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Tactile body image disturbance in anorexia nervosa

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ABSTRACT

Body image disturbances are central to anorexia nervosa (AN). Previous studies have focused mainly on attitudinal and visual aspects. Studies on somatosensory aspects thus far have been scarce. We therefore investigated whether AN patients and controls differed in tactile perception, and how this *tactile body image* related to visual body image and body dissatisfaction. The Tactile Estimation Task (TET) measured tactile body image: Two tactile stimuli were applied to forearm and abdomen, and, while blindfolded, participants estimated the distance between the two tactile stimuli between their thumb and index finger. The Distance Comparison Task (DCT) measured visual body image. Compared to controls ($n=25$), AN patients ($n=20$) not only visualized their body less accurately, but also overestimated distances between tactile stimuli on both the arm and abdomen, which might reflect a disturbance in both visual and tactile body image. High levels of body dissatisfaction were related to more severe inaccuracies in the visual mental image of the body, and overestimation of tactile distances. Our results imply that body image disturbances in AN are more widespread than previously assumed as they not only affect visual mental imagery, but also extend to disturbances in somatosensory aspects of body image.

1. Introduction

The disturbed experience of body weight and shape is a central diagnostic criterion of anorexia nervosa (AN) (American Psychiatric Association, 2002): Despite their emaciated appearance, AN patients experience their body as too fat. This disturbance in body image is considered to be a key factor in the development, maintenance and relapse of AN (Killen et al., 1996; Stice, 2002; Stice and Shaw, 2002; Keel et al., 2005). In addition body image problems are often found to persist after otherwise successful treatment (Carter et al., 2004; Exterkate et al., 2009). Literature on body image in AN has focused mainly on attitudinal (e.g. body dissatisfaction) and visual aspects of body image (Smeets, 1997; Smeets et al., 1997; Skrzypek et al., 2001; Garner, 2002; Farrell et al., 2005), which were found to correlate (Sunday et al., 1992; Cash and Deagle, 1997; Benninghoven et al., 2007), implying a mutual relationship. Cash and Deagle (1997) showed that AN patients are more dissatisfied with their body than controls ($d=1.10$) and that this disturbance in body attitudes is much larger than that of the visual body image disturbance ($d=0.64$).

Even though body image is regarded as a multifaceted concept including cognitive/affective and perceptual aspects of how one's own body is experienced (Cash, 2002; Cash and Pruzinsky, 2002), surprisingly little is known about somatosensory aspects of body image in AN. A few studies have, however, shown that AN patients have a decreased interoceptive awareness and sensitivity. AN patients not only demonstrate a decreased ability to identify and discriminate between visceral sensations related to hunger and satiety (Fassino et al., 2004; Matsumoto et al., 2006; Pollatos et al., 2008), but also find it difficult to recognize physiological stress symptoms such as an increased heart rate (Miller et al., 2003; Zonnevylle-Bender et al., 2005). These findings imply that AN patients have a deficit in recognizing bodily signals, which may extend to deficits in somatosensory perception as well. Therefore, the main aim of the current study was to investigate whether AN patients suffer a disturbance in *tactile body image*.

Previous research suggests that two forms of touch can be distinguished in the brain, primary tactile perception (such as an external object pressing on the skin) and secondary tactile perception (including metric/spatial information and requiring rescaling; Spitoni et al., 2010). We are especially interested in secondary tactile perception, because extracting metric information from the skin surface involves additional computational processing stages over perceiving mere contact to the skin (Dijkerman and De Haan, 2007; Spitoni et al., 2010). It is thought that during these additional

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processing stages touched locations on the skin are linked to a mental body representation (Spitoni et al., 2010).

