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BODY PERCEPTION AND EVALUATION IN ANOREXIA NERVOSA

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My love is as a fever, longing still
For that which longer nurseth the disease,
Feeding on that which doth preserve the ill,
Th’ uncertain sickly appetite to please.
My reason, the physician to my love,
Angry that his prescriptions are not kept,
Hath left me, and I desperate now approve
Desire is death, which physic did except.
Past cure I am, now reason is past care,
And frantic-mad with evermore unrest;
My thoughts and my discourse as madmen’s are,
At random from the truth vainly express’s;
    For I have sworn thee fair, and thought thee bright,
    Who art as black as hell, as dark as night.

William Shakespeare, Sonnet 147

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As the poet in Shakespeare's poem was obsessed with his passion for a Dark Lady, so I had become obsessed with the completion of this work; and as the poet, I would not listen to my reason/physician who told me that my work style was unhealthy. Dear reader, if your reason ever tells you that the obsession you're pursuing is unhealthy, be it a Dark Lady (or Dark Knight), knowledge, thinness, control, or perfection, please follow his prescriptions. Most importantly, take care of your body, for it is the most precious thing you own.

Annika Petra Christine Lutz
Luxembourg, February 2015

Abstract

Body image disturbance is a prominent feature in anorexia nervosa (AN) and encompasses alterations across the different dimensions of body image, that is, perception, affect, cognition, and behaviour. There is a wealth of research regarding the subjective experience of body image disturbance and evidence for underlying neuronal alterations is beginning to emerge. The present project was designed to assess basic processes underlying body image disturbance with the help of psychophysiological measurement techniques and self-other discrimination tasks. In study 1, using a self-other discrimination task with distorted body images, we were able to demonstrate interactions between perceptual factors and cognitive bias which may sustain a distorted and negative body image in healthy women. Study 2 showed a discrepancy between explicit negative ratings for body shapes and implicit neutral affect towards the same images, as assessed with an affective startle-modulation paradigm, in healthy women and women with AN. These results suggest that automatic fear responses to fat-distorted self-body pictures, as well as implicit approach motivation towards thin body images, as reported in previous studies, are not present in all patients with AN. In study 3 a differential alteration of featural and configural visual processing of body images was detected in an event-related brain potentials (EEG-ERP) paradigm. Individuals with AN showed a lack of discrimination between self-body and self-object pictures between 105 and 160 ms after stimulus onset (P1 component, featural processing) and an enhanced processing of body relative to neutral object pictures between 160 and 225 ms after stimulus onset (N1 component, configural processing). This suggests alterations in the basic visual processing of body shapes in AN, which might be related to influences of top-down attentional modulation. Study 4 showed enhanced processing of cardiac visceral signals in the central nervous system (CNS) in individuals with AN, which might either be a marker of psychopathology, in particular anxiety, or an indication of clinical improvement. In summary, the present results do not support the view of a global perceptual deficit in AN, but demonstrate the complexity of body image alterations in AN. It appears mandatory to further investigate basic processes underlying body image disturbances in AN and in healthy women to arrive at a comprehensive understanding of their nature and to provide a theoretical basis for body image interventions. The importance of using specific assessment methods, such as indicators of body-related processing in the CNS, is highlighted.

Contents

1. Introduction

"Our bodies are our gardens, to the which, our wills are gardeners."

William Shakespeare, Othello (Act I, Scene 3)

The central nervous system (CNS) is the control centre of the body. At all times, it must, to a certain degree, possess information about the state of the body in order to move efficiently through the world. By taking into account the internal and the external state, a behavioural decision is made. In this context, an especially important piece of information from the body is the available amount of energy. Without energy, the body is unable to survive. Therefore, when energy levels decrease, a decision to eat is made and put into practice as soon as food is available. Yet, there are situations, in which social constraints may not allow us to eat although we are hungry. Moreover, we may wilfully decide to eat less in order to lose weight. Here, another perception of the body comes into play; this time, it is the perception of the body as an entity in the world, as it is perceived from outside. Our dislike of what we see outside may influence our behaviour in a way that has consequences for what we perceive inside, by reducing energy supply.

In some cases, the attempt to lose weight by restricting food intake may run out of control. If food restriction is carried to the extreme, it becomes a health hazard. It is one of the key characteristics of the clinical presentation of anorexia nervosa (AN) that food intake is reduced to a minimum and disturbances of the hormonal system, resulting in amenorrhea, are usually the consequence. Apart from that, physiological consequences of starvation affect almost all organ systems, from gastrointestinal complications to cardiovascular problems to osteoporosis and electrolyte disturbances (Katzman, 2005; Mitchell & Crow, 2006). These severe physiological consequences contribute to the fact that AN is one of the most lethal mental disorders (Harris & Barraclough, 1998).

Nevertheless, strict fasting with all its consequences is not the only characteristic of AN. On a psychological level, it is characterised by a fear of weight gain and a disturbance in body image (American Psychiatric Association, 2000, 2013). Scientific interest in this aspect of AN was sparked in the 1960's by Hilde Bruch's clinical observations of body image disturbances in her patients with AN (Bruch, 1962). She suggested three main characteristics of AN. The first is a disturbance of body image in relation to body shape and weight, that is, the patients'

inability of perceiving their weight as dangerously low. The second is a disturbance in the perception of signals originating from within the body, especially those related to nutritional needs. As the third characteristic, Bruch suggested a sense of ineffectiveness, that is, a feeling of not being master of one's own body and life. A multitude of studies on body shape distortion and interoception in AN followed these observations in the 1970's, and interest in these topics is still strong in the 2000's, with new possibilities offered by brain imaging methods. Yet, with all the knowledge we have gained throughout the last decades, we are still far from understanding the exact nature of body image disturbances in AN. Research on body image in AN has also benefited from advances in general body image research. It is becoming ever more widely recognised that body image is a multidimensional construct and that perception, affect, cognition, and behaviour must be taken into account when trying to elucidate the nature of body image and its alterations in AN (Cash & Green, 1986). The current research project was based on this idea of a multidimensional body image and provides a detailed analysis of basic processes implicated in the perception and evaluation of the body and their alteration in individuals with AN.

2. State of the Art

2.1. Anorexia Nervosa

AN is an eating disorder, which has been described for the first time by that name in the second half of the 19th century (Vandereycken, van Deth, & Meermann, 2003). The main symptom of AN is a low body weight which is achieved by strict fasting and, in some cases, high levels of exercise or compensatory behaviours such as self-induced vomiting. These nutrition related behavioural patterns are accompanied by body image disturbances, manifest in a prominent fear of weight gain and often a perceptual distortion of body dimensions. Today the Diagnostic and Statistical Manual of Mental Disorders (5th edition; DSM-V; American Psychiatric Association, 2013) lists AN next to bulimia nervosa (BN), which is characterised by recurrent episodes of binge eating and compensatory behaviours in normal-weight individuals, and binge eating disorder (BED), where binge eating occurs in the absence of prominent compensatory behaviours. AN is not a very frequent disorder. A recent review reported lifetime prevalence rates between 0.9 and 2.2% and a point prevalence with an average of 0.3% for young females, with the highest incidence rates between 15 and 19 years of age, and a much lower prevalence for men (Smink, van Hoeken, & Hoek, 2012). Nevertheless, the physiological consequences of malnutrition are severe and contribute to high mortality rates. A recent meta-analysis found a standardised mortality ratio of 5.86 (95% CI, 4.17 - 8.26) for individuals with AN (Arcelus, Mitchell, Wales, & Nielsen, 2011). Moreover, treatment of AN is difficult and long-term prognosis discouraging. A long-term follow-up study found that after 21 years only 50.6% of the patients had achieved and maintained full recovery (Zipfel, Löwe, Reas, Deter, & Herzog, 2000). The seriousness of the disorder and dissatisfying treatment outcome make evident the need for further research on the aetiology of AN and the improvement of current treatment approaches.

2.1.1. Diagnostic Criteria

In the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American Psychiatric Association, 2000) the diagnosis of AN requires a body weight which is less than 85% of expected weight, corresponding to a body mass index (BMI) of 17.5 in adult women. In addition, the patient must display a prominent fear of weight-gain. Moreover, a body image disturbance must be present, or self-esteem must be unduly influenced by body

weight or shape, or the patient must deny that her body weight is seriously low. Furthermore, DSM-IV requires the presence of amenorrhea, that is, menstruation must be absent for at least three consecutive menstrual cycles. AN may manifest in two different subtypes, the binge-eating/purging type, which is characterised by recurrent episodes of binge eating or compensatory behaviours and the restricting type, in which such behaviours are absent. In DSM-V (American Psychiatric Association, 2013) the weight criterion was slightly increased to a BMI of below 18.5 and the amenorrhea criterion was dropped, as the usefulness of both criteria had been criticised (Watson & Andersen, 2003). Moreover, fear of weight gain is no longer mandatory, if the patient engages in behaviours that prevent weight gain. This is due to the frequent presentation of non-fat-phobic AN, especially in Asian countries (Lee, Ho, & Hsu, 1993; Tareen, Hodes, & Rangel, 2005). The diagnostic criteria for AN in DSM-IV are contrasted with those in DSM-V in Table 1.

Table 1

Diagnostic Criteria for AN According to DSM-IV and DSM-V

DSM-IV: 307.1	**DSM-V: K 03**
A. Refusal to maintain body weight at or above a minimally normal weight for age and height (e.g., weight loss leading to maintenance of body weight less than 85% of that expected; or failure to make expected weight gain during period of growth, leading to body weight less than 85% of that expected).	A. Restriction of energy intake relative to requirements leading to a significantly low body weight in the context of age, sex, developmental trajectory, and physical health. Significantly low weight is defined as a weight that is less than minimally normal (e.g. BMI below 18.5), or, for children and adolescents, less than that minimally expected (e.g. BMI below 10^{th} percentile).
B. Intense fear of gaining weight or becoming fat, even though under-weight.	B. Intense fear of gaining weight or becoming fat, or persistent behaviour that interferes with weight gain, even though at a significantly low weight.
C. Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight.	C. Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or persistent lack of recognition of the seriousness of the current low body weight.
D. In postmenarcheal females, amenorrhea, i.e., the absence of at least three consecutive menstrual cycles. (A woman is considered to have amenorrhea if her periods occur only following hormone, e.g., oestrogen administration).	
Specify type:	*Specify current subtype:*
Restricting Type: during the current episode of Anorexia Nervosa, the person has not regularly engaged in binge eating or purging behaviour (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas).	Restricting Type: during the last 3 months, the individual has not engaged in recurrent episodes of binge eating or purging behaviour (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas).
Binge-Eating/Purging Type: during the current episode of Anorexia Nervosa, the person has regularly engaged in binge eating or purging behaviour (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas).	Binge-Eating/Purging Type: during the last 3 months, the individual has engaged in recurrent episodes of binge eating or purging behaviour (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas).

Note. AN = anorexia nervosa; DSM = Diagnostic and Statistical Manual of Mental Disorders; BMI = body mass index.

2.1.2. Risk Factors

The Western beauty ideal of a slim body has often been labelled as the culprit for eating disorders in the media. This idea has been fostered by research studies showing that exposure to media messages related to the thin ideal increases body dissatisfaction (for a review see (Grabe, Ward, & Hyde, 2008). Nevertheless, as most women in Western societies are exposed to the media but not all of them develop an eating disorder, there must be mediating or additional factors. Internalisation of the thin ideal, that is, accepting the society's ideal as one's own ideal, has been shown to be an important link between the societal thin ideal and body dissatisfaction and eating pathology (Thompson & Stice, 2001). In addition, critical comments about one's weight from others have been identified as a potent risk factor for eating disorders (Jacobi et al., 2011). Regardless of what causes body dissatisfaction, body dissatisfaction itself is a well-established risk factor for dieting and eating disorders (Jacobi, Hayward, de Zwaan, Kraemer, & Agras, 2004; Stice, 2002). Apart from society's role, it has been shown that body shape concern underlies a considerable genetic influence (Wade, Martin, & Tiggemann, 1998).

In addition to dissatisfaction with the body's appearance, deficits in interoceptive awareness (cf. chapter 2.2.4) predicted eating disorder symptom onset in several studies (Killen et al., 1996; Leon, Fulkerson, Perry, & Early-Zald, 1995; Leon, Fulkerson, Perry, Keel, & Klump, 1999). However, other findings concerning this risk factor have been variable (Jacobi, Hayward, et al., 2004), probably because of operationalization issues regarding this factor. In most studies a self-report questionnaire was used, that is, the subscale Interoceptive Awareness of the Eating Disorder Inventory (EDI; Garner, Olmstead, & Polivy, 1983). This scale focuses mainly on difficulties in perceiving emotions, with additional items on the perception of hunger and satiety. Accordingly, it comprises a rather broad construct and confounds interoceptive processes of different levels (cf. chapter 2.2.4). This example illustrates the necessity of precise definitions and operationalizations in risk factor research.

Next to the risk factors mentioned above, a multitude of other factors has been suggested, such as negative affect (Leon et al., 1999) or adverse perinatal events (Bulik, Reba, Siega-Riz, & Reichborn-Kjennerud, 2005). A recent meta-analysis has demonstrated the complexity of risk factors so far established for eating disorders (Jacobi, Hayward, et al., 2004). Eating disorders in general and AN in particular are determined by a multitude of factors. These come into play at different points over the lifespan, from the moment of conception to the

teenage years, when the disorder is most likely to appear (Jacobi, Hayward, et al., 2004). In all likelihood, the exact combination of factors that leads to the onset of AN is different in each individual case.

2.2. Body Image

2.2.1. A Multidimensional Approach to Body Image

Body image research began with the simple definition of body image being "the picture of our own body which we form in our mind, that is to say the way in which the body appears to ourselves." (Schilder, 1935; cited from McCrea, Summerfield, & Rosen, 1982). A later definition added influencing factors and described body image as "a loose mental representation of body shape, size, and form which is influenced by a variety of historical, cultural and social, individual, and biological factors, which operate over varying time spans" (Slade, 1994, p. 502). By and by, it was suggested that body image is a multidimensional construct. First, the dimensions of body perception and attitude were distinguished (Rucker & Cash, 1992; Slade, 1988). Later, it was suggested that body image consists of four dimensions: perception, affect, cognition, and behaviour (Cash & Green, 1986; Vocks, Legenbauer, Troje, & Schulte, 2006). Today, the dimensionality of body image is a commonly held view, whereas the exact number of dimensions remains debated (Banfield & McCabe, 2002; Gleaves, Williamson, Eberenz, Sebastian, & Barker, 1995). Using factor analysis, Banfield and McCabe (2002) were able to reproduce the perception and behaviour factors, but found that body-related affect and cognition loaded on the same factor. This is not surprising as the two processes are closely related and might be even more so when assessed via self-report questionnaires, where participants might not make a difference between thinking that a body part is too big and feeling bad about that body part. This finding highlights the importance of precise definitions and precise measurement techniques which include the assessment of implicit affect (cf. study 2).

