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Neural correlates of body dissatisfaction in anorexia nervosa

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ABSTRACT

Body dissatisfaction is an important precipitating and maintenance factor in anorexia nervosa (AN) and behavioral studies suggest that a cognitive–affective component and a perceptual component (perceptual disturbance of one's own body) are both important in this pathophysiology. However, the functional neuroanatomy of body dissatisfaction in AN is largely unknown. This study has investigated self-other body-shape comparison to establish neural correlates of body dissatisfaction in patients with AN. 17 women with AN and 18 age and sex-matched healthy control (HC) subjects were scanned using functional magnetic resonance imaging while comparing themselves with images of slim idealized female bodies (active condition) or viewing images of interior home designs (control condition). Participants were asked to compare their body shape or room design with those presented.

Patients with AN (in comparison to the HC group) showed greater anxiety to the self-other body-shape comparison, and they were less satisfied with their current body shape. In the patient group (in comparison to the HC group) the self-other body-shape comparison induced more activation of the right sensorimotor brain regions (insula, premotor cortex) and less activation of the rostral anterior cingulate cortex (ACC). Insula hyperactivation along with ACC hypoactivation may be critical for altered interoceptive awareness to body self-comparison and/or for altered implicit motivation to thin-idealized body images in AN patients.

1. Introduction

Body dissatisfaction is important in the development, maintenance and relapse of eating disorders (ED) including anorexia nervosa (AN) (Jacobi, Hayward, de Zwaan, Kraemer, & Agras, 2004; Stice & Shaw, 2002; Taylor et al., 2006; Windauer, Lennerts, Talbot, Touyz, & Beumont, 1993). Furthermore, "undue influence of weight and shape on self evaluation" is a diagnostic feature of AN (American Psychiatric Association, 1994). The body dissatisfaction present in people with AN is associated with a perceptual disturbance, an overestimation of body size (Cash & Deagle, 1997).

Exposure to media images of female bodies and self-other comparison of body-shape elicits dissatisfaction with one's own body and emotional distress (i.e. anxiety) (Groesz, Levine, & Murnen, 2002). AN patients (despite their low body weight) report higher levels of anxiety when confronted with slim fashion models (Friederich et al., 2006) or line drawings of slim bodies (Uher et al., 2005).

One mechanism that may contribute to heightened body dissatisfaction in people with AN is an overestimation of their body size (Cash & Deagle, 1997). As this problem is restricted to the estimation of their own body, there is an apparent inaccuracy in self-body representation and awareness and this is supported by recent data showing that they have an impaired perception of physiological feedback from their own body (Papezova, Yamamotova, & Uher, 2005; Pollatos et al., 2008; Wagner et al., 2008).

Functional neuroimaging studies have identified a neural network responsible for processing body-shape related information, comprised of the lateral occipitotemporal gyrus (including the extrastriate body area (EBA) and the fusiform body area (FBA)), the dorsolateral prefrontal cortex (PFC) and the parietal lobe, particularly within the right hemisphere (Friederich et al., 2007; Uher et al., 2005; Wagner, Ruf, Braus, & Schmidt, 2003). Within this network, the occipito-parietal pathway is primarily involved in the detection of body related information and the parieto-frontal pathway represents body identification and self-other discrimination (Hodzic, Kaas, Muckli, Stirn, & Singer, 2009; Hodzic, Muckli, Singer & Stirn, 2009).

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Brain activations within the limbic network have been found in healthy controls exposed to distorted self-images (Kurosaki, Shirao, Yamashita, Okamoto, & Yamawaki, 2006; Miyake et al., 2010; Wagner et al., 2003), to self-other comparison of body shape (Friederich et al., 2007) and by using derogatory body-shape-related words (Shirao, Okamoto, Okada, Okamoto, & Yamawaki, 2003). These studies suggest an engagement of the limbic network including the prefrontal cortex, striatum and temporomesial structures including the amygdala that becomes activated in these conditions.

Functional imaging studies in healthy individuals have identified the sensorimotor cortex including the mid-dorsal insula, the anterior insula and the anterior cingulate cortex as neural correlates for the representation of physiological feedback from the body and all subjective feelings from the body (Craig, 2003; Pollatos, Gramann, & Schandry, 2007).

In patients with AN, several neuroimaging studies have investigated body image disturbance in response to body-shape images using whole brain analyses. In these, group differences with healthy controls were found primarily in the body-shape processing network (Beato-Fernandez et al., 2009; Uher et al., 2005; Wagner et al., 2003). Additionally, during visual self-recognition (processing of self-images compared to non-self-images) and during exposure to distorted thin self-images, patients with AN showed altered insula activation (Mohr et al., in press; Sachdev, Mondraty, Wen, & Gulliford, 2008).

One study specifically assessed brain activation in the ventral striatal system and reported greater ventral striatal activity to underweight compared to normal weight body images in AN patients, whereas healthy controls showed a reversed pattern (Fladung et al., 2010). The authors suggest that increased metabolism in the reward system to underweight body images (i.e. starvation associated cues) support theories of starvation dependence in AN patients. However, it remains unclear whether body dissatisfaction in AN is associated with alterations in the ventral limbic network and/or in self-body representation and interoception.

In the present study, we have enhanced the stimuli and the presentation protocol, on the basis of our previous experience with a body image paradigm (Uher et al., 2005) and induced self-schematic processing by giving instructions that encouraged participants to evaluate their own physical appearance in comparison to thin ideals. In contrast to paradigms of self-body recognition and self-body identification from externally presented self-images, the aim of the present paradigm was to induce interoceptive and emotional–motivational processing triggered by a self-other body-shape comparison. Using this paradigm we previously found that in healthy women, activations of the limbic system were associated with anxiety (Friederich et al., 2007).

