Biological Psychology 108 (2015) 105–114

Contents lists available at ScienceDirect

Biological Psychology

journal homepage: www.elsevier.com/locate/biopsycho

Electrophysiological evidence for an attentional bias in processing body stimuli in bulimia nervosa

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ARTICLE INFO

Article history:
Received 13 October 2014
Accepted 17 March 2015
Available online 23 March 2015

Keywords:
Bulimia nervosa
Body image
Body stimuli
ERP
P2
Slow positive wave

ABSTRACT

Empirical evidence suggests abnormalities in the processing of body stimuli in bulimia nervosa (BN). This study investigated central markers of processing body stimuli by means of event-related potentials in BN. EEG was recorded from 20 women with BN and 20 matched healthy controls while watching and evaluating underweight, normal and overweight female body pictures. Bulimics evaluated underweight bodies as less unpleasant and overweight bodies as bigger and more arousing. A higher P2 to overweight stimuli occurred in BN only. In contrast to controls, no N2 increase to underweight bodies was observed in BN. P3 was modulated by stimulus category only in healthy controls; late slow waves to underweight bodies were more pronounced in both groups. P2 amplitudes to overweight stimuli were correlated with drive for thinness and body dissatisfaction. We present novel support for altered perceptual and cognitive-affective processing of body images in BN on the subjective and electrophysiological level.

1. Introduction

Human bodies provide important social cues, which contribute to the identification of other people, their age and gender as well as their intentions and affective states (Minnebusch & Daum, 2009). Abnormalities in perception and evaluation of body shape are a hallmark of eating disorders (ED) (Birtchnell, Lacey, & Harte, 1985; Lindholm & Wilson, 1988; Miyake et al., 2010; Stice & Shaw, 2002; Uher et al., 2005; Williamson, Davis, Goreczny, & Blouin, 1989), most notably Anorexia Nervosa (AN) and Bulimia **Nervosa** (BN). Bruch (1962) is acknowledged as being the first to describe dysfunctional body image experiences as a main feature of eating disorders. The current diagnostic criteria for AN and BN outlined in DSM-V (American Psychiatric Association, 2013) demand the "undue influence of body weight or shape on self-evaluation" as well as a "disturbance in the way in which one's body weight or shape is experienced" (American Psychiatric Association, 2013). Previous research has demonstrated that body image disturbances are one factor preceding the onset of ED (Jacobi, Hayward, de Zwaan, Kraemer, & Agras, 2004), and, in addition, predict the maintenance (Stice, 2002) and relapse process of ED (Keel et al., 2002). Usually, disturbances of body image can be separated into a perceptual component and a cognitive-affective component (Cash & Brown, 1987; Cash & Deagle, 1997; Slade & Brodie, 1994).

The perceptual disturbance reflects problems to assess one's own body size exactly (body size distortion) (Cash & Brown, 1987; Cash & Deagle, 1997; Slade & Brodie, 1994). Previous research has demonstrated that women with AN and BN seem to overestimate their own body dimensions to a comparable degree, whereas healthy women show a tendency to underestimate them (Cash & Deagle, 1997; Mohr et al., 2011; Vocks, Legenbauer, Rüddel, & Troje, 2007). The cognitive-affective component of body image disturbance comprises negative body-related attitudes and emotions

Abbreviations: AN, anorexia nervosa; BMI, body mass index; BN, bulimia nervosa; DSM-V, Diagnostic and Statistical Manual of Mental Disorders; ED, eating disorder; ERPs, event-related potentials; fMRI, functional magnetic resonance imaging; PET, positron emission tomography.

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http://dx.doi.org/10.1016/j.biopsycho.2015.03.013
0301-0511/

(body dissatisfaction) (Cash & Brown, 1987; Cash & Deagle, 1997; Slade & Brodie, 1994). Eating-disordered individuals are highly dissatisfied with their size, shape and body appearance (Cash & Deagle, 1997). A negative evaluation of one's own body is often associated with body-related avoidance (e.g., not looking in the mirror or hiding one's body under baggy clothes) (Trautmann, Worthy, & Lokken, 2007). Body weight/shape dissatisfaction is the highest in bulimics compared with AN and controls, whereas perceptual distortion parameters do not differentiate between AN and BN and yielded significantly smaller effects than attitudinal indices comparing ED with controls (Cash & Deagle, 1997). Findings on AN imply that body image disturbance is a result of cognitive-evaluative dissatisfaction rather than of perceptual deficits (Skrzypek, Wehmeier, & Remschmidt, 2001).

Cognitive biases are assumed to play a fundamental role in the formation and maintenance of eating disorders (Lee & Shafran, 2004; Williamson, Muller, Reas, & Thaw, 1999; Williamson, White, York-Crowe, & Stewart, 2004). According to cognitive-behavioral theory, dysfunctional schemata in individuals with an ED lead to a biased processing of disorder-relevant information (e.g. body-related stimuli), being expressed in the form of an attention, memory or interpretation bias (Williamson et al., 1999, 2004). An attention bias refers to the fact that individuals with an ED selectively attend to weight/shape-related stimuli (Williamson et al., 1999, 2004). Studies using the dot-probe paradigm (Blechert, Ansorge, & Tuschen-Caffier, 2010; Rieger et al., 1998; Shafran, Lee, Cooper, Palmer, & Fairburn, 2007; Shafran, Lee, Cooper, Palmer, & Fairburn, 2008), the visual search task (Smeets, Roefs, van Furth, & Jansen, 2008) and the emotional stroop task (Dobson & Dozois, 2004; Lee & Shafran, 2004) assessed an attentional bias for shape and weight stimuli in individuals with an ED. Eye-tracking studies indicate avoidance behaviors as well as increased direction of attention to unliked body regions and a difficulty in removing attention from body stimuli in general among females with high levels of drive for thinness and body dissatisfaction (Gao et al., 2013; Janelle, Hausenblas, Ellis, Coombes, & Duley, 2009; Janelle, Hausenblas, Fallon, & Gardner, 2003). In a social comparison setting with self- and other-photos, patients with BN and women high in body dissatisfaction turned their attention away from their own bodies (Blechert et al., 2010; Janelle et al., 2009) and toward bodies with lower BMIs compared to bodies with higher BMIs (Blechert, Nickert, Caffier, & Tuschen-Caffier, 2009).