The division of body image into separate dimensions might be artificial to some degree as they are strongly intertwined with each other. Nevertheless, the distinction of body image dimensions may help to inform research into specific body image processes and their interactions. These interactions become obvious in the following every-day example: A

perception might be one's own body shape seen in a mirror. A resulting affective evaluation might be a feeling of disgust at the sight of one's love handles. This might be accompanied by the cognition: "I am too fat and should lose a couple of pounds", which might result in a weight loss diet on the behavioural level. The effect of the behaviour, for example, losing or not losing the extra pounds after dieting, will in turn influence perception and evaluation.

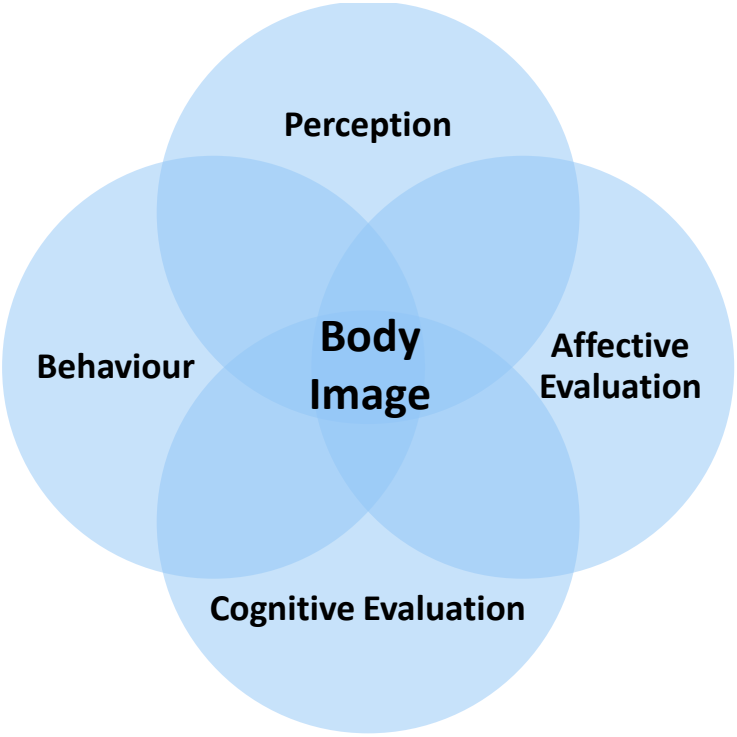

Figure 1. Illustration of the four-dimensional body image model.

Furthermore, body image is often distinguished from body schema, which is action-related and contains sensorimotor representations (de Vignemont, 2010). Whereas the definition of body schema is rather uniform, body image has sometimes been described as containing all other representations of the body, which are not part of the body schema. The exact relationship between body image and body schema remains unclear (de Vignemont, 2010). It has recently been recognised that body schema might also be altered in eating disorders and that this might be linked to alterations in body image (Favaro et al., 2012; Metral et al., 2014). However, the exact role of body schema alterations in eating disorders remains to be determined by future research.

2.2.2. Modalities of Body Perception

We may recruit all our senses in order to obtain information about the current state of the body. There are the senses usually employed for the perception of the outside world, that is, vision, audition, olfaction, gustation, tactile sense. These give us information about the body in relation to the outside world. As humans are social creatures, a very important function of these senses is to inform us about how our body might be perceived by others. However, there are also the senses that inform us about the internal state of the body, only partly with regard to the outside world. Proprioceptive signals feed the brain with information about the position of the body and its limbs and the condition of muscles, tendons, and joints, whereas viscerception provides information about the state of inner organs (Birbaumer & Schmidt, 2006; Schandry, 2003; Vaitl, 1996). All senses combined give us the possibility to perceive the current internal state of our body, its position in space, and its outward appearance. When the current state of the world around us is added, the brain possesses all relevant information in order to effectively adjust behaviour (Vaitl, 1996). Figure 2 illustrates the different modalities of body perception in the exteroceptive and interoceptive domains.

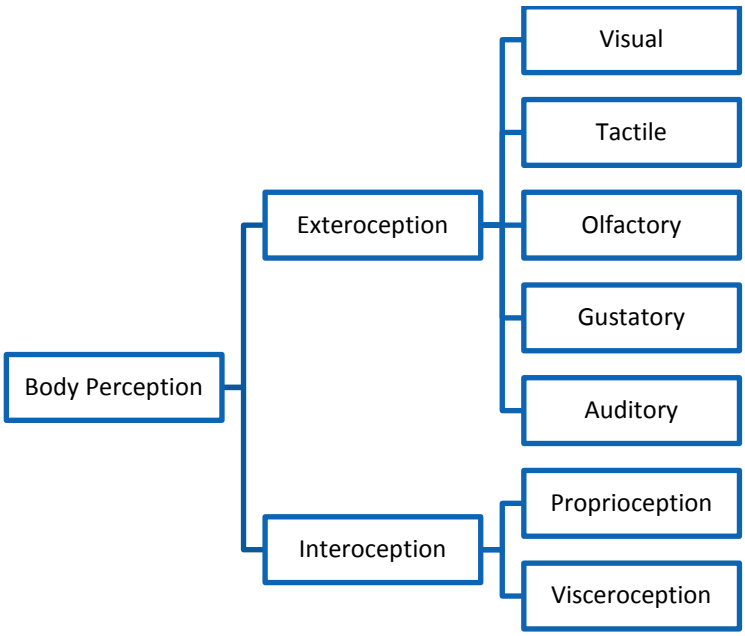

Figure 2. Illustration of the different modalities of body perception in the exteroceptive and interoceptive domains (Birbaumer & Schmidt, 2006; Schandry, 2003; Vaitl, 1996).

There have been reports on alterations in several perceptive modalities in persons with AN, such as lower olfactory sensitivity (Aschenbrenner, Scholze, Joraschky, & Hummel, 2008; Schreder et al., 2008), altered taste processing in the CNS (Wagner et al., 2008), and

impairments in proprioception (Eshkevari, Rieger, Longo, Haggard, & Treasure, 2012, 2013). A recent review summarised findings on deficits in tactile and proprioceptive processing (Gaudio, Brooks, & Riva, 2014). It is important to note that perceptive alterations in different modalities may interact. On this note, it has recently been demonstrated that in AN visual size overestimation might also be related to distorted somatosensory feedback and a disruption of somatosensory and visuospatial connectivity (Favaro et al., 2012). This has direct consequences for actions, as became apparent in a task where participants with AN had to judge whether they could pass through different doorway-like apertures and then actually pass through the doorways (Metral et al., 2014). As the current project is concerned with visual and visceral body perception, these modalities will be described in detail below.

2.2.3. Visual Perception and Body Size Overestimation

Of the exteroceptive senses, the most relevant one with regard to eating disorders is most likely vision. By looking at ourselves in the mirror, we may obtain information about what we look like to others. These perceptions inform our visual body image, that is, the representation of our body shape and outward appearance (Slade, 1994). This visual body image has been found to be distorted in individuals with AN. On average, they overestimate the size of their bodies, an effect, which has been replicated many times and has been confirmed in three meta-analyses up to date (Cash & Deagle, 1997; Sepúlveda, Botella, & León, 2002; Smeets, 1997). Moreover, overestimation has been found to be related to worse prognosis (Garfinkel, Moldofsky, & Garner, 1977; Slade & Russell, 1973). It has been suggested that overestimation in individuals with AN is a mere consequence of their low BMI, as underweight individuals without AN also show body size overestimation (Penner, Thompson, & Coovert, 1991). Nevertheless, this cannot explain why individuals with BN also overestimate their body size (Cash & Deagle, 1997), as they are not usually underweight. It appears therefore that size estimation may be influenced by more than one process and it has repeatedly been suggested that body perception is influenced by affective, cognitive, and other factors, such as hunger (Farrell, Lee, & Shafran, 2005; Slade, 1994). In this context, the distinction between perceptual and attitudinal factors has been proposed, which may exert more or less influence on body size judgement according to the method applied (Cornelissen, Johns, & Tovée, 2013). This in turn would mean that body size estimation is not a measure of visual body perception per se and that more precise measures are needed to tackle this component of body image. Some investigations have addressed this issue by applying signal

detection methodology, which allows for the separation of sensitivity from response bias (cf. chapter 3.1.2). These studies found alterations only in response bias, but not in sensory sensitivity in individuals with AN (Gardner & Moncrieff, 1988; Smeets, Ingleby, Hoek, & Panhuysen, 1999). Yet, it has been pointed out that cognitive bias may affect sensory processing in a top-down manner and therefore lead to alterations in sensory processes after all (Farrell et al., 2005). In consequence, it appears mandatory to more closely investigate processes of basic body perception in AN.

The brain areas mainly associated with visual body perception are the extrastriate body area (EBA; Downing, Jiang, Shuman, & Kanwisher, 2001) and fusiform body area (FBA; Peelen & Downing, 2005; for reviews see: De Gelder et al., 2010; Peelen & Downing, 2007).Women show a lateralisation with greater activation in the right hemisphere in both areas, whereas men do not (Aleong & Paus, 2010). The right EBA seems to contain neural sub-populations that are selectively activated by one's own vs. other bodies (Myers & Sowden, 2008). Functionality (Uher et al., 2005) and connectivity (Suchan et al., 2012) of the EBA appear to be altered in patients with AN and a reduced density of grey matter has also been observed (Suchan et al., 2010). A recent review by Gaudio and Quattrocchi (2012) identifies the EBA, fusiform cortex, inferior parietal lobe, and precuneus as being mainly affected during body image perception in patients with AN. The authors especially stress the possible role of the inferior parietal lobe and precuneus in the distorted perception that patients display towards their own body and not towards other women's bodies (Gaudio & Quattrocchi, 2012). Activity in the EBA has been shown to increase with body image treatment (Vocks et al., 2010).

2.2.4. Visceroception and the Perception of Hunger and Satiety in Anorexia Nervosa

Visceroception refers to the perception of signals from internal organs. Although it is a subcomponent of interoception, the two terms have often been used interchangeably, and will be used so in the following. A variety of measures have been used in order to assess interoception. As correlations between different assessment methods are often weak, it has been suggested that they refer to different aspects of interoception, that is, the dimensions of interoceptive accuracy, sensibility, and awareness (Garfinkel & Critchley, 2013; Garfinkel, Seth, Barrett, Suzuki, & Critchley, 2014). According to this terminology, interoceptive accuracy refers to measures of accuracy of the perception of bodily signals, such as the

number of counted heartbeats in relation to the number of recorded heartbeats during a given interval. Interoceptive awareness is the metacognitive awareness about interoceptive accuracy while interoceptive sensibility encompasses self-report measures of body perception tendencies.

Visceroceptive signals are encoded by mechanoreceptors, thermoreceptors, chemoreceptors, and nociceptors and are transmitted to the brain via afferent fibres of the parasympathetic and sympathetic nervous system (Vaitl, 1996). Via nuclei in the brain stem, for example, nucleus tractus solitarii, the signal is transferred to subcortical and cortical areas where a representation of the signal is formed, including hypothalamus, thalamus, insular cortex, cingulate gyrus, and amygdala (Cameron, 2009). The majority of afferent signals from the viscera serves homeostatic functions and does not enter conscious processing (Birbaumer & Schmidt, 2006). A major role in the conscious perception of visceral signals seems to be played by the right anterior insula (Craig, 2002; Critchley, Wiens, Rotshtein, Öhman, & Dolan, 2004; Pollatos, Kirsch, & Schandry, 2005a). In this context, it has been suggested that there is a competition between internal and external cues to attain the limited resources of cognitive processing with preference being given to the more salient cue (Pennebaker & Lightner, 1980). Accordingly, external cues will be more salient most of the time, while internal sensations become salient after exertion, morbid processes, or when attention is explicitly focused on them. A simplified model of interoceptive processing from the visceral process to verbal or motor report is presented in Figure 3.

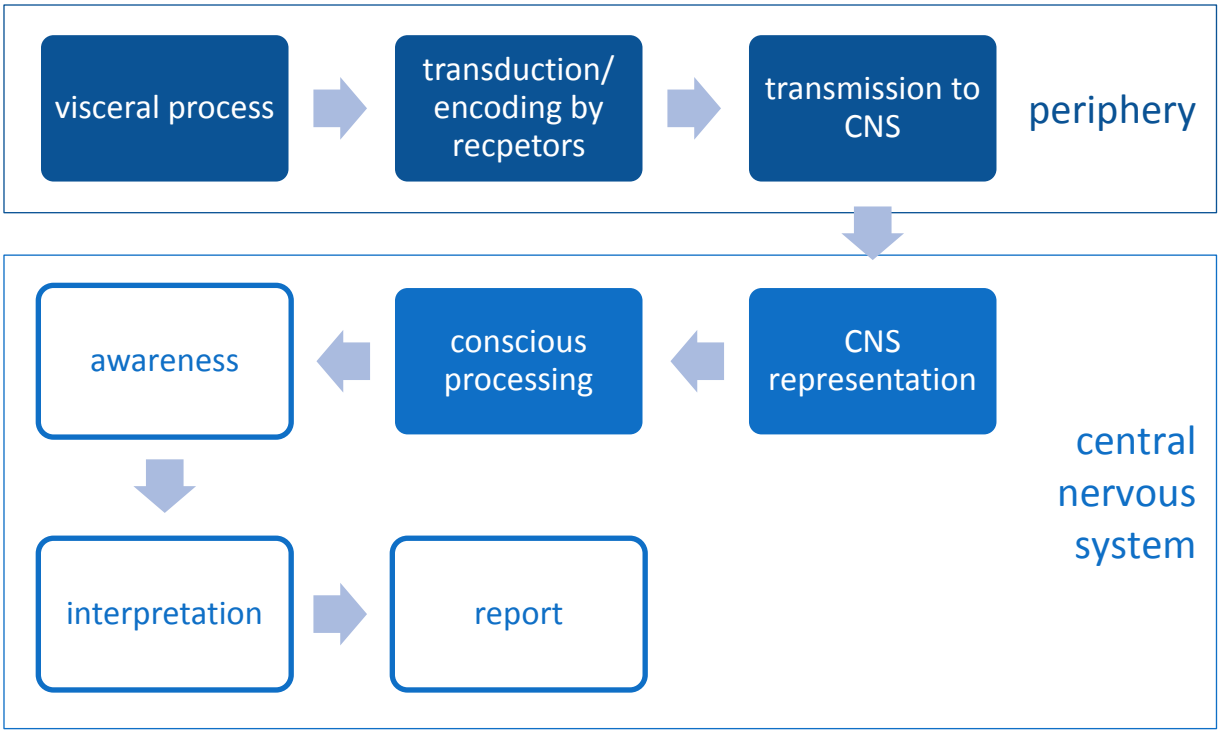

Figure 3. Flow chart of interoceptive processing. The visceral process in question, for example, a heartbeat, is encoded by receptors and transmitted to the central nervous system (CNS). In the CNS, a preconscious representation of the visceral process is formed, which may be accessed by conscious processing. This in turn involves awareness of the visceral process, its interpretation, and finally, a report on what has been perceived (Vaitl, 1996).