The concept of mental body representation refers to the multiple abstract perceptual representations of the body in the brain that store information about the shape and size of body parts, their position in space and the integration of the parts into a structural whole (Paillard, 1999; Gallagher, 2005; Dijkerman and De Haan, 2007; Serino and Haggard, 2010). It has been suggested that these mental body representations are constructed from and reciprocally influenced by input from various senses such as vision and touch (Serino and Haggard, 2010). Moreover, certain aspects of body representations may not only be influenced by bottom-up sensory input, but also by top-down cognitive, semantic and affective representations: In perception of the body or sensations on the skin, top-down information is used (Paillard, 1999; De Vignemont et al., 2005; Gallagher, 2005; Dijkerman and De Haan, 2007).

Touch is necessarily perceived in reference to the own body. Since somatosensory afferents do not provide bottom-up information about the size of a body part (Serino and Haggard, 2010), it is crucial to tap into other sources of information, providing top-down input, such as vision (Taylor-Clarke et al., 2004) or perhaps mental imagery, in order to make size estimations of tactile objects. In addition, top-down processes related to, for example, body dissatisfaction could influence and distort mental representations, making it plausible that AN patients estimate the size of external tactile stimuli in reference to a disturbed mental representation of the body. In healthy individuals it was indeed shown that after experimentally inducing a disturbed experience of the body, tactile perception of distances was altered (Taylor-Clarke et al., 2004; De Vignemont et al., 2005).

Previous work has already demonstrated that top-down processes related to body attitudes can lead to marked visual body image disturbances. For example, Smeets and Kosslyn (2001) found that AN patients' visual body image disturbance results from body size distortions in memory rather than perception (see also Kosslyn, 1987; Smeets et al., 1999). While AN patients' visual size discrimination is undisturbed (Garfinkel et al., 1978; Smeets et al., 1999), thinking about the self as fat (i.e. high body dissatisfaction) may cause size distortions of the visual mental body image. One proposed mechanism held that "thinking fat" activated prototypical images of fat somatotypes which interfere with the construction of a visual mental image of the body and distort it in the direction of fatness (Smeets and Kosslyn, 2001; Mohr et al., 2007). Following this line of reasoning, we believe an investigation of body size representations within multiple modalities in AN is warranted. Therefore we specifically investigated whether AN patients demonstrate a disturbance in tactile aspects of body image, and explored how this disturbance related to body dissatisfaction and visual aspects of body image.

2. Methods

2.1. Participants

The present research was approved by the local medical ethical committees of the involved institutions. Forty-five Dutch females participated: 20 AN patients and 25 healthy controls. All participants were over 18 years of age, free from medication that could influence psychomotor speed (e.g. due to sedative effects, drowsiness, or psychomotor impairment), and scar tissue (e.g. due to self-injuring behavior, a surgery, or an accident) or skin problems (e.g. a rash due to allergies) on their forearms and abdomen. Participants received a monetary reward for a 90-minute session.

AN patients were recruited from an eating disorder clinic outpatient population. All patients received treatment as usual and were diagnosed with AN ($n=15$) or the AN subtype of Eating Disorder Not Otherwise Specified (EDNOS) ($n=5$) by administering the Eating Disorder Examination (EDE; Fairburn and Cooper, 1993) and a psychiatric interview. We included both AN patients and AN subtype EDNOS patients who no longer or had never fulfilled the AN Body Mass Index (BMI) and/or amenorrhea criterion, as symptoms are similar although less severe in EDNOS (Williamson et al., 2002). Mean disease duration was 8.4 months (±6.5): Note that patients may have previously received treatment elsewhere. Healthy controls were recruited from a student population. Based on their measured weight and height, all controls had a healthy BMI (18.5 to 25) and the presence of an eating disorder was excluded by administering the Eating Disorder Diagnostic Scale (EDDS) (Stice et al., 2004). Mean age was 22.30 years (±3.01) for AN patients and 21.32 years (±2.19) for controls, $t(43)=1.26$, $P=0.213$. Mean BMI was 18.54 (±2.03) for AN patients; and 21.43 (±1.77) for controls, $t(43)=-5.11$, $P<0.001$. Note that the mean BMI in the AN group is relatively high as the AN group consists of both AN patients and EDNOS patients.

