



Effects of body image therapy on the activation of the extrastriate body area in anorexia nervosa: An fMRI study

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ABSTRACT

To test effects of body image therapy in anorexia nervosa, functional magnetic resonance imaging was used to assess neuronal responses to viewing photographs of one's own body before and after treatment. Activation decreases emerged in a distributed network and increases were observed in the extrastriate body area, possibly reflecting more intense body image processing.

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1. Introduction

Anorexia nervosa is a serious mental disorder that results in approximately 10% of cases in death (Hoek, 2006). In general, treatment for anorexia nervosa is only moderately successful (Fairburn, 2005), indicating that an advancement of treatments for anorexia nervosa is of central relevance. Beyond self-starvation to cachexia, anorexia nervosa is characterized by body image disturbance including a misperception of one's own body size and an extreme dissatisfaction with one's own body (Cash and Deagle, 1997). Although several attempts have been made in the past to explain body size overestimation through dysfunctional information processing, e.g., in cognitive behavioral theories (Williamson et al., 2004), as well as through the syndrome of neglect and possible dysfunctions of the parietal, frontal and cingulate cortex (Kaye, 2008), the phenomenon of body size overestimation in anorexia nervosa is not yet fully understood.

Results of a recent functional magnetic resonance imaging (fMRI) study (Uher et al., 2005) provide first evidence that body image disturbance in anorexia nervosa might be associated with dysfunctional body-image-processing brain circuits. In patients with anorexia nervosa compared with controls, a lower activation was found in the extrastriate body area, a brain region that is located in the occipito-temporal visual cortex and is specialized in the visual perception of human bodies (Downing et al., 2001; Peelen and Downing, 2007). This

relative underactivation was suggested to underlie the body image disturbance, including body size overestimation and negative evaluation of one's own body. Beato-Fernandez et al. (2009) also reported functional abnormalities in temporal and occipital areas among females with eating disorders, but they found a hyperactivity to viewing a film of one's own body in bulimia nervosa. This result was discussed by the authors in the context of specifics in brain areas responsible for the processing of body stimuli, i.e. the extrastriate body area, in eating disorders. In patients with anorexia nervosa, however, Beato-Fernandez et al. (2009) observed an enhanced activation to viewing one's own body in left parietal and right superior frontal areas. This finding was set in the context of the probable role of the left parietal lobe in body image distortion in anorexia nervosa. Additionally, Uher et al. (2005) found that the inferior parietal lobule, which belongs to the attentional network and is involved in visuo-spatial processing (Clower et al., 2001), seems to be implicated in disturbed body image processing in eating disorders. Therefore, a hyperactivation in this brain area in anorexia nervosa as described by Wagner et al. (2003) might reflect the extreme preoccupation with body weight in this disorder. Furthermore, in previous research, it was found that patients with anorexia nervosa show a hyperactivation of the amygdala when viewing their own body (Seeger et al., 2002; but see also Wagner et al., 2003). This result might be regarded in the context of previous research demonstrating a stronger negative emotional reaction in females with eating disorders to looking at their own body compared with non-eating-disordered controls (Tuschen-Caffier et al., 2003; Vocks et al., 2007).

Due to the central role of body image disturbances in the onset and maintenance of eating disorders (Stice, 2002), direct interventions

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aiming at an improvement of body image have been applied as one component in the treatment of eating disorders (Vocks et al., 2008). Although it has been demonstrated that cognitive behavioral body image therapy can reduce body image problems in anorexia nervosa in terms of a reduction of body size overestimation and body dissatisfaction (Key et al., 2002; Rushford and Ostermeyer, 1997), no study has yet analyzed whether the dysfunctional body-image-processing brain circuits that seem to be associated with body image distortion, preoccupation with body weight and negative body-related emotions are modifiable by cognitive-behavioral interventions. Therefore, the aim of the present pilot study was to find out whether neuronal correlates of processing photographs of one's own body show changes before and after body image therapy including frequent body exposure sessions. Based on the findings of the studies described above, the primary hypothesis of the present study was that after treatment, patients with anorexia nervosa might display an enhanced activation of the extrastriate body area and a reduced activity in the inferior parietal lobule and the amygdala, going along with a decrease in negative body-related emotions and cognitions compared with before the intervention.

2. Methods

2.1. Participants

Participants were recruited via the waiting list of the outpatient therapy center of the Ruhr-University of Bochum. The sample was composed of five right-handed females with anorexia nervosa. Each of the participants reported binge eating episodes, but only one of them showed purging behavior in the form of self-induced vomiting and laxative abuse. The mean age was 26.40 years (S.D. = 6.66, range: 18–35 years) and the mean body mass index was 16.01 kg/m² (S.D. = 0.93, range: 14.53–17.04 kg/m²). The average duration of illness was 2.20 years (S.D. = 0.84, range: 1.00–3.00 years). Two participants were taking oral contraceptives and none of the participants were on any other medication. After the diagnosis of anorexia nervosa was confirmed using the *Structured Clinical Interview for Psychiatric Disorders* according to the DSM-IV-TR (First et al., 1996), the procedure was explained and written consent was obtained from each participant. The study protocol was approved by the ethics committee of the Ruhr-University.

