DISTURBED EATING PATTERNS AND BODY IMAGE DISTORTIONS
A review

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Disturbed Eating Patterns and Body Image Distortions
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I hereby certify that all material in this final year project which is not my own work has been identified and that no work is included for which a degree has already been conferred on me.

Signature: __________________________
Abstract

Women in general seem to have a complicated relationship with their bodies and their body image. A small percent of the female population develop a serious pathological eating pattern which is characterized by a disturbed image of body size and shape. This disturbance has been investigated by many researchers and the quest of finding the underlying neural correlates has progressed enormously during the last decade. The relationship between disturbed eating patterns and body image distortions is highly complicated. The purpose of this review article is to give an overview of current research literature and scientific results. The aim is to find a framework for the phenomenon of body image distortions among both healthy and non-healthy women. Differences between genders and how food intake affects body image will also be addressed. The focus lies on behavioral traits and the underlying neural correlates, with focus on both the perceptual and the cognitive-affective component.

*Keywords:* body image distortions, anorexia nervosa, bulimia nervosa, fMRI, perception, emotion
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Introduction

The current pressure of thinness that can be seen in our western society affects, especially women, in the way they perceive themselves. In some cases one can suspect that a disturbance in the body image perception is present. This means that the individual inaccurately estimates her/his body size to be bigger or smaller than it actually is (Kaye, 2008).

One of the most prominent characteristics of individuals diagnosed with eating disorders, especially in anorexia and bulimia nervosa, is a disturbed attitude towards and perception of their own body (Beato-Fernández et al., 2009; Vocks et al., 2010). Researchers are trying to find the neural mechanisms underlying this particular disturbance to explain the phenomenon and to improve treatment for specific eating disorders. However, there seems to be disagreement as to exactly which neural circuits are involved and to what degree. Two different components, in the processing of body images, have been identified: The perceptual component and the cognitive-affective component. The perceptual component refers to the neural basis for perceiving the body itself while the cognitive-affective component refers to the neural basis for constructing semantic knowledge and attitudes about the own body (Longo, Azañón, & Haggard, 2010). Both of these aspects are of great interest in the research literature.

The purpose of this article is to present recent findings on the topic of body image distortions, both in healthy and non-healthy individuals. Some differences between genders and how food intake affects body image will also be addressed. However, the main focus will lie on studies conducted on women diagnosed with either anorexia or bulimia nervosa according to the DSM-IV diagnostic criteria. The reason for this is because many more studies are conducted on women with eating disorders than on healthy women. Also the body image disturbance is a prominent feature in both of these disorders. The main goal is to find
relations among the studies, inconsistencies, gaps and discuss future research approaches. Further, there will be discussion about whether the results from presented studies could be applied to a more general population, especially women with concerns about their body weight and shape but do not suffer from a diagnosable eating disorder.

**Eating Disorders**

**Anorexia Nervosa**

Anorexia nervosa is a life-threatening condition affecting mostly young girls in their adolescence. It often starts out as non-harmful dieting that gradually goes out of control and could in a worst case scenario lead to death of the patient (Athey, 2003). The main characteristics of this particular disease and the diagnostic criteria from the DSM-IV are: (1) A persistent desire to lose weight, even when one’s body weight already is below normal (BMI under 17.5). (2) An intense fear of weight gain and of becoming fat. (3) A disturbance in the estimation of body size (body image distortions) and an undue influence of the body weight/shape on self-evaluation, and finally (4) a disturbance in the woman’s menstrual cycle also called amenorrhea. All these four criteria’s has to be met in order to be diagnosed with anorexia nervosa (American Psychiatric Association, 2000).

Coupled with these above mentioned characteristics Allgulander (2008) also mentions depression, anxiety, constipation, reduced sexual drive, irritability and compulsive symptoms among these individuals. The patients also often avoid socializing. Besides these behaviors, severely restricting the diet and reducing the calorie intake affects other organs in the body. The thyroid gland, the growth hormones, sex hormones and bone density are examples of affected areas and functions as an effect of malnutrition (Athey, 2003).

**Restricting type and binge-eating/purging type.** There are two different types of anorexia nervosa in the DSM-IV diagnostic criteria. One of these two is called restricting type which means that during the episode of the illness the individual does not exhibit binge-
eating or purging behavior, such as self-induced vomiting or the misuse of laxatives, regularly. In the other type, called binge-eating/purging type, this type of behavior is regularly present during the episode of anorexia (American Psychiatric Association, 2000).

**Bulimia Nervosa**

Bulimia nervosa is somewhat different from that of anorexia nervosa. According to the DSM-IV the criteria’s are the following, (1) the individual has episodes where she/he loses control over eating and consumes thousands of calories, much more than a regular person would consume. This is also referred to as binge-eating. (2) After the attack the individual feels a desire to compensate for the large amount of calorie intake by various means. (3) This destructive compensatory behavior has to be recurrent and appear at least twice a week for 3 months. (4) Similarly to anorexia, a disturbance in the estimation of body size (body image distortions) is present and there is an undue influence of the body weight/shape on self-evaluation. Lastly, (5) the disturbance does not occur exclusively throughout episodes of anorexia. As in the case of anorexia, all these criteria’s have to be fulfilled in order to get diagnosed with bulimia nervosa (American Psychiatric Association, 2000).