As patients with AN show higher anxiety in response to media images (Friederich et al., 2007), we hypothesized that (i) body-shape comparison is associated with greater activation of the ventral limbic system (i.e. ventral striatum, mesial temporal regions including the amygdala, rostral anterior cingulate cortex (ACC), ventral PFC) (Phillips, Drevets, Rauch, & Lane, 2003). Given the apparent inaccuracy in the estimation of one's own body size, we also hypothesized that (ii) areas involved in the processing of interoceptive awareness and self-body representation such as the insular cortex, sensorimotor cortical regions and the ACC would be differentially engaged in the patient compared to the control group (Craig, 2003; Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004).

2. Methods

2.1. Participants

Thirty-five right handed women aged between 18 and 35 years were enrolled in the study, 17 patients with a DSM diagnosis of AN and 18 age-matched healthy females in the normal weight range and without a lifetime diagnosis of a psychiatric disease. The patients with AN were recruited from the South London and Maudsley NHS Trust. This is a newly recruited group of patients and there is no overlap with groups of patients reported previously (Uher et al., 2005). The HC group was recruited by advertisements among college students and findings from this group have been published (Friederich et al., 2007).

Diagnoses were made using the Structured Clinical Interview for DSM-IV (SCID; First, Spitzer, Williams, & Gibbon, 1995). General exclusion criteria were a history of head injury, hearing or visual impairments, neurological disease, metallic implants, claustrophobia and psychotropic medication other than selective serotonin reuptake inhibitors (SSRI) in patients. All participants gave their written informed consent prior to inclusion in the study, as approved by the South London and Maudsley NHS Trust Ethics Committee.

2.2. Stimuli

Body-shape images of slim fashion models and interior design images were provided by a women's magazine (see Acknowledgements). Selection and evaluation of the 72 images in each category have been described (Friederich et al., 2007). The body-shape images show either body parts or the whole body of female fashion models that wear tight fitting clothes or swimwear that emphasize their slim figure (head and face were not visible). Control images were creative interior designs and furniture (inanimate objects only, i.e. rooms containing designer cupboards, drawers, curtains and lights). Examples are shown in Fig. 2. As an emotional control condition to the body images, aversive images were selected from the International Affective Picture System (IAPS) and contrasted with neutral images of the same system (Lang, Bradley, & Cuthbert, 1999).

2.3. Procedure

Participants were asked to avoid eating and drinking caffeine-containing beverages for 2 h and alcohol for 24 h preceding the experiment. Before entering the study, participants were interviewed (SCID) to screen for psychiatric diseases (First et al., 1995) and completed a package of self-report questionnaires. The Eating Disorder Examination Questionnaire (EDE-Q) is an established measure that assesses behavioral and attitudinal eating pathology (Fairburn & Beglin, 1994). The Hospital Anxiety and Depression Scale (HADS) is a valid self-report instrument measuring the level of depression and anxiety (Zigmond & Snaith, 1983).

The functional neuroimaging experiments took place between 3.00 and 4.30 p.m. Images were presented on a rear-projection screen and viewed through a double-mirror periscope fitted to the headcoil. Twelve body images (active condition) were followed by twelve interior design images (control condition). This sequence was repeated six times, and the images were presented for 3 s without a gap. Each block was preceded by audio instructions to compare their own body-shape/own home with the one in the images. At the end of each block, participants verbally rated their level of anxiety on a scale from 0 (no anxiety) to 10 (high anxiety). An identical procedure was followed with aversive (active condition) and neutral (control condition) IAPS images. For the affective images (IAPS), the instructions were to imagine touching or standing next to the objects (aversive images)/or to imagine or look at the scenes (neutral images). Presentation order of the body task and the affective task was counterbalanced across participants.

Besides anxiety to body images, body dissatisfaction was also assessed offline with the 9-item Body Area Satisfaction Subscale (BASS) of the Multidimensional Body-Self Relations Questionnaire (MBSRQ) (Brown, Cash, & Mikulka, 1990). This questionnaire uses a 5-point dissatisfaction-satisfaction rating scale that assesses eight distinct body areas and attributes (e.g., waist, hips, thighs), as well as overall appearance.

2.4. Image acquisition

Functional MRI (fMRI) of the brain was performed with a GE Signa 1.5-T scanner (GE Medical Systems, Milwaukee, Wisconsin). T2*-weighted images depicting Blood Oxygen Level Dependent (BOLD) contrasts were acquired every 4 s (repetition time) with an isometric 3.3 mm × 3.3 mm resolution. The echo time was 4 ms and the flip angle was 90°. Whole brain coverage was acquired with 43 slices (slice thickness 3 mm, interslice gap 0.3 mm). Fifty-four T2*-weighted whole brain volumes were acquired in each condition.

2.5. Data analysis

Data were analyzed with the XBAM (version 4) software developed at the Institute of Psychiatry, using a non-parametric approach (Brammer et al., 1997; Bullmore et al., 1999). The choice of non-parametric analysis is reinforced by a report of widespread departures from normality in group fMRI data (Thirion et al., 2007). After motion correction, the estimated BOLD effect was modeled by two Poisson functions with haemodynamic delays of 4 and 8 s. All subjects were within acceptable limits for head movement (below 3.0 mm). *T*-tests showed no significant group differences in the extent of three-dimensional motion in *x*, *y*, and *z* translation and rotation for any of the two tasks.