2.2. Procedure

Photographs of each participant were taken under strictly constant conditions from 16 fixed perspectives from the neck down while participants were wearing a standardized pink bikini (identical style from the same manufacturer), which was available in various sizes, ensuring that the proportion of skin visible was approximately uniform across participants. Afterwards, imaging of the brain was performed. Following the first scanning session, body image therapy was carried out in a group format by two clinical psychologists. The intervention was manualized (Vocks and Legenbauer, 2005). It lasted for a 3-month period and consisted of ten 90-min sessions with fixed contents. The main treatment components were various body exposure exercises aiming at a correction of body size overestimation, a reduction of body-related avoidance, and overcoming negative body-related emotions as well as cognitive techniques in order to modify negative body-related thoughts. The efficacy of this treatment program has been demonstrated in previous research (Vocks et al., 2008). On a separate day after the final therapy session, photographs of the participants were taken again under exactly the same conditions as before treatment, and the second scanning session was conducted using the same protocol as for the first session. Following each of the two scanning sessions, participants were presented with the photographs again on a computer screen. They were instructed to

indicate the degree of positive and negative emotions experienced when looking at the pictures using the *Positive and Negative Affect Schedule* (Krohne et al., 1996; Watson et al., 1988) as well as the degree of negative body-related cognitions that came to mind whilst regarding the pictures using the *Thoughts Checklist* (Cooper and Fairburn, 1992; Vocks et al., 2007).

2.3. Data acquisition

The set of the 16 photographs of one's own body was presented three times using a blocked design. Each of the 16 images within one block was presented for 3 s. The order of the images within one block was fixed across subjects. Before and between each of the blocks containing the 16 images, a fixation cross (baseline condition) was presented for 48 s. Participants were instructed not to close their eyes, and to look at the photographs presented with no additional behavioral task. Images were acquired on a 1.5 T Symphony scanner (Siemens, Erlangen, Germany). A total of 440 T2*-weighted whole brain volumes were acquired in each condition. Each volume consisted of 25 slices of 3 mm with an interslice gap of 1 mm. The repetition time was 80 ms with a flip angle of 90°. In order to facilitate localization and coregistration of the functional data, additional T1-weighted high-resolution images were acquired.

2.4. Data analysis

Data analysis was conducted using SPM5 (<http://www.fil.ion.ucl.ac.uk/spm/software/spm5/>) starting with slice time and motion correction. Each scan was realigned to the first scan of the session. Images were normalized to the standard brain of the Montreal Neurological Institute provided by SPM5. Afterwards, images were smoothed using a Gaussian kernel of 8 mm. A GLM was applied to these data using a boxcar function. The contrast was determined between viewing the photograph of one's own body and the fixation cross as implicit baseline. This contrast was fed into a second-level analysis using a paired *t*-test. Results were thresholded at $P < 0.001$ (uncorrected) including at least eight contiguous voxels. Resulting coordinates were transformed into the Talairach space using the algorithm suggested by Brett (<http://imaging.mrc-cbu.cam.ac.uk/downloads/MNI2tal/mni2tal.m>).

3. Results

Results from the paired *t*-test of the post>pre contrast yielded evidence of a significant activation increase from pre- to post-treatment in the right middle temporal gyrus, covering the extrastriate body area, when looking at pictures of one's own body (Table 1, Fig. 1a).

Furthermore, results of the pre>post-contrast indicated activation decreases from pre- to post-treatment in the left precuneus, the right inferior and superior frontal gyri, the left posterior cingulate gyrus, the bilateral inferior parietal lobule, the left fusiform gyrus, and the right parahippocampal gyrus when regarding one's own body (Table 1, Fig. 1b).

Behavioral data indicate a non-significant increase in positive emotions (pre: $M = 19.60$, S.D. = 4.67; post: $M = 21.00$, S.D. = 4.12; $t(4) = -0.71$, $P = 0.515$) as well as a non-significant decrease in negative emotions (pre: $M = 30.60$, S.D. = 6.69; post: $M = 28.40$, S.D. = 8.96; $t(4) = 0.47$, $P = 0.66$) and negative body-related cognitions (pre: $M = 58.60$, S.D. = 19.49; post: $M = 47.40$, S.D. = 24.33; $t(4) = 1.31$, $P = 0.26$) from pre- to post-treatment elicited by looking at the photographs of one's own body. Similarly, the body mass index increase from pre- to post-treatment failed to reach statistical significance (pre: $M = 16.12$, S.D. = 1.12; post: $M = 16.54$, S.D. = 1.47; $t(4) = -1.64$, $P = 0.18$).

The correlations (Pearson) of the extracted activation changes from pre- to post-treatment in the left extrastriate body area and the

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