Findings from brain imaging also indicate processing abnormalities for body shape stimuli in patients with an ED. The main finding was the activation of a specific neural network in response to own and others body shapes in ED (Friederich et al., 2010; Uher et al., 2005), including the lateral fusiform gyrus, the inferior parietal cortex and the lateral prefrontal cortex, with regional hypoactivations within this network in women with an ED (Uher et al., 2005). In an imaging study of Fladung et al. (2010), ventral striatal activation was higher during processing of underweight stimuli compared with normal-weight stimuli in AN, while the reverse pattern was observed in healthy women. The authors interpreted their results as support for theories of starvation dependence in maintenance of AN stressing the pivotal role of the human reward system in AN. One recent fMRI study by Mohr et al. (2011) in BN showed that the patients were less sensitive to body size distortions as reflected by the absence of neural modulation when watching distorted body images. Moreover, bulimics overestimated their own body size, suggesting a deficit in body size perception (Mohr et al., 2011).

Abnormalities in the processing of body stimuli in ED have also been assessed by self-reported emotions and ratings of body shape and weight. Women with BN and AN rated underweight, normal weight and overweight female body stimuli as more aversive than controls; with higher levels of self-reported aversion to overweight compared with underweight and normal bodies (Uher et al., 2005). Being confronted with self-images, bulimics reported higher levels of insecurity and sadness (Tuschen-Caffier, Vögele, Bracht, & Hilbert, 2003); in a social comparison task with a slim body ideal patients with BN reported increased levels of anxiety (Van den Eynde et al., 2013). Studies which investigated ratings of body weight or shape in BN illustrate that the patients do not only overestimate their own body size (Blechert et al., 2009, 2010; Mohr et al., 2011), but also rated bodies with a comparable BMI to their own and bodies of others with higher BMIs larger as compared with AN and controls (Blechert et al., 2009, 2010). Bodies of others with lower BMIs, on the contrary, achieved similar ratings by bulimics and controls (Blechert et al., 2009).

While imaging approaches (e.g., fMRI, PET) allow for identifying brain areas involved in processing of body stimuli with high spatial accuracy, they lack the fine temporal resolution to investigate the time course of brain dynamics accompanying body-selective processing. Event-related potentials (ERPs) on the contrary allow for recording of neuronal activity underlying attentional processing of stimuli with high temporal resolution. The early deflections in the ERPs of body perception are characterized by a P1 and a prominent N1, better known as the 'N170′ in the case of face processing, a negative deflection at occipitotemporal electrodes peaking between 140 and 220 ms post-stimulus onset. The N170 is thought to reflect a late stage in the structural encoding of the visual stimulus (de Gelder et al., 2010). Underlying neural generators for body perception in the N170 time window were found in the right lateral occipitotemporal cortex, a location corresponding to the extrastriate body area (de Gelder et al., 2010). In an ERP study, Gao et al. (2011) registered higher amplitudes of the N170 toward fatness-related words compared with thinness-related words in body weight dissatisfied women and interpreted their findings in terms of an early negativity bias.

The P2, which is described as a positive deflection (Carretié, Mercado, Tapia, & Hinojosa, 2001; Huang & Luo, 2006) with an onset between 180 and 200 ms after stimulus presentation (Carretié, Hinojosa, Martín-Loeches, Mercado, & Tapia, 2004; Carretié et al., 2001) is attributed to reflect automatic attention processes (Carretié et al., 2004) and is associated with an early attentional negativity bias in emotional perception (Carretié et al., 2001; Delplanque, Lavoie, Hot, Silvert, & Sequeira, 2004; Huang & Luo, 2006). Several studies showed higher amplitudes of the P2 for unpleasant relative to pleasant stimuli at frontal, central and parieto-occipital sites (Carretié et al., 2001; Delplanque et al., 2004; Huang & Luo, 2006). Suggested neural generators of the P2 are the sensory cortex and the anterior cingulate cortex (ACC) (Carretié et al., 2004). One of the first ERP studies with fatness- and thinness-related stimuli assessed higher P2 amplitudes for body words than for neutral words for both weight dissatisfied women and controls (Gao et al., 2011).

Subsequent phases of stimulus processing are reflected in the N2 and P3. The N2 is a negative deflection with a peak at 240 ms which is assumed to represent a final stage of automatic attention-related processing (Carretié et al., 2004) and deviation from implicit expectations (Gramann, Toellner, Krummenacher, Eimer, & Muller, 2007). Together with the P3a, the N2 is suggested to be part of an orienting complex, being involved in the detection of novel stimuli (Campanella et al., 2002). The P3, a later component in stimulus processing is described as a positive deflection in the time window from 250 to 500 ms after stimulus onset (Picton, 1992; Polich, 2007). The P3 is associated with attention and working memory (Linden, 2005; Polich, 2007), and it is assumed to reflect an attention-driven comparison process to evaluate the representation of stimuli in working memory (Polich, 2007). The P3 component is regarded to mirror the cognitive evaluation of the meaning of a stimulus, which involves a deliberative, conscious and