Perception of Hunger and Satiety in Anorexia Nervosa

In eating disorder research, interoception has mainly been investigated in the sense of hunger and satiety sensations. Since Bruch (1962) observed deficits in the perception of hunger and satiety in her patients with AN, several studies have been conducted in order to explore this phenomenon. In the fasted state, individuals with AN were found to give lower ratings of hunger as compared to healthy controls in some studies (Halmi, Sunday, Puglisi, & Marchi, 1989; Halmi & Sunday, 1991; Herpertz, Moll, Gizewski, Tagay, & Senf, 2008), but not in another (Garfinkel, 1974). Ratings of satiety after fasting were consistently elevated (Garfinkel, Moldofsky, Garner, Stancer, & Coscina, 1978; Halmi et al., 1989; Halmi & Sunday, 1991). Findings of reduced hunger levels in AN have been replicated with a dose of 2-deoxy-D-glucose (Yoshikatsu Nakai, Kinoshita, Koh, Tsujii, & Tsukada, 1987) and during insulin-induced hypoglycemia (Nakai & Koh, 2001). During meal intake, hunger and satiety ratings appear to be altered in AN, although the precise nature of these alterations remains unclear due to the small number of studies available at this moment and methodological differences between the studies. One study reported a possible confusion of the concepts of

hunger and satiety in AN, as the negative relationship between the two was less pronounced than in the healthy control group (Halmi & Sunday, 1991). Moreover, hunger and satiety curves across a meal were generally altered (Halmi et al., 1989; Halmi & Sunday, 1991), a phenomenon, which persisted even after successful treatment (Halmi et al., 1989). A more recent study (Herpertz et al., 2008) found that satiety ratings continued to rise in patients with AN, whereas they reached a plateau in healthy controls. In an attempt to measure gastrointestinal perception more directly, Coddington and Bruch (1970) introduced a liquid meal directly into their participants' stomachs and found that individuals with AN were less accurate in judging the amount introduced than healthy controls. Concerning the period after a meal, a poor responsiveness to physiological satiety signals has been described by Garfinkel (1978) using an aversion to sucrose test. The control group developed an aversion to sucrose tastes after a test meal, while the anorexic group failed to do so. This effect was related to body size overestimation and remained unaltered after treatment.

It should be mentioned, however, that hunger and satiety ratings may not depend on the perception of physiological symptoms alone, but might be influenced by cognitive processes. Accordingly, it has been found that external cues, such as calorie content (Garfinkel et al., 1978) and amount (Herpertz et al., 2008) of the food consumed affect satiety ratings in individuals with AN. Moreover, in one study, persons with AN experienced the viewing of food pictures as satiating (Herpertz et al., 2008). Meal termination appears to be cognitively determined in AN, according to the individual's dieting rules (Garfinkel, 1974). These findings suggest that individuals with AN might not rely entirely on physiological sensations when reporting hunger and satiety levels and when deciding how much to eat. It might therefore be possible, that lower hunger and higher satiety ratings found in samples with AN are biased by cognitive distortions that facilitate fasting. Consequently, we are facing a similar problem as in the case of body size estimation, that is, that self-reported perception might not be perception in the narrow sense of the word, but might be influenced by cognitive factors.

Findings on altered hunger and satiety ratings have recently been complemented by a study demonstrating deficits in the perception of heartbeats in persons with AN (Pollatos et al., 2008). This finding, concerning interoception of a different visceral system, may hint at a more general interoceptive processing deficit, but again, cognitive bias in the reporting of internal sensations cannot be excluded. In conclusion, methods are required, which assess interoceptive signal processing in a more direct way, in order to be able to clearly distinguish between perception and cognitive bias. In addition, it must be clarified if the ability to

perceive internal signals is at all relevant in AN, or if the link between perception and action has simply been disrupted by cognitive attitudes. It might be the case that individuals with AN are well aware of their bodily sensations, but that they do not interpret them as a motivational state, that is, hunger, and do not act upon them, that is, by eating.

The results of a study on gastric functioning are in line with this idea. After short-term food deprivation, persons with AN had measurable stomach contractions, which at least some of them were able to feel, but which they did not interpret as indicators of hunger (Silverstone & Russell, 1967). Similar findings were obtained by Crisp (1965). Other studies reported delayed gastric emptying and alterations in gastric motility in individuals with AN (Dubois, Gross, & Ebert, 1984; Holt, Ford, Grant, & Heading, 1981; Hölzl & Lautenbacher, 1984). On a biochemical level, prolonged insulin responses after glucose injection have been found (Crisp, 1965). Insulin is known to affect CNS processing of food pictures in a way, which is likely to be associated with the termination of food intake (Guthoff et al., 2010). Prolonged insulin responses in AN might, therefore, be associated with higher satiety levels and might facilitate fasting. These findings indicate that alterations in the visceral processes, which are likely to be involved in forming sensations of hunger and satiety, are another factor that needs to be taken into account when investigating visceroception in AN.

Altered perception or interpretation of visceral stimuli in AN has also been found to be represented by alterations in CNS activity. While several studies have investigated neural responses to food stimuli in AN, only a small number of these investigations have explicitly manipulated hunger and satiety by short-term fasting and test meals. One study (Santel, Baving, Krauel, Münte, & Rotte, 2006) found that during the satiated state, individuals with AN showed decreased activation in the inferior parietal lobe, which was related to dietary restraint. Consequently, a lower level of somatosensory-gustatory processing might support fasting behaviour. In the hungry state, there was decreased activation in the occipital cortex, which most likely indicates reduced salience of food stimuli (Santel et al., 2006). Note that the above described alterations occur at different levels of interoceptive processing, that is, CNS representation of visceral processes in the satiated state versus attentional allocation as a consequence of visceroceptive processing in the hungry state. Another study (Vocks, Herpertz, Rosenberger, Senf, & Gizewski, 2011) performed gustatory stimulation during hunger and satiety and reported greater activations in amygdala and EBA in individuals with AN during satiety than during hunger, which they suggested might relate to fear of weight gain. In contrast, the control group showed stronger activation of the insula during satiety than

hunger (Vocks et al., 2011). Accordingly, the AN group did not show the same differential insula activation as the control group, which is in line with other reports on altered insula activity in AN. The possible role of the insula in the aetiology of eating disorders is discussed in detail in chapter 2.3.2.

Interoceptive Sensibility

In eating disorder research the most frequently used measure of interoceptive sensibility is the subscale Interoceptive Awareness of the EDI (Garner et al., 1983). This subscale consists of items referring to the experience of hunger and satiety, as well as items on the experience of emotions. The EDI subscale Interoceptive Awareness predicted symptom onset in several studies (Killen et al., 1996; Leon et al., 1995, 1999). Moreover, the Interoceptive Awareness subscale has been found to be related to depression, perfectionism, and low levels of self-directedness (Fassino, Pierò, Gramaglia, & Abbate-Daga, 2004). Items on the experience of emotions in the EDI subscale Interoceptive Awareness are nearly identical to items in frequently used measures of alexithymia, for example, the Toronto Alexithymia Scale (Taylor, Ryan, & Bagby, 1985). Alexithymia refers to deficits in identifying and describing emotions (Taylor et al., 1985). Consequently, individuals with AN have been found to display elevated levels of alexithymia (Bydlowski et al., 2005; Speranza et al., 2005; Zonnevijlle-Bendek, van Goozen, Cohen-Kettenis, van Elburg, & van Engeland, 2002). Moreover, higher levels of alexithymia were associated with unfavorable long-term outcome in one study (Speranza, Loas, Wallier, & Corcos, 2007). It is reasonable to mention these findings in the context of interoception as several theories of emotion have emphasized an important role of the perception of bodily symptoms for the experience of emotions (Damasio, 1996; James, 1884; Schachter & Singer, 1962). Another associated function is decision making, which has been suggested to partly rely on bodily sensations, so called *somatic markers* (Damasio, 1996). This process has also been found to be impaired in AN and other eating disorders (Brogan, Hevey, & Pignatti, 2010). Yet, as emotions and decision making are assumed to be secondary processes building on primary interoceptive processes, it is necessary to treat them separately in order to form a comprehensive picture of interoceptive alterations in AN. In consequence, the usefulness of the EDI subscale Interoceptive Awareness in interoception research is limited.

Taken together, findings on interoception support Bruch (1962)'s idea of wide-ranging alterations in interoceptive processes in AN. Nevertheless, the predominant use of self-report

measures leaves questions about underlying processes largely unanswered. Of particular interest should be the investigation of the particular roles played by alterations in the visceral process itself, its CNS representation, and its conscious perception and interpretation (cf. study 4).

2.2.5. Affective and Cognitive Evaluation and Behavioural Consequences

Looking at their body in a mirror evokes negative thoughts and feelings in individuals with eating disorders (Vocks, Legenbauer, Wächter, Wucherer, & Kosfelder, 2007). As these negative thoughts and feelings are deeply intertwined, it is difficult to distinguish between cognitive and affective aspects of body dissatisfaction (Banfield & McCabe, 2002). Consequently, studies assessing purely affective or purely cognitive evaluation remain rare. In an attempt to directly investigate emotional processes in the brain, two studies have reported activation of the amygdala when individuals with AN were confronted with manipulated photographs of their own bodies which had been distorted in order to simulate weight gain (Miyake, Okamoto, Onoda, Kurosaki, et al., 2010; Seeger, Braus, Ruf, Goldberger, & Schmidt, 2002). Moreover, amygdala activation has been reported in persons with AN when reading unpleasant body-related words (Miyake, Okamoto, Onoda, Shirao, et al., 2010). Nevertheless, it must be mentioned that amygdala activation was not found in other studies using fat-distorted body pictures (Wagner, Ruf, Braus, & Schmidt, 2003) or unpleasant body-related words (Redgrave et al., 2010). In contrast, drive for thinness appears to be associated with the elicitation of implicit positive affect by pictures of underweight female bodies, as assessed with an implicit association test (Ahern, Bennett, & Hetherington, 2008) and a startle eye-blink modulation paradigm (Reichel et al., 2014). It has been suggested that fear of fatness and drive for thinness are components of body image in addition to size estimation and body dissatisfaction (Gleaves et al., 1995). Yet, they appear to represent basic motivational drives for approach (of thinness) and avoidance (of fatness). Approach and avoidance motivations are usually the consequence of positive and negative affect, respectively (Lang, 1995). Fear of fatness and drive for thinness might, therefore, be subcomponents of affective body image. These two aspects of body image disturbance and their underlying neuroanatomy are discussed in more detail in chapter 3.3.2.

Next to these immediate affective reactions, individuals with AN show prominent cognitive distortions, such as black and white rules with regard to weight regulation or an overvalued significance of control over eating and weight (Butow, Beumont, & Touyz, 1993). Moreover,

persons with AN have an implicit association between weight and self-esteem (Blechert, Ansorge, Beckmann, & Tuschen-Caffier, 2011). This has led researchers to adopt cognitive strategies for the treatment of AN (Garner & Bemis, 1982). In addition, individuals with AN have been found to show a range of attentional biases for body-related information (Faunce, 2002). For example, they show an attentional bias for their own body versus another woman's body (Blechert, Ansorge, & Tuschen-Caffier, 2010). They also appear to have a preference for thin body shapes over fat body shapes over social scenes, as detected with a free viewing eye-tracking paradigm (Pinhas et al., 2014). Moreover, it appears to make a difference whether individuals with AN are looking at their own body or at another person's body. This was shown in another eye-tracking study (Jansen, Nederkoorn, & Mulkens, 2005). In the latter study, persons with eating disorder symptoms preferentially looked at body parts they disliked when looking at their own body. In contrast, they had a bias for body parts they liked when looking at another person's body. Moreover, the induction of an attentional bias has been shown to increase body dissatisfaction (Smith & Rieger, 2006). Interactions with the behavioural domain have also been demonstrated, as body checking behaviour has been shown to cause an attentional bias for body-related stimuli (Smeets et al., 2011). The possible role of attentional bias in body image overestimation has been discussed in chapter 2.2.3. In summary, these findings highlight the interactions between body image dimensions and the necessity to operationalise each dimension in a precise manner, for example, by employing measures of implicit affective reactions rather than self-report.

Two prominent behavioural tendencies with regard to body image have been observed in AN: body checking and body avoidance (Shafran, Fairburn, Robinson, & Lask, 2004). Body checking behaviour describes a tendency to examine the body in detail for signs of fatness and thinness (Reas, Whisenhunt, Netemeyer, & Williamson, 2002), whereas body avoidance behaviours aim at an avoidance of the confrontation with one's body shape, for example, by wearing lose fitting clothing (Rosen, Srebnik, Saltzberg, & Wendt, 1991). Body checking is believed to arise from distorted thoughts about weight and shape (Mountford, Haase, & Waller, 2008). These behaviours have been proposed to perpetuate a distorted body image through magnification of some and neglect of other body parts, as well as by preventing an update of the distorted body image (Fairburn, Shafran, & Cooper, 1999). Cognitive-behavioural treatment programmes therefore usually include modules aiming at a decrease of such behaviours (Vocks et al., 2006).

2.3. Theoretical Models for the Development and Maintenance of Body Image Disturbance and Anorexia Nervosa

2.3.1. Cognitive Behavioural Models

Cognitive behavioural models of eating disorders build on the assumption that mental disorders develop through the interplay of a biological disposition with psychological and social variables. It is assumed that there are certain predisposing variables, such as fear of fatness, over-concern with body size, internalisation of the societal thin ideal, and perfectionism (Williamson, White, York-Crowe, & Stewart, 2004), as well as a heightened need for control (Fairburn et al., 1999). Specific events, such as negative comments about weight or shape from others (Jacobi et al., 2011) may then trigger initial dieting behaviour. In AN, dieting is then maintained as it increases feelings of self-control and improves self-esteem. In this context, body weight and shape serve as indicators for control in typical Western cases (Fairburn et al., 1999).

A cognitive-behavioural model on the development and maintenance of body image disturbance proposed by Vocks and Legenbauer (2010) also distinguishes between developing and maintaining factors. Body image disturbance develops against the background of sociocultural context, such as the emphasis placed on slimness in Western society (Grabe et al., 2008). Individual factors contributing to the development of body image disturbance are sensory information concerning the body, which contribute to the shaping of body image (Slade, 1994), physiological factors such as previous overweight or individual learning experience with influence from parents and peers (Jacobi et al., 2011), and personality traits, such as low self-esteem, depression, and anxiety (Strober, 1981). Once the negative body image has been formed, it can be activated by certain situations, for example, negative comments about the body from peers. The accompanying negative affect is then down-regulated by strategies such as body checking and body avoidance, which are dysfunctional in the long run and serve to maintain body image disturbance (Shafran et al., 2004). This model provided a suitable basis for a cognitive-behavioural body image treatment programme (Vocks & Legenbauer, 2010), which has been shown to reduce distorted cognitions and eating disorder psychopathology (Legenbauer, Schütt-Strömel, Hiller, & Vocks, 2011; Vocks et al., 2006) and to increase activity in the EBA (Vocks et al., 2010).

The evaluation of body image interventions in the context of eating disorder treatment is currently ongoing. Nevertheless, it has been criticised that many cognitive-behavioural treatments for body image disturbance, for example, mirror exposure, lack a clear theoretical basis (Farrell, Shafran, & Lee, 2006). In this context, the current project aims at elucidating underlying processes of body image disturbances, which have the potential of being targets for cognitive-behavioural interventions, for example, hypothesised fear responses when exposed to one's own body shape in AN (study 2) might be modified with exposure techniques.