It is worth noting that despite the differences between anorexia and bulimia they are still closely related. Transitions between these syndromes can in many cases be detected and 25 - 30 % of people suffering from bulimia have a prior history of anorexia (Kaye, 2008). Therefore it could be argued that anorexia and bulimia share some risk and liability factors (Bulik et al., 2010; Kaye, 2008).

**Purging type and non-purging type.** The DSM-IV separates between two types of behavior in bulimia nervosa. One is the purging type where the individual suffering from bulimia regularly engages in the misuse of laxatives or self-induced vomiting, enemas or diuretics to compensate for the high calorie intake. While the other type, non-purging type,
only uses other inappropriate compensatory behaviors, such as fasting or excessive exercise during the episode of the illness (American Psychiatric Association, 2000; Kaye, 2008).

**Potential Causes of Eating Disorders**

Several different factors are believed to be involved in the development of eating disorders. Genetic factors, psychological predispositions and environmental triggers may be of great importance in understanding the onset of both anorexia and bulimia nervosa (Woerwag-Metha & Treasure, 2008). Understanding the environmental triggers and vulnerable traits might help in preventing the onset of eating disorders. It might also lead to better treatment of patients and with better treatment comes a better chance of maintaining a healthy lifestyle.

**Cultural Influences**

In today’s western society there is an unrealistic ideal of thinness. The pressure that media and celebrities evoke might make many feel unease about their bodies. The question is how much the current cultural ideals affect the onset of disturbed eating patterns.

Eating disorders have long been thought only to be a “western” phenomenon not seen in any other societies and cultures. Today, eating disorders seem to be a global phenomenon existing in all kinds of cultures around the world (Nasser, 2009). Nasser (2009) describes the cultural aspects of pathological eating patterns and the potential causes behind it. He argues that eating disorders are not bound to the western culture and our specific ideal of thinness, rather, disturbed eating patterns could be caused by cultural changes in general. When a society changes it often affects the individuals’ lifestyle, e.g. work and dietary habits which over time may develop into more pathological eating patterns. Nasser also points out that immigrants are at greater risk for developing eating disorders than natives and he suggests that confusion about cultural identity and a strong need to fit in might underlie this trend.
Genetic Factors

It seems as though cultural ideals and pressure from media is not enough for developing eating disorders. According to the American Psychological Association an estimate is that 5 million Americans suffer from a diagnosable eating disorder (“APA Public Interest Government Relations Office”, n.d., para. 1). This is approximately 1.5% of the whole American population, which is quite a low percentage. The question is then why some people develop serious psychiatric illnesses while others do not when the cultural pressure is somewhat the same in the whole country. The answer to this question might lie in genetics. Twin studies have been conducted and the results yield a heritability of between 50 and 80% (Kipman, Gorwood, Mouren-Siméoni, & Adès, 1999). This suggests an important genetic predisposition in developing any kind of eating disorder. Further, other twin-studies conducted have reported evidence of shared genetic predispositions between anorexia and bulimia nervosa. Approximately half of the genetic factors contribute to liability to both of the disorders. The other 50% of genetic factors are contributing independently to both anorexia and bulimia (Bulik et al., 2010).

Not only are the genetic predispositions for developing eating disorders heritable, but the body mass index and body compositions are also heritable (Woerwag-Metha & Treasure, 2008), which also is an important aspect in the development of pathological eating patterns.

The Effect of Malnutrition

As mentioned earlier many organs and functions are negatively affected by malnutrition (Athey, 2003). Even before the birth of a child, during the pregnancy, malnutrition might affect nutritional status and appetite regulation throughout the child’s whole life. Also prematurity, low weight at birth and cephalhaematoma have been shown to be present more frequently in patients with anorexia nervosa than in healthy women (Woerwag-Metha &
This implies that nutrition in very early stages in life play a key role in eating patterns and metabolism during the whole life-span.

Further there has been debate whether symptoms of anorexia nervosa are caused by malnutrition or the other way (Kaye, 2008). In this article, the primary interest is whether malnutrition, due to disturbed eating patterns, might be the cause of neurological changes that leads to a body image distortion or if body image distortion predates the onset of pathological eating patterns.

**Personality Traits Coupled with Disturbed Eating Patterns**

Certain personality traits have been identified as common among those developing eating disorders. Often these personality traits and behaviors have been present since early childhood and maintained during the illness and also after recovery. The most common personality traits and psychopathological disorders one can find in anorexia and bulimia nervosa are obsessive compulsiveness, perfectionism, a need for order and control and anxiety (Hudson, Hiripi, Pope, & Kessler, 2007; Kaye, 2008; Woerwag-Metha & Treasure, 2008). Also substance abuse is common among eating disordered individuals (Hudson et al., 2007). Because these traits persist after recovery one could possibly conclude that they also predate the onset of eating disorder. However, it has been suggested that malnutrition exaggerates many of the identified psychiatric symptoms in both anorexia and bulimia nervosa (Kaye, 2008).