2.2. Instruments and procedures

2.2.1. Body dissatisfaction

The Dutch translation of the Body Shape Questionnaire (BSQ; Cooper et al., 1987) assessed body dissatisfaction. This widely used, 34-item, self-report questionnaire with an internal consistency of $\alpha=0.97$ (Pook, et al., 2008) assessed concerns regarding body shape during the last 4 weeks on a 6-point Likert-scale (e.g. "Did you avoid social events (such as parties) because you felt bad about your body size?"). Cronbach's α in the current sample was 0.99.

2.2.2. Tactile body image

The Tactile Estimation Task (TET; adapted version based on Taylor-Clarke et al., 2004; De Vignemont et al., 2005; Anema et al., 2008) measured tactile body image. While participants were blindfolded, the experimenter pressed the two pointers of a caliper simultaneously and lightly on the skin. The distance between the two pointers was set at 50, 60, and 70 mm, with each distance being presented seven times in a random order on the right side of the body. Two body parts were tested in a counterbalanced order, the center of the right forearm (insensitive body area, see Fig. 1a) and the abdomen in the area below the belly button (sensitive body area, see Fig. 1b). We distinguished between sensitive and insensitive body areas to investigate whether body image disturbances in AN occur for any body part, or only for those subject to the highest level of body dissatisfaction. During the task, participants estimated the distance between the two tactile stimuli by varying the separation between their right thumb and index finger. The experimenter measured this estimation with the caliper (see Fig. 1c).

2.2.3. Visual body image

The Distance Comparison Task (DCT; Denis and Zimmer, 1992; Noordzij and Postma, 2005; Smeets et al., 2009) is not a classical body size estimation task; it is a task in which participants estimate the size of their body by manipulating a distorted visual stimulus depicting their own body until it is perceived as matching own size. The disadvantage of such a task would be that presenting a visual image will influence the person's own visual mental image, preventing an unbiased assessment of that image (see e.g. Kosslyn, 1987; Smeets et al., 1999; Smeets and Kosslyn, 2001). The DCT was designed to spontaneously activate the visual body image (i.e. a visual image *must* be constructed in order to conduct the task and derive size estimates) without presenting a visual depiction of the body. The DCT is based on the so-called "image-scanning paradigm" (see Smeets et al., 2009) in which a visual mental image of one's own body is constructed and used when judging size differences between word-pairs. In each trial two word-pairs were presented, both representing a horizontal distance on the body. Each word-pair consisted of two identical body parts, representing the left and right side of the body, e.g. ear-ear and hip-hip. Participants were subsequently asked to indicate whether the last presented word-pair reflected a larger or smaller distance on their own body than the first presented word-pair. For example, participants had to indicate whether the horizontal distance between their left and right hip was larger or smaller than the horizontal distance between their left and right ear; see Fig. 2.

We demonstrated an inverse relation between reaction time (RT) and the absolute distance between the word-pair combinations confirming that a visual mental image was generated and used during the task. For example, the distance difference between ear-ear and hip-hip is large, as the ears are close to each other, while the hips are not, resulting in small RTs. Word-pairs consisted of the body parts waist, hips, and thighs (sensitive body parts), and ears, shoulders, armpits, elbows, and knees (insensitive body parts). A total of 28 word-pair combinations (e.g. a trial consisting of shoulder-shoulder paired with hip-hip) were presented twice in two cycles in a counterbalanced order; word-pair combinations within the cycles were randomized. Presentation times of the word-pairs were based on Smeets et al. (2009).

3. Results

3.1. Tactile body image

The effect of distance between the two simultaneously applied tactile stimuli on the index finger-thumb separation was not relevant to the aims of the current study and did not interact with group, $F(2,42)=2.48$, $P=0.096$; therefore, responses on the three distances were averaged, and the analyses were proceeded without stimuli distance as a variable. Mean distance estimation in the TET was 80.60 mm (±13.18) for AN patients and 49.88 mm (±12.47) for controls. A mixed repeated measures analysis of variance (ANOVA) showed a significant main effect of group, $F(1,43)=64.16$, $P<0.001$,