2.3.2. Neurobiological Models: A Possible Role of the Insular Cortex

Recently, several neurobiological models have been proposed for AN, in light of the increasing amount of knowledge on alterations in brain processes, which has been obtained with neuroimaging techniques during the last 20 years. A range of neurological alterations has been described in AN, encompassing several brain structures. The model by Nunn and colleagues (Nunn, Frampton, Fuglset, Törzsök-Sonnevend, & Lask, 2011; Nunn & Frampton, 2008) proposes a key role for the insular cortex in these alterations, in its function as meditator between other brain structures. Another model, by Kaye and colleagues (Kaye, Fudge, & Paulus, 2009; Kaye, Wierenga, Bailer, Simmons, & Bischoff-Grethe, 2013) proposes that in AN the balance of reward and inhibition is shifted towards inhibition. Again, their model suggests that an important part is played by the anterior insula, as a key structure in encoding taste-related reward and bodily needs, through interconnections with the ventral striatum (Kaye et al., 2009).

The insula is a cortical structure, which lies at the base of the Sylvian fissure and is covered by the orbito-frontal, fronto-parietal, and temporal opercula. It forms part of the primary taste cortex and receives a variety of sensory information (Rolls, 2006). Accordingly, it plays a central role in integrating external information with information originating from within the body, which is the basis for effective behavioural adaptation. Moreover, it is involved in sympathetic and parasympathetic cardiovascular regulation (Shelley & Trimble, 2004). The insula is involved in experiencing emotions and sensing the state of the body and has, therefore, been brought forth as a possible neural substrate for self-awareness, that is, in creating the experience of a sentient being in the here and now (Craig, 2009). A theory on the role of the insular cortex in anxiety disorders suggests that the insula produces a predictive signal of future body states, in particular aversive body states. The anterior cingulate cortex

(ACC) then processes possible discrepancies between predicted and actual body state and generates an error signal. Based on this error signal a redistribution of cognitive resources is initiated. It has been proposed that in anxiety disorders the predictive signal is heightened, leading to the constant expectancy of aversive body states (Paulus & Stein, 2006). The theories detailed above also highlight the close interconnection between insula and ACC, possibly serving as somatosensory and motor cortices, respectively (Craig, 2009).

In individuals with AN several studies have reported structural and functional alterations of the insular cortex. Concerning morphology, two studies found reduced insula grey matter volume (Brooks et al., 2011; Friederich et al., 2012), while another found increased grey matter volume (Frank, Shott, Hagman, & Mittal, 2013). The authors of the latter study attribute these discrepant findings to differences in methodology, with possible confounding of grey and white matter alterations in the former studies. In studies assessing resting state cerebral activity, decreases in insula and ACC activation have been found in AN (Kojima et al., 2005; Naruo et al., 2001; Takano et al., 2001). Decreased activity in the ACC remained present after weight gain (Kojima et al., 2005). A preliminary clinical trial applied deep brain stimulation to the ACC of individuals with treatment resistant AN, which produced decreased metabolism in the ACC and bilateral insula, and metabolic changes in several other areas (Lipsman et al., 2013). Taken together, these studies indicate reductions in insula volume and activity in AN, with one exception (Frank et al., 2013).

A range of studies assessed brain activity during exposure to disorder relevant stimuli, that is, the sight and taste of food and the sight of body shapes. Taste processing is immediately associated with the insula, as this brain region forms part of the primary taste cortex (Rolls, 2006). In this context, lower activation of the insula in response to sucrose has been reported in individuals recovered from AN (Oberndorfer, Frank, et al., 2013; Wagner et al., 2008). Although taste ratings were correlated with insula activity in the control group, this was not the case in recovered individuals (Wagner et al., 2008). Another study also assessed individuals recovered from AN and found increased activation in insula and putamen in response to aversive tastes, in contrast to increased activation of the ventral striatum in response to pleasant tastes, when compared to healthy controls (Cowdrey, Park, Harmer, & McCabe, 2011). In addition, one study assessed taste-related reward learning and found stronger activation of the insula, antero-ventral striatum and prefrontal cortex in individuals with AN. Interestingly, obese individuals displayed smaller brain responses in the same areas (Frank et al., 2012). The latter studies indicate increased reactivity of reward-related brain

areas in response to tastes, while the former suggest generally diminished taste processing. This is in line with findings on reduced gustatory and olfactory sensitivity in AN, a deficit, which has been shown to improve with treatment (Aschenbrenner et al., 2008). As healthy control persons have been found to display *enhanced* insula responses to gustatory stimuli after 24 hours of fasting (Uher, Treasure, Heining, Brammer, & Campbell, 2006), *reduced* insula responses might be specific to AN or long-term fasting.

With regard to the processing of food pictures, findings are less consistent. Two studies report increased insula activation in individuals with AN when viewing high-calorie foods and drinks (Ellison, Foong, Howard, & Bullmore, 1998; Kim, Ku, Lee, Lee, & Jung, 2012), while another two studies describe decreased activation (Brooks et al., 2012; Holsen et al., 2012). A possible difference between the studies is that the latter involved either thinking about eating food (Brooks et al., 2012) or a test meal in between scans (Holsen et al., 2012), thereby providing a more direct link to food ingestion than mere picture viewing paradigms. Ingesting a meal did not produce alterations in insula activation in persons with AN, with continuing hypoactivation post-meal (Holsen et al., 2012). Two studies reported the absence of a correlation between insula activity and food stimuli ratings in individuals with AN, although this correlation was present in the control group (Holsen et al., 2012; Oberndorfer, Simmons, et al., 2013). This parallels findings on taste ratings, as described above (Wagner et al., 2008), indicating a decoupling of insula activation and food valuation in AN. Furthermore, one study reported increased activation of the anterior insula when anticipating food pictures (Oberndorfer, Simmons, et al., 2013). This finding is reminiscent of Paulus and Stein (2006)'s theory of a heightened insular prediction signal of future aversive body states in anxiety disorders. In a similar way, individuals with AN might have a heightened prediction signal for aversive body states related to food ingestion.

Apart from its relevance in the processing of food pictures, the insula has been found to be implicated in body-image related processes. In healthy persons, it has been reported to be involved in the processing of self-related stimuli (Devue et al., 2007) and the mental rotation of one's own hand (Bonda, Petrides, Frey, & Evans, 1995), indicating that it plays some role in forming a mental representation of one's own body, that is, the body image. In individuals with AN responses to self- versus non-self-pictures included decreased activation in the insula when compared to healthy controls, hinting at altered processing of self-related body information (Sachdev, Mondraty, Wen, & Gulliford, 2008). Other studies more explicitly examined affective body image (cf. chapter 2.2.5). Satisfaction ratings of own thin-distorted

body shapes produced insula and prefrontal cortex activation in individuals with AN (Mohr et al., 2010). In a similar vein, a comparison of one's own body to that of a slim model induced increased activation of the insula and the premotor cortex in individuals with AN, along with reduced activation of the ACC (Friederich et al., 2010). In addition, words related to thinness produced greater activation in the insula and surrounding regions in individuals with AN when compared to healthy controls (Redgrave et al., 2010). In summary, these findings indicate a role of the insular cortex in body dissatisfaction. Combining these results with findings concerning other brain regions, a recent review described a prefrontal cortex-insula-amygdala network as being involved in the affective component of body image (Gaudio & Quattrocchi, 2012). Findings of amygdala activation in response to body-related stimuli are reviewed in chapter 3.3.2.

In summary, the insula is a brain structure, which seems to be involved in a variety of symptoms characteristic of AN, from the visual and gustatory processing of food to affective body shape evaluation. The diversity of processes, in which the insula appears to be involved highlights the idea of its being a central structure, in which processes from several domains, such as interoception, visual perception, and affective evaluation converge, and which may, therefore, provide a link between different aspects of body image disturbance in AN (Nunn et al., 2011; Nunn & Frampton, 2008). With regard to the development of disordered eating behaviour, it has been highlighted that puberty is a critical period in CNS development, associated with changes in anatomy, functionality, and neurotransmitter systems (Kaye et al., 2009). These changes might interact with personality factors, such as harm avoidance, and changes in social roles during puberty, and thereby mediate the development of eating disorders at this critical period in the transition to adulthood (Kaye et al., 2009). These preliminary theories on the neurobiological basis of eating disorders appear promising, but require further research until the complexity of neurobiological alterations in eating disorders is fully understood. Especially, the ability of such theories to predict onset and outcome of eating disorders needs to be challenged by empiric scrutiny. In this context, it appears worthwhile to employ psychophysiological paradigms with well-established underlying neurophysiology, such as the affective startle-modulation paradigm (study 2) and to examine the functional processes associated with CNS activity, such as featural and configural visual body perception (study 3) and the CNS processing of visceral signals (study 4).

2.4. Research Questions

The present project is based on a multidimensional view of body image, as proposed by the literature (Cash & Green, 1986; Vocks et al., 2006). The focus lies on basic mechanisms of body image distortions in the perceptual, affective, and cognitive domains. In order to tap into these basic mechanisms, the present project relies on psychophysiological and psychophysical measurement techniques, which target more immediate processes than questionnaire measures. Although body image is of relevance in many mental disorders, such as eating disorders and body dysmorphic disorder, the current investigation is limited to the context of eating behaviour and AN. As body image distortions play a major role in AN, it is indispensable to explore the basic mechanisms associated with them, in order to understand the disorder and inform intervention approaches. The question whether similar processes are at work in other body-image related disorders remains to be elucidated by future research. The current project was designed to investigate the following research questions in the different dimensions of body image:

Cognitive dimension: How is cognitive bias in the recognition of one's own body related to a distorted body image? (Study 1)

Affective dimension: Do individuals with AN differ from healthy controls in their implicit affective evaluation of distorted body shapes? (Study 2)

Perceptual dimension – visual perception: Is early visual processing of body images altered in individuals with AN? (Study 3)

Perceptual dimension – viscerception: Do individuals with AN differ from healthy controls with regard to the cortical processing of visceral signals? (Study 4)

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3. Empirical Studies

A series of four studies was conducted, assessing three domains of body image, that is, cognition, affect and perception, with perception being explored in the visual and in the visceroceptive domain. Study 1 involved a community sample of healthy persons, while studies 2, 3, and 4 included a clinical sample of AN patients.

3.1. Cognitive Bias and Sensitivity for Self-Other Discrimination of Distorted Body Shapes in Healthy Females (Study 1)

3.1.1. Abstract

Individuals with eating disorders overestimate their body size and display cognitive bias for their own body in general, and for disliked body parts in particular. Similar perceptual distortions and cognitive biases are present in some young women without eating disorders. We explored the relationship between cognitive and perceptual factors in the context of a self-other discrimination task involving thin- and fat-distorted body images. The sample consisted of 30 women with a mean age of 23 years. A cognitive bias for classifying fat-distorted images as being oneself was related to body size overestimation, whereas better discrimination of thin- and fat-distorted bodies was related to a slimmer ideal body image. These findings highlight the complex interactions between perceptual and attitudinal factors. They furthermore demonstrate that perceptual distortions and cognitive bias are not limited to individuals with eating disorders, but also play a role for the body image of young women in general.

3.1.2. Cognitive Bias and Discrimination – A Signal Detection Approach to Body Image

Size Estimation, Recognition and Cognitive Bias

One of the most intriguing findings in eating disorders is that patients with AN and BN tend to overestimate their body size (Cash & Deagle, 1997; Farrell et al., 2005; Sepúlveda et al., 2002; Smeets, 1997). Moreover, body images of individuals with eating disorders have been

found to be more variable (Mussap, McCabe, & Ricciardelli, 2008). It has recently been suggested that body size distortion is located on a continuum and not qualitatively different between individuals with or without eating disorders (Cornelissen et al., 2013). We may therefore expect considerable variation in size estimation also in samples without eating disorders. The phenomenon of size estimation distortion in eating disorders has been known for decades (Bruch, 1962). Yet, the causes of this phenomenon remain heavily debated (cf. chapter 2.2.3).

In recent years, a wealth of studies has investigated the neural basis of body processing in eating disorders and healthy populations. These studies often employ faceless photographs of their participants, sometimes in combination with photographs of other persons or even distorted to simulate weight change (Mohr et al., 2011; Sachdev, Mondraty, Wen, & Gulliford, 2008; Vocks et al., 2010; Vocks et al., 2010). The face is omitted in order to control for processes specific to face processing. Moreover, it has been found that one target brain area of many body-image related studies, the EBA, shows reduced activation for bodies with visible faces as compared to bodies without faces (Morris, Pelphrey, & McCarthy, 2008). Nevertheless, it has rarely been verified whether participants recognise themselves on standardised, faceless pictures (Hodzic, Kaas, Muckli, Stirn, & Singer, 2009). Manipulating the attractiveness of participants' own faces results in an advantage in self-recognition over participants' real faces (Epley & Whitchurch, 2008). Accordingly, manipulating body shape, that is, distorting the participant's real body photograph in order to create slimmer and heavier versions, might result in similar effects and alter the differentiation between one's own and other bodies. The aim of the current study was, therefore, to test the recognisability of standardised body pictures on which the face is not visible, along with possible effects of picture distortion.

In addition, we aimed at investigating self-recognition in interaction with body image distortion and eating behaviour. Patients with AN show deficits in self-concept which are, however, not specific to this disorder (Jacobi, Paul, de Zwaan, Nutzinger, & Dahme, 2004). In healthy populations, it has been shown that high self-esteem is associated with a processing advantage for self-related information, for example the recognition of own body parts (Richetin, Xaiz, Maravita, & Perugini, 2012). There is also a positive association between self-esteem and the tendency to recognise a manipulated more attractive version of one's face as one's own face (Epley & Whitchurch, 2008). We may, therefore, expect that alterations in

self-concept, which are associated with eating disorder symptoms, may affect recognition of one's own real and digitally manipulated body.

Individuals with AN have been found to show an attentional bias for their own body versus another woman's body (Blechert et al., 2010). They also appear to have a preference for thin body shapes over fat body shapes over social scenes, as detected with a free viewing eye-tracking paradigm (Pinhas et al., 2014). Moreover, it appears to make a difference whether individuals with AN are looking at their own body or at another person's body (Jansen et al., 2005). In this study, employing eye-tracking methods, persons with eating disorder symptoms preferentially looked at body parts they disliked when looking at their own body, but at body parts they liked when looking at another person's body. This indicates that in eating disorders different attentional biases may be present when looking at one's own versus another woman's body. In summary, these findings suggest that, when using body image photographs in body image research, interactions between the identity of the person on the photograph, that is, self or other, as well as effects of distorting the photographs in width must be taken into account.