**Body Image in the Brain**

**The Perceptual Component**

There are several areas in the brain that are involved in the visual processing of bodies and the construction of a body image. The occipital lobes are well known for their involvement in processing visual stimuli in general. From the primary visual area the stimulus travels either through the ventral or the dorsal pathways to the secondary visual...
cortex (Gazzaniga, Ivry, & Mangun, 2008). Downing, Jiang, Shuman, and Kanwisher (2001) found that an area in the right lateral occipitotemporal cortex is specifically involved in the processing of body parts and the human body. This area is also referred to as the extrastriate body area, or the EBA.

The parietal cortex and the multisensory association cortex are known as a point of convergence between somatosensory and visual areas. This convergence enables one to determine where objects are in relation to the body. This same area is also involved in the construction of body image (Shimada, Hiraki, & Oda, 2005). Body image in this sense means a conscious representation of one’s body and the sense of self. One theory is that functional abnormalities in the parietal cortex could be involved in body image distortions in patients suffering from anorexia nervosa (Kuyck et al., 2009).

**The Cognitive-Affective Component**

There is some debate on whether disturbance of body image is primarily a perceptual dysfunction or one of cognitive-affective dysfunction. Perhaps individuals do perceive the body realistically but have exaggerated negative attitudes and emotions towards it. It is hypothesized that women suffering from anorexia or bulimia nervosa elicit an aversive response towards images of body shapes and show greater anxiety when comparing their own body with other female bodies (Uher et al., 2005; Friederich et al., 2010).

Areas involved in emotional processing and self-evaluation are the limbic system including the amygdala, the insula, anterior cingulate cortex and the prefrontal cortex (Gazzaniga et al., 2008). More specifically it has been demonstrated that the cortical midline, including orbito- and dorsomedial prefrontal cortex, medial parietal cortex and insula, are all correlated with the degree of emotional valence in visual stimulus (Heinzel et al., 2005). Furthermore, one area involved in emotional processing is specifically important in relation to the subject of body image distortions, namely the amygdala. There is extensive research on
the function of the amygdala and the results indicate that the amygdala is activated during emotional processing, particularly negative emotional processing such as disgust and fear (Costafreda, Brammer, David, & Fu, 2008). All these mentioned areas are of interest for those researchers that investigate the neural circuits underlying body image distortions.

**Body Image Distortion in Eating Disorders**

According to the DSM-IV diagnostic criteria individuals suffering from anorexia or bulimia nervosa have a disturbed perception of the body. They tend to overestimate the size of the body and experience themselves as fat. Also body shape and weight unduly influence the self-evaluations (American Psychiatric Association, 2000; Kaye, 2008; Kuyck et al., 2009). Many studies have been conducted in order to find the neural mechanisms of this disturbance. As the technology of functional neuroimaging has developed, for example functional magnetic resonance imaging (fMRI), positron emission topography (PET) and single-photon emission computed tomography (SPECT), researchers are now able to investigate the functional differences in individuals with anorexia and bulimia compared to that of healthy control groups. The most common stimuli which induce the specific symptom of body image disturbance experimentally are pictures of female bodies, the own body and distorted pictures of the own body.

**Changes in Brain Structure and Function**

Studies conducted on either anorexia or bulimia nervosa, or both of them, have provided evidence that both functional and structural changes in the brain can be seen in these illnesses compared to healthy controls. Structural changes such as reduced gray matter in lateral occipital cortex (Suchan et al., 2010) enlarged ventricles and larger volumes of cerebrospinal fluid (CSF), that are associated with deficits in total white and gray matter volumes, have been reported in patients suffering from anorexia (Katzman et al., 1996). It could be suggested that these structural abnormalities are a function of dietary restrictions.
Functional abnormalities have also been reported from several functional brain imaging studies. Both hyper- and hypo-activation have been demonstrated in brain areas such as occipital, parietal, temporal and frontal cortices (Beato-Fernández et al., 2009; Delvenne et al., 1996; Kojima et al., 2005; Sachdev, Mondraty, Wen & Gulliford, 2008; Uher et al., 2005). Other regions that have been shown to be under or over activate are the insula, premotor cortex, anterior cingulate cortex (ACC), (Friederich et al., 2010), frontal gyri (Sachdev et al., 2008), lateral fusiform gyrus (Uher et al., 2005) and the amygdala (Seeger, Braus, Ruf, Goldberger & Schmidt, 2002; Vocks et al., 2010). The demonstrated involvement of these brain regions implies a distributed neural network correlating with disturbances of body image. However, some regions are more frequently presented and discussed in the research literature. Brain areas involved in perceptual processing, such as occipital and parietal lobes, including the EBA are frequently occurring in scientific articles. Similarly, brain areas involved in emotional/affective processing and attentional monitoring, such as frontal cortices, insula, amygdala, ACC and lateral fusiform gyrus, also repeatedly occur in the research literature. These regions are of great interest and might explain body image distortions at the neuronal level.

