. Res. Ther.* 56, 39–46. <http://dx.doi.org/10.1016/j.brat.2014.02.008>.
- Tatham, M., 2011. The role of imagery-based techniques in cognitive-behavioural therapy for adults with eating disorders. *Clin. Psychol. Rev.* 31, 1101–1109. <http://dx.doi.org/10.1016/j.cpr.2011.06.008>.
- Tiggemann, M., Kemps, E., 2005. The phenomenology of food cravings: the role of mental imagery. *Appetite* 45, 305–313. <http://dx.doi.org/10.1016/j.appet.2005.06.004>.
- Tuschen-Caffier, B., Vögele, C., 1999. Psychological and physiological reactivity to stress: an experimental study on bulimic patients, restrained eaters and controls. *Psychother. Psychosom.* 68, 333–340, (doi:12352).
- Villejo, R.E., Humphrey, L.L., Kirschenbaum, D.S., 1997. Affect and self-regulation in binge eaters: effects of activating family images. *Int. J. Eat. Disord.* 21, 237–249.
- Waller, G., Ohanian, V., Meyer, C., Osman, S., 2000. Cognitive content among bulimic women: the role of core beliefs. *Int. J. Eat. Disord.* 28, 235–241.
- Weßlau, C., Steil, R., 2014. Visual mental imagery in psychopathology – Implications for the maintenance and treatment of depression. *Clin. Psychol. Rev.* 34, 273–281. <http://dx.doi.org/10.1016/j.cpr.2014.03.001>.
- Wittchen, H.-U., Fydrich, T., Zaudig, M., 1997. *Strukturiertes Klinisches Interview Für Dsm-iv: Skid; Eine Deutschsprachige, Erweiterte Bearbeitung Der Amerikanischen Originalversion Des. SCID*, Hogrefe, Göttingen.