Signal Detection Theory

Signal detection theory (SDT) is an approach from the domain of sensory psychophysics, which allows for a theoretical distinction between the ability to discriminate between signals or events and response bias (Pastore & Scheirer, 1974). SDT is grounded on the assumption that each signal is perceived by the receiver at a given intensity. When the receiver is asked to report whether or not the signal is present, this report will be influenced by his or her ability to perceive the signal as well as cognitive tendencies to report the presence of the signal at a given intensity. Accordingly, a liberal decision maker will report presence of the signal at lower perceived intensities than a conservative decision maker, that is, with less certainty about the correctness of the response (Snodgrass & Corwin, 1988).

SDT has been successfully applied in the investigation of body image distortion in AN, with the finding that body size estimation seems to be influenced by non-sensory, cognitive components rather than by discriminatory ability (Gardner & Moncrieff, 1988; Smeets, Ingleby, Hoek, & Panhuysen, 1999). Because of the large number of trials needed for the calculation of SDT indices (Vossel, 1985), they have not been widely applied in body image research and researchers have developed more efficient methods for the assessment of sensory

and non-sensory components of body size estimation (Gardner & Boice, 2004). In those studies that did apply SDT in body image research (Gardner & Moncrieff, 1988; Smeets et al., 1999) participants were asked to detect changes in body size distortion. For the present study, we took a different approach and used SDT in order to assess recognition of one's own body at different degrees of distortion, that is, the decision concerning the identity of a given body and not the distortion. As this approach is novel, effects of body identity and body shape distortion on sensory and cognitive aspects of body recognition and their possible relationship with body image and eating disorder symptoms were investigated and are reported in an exploratory manner.

Research Questions and Hypotheses

Due to the novel and exploratory character of the study, we chose a descriptive approach and formulated broad research questions rather than precise hypotheses for some parts of the study.

Body Size Estimation

A first aim of this study was to establish the validity of a custom-made assessment tool for body size estimation, that is, a figure rating scale composed of distorted images of the participant herself. In this context, we hypothesised that participants would, on average, choose the correct image as their real body image, that is, the picture not showing body size distortion. Moreover, we expected participants to choose a figure thinner than their own body as their ideal body image. We furthermore hypothesized that body size overestimation and thinner ideal body image would be related to higher levels of eating disorder symptoms.

Self-Other Discrimination Task

The main goal of the study was to explore the effect of distorting self- and other-images in width on self-recognition and self-other discrimination. We, therefore, analysed performance on a self-other discrimination task using the variables reaction time, reaction accuracy, sensitivity (*d'*), and reaction bias ($\ln\beta$). From previous research we may only deduct the hypothesis that responses to self-pictures are faster than to other-pictures (Sui, Zhu, & Han, 2006; Tacikowski & Nowicka, 2010). Moreover, we explored the relationship of self-other discrimination at various levels of distortion with body size estimation and body dissatisfaction.

3.1.3. Method

Sample

Participants were recruited via campus notes and the student mailing list of the University of Luxembourg. The sample consisted of 30 German speaking female students from the University of Luxembourg. Of these, 50% were of Luxembourgish nationality, 33% were of German nationality, 7% had multiple citizenships, and 10% were of other nationalities. Mean age was *M* = 22.70 years (*SD* = 3.20) and mean BMI was *M* = 22.71 (*SD*= 3.97; range: 17.01 to 35.93). Two persons were left-handed (6.70%).

Procedure

Participants attended two separate laboratory sessions individually. During the first session, participants signed an informed consent form. In addition, questionnaires were filled in, the participant's photograph was taken and her height and weight were measured. During the second session, the recognition task was run, as well as the visual size estimation body image assessment, and a rating of the photographs for valence and arousal. Time elapsed between sessions was *M* = 4.03 days (*SD* = 2.83).

Questionnaires

Eating Disorder Inventory-2

Eating disorder symptoms were assessed with the EDI-2 (English: Garner, 1991; German: Paul & Thiel, 2005). The EDI-2 is a 91-item self-report measure assessing cognitive, affective, and behavioural aspects of eating disorder symptoms. Answers are given on a 6-point Likert scale ranging from 1 (*never*) to 6 (*always*). Sum scores are calculated for the subscales Drive for Thinness, Bulimia, Body Dissatisfaction, Ineffectiveness, Perfectionism, Interpersonal Distrust, Interoceptive Awareness, Maturity Fears, Asceticism, Impulse Regulation, and Social Insecurity. The first three subscales are designed to reflect eating-disorder specific symptoms, while the other subscales reflect symptoms which are common in eating disorders, but not specific to them (Paul & Thiel, 2005). Therefore, only the first three subscales were further analysed in the current study. Internal consistencies for these subscales were acceptable to very good with Cronbach's α ranging from α = .78 (Bulimia) to α = .92 (Body Dissatisfaction).

Beck Depression Inventory

Symptoms of depression were assessed with the Beck Depression Inventory-II (BDI-II; English: Beck, Steer, & Brown, 1996; German: Hautzinger, Keller, & Kühner, 2006). The BDI-II is a 21-item self-report measure. Each item represents a symptom of depression and the participant is given four options for reporting the degree to which each symptom is present. The symptoms contained in the questionnaire correspond to those listed in the DSM-IV criteria for major depression, such as negative mood, feelings of guilt, loss of energy, changes in sleeping habits, etc. A total score is calculated as the sum of all scores. Internal consistency was acceptable with Cronbach's $\alpha = .79$.

Photo Shooting and Image Manipulation

For the photo shooting, participants wore skin-coloured, skin-tight leotards and tights, covering the entire body (except for feet, hands, and head). They were standing in front of a black background with their feet approximately 70 cm apart and their arms stretched out to the sides. Digital images were first manipulated by covering the entire head (everything above the neck) with black colour, making it identical to the background. Participants' images were then distorted with the Body Form Imaging Programme (Sands, Maschette, & Armatas, 2004). For each participant, five thinner pictures decreasing in steps of 3% were created, as well as five fatter pictures increasing in steps of 3%, resulting in a total of 11 images ranging from 85% to 115%, with the undistorted picture representing 100%. Accordingly, the range was identical to that used in previous studies by Mohr et al. (2010, 2011), but with larger steps between the individual pictures (steps of 1% in Mohr et al., steps of 3% in the current study).

Self-Other Discrimination Task

Participants were shown their own undistorted photograph and the ten distorted images of themselves, as well as the same range of pictures of three persons unknown to them who were matched for BMI. We chose three rather than one comparison person in order to probe the distinction between "myself" and "others", rather than "myself" versus "the other woman". The participants' own images were each repeated 30 times, while each picture of an unknown person was repeated 10 times. This resulted in a total of 330 trials showing the participants' own body and a total of 330 trials showing an unknown person (110 trials per unknown person). Altogether, 660 trials were run, organised in 6 blocks with short breaks in between.

All pictures were presented in a randomised order with a presentation time of 2000 ms and an inter-stimulus interval of 1000 ms. Participants were instructed to press the button "Alt" on the keyboard whenever they saw pictures of themselves and the button "Alt Gr" for pictures of another person. This association was reversed for one half of the participants, with picture category-button associations being randomly allocated to participants. Furthermore, participants were asked to respond as quickly and as accurately as possible.

After the task, participants were asked to rate the pictures on 9-point Self-Assessment Manikin Scales (SAM; Bradley & Lang, 1994) for valence (1 = *positive*, 9 = *negative*) and arousal (1 = *high arousal*, 9 = *low arousal*). For the rating, all of the participants' own pictures were presented, as well as a selection of the pictures of the unknown persons, which consisted of a random selection of one picture at each level of distortion. This procedure was chosen due to the long duration of the task, which was more than 30 minutes for the reaction time task alone. Arousal ratings were recoded before statistical analysis by subtracting each value from 10 so that higher numbers represent higher levels of arousal in the following.

Visual Body Size Estimation

After the recognition task, the participant's 11 photographs (the real photograph, the five thinner distorted pictures and the five fatter distorted pictures) were presented at the same time, arranged on the screen in random order. We chose this procedure to avoid participants' simply choosing the middle image as their real image, which would have always been correct had the figures been arranged in the order of distortion. Participants were then asked to select the figure that represented best what they look like (real body image) and the one representing what they would like to look like (ideal body image). For each criterion, a new random order of the pictures was created.

Data Analysis

Reaction times, hit rates, and false alarm rates were calculated for the two picture categories self and other. From hit rates and false alarms, the signal detection indices *d'* and lnβ were calculated according to Equation 1 and Equation 2 (Snodgrass & Corwin, 1988).

$$d' = z(Hits) - z(False\ Alarms)$$

Equation 1

$$ln\beta = \ln\left(\frac{y(Hits)}{y(False\ Alarms)}\right)$$

Equation 2

The SDT index *d*' represents the sensitivity of the observer, that is, his or her ability to discriminate between signal and noise. A *d*' = 0 means that the observer was unable to discriminate between signal and noise. Higher values of *d*' signify better discrimination. The SDT index lnβ is a measure of reaction bias. If lnβ = 0 the observer is unbiased. An lnβ < 0 means that the observer has a liberal decision criterion, that is, he or she responds to rather low levels of signal perception. In contrast, an lnβ > 0 stands for a conservative observer who only responds to very high levels of signal perception.

Outcome variables of the discrimination task, that is, reaction times, percentage of hits, discrimination (*d*'), and reaction bias (lnβ), as well as valence and arousal ratings, were analysed separately with 2 × 11 repeated measures analyses of variance (ANOVA). There were two within participant factors: identity of the person displayed (self vs. other) and degree of distortion (85 vs. 88 vs. 91 vs. 94 vs. 97 vs. 100 vs. 103 vs. 106 vs. 109 vs. 112 vs. 115). Greenhouse-Geisser corrections for degrees of freedom were used when applicable. Post hoc *t* tests for significant interactions were performed without correction for multiple comparisons, due to the preliminary nature of the study and the small sample size (Friederich et al., 2006). As measures of effect size, partial eta squared is reported for ANOVAs, while Cohen's *d* is reported for post hoc tests. Correlations between body image distortion and eating disorder symptoms, and between body image distortion and self-other discrimination were performed with Pearson's correlation coefficient. The critical α-level was set to α = .05 for all analyses.

3.1.4. Results

Visual Body Size Estimation

On average, participants chose the correct figure as their real body image (M = 100, SD = 4.73). However, there was considerable variation in size estimation with a range of 92 to 112. Concerning ideal body image, participants wished to be slightly thinner than they actually were (M = 92.3, SD = 4.84). The range in ideal body image of 85 to 100 clearly shows that no participant wished to be heavier, but all wished to be thinner or stay the same. Average choices for real and ideal body image are illustrated in Figure 4.

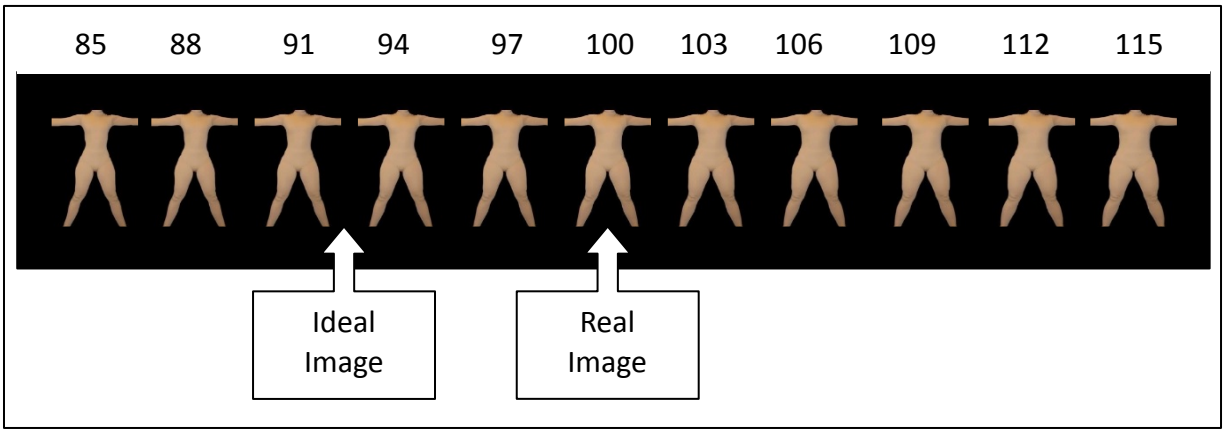

Figure 4. Exemplary figure rating scale composed of a participant's own distorted body images. For the sake of clarity, the figures are ordered according to the degree of distortion, with the real photograph of the participant (100%) in the middle. For the actual size estimation task the figures were displayed in random order. Average choices for real and ideal body image are indicated with arrows.

The wish to be thinner, as assessed by ideal body image choice, was related to higher BMI and higher scores on the EDI subscales Drive for Thinness and Body Dissatisfaction. There was a trend for an association with bulimic symptoms. For size estimation, there were trends in the correlations with BMI, EDI Bulimia and EDI Body Dissatisfaction, with higher BMI and EDI scores being associated with size overestimation. There were no significant correlations or trends between body size measures and symptoms of depression. All correlations are displayed in Table 2.

Table 2

Pearson Correlations of Body Size Estimation and Ideal Body Image with BMI, Eating Disorder Symptoms, and Symptoms of Depression

Measure	Size Estimation	Ideal Body Image
BMI	.36†	-.45*
EDI-Drive for Thinness	.057	-.38*
EDI-Bulimia	.32†	-.31†
EDI-Body Dissatisfaction	.32†	-.50*
BDI-II	.12	-.11

Note. Higher values of size estimation indicate overestimation of body size. Lower values of ideal body image indicate a wish to be thinner.

BMI = Body Mass Index; EDI = Eating Disorder Inventory; BDI-II = Beck Depression Inventory-II

† $p < .10$. * $p < .05$.

Self-Other Discrimination Task

Reaction Times

There was a significant main effect for the factor identity, with reaction times being longer for the participant's own body (M = 1034.16, SD = 168.67) than for the other bodies (M = 967.53, SD = 116.36), $F(1, 29) = 12.37$, $p = .001$, $\eta_p^2 = .30$. The main effect for degree of distortion was not statistically significant, $F(2.77, 80.36) = 1.48$, $p = .23$, $\eta_p^2 = .048$. There was a trend towards an interaction between identity and degree of distortion, $F(4.49, 130.30) = 2.23$, $p = .061$, $\eta_p^2 = .071$. Post hoc tests showed that at $\alpha = .05$ the differences between self- and other-pictures were significant at all degrees of distortion, ps < .039, except for a distortion of 94% ($p = .30$) and the real image of 100% ($p = .42$).