Perceptual disturbances. Suchan et al. (2010) investigated if there were any structural differences in the brain between healthy women and women diagnosed with anorexia using voxel based morphometry (VBM). They scanned the brains of 15 women diagnosed with anorexia and 15 healthy control women. Their results yield evidence of reduced gray matter volume in the left extrastriate body area (EBA) in individuals with anorexia compared to controls. As mentioned earlier the EBA has previously been shown to be involved in the processing of human bodies (Downing et al., 2001). The authors hypothesize that this gray matter reduction in the EBA might explain why individuals with anorexia have a tendency to
overestimate their body size. If this is the case, then one can conclude that these women have a disturbance in the perceptual component of the body image (Suchan et al., 2010).

Sachdev et al. (2008) hypothesized that patients suffering from anorexia process self-images differently from non-self images. By using fMRI the authors could examine the brains of 10 healthy women and 10 patients suffering from anorexia, while they viewed pictures of both the self and of other women. The results of this particular study show differences in brain activation between healthy controls and patients suffering from anorexia in regard to processing self-images and non-self images. Control participants showed activation in occipito-parietal regions including secondary visual cortices, fusiform gyrus. Also the dorsolateral prefrontal cortex and thalamus were activated during both conditions (self and non-self images). In patients suffering from anorexia however, the activation was somewhat similar in the processing of non-self images but during the processing of self-images patients did not show increased activation in these brain regions, as compared to the control group. The authors explain the lack of activation as evidence that the emotional, perceptual and cognitive processing is suppressed in patients suffering from anorexia in respect to their own body. The reduced activity in perceptual areas might underlie the perceptual disturbance causing body image distortions and further, the reduced activity in insula and the attentional network might underlie a feedback-failure for correcting the unrealistic self-image. This could be the explanation as to why patients with eating disorders tend to distort their own body image, both in a perceptual perspective and at the affective-cognitive level. Interestingly, only anorexic participants did display significant activation in the medial prefrontal cortex while confronted with other female bodies. This could be explained by an intense comparison process in the anorexic group which is not present in the control group.
**Affective disturbances.** Turning focus from the perceptual component to the affective component many researchers have found the emotional system to be involved in the processing of the body images. Fernández-Aranda, Dahme and Meermann (1999) suggested that no perceptual disturbance was present in patients diagnosed with either anorexia or bulimia nervosa. Only a disturbance in the emotional aspects of body image was thought to be present. They compared 44 patients, 25 diagnosed with bulimia and 19 diagnosed with anorexia, before and after therapy by using video-distortion and image-marking techniques coupled with self-report questionnaires. Their results suggest that there was no difference in body size estimations between the two groups with eating disorder. Further, no difference could be seen before and after treatment/therapy. This could imply that no perceptual disturbance underlies the onset of body image distortions. However, authors found differences between the two groups of eating disorders before and after therapy in respect to the emotional component. They suggest a negative attitude towards one’s own body to be involved in both anorexia and bulimia nervosa. Further, authors state that the relationships between body image distortions and disturbed eating patterns need to be sought on a cognitive and emotional level. It is important to remember that this particular study only considered behavioral and subjective measures.

Supporting the results from Fernández-Aranda et al. (1999) research from the field of neuroscience have provided further evidence for the involvement of the emotional network. Seeger et al. (2002) used fMRI to investigate body image distortions in patients with anorexia nervosa. They used computer-based live image distortion technique to produce distorted body images of the subjects own bodies and used these images as stimuli for both healthy controls and patients with anorexia. Their results from the fMRI scan shows that in anorexic patients, activation in the “fear network” was associated with exposure to one’s own distorted body image. More specifically, activation was recorded in right amygdala, the right fusiform gyrus.
and the brainstem regions. These findings suggest a disturbance in the emotional component, which is in accordance to the above mentioned study. Right amygdala activation is thought to be associated with aversive and threat-related stimuli (Costafreda et al., 2008; Gazzaniga et al., 2008), in this case distorted images of the own body. This corresponds to the idea of anorexics having unjustified fear of becoming fat.

**The role of attention.** Not only are the perceptual and the emotional components, with their corresponding neural correlates, relevant in the discussion about body image distortions. The attentional system is also highly interesting. The study conducted by Sachdev et al. (2008), mentioned above, did demonstrate that patients suffering from anorexia nervosa did not engage the attentional system during processing of images of their own bodies. However, when patients were confronted with another woman’s body, activation was similar to those of control subjects, displaying activation in regions associated with perceptual, cognitive and emotional processing.

Kurosaki, Shirao, Yamashita, Okamoto and Yamawaki (2006) investigated gender differences in activation pattern while confronted with distorted images of one’s own body. They found that women, confronted with a thin body image, had activation in the anterior cingulate gyrus. This indicates that women engage the attentional network and process their body image with attentional and self-monitoring processing. The same activation was not found among male participants. Further, activation could also be seen in limbic/paralimbic lobes and PFC in women confronted with both fat and thin distorted images of their own body. Authors suggest that women tend to perceive themselves with both cognitive and emotional processing, and that they regulate the emotional stimulation by themselves and finally that they turn their attention inwards to assess emotional awareness about oneself.