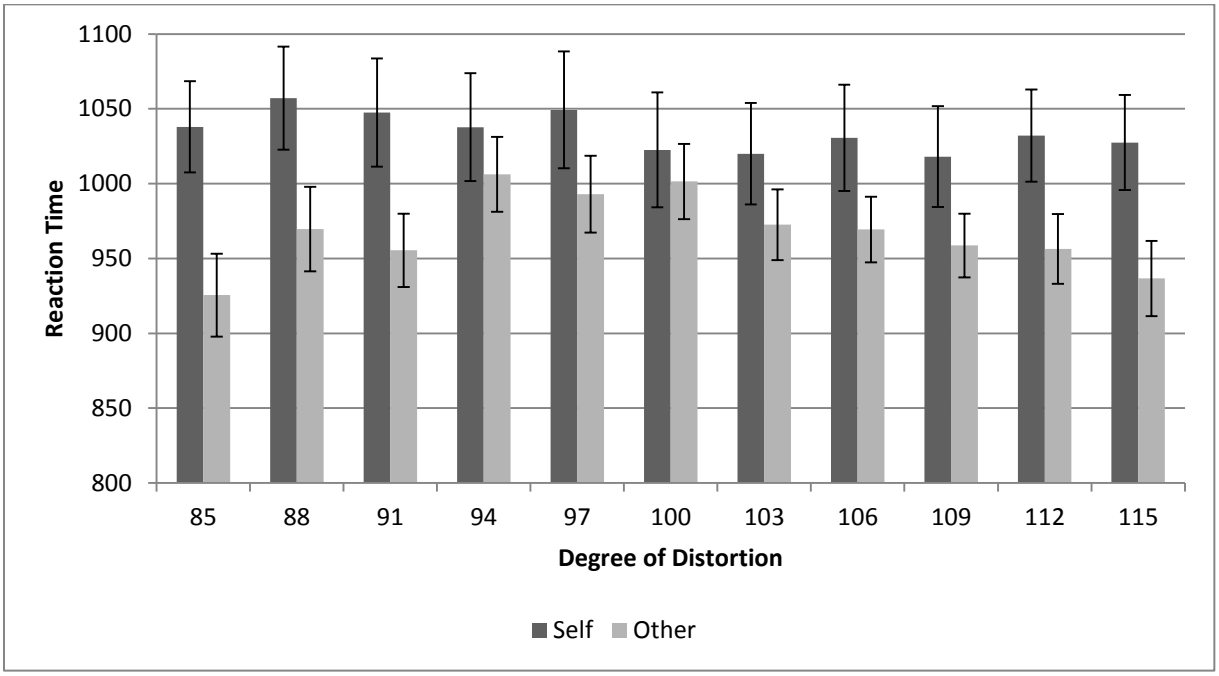

Figure 5. Mean reaction times for self- versus other-body pictures at varying degrees of image distortion. Error bars represent +/- 1 *SEM*.

Reaction Accuracy

For hit rates, the main effect for identity was not statistically significant, $F(1, 29) = 2.37$, $p = .13$, $\eta_p^2 = .076$. In contrast, there was a significant main effect for degree of distortion, $F(2.91, 84.33) = 4.95$, $p = .004$, $\eta_p^2 = .15$. Furthermore, there was a significant interaction between identity and degree of distortion, $F(2.25, 65.18) = 12.80$, $p < .001$, $\eta_p^2 = .31$. Post hoc tests showed that at $\alpha = .05$ the differences between self- and other-pictures were significant at 85, 88, 97, 112, and 115 percent distortion, *p*s < .034, all other *p*s > .068. In a descriptive manner, it is interesting to note that mean percentages of hits ranged from 21.21% to 98.48% ($M = 69.53$, $SD = 20.07$) for self-body pictures and from 35.26% to 98.48% ($M = 75.74$, $SD = 16.66$) for other pictures. These descriptive values indicate a wide range of performances, with some participants performing worse than on chance level.

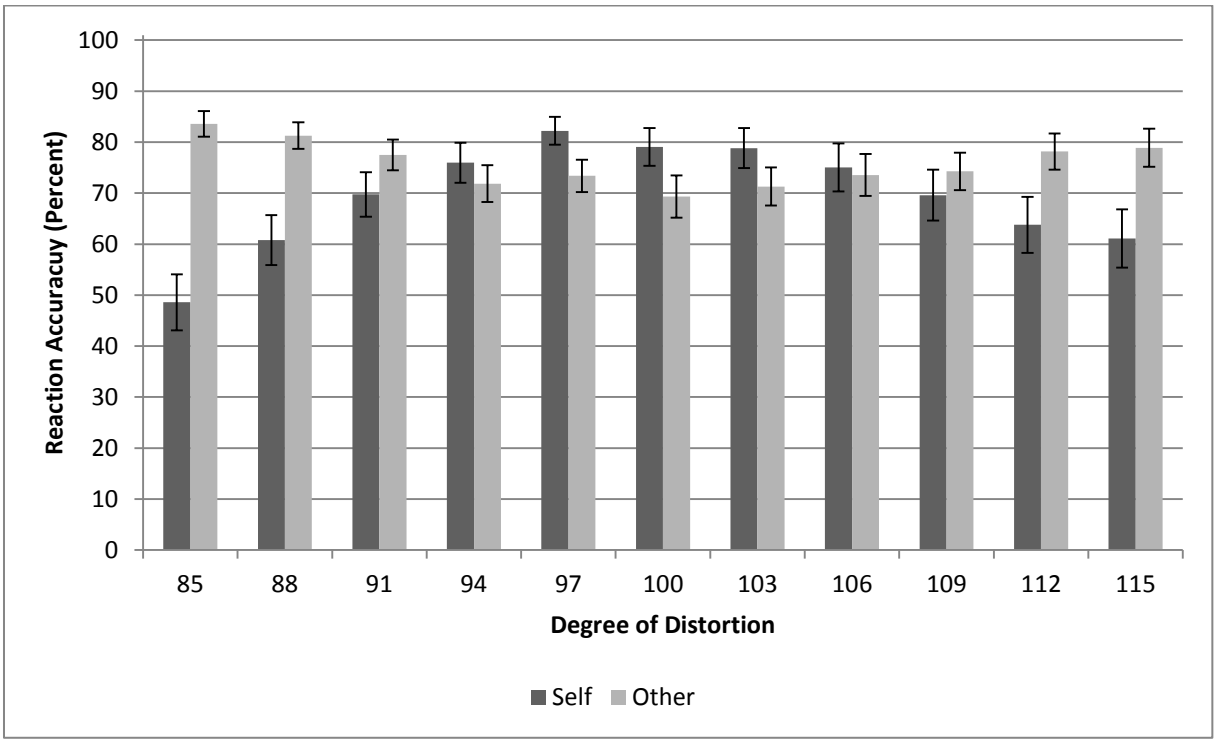

Figure 6. Mean reaction accuracy (in percent) for self- versus other-body pictures at varying degrees of image distortion. Error bars represent +/- 1 *SEM*.

Discrimination (*d*')

The analysis of effects on discrimination yielded no significant effect for identity, $F(1, 29) = 0.25$, $p = .62$, $\eta_p^2 = .009$, and no significant interaction between identity and degree of distortion, $F(5.71, 165.56) = 0.42$, $p = .86$, $\eta_p^2 = .014$. There was, however, a significant main effect for degree of distortion, $F(3.39, 98.23) = 5.62$, $p = .001$, $\eta_p^2 = .16$.

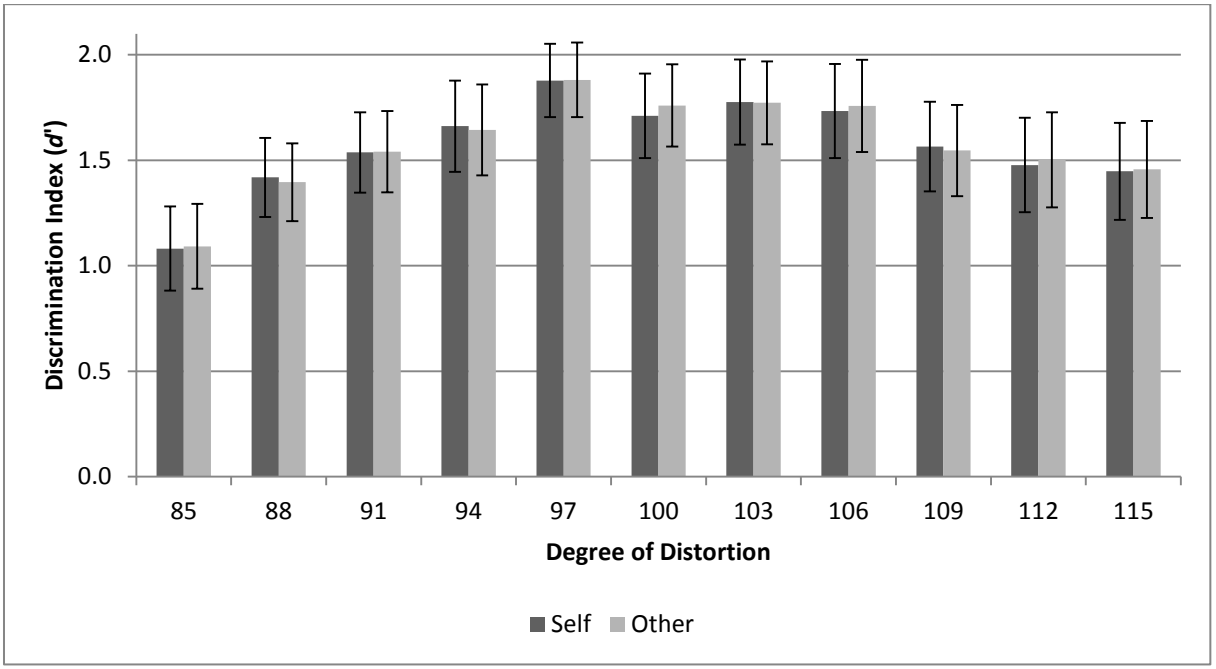

Figure 7. Mean discrimination index (*d*') for self- versus other-body pictures at varying degrees of image distortion. Higher values represent better discrimination. Error bars represent +/- 1 *SEM*.

Reaction Bias (lnβ)

On the dependent variable reaction bias there were no significant main effects for identity, $F(1, 29) = 0.017$, $p = .90$, $\eta_p^2 = .001$, or degree of distortion, $F(5.18, 150.17) = 0.62$, $p = .69$, $\eta_p^2 = .021$. Nevertheless, there was a significant interaction between identity and distortion, $F(4.03, 116.99) = 5.13$, $p = .001$, $\eta_p^2 = .15$. Post hoc tests showed that at $\alpha = .05$ self- and other-pictures differed significantly only at 85, 88, and 97 per cent distortion, ps $< .044$, all other ps $> .057$. Visual inspection of the graph suggests a shift in decision strategies between pictures nearer the real picture versus more strongly deviating pictures in both directions. The decision criterion was more liberal for self-pictures and more conservative for other-pictures near the real picture. In contrast, for strongly distorted pictures in both directions the decision criterion was more conservative for self-bodies and more liberal for other-bodies.

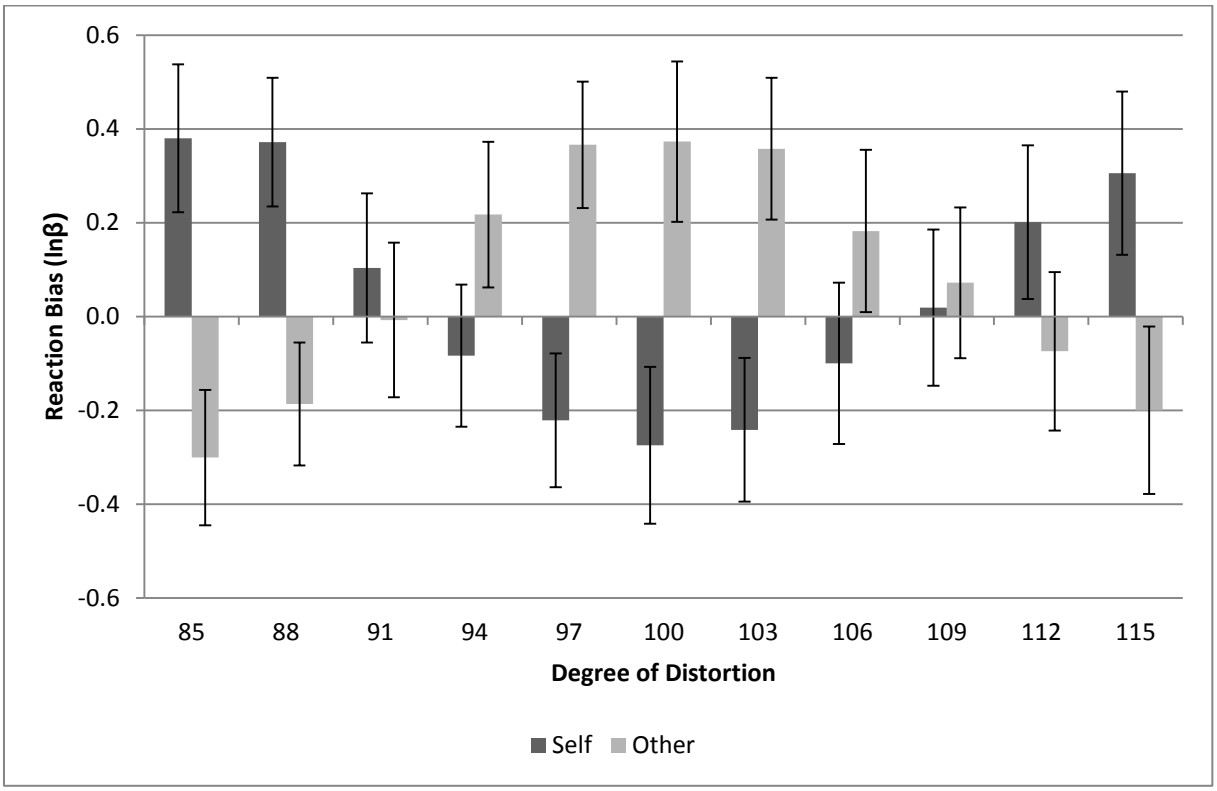

Figure 8. Mean reaction bias for self- versus other-body pictures at varying degrees of image distortion. Positive values represent conservative decision making while negative values represent liberal decision making. Error bars represent +/- 1 *SEM*.

Correlational Analyses

Correlations between performance indicators from the discrimination task and body image variables (size estimation and ideal body image) were calculated for performance regarding the real (100%), the thinnest (85%) and the fattest (115%) body pictures. Body size estimation

was only significantly related to reaction bias for fat-distorted self- and other-pictures. The direction of the correlation was opposite for self and other pictures, indicating a bias towards classifying fat-distorted pictures as being of oneself at high levels of body size overestimation. Ideal body image was positively related to reaction times, that is, a slimmer ideal body image was associated with faster reaction times. Furthermore, ideal body image was negatively related to discrimination of thin and fat-distorted bodies, that is, a slimmer ideal body image was associated with better discrimination for thin and fat-distorted body pictures. Correlations with reactions to self-images are displayed in Table 3, whereas correlations with reactions to other-images can be found in Table 4.

Table 3

Pearson Correlations of Size Estimation and Ideal Body Image with Performance Measures for Reactions to Self-Body Images.

Measure	Distortion	Size Estimation	Ideal Body Image
	Thin (85%)	-.19	.16
Reaction Time	Real (100%)	-.25	.41*
	Fat (115%)	-.13	.39*
	Thin (85%)	-.14	-.40*
Discrimination	Real (100%)	.082	-.18
	Fat (115%)	.10	-.38*
	Thin (85%)	-.22	-.20
Reaction Bias	Real (100%)	-.25	.12
	Fat (115%)	-.52**	.12

Note: * $p < .05$. ** $p < .01$.