Vocks et al. (2010) also found evidence of the attentional system being involved in the processing of body images in patients with pathological eating concerns. Their results
indicate that both anorexic and bulimic women display an avoidance behavior, while confronted with pictures of their own body, which is reflected in decreased activity in the attentional network including the inferior and the superior parietal lobules. The expected activity in amygdala and the fear network was not found in this study. Amygdala activation when confronted with one’s own body image has been reported by Seeger et al. (2002) and Miyake et al. (2010). Authors explain the unexpected results by suggesting that the avoidance behavior and lack of activation in attentional networks might underlie the lack of emotional response that was expected. They speculate whether attention is crucial to elicit amygdala activation. However, when participants with anorexia viewed pictures of another woman’s body limbic activation, including amygdala, was reported. This activation was less pronounced in participants with bulimia. This indicates that anorexics elicit higher aversive response and might engage in social comparison processes when confronted with another woman’s body compared to bulimics and controls. Vocks and her colleagues’ results are in accordance with those of Sachdev et al. (2008).

All and all it seems as though the attentional system play a crucial role in the phenomenon of body image disturbances. There seems to be evidence of discrepancies between activation patterns regarding attentional processing. Either the attentional system is significantly activated, possibly as a result from a social comparison process, or the attentional system is non-significantly activated, reflecting an avoidance behavior. These findings are highly interesting and might reflect different cognitive styles.

**Anorexic, Bulimic and Healthy Women – Comparisons**

There seems to be differences as to how patients with diverse subtypes of eating disorders and healthy women process body images. Different activation patterns which reflect different cognitive styles have been reported from various studies.
Miyake et al. (2010) were interested in these differences in brain activation patterns between healthy controls and various subtypes of eating disorders. They recruited 33 patients diagnosed with either anorexia (both restricting-type and binging-purging type) or bulimia and also 11 healthy control women. Authors used fMRI to investigate brain activation during exposure to one’s own distorted body image as well as distorted images of another woman’s body. They hypothesized that brain activation would differ in the various subtypes of eating disorder compared to controls. Further, they also hypothesized that there would be discrepancies in the activation of limbic area, including amygdala, and in the prefrontal cortex reflecting an aversive and strong emotional response in eating disordered women.

The results from Miyake et al. (2010) show that different subtypes of eating disorders do activate different neural networks. Exposure to one’s own fat image was associated with amygdala activation in both subtypes of anorexia and in healthy controls. However, this activation was not present in bulimics. The prefrontal cortex was activated during the own fat image in anorexics with binging-purging type and in healthy controls but not in anorexics with restricting-type and bulimics. These results imply that different subtypes of eating disorder process distorted body images of oneself differently. Authors discuss whether this difference in activation reflects differences in the cognitive style and evaluation of body images. One theory that they suggest is that anorexics with restricting type process their body image more emotionally than those with binging-purging type and bulimics, hence the activation in the amygdala when exposed with own fat image. Whereas anorexics with binging-purging type have greater balance between the cognitive and the emotional processing resulting in greater activation in both the amygdala and the prefrontal cortices. However, activation in bulimics does not resemble that of anorexics, rather the occipital and parietal lobes were activated, suggesting that patients with bulimia tend to pay more attention to size estimations and comparisons between their own fat image and a real image.
Uher et al. (2005) designed an fMRI experiment, including both patients suffering from anorexia and bulimia and healthy controls, in order to test several hypotheses. During the brain scan, participants were presented with line drawings of underweight, normal weight and overweight female bodies. Firstly, they hypothesized that in patients with bulimia or anorexia, as well as in healthy women, there will be category-specific responses to bodies. More specifically they believed to find activity in the lateral occipitotemporal cortices (EBA) and right parietal cortex (body schema system). Secondly, they also hypothesized that fat/overweight bodies would elicit an aversive response showing activity in amygdala and the insula. Thirdly they also expected to see discrepancies between patients and healthy controls in activation pattern, more specifically in parietal regions and in the EBA. Fourthly, patients were believed to show a greater aversive response to the presented body images than healthy participants. This would be reflected in greater activation medial prefrontal cortex, insula and amygdala. Further, authors theorized that there would be greater activation in the emotion-processing regions in the patient group when confronted with both fat and normal body images compared to healthy participants. Last, but not least, they expected to see a correlation between aversive response (subjective ratings) and neural activity in the brain regions underlying emotional processing.

Hypothesis number one in this study was confirmed, as well as hypothesis number three. There were category-specific responses to bodies, resulting in activity in the EBA and right parietal cortex, and they also found discrepancies in the activation pattern between healthy and eating disordered women. However, where Uher et al. (2005) expected to find greater activation in patients than in healthy women, such as in the amygdala, prefrontal cortex and insula, they instead found these areas to be under-active in the patient groups. No clear group differences were recorded and the expected emotional responses were non-significant. These results go against several of the author’s hypotheses and they imply that patients suffering
from eating disorders such as anorexia or bulimia exhibited a relative under-activity in the network related to body image processing. Further, this under activity may reflect a failure to represent and evaluate one’s own body shape in a realistic manner.

Holder and Keates (2006) were somewhat critical of the phenomenon of body image distortions and question whether the overestimation of body size among women might be exaggerated. The inconsistencies they found among research literature triggered an interest to find out how the size of drawings/pictures affects body size estimation in women with and without eating concerns. They presented drawings of female bodies ranging from underweight to overweight that were both in actual size (same size as the participants) and in reduced size. The participants were instructed to select the drawing that best represented how they thought they looked (cognitive rating), felt they looked (affective rating), and how they would like to look (desired rating). The results show that the size of the drawings influenced women’s ratings of the size they felt they were (affective) and wanted to be (desired). Also, women with eating concerns tend to overestimate their body size, which is in accordance with previously mentioned studies. However, the overestimation was more prominent when size reduced drawings were used. This might indicate, according to the authors, that the overestimations of body sizes, reported in the research literature, have been exaggerated. That the difference in estimates of body size and shape between healthy women and women suffering from pathological eating patterns or eating concerns in general may not be so prominent.

The results from Holder and Keates (2006) study seem somewhat puzzling. One could suspect that the actual size images would produce a more prominent overestimation of body size than reduced size drawings. That would lead to opposite results than those reported. Replication of this particular study would be preferable. Using real people, tentatively with distorted mirrors, as stimuli in the field of body image research might be a better option.
At least there seems to be an agreement that women suffering from both anorexia and bulimia show higher body image dissatisfaction than healthy women (Beato-Fernández et al., 2009; Friederich et al., 2010; Holder & Keates, 2006). However, the neural correlates underlying these differences in body image dissatisfaction and body image distortions seem to be diverse from study to study.

**Food Intake Affects Body Image**

One very important aspect in the discussion about disturbed eating patterns and body image distortions is that of emotional responses to food. McNamara, Hay, Katsikitis and Chur-Hansen (2008) examined the emotional responses to food in three different age groups with mixed genders; children, adolescents and young adults. Participants were shown pictures of different kinds of food and three types of emotional responses were rated, happiness, fear and disgust, through visual analog scales. Body image concern and eating disorder symptoms were also addressed. The hypothesis was that negative emotional responses would be greater within those individuals who had higher body image dissatisfaction and in older females. Their results show that with increasing age all emotional responses fell and also body image dissatisfaction became higher. In the group of young adult females, negative emotional responses such as fear correlated positively with eating concerns and body dissatisfaction. While men, on the other hand, showed significantly higher levels of “happy” responses to food. Authors suggest that this reported gender difference might reflect why women are more vulnerable for the development of eating disorders.

Vocks, Legenbauer and Heil (2007) investigated whether recent food intake affected body image. They recruited 57 women without clinically relevant eating disorders. They did, however, assess their eating patterns and general weight concerns. Further, they divided the women into 2 different groups, control and experimental groups, were the experimental group consumed milkshakes while watching a movie and the control group only watched the movie.
Mood questionnaires and the “body image state scale” coupled with a digital distortion technique based on photographs of their own bodies were used to indicate the felt, actual and ideal body shape. State body dissatisfaction and discrepancies between “actual-ideal” and “felt-ideal” body size estimations were found to be higher in the experimental group that consumed milkshakes than in the control group. Authors propose that the discrepancy between “actual-ideal” and “felt-ideal” body size estimations reflects the body image dissatisfaction. However, judgments of “actual”, “felt” and “ideal” body dimensions were unaffected by milkshake consumption. These findings suggest that the perceptual component is unaffected by recent food intake because judgment about “actual”, “felt” and “ideal” body dimensions were stable in both groups. Instead the affective component of state body image seems to be negatively affected by food intake such as high calorie milkshakes.

Moreover the demonstrated effects of milkshake consumption was shown to correlate with restrained eating patterns and concerns about eating, shape and weight in general. Women who displayed concerns about the body shape and/or had restrained eating patterns demonstrated higher effects of milkshake consumption on both state body image and mood (Vocks et al., 2007).

Both of the above mentioned studies indicate that women’s emotional state and body dissatisfaction are negatively affected by food and recent food intake (McNamara et al., 2008; Vocks et al., 2007). Further it seems as though this negative emotional response does not exist, to the same extent, in the male population. This might be one explanation as to why women are more vulnerable for the development of eating disorders.