Table 4

Pearson Correlations of Size Estimation and Ideal Body Image with Performance Measures for Reactions to Other-Body Images.

Measure	Distortion	Size Estimation	Ideal Body Image
	Thin (85%)	-.17	.19
Reaction Time	Real (100%)	-.003	.37*
	Fat (115%)	.33	.27
	Thin (85%)	-.13	-.40*
Discrimination	Real (100%)	.046	-.16
	Fat (115%)	.073	-.37*
	Thin (85%)	.17	.14
Reaction Bias	Real (100%)	.25	-.042
	Fat (115%)	.47**	-.14

Note: * $p < .05$. ** $p < .01$.

Subjective Ratings

Valence

There was a significant main effect for identity, with more positive ratings for self-bodies (M = 4.49, SD = 1.07) than for other-bodies (M = 5.13, SD = 1.38), $F(1, 29) = 5.52$, $p = .026$, $\eta_p^2 = .16$. In addition, there was a significant main effect for distortion, $F(2.79, 80.91) = 18.96$, $p < .001$, $\eta_p^2 = .40$. The interaction between identity and distortion was also significant, $F(6.45, 187.08) = 3.00$, $p = .007$, $\eta_p^2 = .094$. Post hoc tests showed that at $\alpha = .05$ self- and other-pictures differed significantly for 88, 91, 94, and 97 per cent distortion, ps < .043, all other ps > .12.

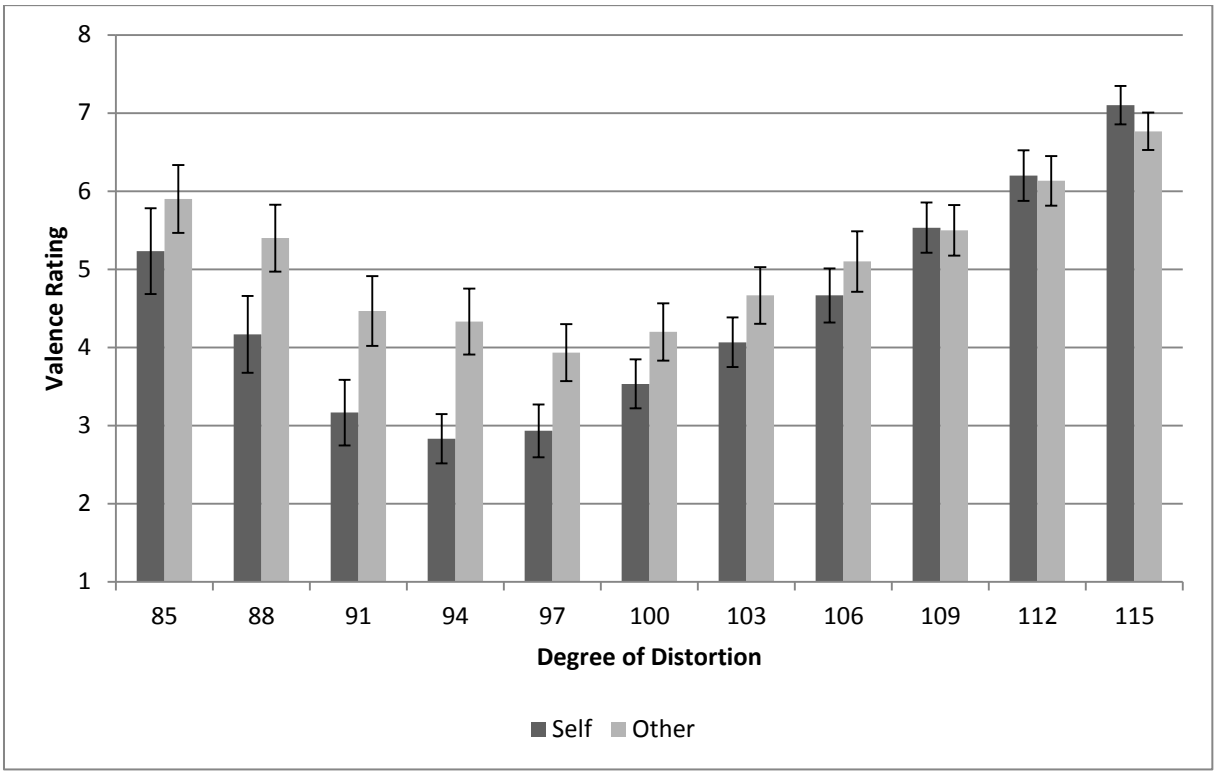

Figure 9. Mean valence ratings for self- versus other-body pictures at varying degrees of image distortion. The scale ranged from 1 to 9 with lower numbers indicating increasingly positive affect and higher numbers indicating increasingly negative affect. Error bars represent +/- 1 *SEM*.

Arousal ratings

There was a trend towards a main effect for identity, $F(1, 28) = 3.13$, $p = .088$, $\eta_p^2 = .10$. The main effect for distortion was not significant, $F(3.73, 104.55) = 1.48$, $p = .22$, $\eta_p^2 = .050$, nor was the interaction between identity and distortion, $F(5.34, 149.61) = 1.18$, $p = .32$, $\eta_p^2 = .041$.

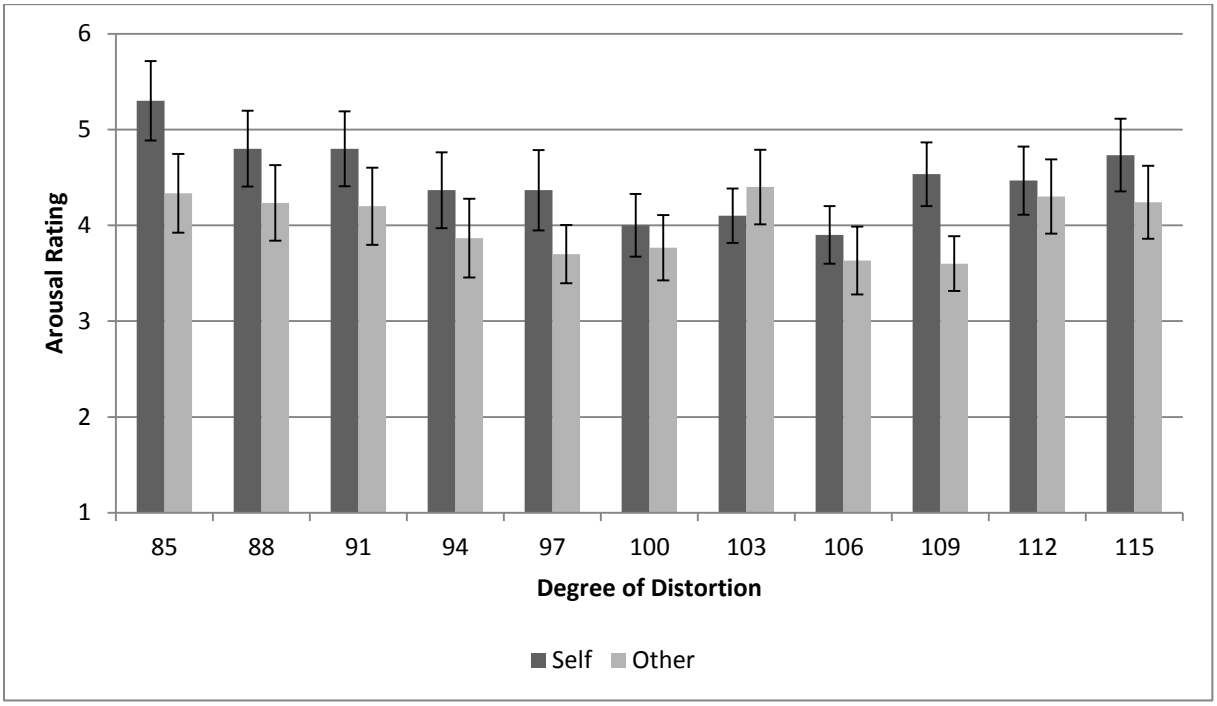

Figure 10. Mean arousal ratings for self- versus other-body pictures at varying degrees of image distortion. The scale ranged from 1 to 9 with higher numbers indicating higher arousal. Error bars represent +/- 1 *SEM*.

3.1.5. Discussion

Summary and Interpretation of Results

Size Estimation

We were able to replicate the typical finding that young women, on average, have an ideal body image which is thinner than their current body (Swami, Salem, Furnham, & Tovee, 2008). Although participants on average chose the correct image as their real image, there was considerable variance in body size estimation. Both, a slim ideal body image and body size overestimation, were related to higher levels of BMI and eating disorder symptoms, albeit with weaker associations for body size estimation than for ideal body image. We thereby extend previous findings on altered body size estimation in eating disorders (Cash & Deagle, 1997; Farrell et al., 2005; Sepúlveda et al., 2002; Smeets, 1997) by demonstrating that altered size estimation may also be present in individuals with non-clinical eating disorder symptoms. This is in line with more recent findings, which suggest that body size estimation occurs on a continuum, with individuals with eating disorders showing the highest degrees of distortion (Cornelissen et al., 2013). Nevertheless, the trend of a positive correlation between BMI and size estimation in our study is contrary to previous findings of a negative correlation (Cornelissen et al., 2013). This underlines the notion that size estimation is not merely a function of body size, but is strongly related to other factors.

To the best of our knowledge, this is the first study assessing estimated and ideal body image with a figure rating scale consisting of the participant's own distorted photographs. The real body was, therefore, always the middle anchor of the scale, in contrast to silhouette rating scales (Thompson & Altabe, 1991) or the Photographic Figure Rating Scale (Swami et al., 2008; Viren Swami, Taylor, & Carvalho, 2011), which use identical anchors for all participants. The individualised approach ensures that participants have the possibility to make judgements in both directions of their real body, thereby avoiding possible ceiling and floor effects of silhouette rating scales for individuals with comparably high and low BMIs. Results on mean values and correlations with eating disorder variables indicate good validity of the scale, while reliability needs to be examined by further research. The scale furthermore renders possible the evaluation of size distortion and ideal body image with the same pictures, which are used in a reaction time task.

Self-Other Discrimination Task

Results of the self-other discrimination task showed slower reaction times for self- than for other-pictures. This is contrary to the well-established processing advantage for self-related information and one's own body (Sui et al., 2006; Tacikowski & Nowicka, 2010). It appears that in our experiment, where it was rather difficult to distinguish between self and other-bodies due to the highly standardised photographs, participants were able to decide more quickly that a given body was not theirs, but that of another person. Results in recognition performance suggest that the task was generally difficult and that some participants even performed worse than chance level. This finding strongly suggests that self-recognition should be checked whenever highly standardised, distorted body pictures without faces are used as stimulus material. Furthermore, recognition performance seemed to be especially low for strongly distorted thin and fat self-pictures. It seems plausible that it is more difficult to recognise manipulated pictures of oneself that do not correspond to the mental representation of one's body, than to recognise an unaltered picture which does correspond to the mental representation (Slade, 1994).

Signal detection indices showed that the ability to accurately discriminate body identity (*d'*) did not differ between self- and other-pictures. Discrimination performance, however, was affected by degree of distortion, with higher levels of distortion in both directions resulting in less accurate discrimination. It appears, therefore, that for strongly distorted body images, which do not correspond to the body image one has in mind (Slade, 1994), identities begin to blur. Consequently, distorted images may be expected to produce lower levels of self-identification than real images. Interestingly, discrimination performance for fat- and thin-distorted body images tended to be better in persons with a slimmer ideal body image. These individuals with high levels of body dissatisfaction might engage in body checking behaviours to a greater degree (Reas et al., 2002). This might make them more familiar with their body, enabling them to recognise it even when distorted. Moreover, body checking has been shown to induce an attentional bias for body cues (Smeets et al., 2011), which might be an explanation for the association between slimmer ideal body image and speeded reaction times in the discrimination task in our study.

Reaction bias ($\ln\beta$) results suggest a shift in decision strategies between pictures nearer the real picture versus more strongly distorted pictures in both directions. The decision criterion was more liberal for self-pictures and more conservative for other-pictures near the real

picture. In contrast, for strongly distorted pictures in both directions the decision criterion was more conservative for self-body pictures and more liberal for other-body pictures. This suggests that pictures nearest the real picture were associated with a bias towards one's own body while more strongly distorted pictures were associated with a tendency to classify them as other-pictures. In addition, response bias scores for the pictures which were distorted most extremely into the fat direction were related to body size estimation, in a way that overestimators had a bias towards classifying all fat pictures as their own body. This tendency to reference fat-related information to oneself may contribute to the belief that one is heavier than one actually is. Whereas it has been shown that the induction of an attentional bias for body shape- and weight-related information increases body dissatisfaction (Smith & Rieger, 2006), it remains unclear to what extent such a bias might contribute to body size distortion.

Subjective Ratings

Valence ratings indicate that participants rated slightly thinner versions of themselves as particularly positive, that is, more positive than other pictures of themselves and more positive than pictures of other women at the same degrees of distortion. There were no significant effects regarding arousal, with a trend towards higher arousal ratings for self-pictures. The valence ratings correspond to the results concerning ideal body image, that is, that participants wished to be slightly thinner, on average. This wish and general body dissatisfaction possibly reflect an internalisation of the sociocultural idealisation of slimness and dieting (Cafri, Yamamiya, Brannick, & Thompson, 2005).

General Discussion

The present results indicate that body dissatisfaction and size estimation vary substantially in young women. Body dissatisfaction was associated with improved discrimination between one's own and other bodies. Body size overestimation was related to a bias towards classifying all fat bodies as being oneself. Strikingly, the measure of size perception (body size estimation) was related to cognitive bias in the discrimination task, while body dissatisfaction (ideal body image) was related to the sensory discrimination index. This finding illustrates the high complexity of body image and of interactions between its components (Slade, 1994). It furthermore demonstrates the flaw in signal detection approaches, in that their distinction between sensory sensitivity and response bias is rather arbitrary and does not provide information on when exactly in the stream of visual processing alterations occur (Farrell et al., 2005). Although this illustrates the interaction of attitudinal

and perceptual factors, more precise measures are needed in order to determine their relative importance in body image distortion and dissatisfaction, and for the aetiology of eating disorders.

Limitations

The present study was of an exploratory and preliminary nature. Therefore, the effects must be replicated in larger samples, including those with eating disorders. Nevertheless, the current results demonstrate the large variability in body image parameters in young women and thereby inform future studies on risk factors for eating disorders.

Conclusion

Response bias and discrimination of distorted body pictures are linked differentially to various body image and eating disorder symptom variables. Their exact role in the development and maintenance of distorted body image and eating disorder symptoms remains unclear at this point, but may help to inform our understanding of eating disorders, as well as prevention and intervention approaches in the future.

3.2. Investigating Basic Aspects of Body-Related Processing in Anorexia Nervosa

The present findings on visual body-related processing in healthy persons may be of importance for a better understanding of the aetiology of mental disorders, in particular eating disorders, and here most prominently, AN. We, therefore, conducted a series of three studies with individuals currently in in-patient treatment for AN. The first study is concerned with implicit affective evaluation of body pictures, while the second and third studies focus on body perception. One of the latter studies was designed for the assessment of visual perception of the body, while the other examines perception of signals originating from within the body. As all three studies were conducted with the same participants in a single experimental session, the present chapter gives an overview of sample characteristics, the general experimental procedure, and those methods that were common to the three studies.