**Gender Differences**

The fact that the majority of people suffering from either anorexia or bulimia nervosa are women (Kaye, 2008) might imply a difference in the processing of body images between genders. Kurosaki et al. (2006) investigated the differences between genders in respect to
brain activation during exposure of distorted images of one’s own body. They used fMRI on 11 healthy young women and 11 healthy young men while performing “body image tasks” consisting of fat, real and thin shapes of the body. They hypothesized that difference in brain activation between the genders would be seen in areas such as amygdala, paralimbic area and prefrontal cortex. Their results yield evidence of discrepancies between the genders in respect to the processing of body images. The authors compared brain activation in women and men respectively. Comparisons were made between fat-image versus real image tasks, but also between thin-image and real image tasks. In both of these conditions, the fMRI results show differences in brain activation patterns between the genders. In the fat-image task women displayed activation in the PFC, paralimbic lobe including the amygdala and the right cerebellum, whereas men did not display such activation. Further, in fat-image task, men showed activation in the dorsal and ventral pathways in the occipital, temporal parietal lobes and the left cerebellum, while this activation could not be seen in women. Thin versus real-image task showed a similar activation pattern were women displayed a significant activation in the left PFC, left limbic area including cingulated gyrus, the paralimbic area including the insula, and the left cerebellum. Men, however, showed activation in the occipital lobe, the temporal lobe including bilateral fusiform gyrus, and the right parietal lobe.

Kurosaki et al. (2006) interpreted their results as evidence of differences in the processing of body images between the genders. The differences in activation patterns reflect different cognitive styles and suggest that women tend to pay more attention inwards and are more emotionally engaged while viewing distorted pictures of their own body compared to men. Men, on the other hand, tend to perceive distorted images of their own body in a more objective way involving visual and spatial processing.

The idea that men and women have different cognitive styles when perceiving body images is shared by other groups of researchers. Mohr, Porter and Benton (2007) used
classical psychophysics in order to investigate hemispheric contribution to body image
distortion in women compared to men. 60 healthy women and men were presented with
distorted pictures of themselves, another person’s body and a non-corporal, familiar object.
These pictures were presented to both visual fields respectively and the subjects were asked
to judge whether the object in the picture were fatter or thinner than the real object. The
experiment revealed that left hemisphere generally had a bias for “fatter”, especially in the
processing of human bodies. However, results also show a “fatter” bias for one’s own body in
the right hemisphere only in women. Behavioral measures also reveal that women were more
prone to overestimate their own body size than men were. Authors suggest that right
hemispheric contribution to body image distortions in women reflects a sex-specific body
image disturbance. They further suggest that right hemispheric dysfunction might play a very
important role in body image distortions.

Owens, Allen and Spangler (2010) is another group interested in the gender differences
in cognitive representations of the self and own body image. They scanned the brains of 10
women and 9 men while viewing pictures of gender-matched bodies that either were
overweight or thin body shapes. The instructions were such that participants had to evaluate
their own body in relation to the pictures presented. The main area of interest, that authors
hypothesize play a key role in the processing of self-evaluation and body image
representations, is the medial prefrontal cortex (mPFC). The hypothesis that women would
display stronger activation in mPFC, reflecting higher engagement of self-evaluation, was
confirmed. Women displayed significant mPFC activation only when shown fat pictures,
whereas males did not display any significant activation in either condition. Authors are
unsure about the implications of these results because the design of the experiment required
both genders to engage in self-evaluation. One explanation that Owens et al. suggest is that
men in general do not consider body image as central to self-evaluation and self-definition,
while women do. Therefore women tend to activate areas involved in self-evaluation when confronted with non-idealistic body shapes. However, these results provide further evidence that gender differences do exist and that women and men may have different cognitive styles and process body images differently.

These above mentioned studies might explain why women are more vulnerable to social pressure of thinness and are at greater risk of developing pathological eating patterns. However, it is worth noting that the reported differences in brain activation patterns, when processing human bodies, between genders could be explained from a psychosocial point of view. It would have been preferable to test whether male participants would elicit different activation patterns when confronted with female bodies and whether female participants would respond differently to male body shapes. If this would have been the case, then a psychosocial explanation would have been reasonable.

**Discussion**

One can conclude from the reviewed research literature that body image processing involves a distributed neural network, related to perceptual, emotional/affective and higher cognitive processes. The distinction between the perceptual component and the cognitive-affective component and their involvement in body image processing is commonly discussed in the research literature. Some claim that a perceptual disturbance is present in body image distortions (Suchan et al., 2010; Sachdev et al., 2008) while others claim that a cognitive-affective disturbance is more likely involved in this phenomenon (Fernández-Aranda et al., 1999; Kurosaki et al., 2006; Miyake et al., 2010; Seeger et al., 2002). This distinction reflects two different theories in the field of body image distortions.

One puzzling aspect found is that while some researchers have found certain brain areas to be activated under certain conditions (Kurosaki et al., 2006; Miyake et al., 2010; Seeger et al., 2002) other researchers have found these same areas to be under-active under similar
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conditions (Sachdev et al., 2008; Uher et al., 2005; Vocks et al., 2010). The distinction between the reported under- and over-activity reflects the division between the perceptual and the cognitive-affective component. Brain areas involved in perceptual processes, such as occipito-parietal regions have been demonstrated to be under-active in women suffering from anorexia (Sachdev et al., 2008). Further, brain areas involved in emotional processes, such as amygdala, prefrontal cortex and insula, have also been demonstrated to be under-active in eating disordered women (Uher et al., 2005).

The reported under-activity could be a function of attention. Vocks et al. (2010) did report that women with anorexia and bulimia had decreased activation in the attentional network, including the inferior and the superior parietal lobules, while confronted with their own body image. This is also explained as avoidance behavior and lack of attention towards their own body image, which might also explain the lack of activation in both visual areas and emotional networks.

Interestingly, Vocks et al. (2010) found the limbic network to be activated in anorexic participants while looking at another woman’s body. This enhanced limbic activity might reflect a strong emotional response and also enhanced vigilance, which authors suggest is a result of a social comparison process. This leads us to the hypothesis that women suffering from eating disorder elicit an aversive response with correlated activity in the emotional/fear network, including amygdala, insula and PFC.

In contrast to the previously discussed research literature other researchers’ have demonstrated activity in limbic areas, including amygdala and the PFC, in women while confronted with distorted images of one’s own body (Kurosaki et al., 2006; Seeger et al., 2002), both in healthy and non-healthy women. These results are in accordance to that of Miyake et al. (2010) who also reported amygdala activation in both women with anorexia and
healthy controls while confronted with distorted “fat” images of themselves. Interestingly this amygdala activation could not be seen in women with bulimia.

In summary, it seems as though in some severe cases a perceptual disturbance is involved in body image distortions. This might be due to serious malnutrition leading to functional abnormalities in brain areas involved in perceptual processing. However, the cognitive-affective component seems more likely to be the cause of body image disturbances and dissatisfaction in general. There is strong evidence that the emotional and attentional network is involved in body image processing, especially in women. Women tend to engage both emotion and higher cognitive evaluation, more than men do, when they are confronted with their own body image (Kurosaki et al., 2006). These emotional responses that have been reported from several studies seem to be present in both healthy and eating disordered women. The puzzling thing is that while some studies have reported activation in emotional networks, others have found these same areas to be under-active. One possible explanation to why these discrepancies of activation exists, is that while some women have an aversive response towards their body image, as being unacceptable, others simply avoid their body image by withdrawing their attention from it.

One very important aspect in the discussion about body image distortions is that of causality. As Kaye (2008) discuss in his article there is still debate about whether the symptoms, including body image distortions, in individuals with eating disorders are a cause or a consequence of malnutrition. One way to solve the problem of causality, regarding body image distortions, is to look at individuals that have recovered from eating disorders. Do they still suffer from body image disturbances even after recovery? More research, including recovered eating disordered women, is needed to assess this question. More specifically I believe that longitudinal studies, following eating disordered women throughout their illness
and after recovery, would give an even deeper understanding of the workings of body image distortion and its relation to current eating patterns.

Liechty (2010) who investigated the relationship between body image distortions and three different types of weight loss behaviors in normal- and underweight girls found that girls with a body image disturbance were at greater risk for developing pathological eating patterns and unsafe weight loss behavior than those without any distortions. This finding does indicate that body image disturbances predate the onset of eating disorders.

Even if it is the case that body image distortions predates the onset of eating disorders there is still other factors that need to be considered. The proposed genetic predispositions seem to play a crucial role in the development of eating disorders (Bulik et al., 2010; Kipman et al., 1999; Woerwag-Metha & Treasure, 2008). The same applies to both psychological traits and nutritional history (Hudson et al., 2007; Kaye, 2008; Woerwag-Meta & Treasure, 2008). Even though cultural factors might have some influence the onset of eating disorders (Nasser, 2009) this influence is in my opinion minor compared to the other vulnerabilities. The risk for developing a pathological eating pattern seems to be dependent on all the mentioned factors, where some are at greater risk than others.

Another crucial aspect that needs to be considered is that of limitations. Every study that was reviewed here, on the topic body image distortions, has its limitations. In most studies very few participants were recruited. A much larger number of participants are needed in order to make any bold inferences from the results. Further, it might be problematic to use healthy individuals as control participants when comparing brain activation patterns, as discussed by Kuyck et al. (2009). They claim that healthy, normal weight controls might not be the optimal choice when comparing them to anorexic participants. The reason for this is that anorexic women might exhibit changes in regional brain metabolism, which are not
correlated to the psychiatric symptoms of interest, due to prolonged malnutrition. Rather an additional control group, with underweight participants, might be a better option.

Conclusion

Body image distortions seem to involve a distributed neural network. This neural network involves deviations in perceptual, emotional and cognitive processes. There seems to be a disagreement as to exactly which neural networks, and to what degree, that are active during body image disturbances. Evidence points toward a combination of both a perceptual and a cognitive-affective component. Differences in the underlying neural activity might reflect different cognitive styles and evaluations among those suffering from pathological eating patterns. Further, there is also evidence of different cognitive styles between genders. In conclusion, the relationship between body image distortions and disturbed eating patterns is complex in its nature. The question of how disturbed eating patterns might influence body image distortions and whether these distortions could be applied to women in general is still ambiguous. More research, especially longitudinal studies is needed in order to find the exact neural mechanisms behind the phenomenon of body image distortions.
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