3.2.1. Sample Characteristics

In studies 2-4 the same sample of patients with AN and healthy control persons took part. The total sample size was $N = 40$, with 20 participants diagnosed with AN according to DSM-V (American Psychiatric Association, 2013) and 20 healthy control persons without current DSM-IV diagnosis (American Psychiatric Association, 2000), matched for age and socio-economic status (SES). All participants were female. Exclusion criteria were past or current psychotic disorders, current substance abuse or dependence, current posttraumatic stress disorder, hearing defects and tinnitus, skin diseases and skin allergies, and a proneness to fainting when seeing blood.

Patients with AN were recruited from Schön Klinik Roseneck in Rosenheim, Germany, a psychosomatic hospital. The diagnosis of AN according to DSM-V (American Psychiatric Association, 2013) was confirmed for each patient with the Structured Clinical Interview for DSM-IV (SCID-I; First, Spitzer, Gibbon, & Williams, 2002; German version by Wittchen, Zaudig, & Fydrich, 1997), the self-report screening version of the Structured Interview for Anorexic and Bulimic Syndromes (Fichter & Quadflieg, 2000) and consultation of the DSM-V criteria (American Psychiatric Association, 2013). The SCID-I also served to screen patients for current comorbid disorders and lifetime diagnoses of mental disorders. Of these patients, $n = 10$ (50 %) were classified as restricting type AN and $n = 10$ (50 %) as binge eating/purging subtype. Comorbid DSM-IV disorders were present in 7 patients (35 %), of

which 5 met diagnostic criteria for a major depression episode and two for major depression and anxiety disorders. Seven patients (35 %) were currently treated with psychoactive medication, with four patients taking selective serotonin reuptake inhibitors (SSRI), one patient taking SSRI and a tricyclic antidepressant, one patient taking a selective serotonin-norepinephrine reuptake inhibitor (SSNRI), and one patient taking antipsychotic medication (Melperone). The patients in our sample reported symptom onset at approximately 15 years of age and had had AN symptoms for over 9 years on average. Detailed characteristics of the AN group with regard to treatment and symptom duration are presented in Table 5.

Table 5

Symptom and Treatment Related Characteristics of the Clinical Sample of AN patients

Characteristic	*M*	*SD*
Age at symptom onset	15.30	3.25
Years since symptom onset	9.50	6.56
Age at first inpatient treatment	19.10	4.22
Years since first in-patient treatment	5.55	5.71
Number of in-patient treatments (including current treatment)	2.85	1.76
Duration of current in-patient treatment up to participation (in days)	26.65	23.04

Healthy participants for the control group were recruited from the female student population of the University of Luxembourg through campus notes and mailing lists, and were screened for current and lifetime DSM-IV diagnoses with the SCID-I. In accordance with the current practice at the respective institution, participants at the University of Luxembourg received a gift voucher worth €50 and participants at the psychosomatic hospital received a gift voucher worth €40 as a reimbursement for their participation.

Most participants were right-handed, with 3 left-handers in the control group (15 %) and 2 left-handers in the clinical sample (10 %). Five participants in the control group indicated that they were smokers (25 %) compared to 4 smokers in the AN group (20 %). Detailed sample characteristics are displayed in Table 6. The samples did not differ significantly in age, SES, or in the number of days per week on which they regularly consumed alcohol. The AN group had a significantly lower BMI and were less physically active than the control group. The latter effect may be due to the AN-inpatient treatment regime, which requests patients to refrain from exercise and strenuous physical activity. As expected, the groups also differed with regard to eating disorder symptomatology, and symptoms of depression and anxiety,

with AN patients scoring higher on all variables than control participants, as shown in Table 7. Furthermore, the groups neither differed with respect to visual body size estimation, nor in ideal body image and maximally and minimally acceptable body images, all relative to the participant's real body size. In absolute terms both patients and control participants over-estimated their body size by about 20%. This contrasts with the results of study 1, in which healthy women did not show body size overestimation on average. Although meta-analyses suggest that individuals with AN show overestimation to a larger degree than healthy controls across studies (Cash & Deagle, 1997; Sepúlveda et al., 2002; Smeets, 1997), there are also studies which report overestimation in healthy persons (Fuentes, Longo, & Haggard, 2013). It has been suggested that body size distortion is located on a continuum and not qualitatively different between individuals with or without AN, which would explain why some studies report overestimation even in healthy samples (Cornelissen et al., 2013). Furthermore, at the beginning of the second testing session AN patients reported higher levels of state anxiety than control participants. Patients had also eaten more recently before the second session than control persons, which was due to the hospital routine, which strictly required eating three meals a day. As the second session took about three hours, patients usually attended after breakfast or lunch.

Table 6

Means and Standard Deviations of Socio-Demographic Sample Characteristics

Characteristic	AN Group	Control Group	*t* (*df*)	*p*	*d*
Age	25.06 (5.17)	24.88 (4.04)	-0.12 (38)	.90	0.038
BMI	15.80 (1.63)	22.57 (3.28)	8.27 (27.80)	< .001	2.62
Socio-economic status	4.65 (0.88)	4.70 (0.92)	0.18 (38)	.86	0.057
Alcohol consumption (days per week)	1.01 (2.16)	0.78 (1.21)	-0.41 (37)	.69	0.13
Exercise (MET-minutes per week)	1434.70 (1416.19)	4672.23 (3521.87)	3.81 (24.99)	< .001	1.20

Note. Group differences were tested with *t* tests. Degrees of freedom were corrected whenever equality of variances could not be assumed. Cohen's *d* is reported as a measure of effect size. BMI = body mass index; MET = metabolic equivalent of task.

Table 7

Means and Standard Deviations of Psychometric Sample Characteristics

Scale	AN Group	Control Group	*t* (*df*)	*p*	*d*
EDI Drive for Thinness	3.85 (1.07)	2.23 (0.75)	-5.55 (38)	< .001	1.76
EDI Bulimia	2.46 (1.32)	1.61 (0.46)	-2.72 (23.54)	.012	0.86
EDI Body Dissatisfaction	3.84 (1.12)	2.94 (1.01)	-2.67 (38)	.011	0.84
Body size estimation	1.18 (0.27)	1.20 (0.17)	0.33 (38)	.75	0.10
Ideal body image	1.06 (0.32)	1.00 (0.11)	-0.80 (23.12)	.43	0.25
Maximally acceptable body image	1.29 (0.35)	1.45 (0.26)	1.63 (38)	.11	0.52
Minimally acceptable body image	0.85 (0.22)	0.84 (0.13)	-0.16 (38)	.88	0.05
BDI-II	0.90 (0.65)	0.28 (0.16)	-4.11 (21.40)	< .001	1.30
STAI-Trait	2.53 (0.70)	1.69 (0.39)	-4.68 (29.90)	< .001	1.48
STAI-State	2.35 (0.61)	1.67 (0.38)	-4.20 (38)	< .001	1.33
Time since last meal (in minutes)	72.05 (16.38)	239.70 (268.26)	2.79 (19.14)	.012	0.88

Note. Group differences were tested with *t* tests. Degrees of freedom were corrected whenever equality of variances could not be assumed. Cohen's *d* is indicated as a measure of effect size. EDI = Eating Disorder Inventory; BCQ = Body Consciousness Questionnaire; STAI = State and Trait Anxiety Inventory.

3.2.2. Ethical Approval

Ethical approval was obtained from the Ethics Review Panel of the University of Luxembourg, the national ethics board of Luxembourg (Comité National d'Ethique de Recherche Luxembourg), and the ethics committee of the medical faculty of the University of Munich. The national commission for data protection in Luxembourg (Commission Nationale Pour la Protection des Données Luxembourg) was notified of the data collection. All participants provided informed consent for participation in the study and for the use of their photographs for research purposes in the wake of the study.

3.2.3. Procedure

Participation in the study took place in two sessions. During the first session, participants were interviewed with a custom-made socio-demographic interview and the SCID-I (First et al., 2002). Then, participants' photographs were taken. For the photographs, participants were

dressed in a skin-coloured leotard and tights and were photographed in standardised poses. We chose standardised clothing covering the whole body in order to remove particular features that might ease recognition for some, but not all participants, such as tattoos. In addition, it has been shown that women with eating disorders display an attentional bias for body parts without clothing (Horndasch et al., 2012), which might introduce artificial effects when using clothing which only covers some parts of the body but not others. Control participants were weighed and measured in the standardised clothing. For therapeutic reasons, this was not possible for the AN group. Instead, height measurements from hospital admission were used and weight was collected from the last twice-weekly official weighing in underwear. For reasons of data protection both height and weight measurements were self-reported by patients. At the end of the session, participants received the trait questionnaires and were asked to fill them in until the next session.

The second session consisted of the experiments for studies 2 to 4. The experiments were run in fixed order. After preparation of the electroencephalograph (EEG), three resting measurements took place. A one-minute measurement with open eyes and a one-minute measurement with closed eyes took place in random order. Afterwards, a five-minute resting measurement with open eyes was conducted. Then, the experiment of study 3 (visual evoked potentials paradigm) was run prior to the experiment of study 4 (heartbeat perception task) which was followed by the experiment of study 2 (startle eye-blink modulation paradigm). At the end of the experiments, the participants' real, ideal, maximum and minimum body images were assessed with the digital photo distortion software BodyImage (Shibata, 2002). To conclude the session, the participants received their reimbursement and were given the opportunity to ask any further questions.

3.2.4. Psychometric and Clinical Assessment

In addition to the psychophysiological measurements, which are described in detail in the respective chapters, we employed several psychometric questionnaires for the trait and state assessment of eating disorder symptoms, depressive symptoms, and anxiety. Furthermore, two semi-structured interviews were conducted to assess DSM-IV diagnoses and socio-demographic information. Body image distortion was tested with a special computer programme. These non-physiological assessments, which were identical for all three studies, will be detailed in the following.

Interviews

Structured Clinical Interview for DSM-IV

The SCID-I (First et al., 2002; Wittchen et al., 1997) is a semi-structured interview which allows the assessment of symptoms and diagnoses of major DSM-IV disorders. It contains sections on affective disorders, psychotic disorders, substance abuse and dependence, anxiety disorders, somatoform disorders, and eating disorders. Inter-rater reliabilities for the individual categories range from moderate to excellent (Lobbestael, Leurgans, & Arntz, 2011). The interview was conducted by a specially trained psychologist for the assessment in the patient sample, and by specially trained psychologists or psychology students for the assessment in the control sample.

Socio-Demographic Interview

A custom-made interview with structured and semi-structured questions was conducted for the assessment of several socio-demographic characteristics, such as age, nationality, and mental disorder and treatment history (see Appendix). This interview contained several custom-made questions for the assessment of SES according to the International Standard Classification of Education (ISCED-97) of the Organisation for Economic Co-operation and Development (OECD). SES for each participant was determined by establishing the SES for each member of the participant's household, including parents in the case of students who did not live at home but were still economically dependent on their parents, according to the ISCED-97 manual (Organisation for Economic Co-operation and Development, 1999). A participant's SES was then determined as the highest SES in her household.

This interview also included the interview version of the International Physical Activity Questionnaire (IPAQ; http://www.ipaq.ki.se/downloads.htm). The IPAQ was used in the short version with the last seven days as reference period. This version contains an assessment of the number of days and the number of hours per day during which vigorous- and moderate-intensity activity and walking were performed. The time spent with physical activity of each category was then weighted with metabolic equivalent of task (MET) energy expenditure estimates. The sum of the weighted categories served as an estimate of MET energy expenditure per week. The IPAQ has been shown to have adequate reliability and validity across countries (Craig et al., 2003).

Questionnaires

Several psychometric questionnaires were used for the assessment of eating-disorder and general psychopathology in the current study. Trait questionnaires were filled in by participants in the period between the first and second experimental sessions, whereas state questionnaires were used in order to assess the current state of the participant during the second session, which involved the psychophysiological measurements.

Eating Disorder Inventory-2

Eating disorder symptoms were assessed with the EDI-2 (English: Garner, 1991; German: Paul & Thiel, 2005). The EDI-2 is a 91-item self-report measure assessing cognitive, affective, and behavioural aspects of eating disorder symptoms. Answers are given on a 6-point Likert scale ranging from 1 (*never*) to 6 (*always*). Scores are calculated for the subscales Drive for Thinness, Bulimia, Body Dissatisfaction, Ineffectiveness, Perfectionism, Interpersonal Distrust, Interoceptive Awareness, Maturity Fears, Asceticism, Impulse Regulation, and Social Insecurity. In the current study, we calculated subscale scores as the average of all items belonging to the subscale. The first three subscales are designed to reflect eating-disorder specific symptoms, while the other subscales reflect symptoms which are common in eating disorders, but not specific to them (Paul & Thiel, 2005). In the current sample, Cronbach's α ranged from α = .83 to α = .95 for the subscales of the EDI-2 and therefore demonstrated adequate to high internal consistency.

Beck Depression Inventory

Symptoms of depression were assessed with the BDI-II (English: Beck et al., 1996; German: Hautzinger et al., 2006). The BDI-II is a 21-item self-report measure. Each item represents a symptom of depression and the participant is given four options for reporting the degree to which each symptom is present. The symptoms contained in the questionnaire correspond to those listed in DSM-IV criteria for major depression, such as negative mood, feelings of guilt, loss of energy, changes in sleeping habits, etc. In the current study, the BDI-II total score was calculated as the mean of all items. Internal consistency was high with Cronbach's α = .96.

State and Trait Anxiety Inventory

Anxiety symptoms were assessed on a trait level and, during the second experimental session, on a state level with the State-Trait Anxiety Inventory (STAI; English: Spielberger, Gorsuch, & Lushene, 1970; German: Laux, Glanzmann, Schaffner, & Spielberger, 1981). The trait and state scales consist of 20 items each. Answers are given on a 4-point Likert scale ranging from

1 (*almost never*) to 4 (*almost always*). For both versions the total score was calculated as the average of all items in the current study. Internal consistency for the STAI-Trait was high with Cronbach's $\alpha = .96$. Internal consistencies for the STAI-State scale were also excellent and ranged between $\alpha = .95$ and $\alpha = .97$ for the four measurement time points.

Self-Report Version of the Structured Interview for Anorexic and Bulimic Disorders

The self-report screening version of the Structured Interview for Anorexic and Bulimic Syndromes (SIAB-S; Fichter & Quadflieg, 2000) was filled in by patients only in order to gain additional information for the confirmation of AN diagnoses from the SCID-I. The SIAB-S assesses all criteria relevant for eating disorder diagnoses according to DSM-IV, in their current manifestation and in the worst-ever manifestation. The self-report version has been shown to have good agreement with the interview form of the SIAB (Fichter & Quadflieg, 2000).

Self-Assessment Manikin

Current affective state during the second experimental session was assessed with the SAM scale (Bradley & Lang, 1994) in which participants are asked to rate the valence and arousal of their current affective state on a 9-point scale. Each point on the scale is illustrated with a manikin with varying facial expression for the valence scale and varying levels of stomach prickling for the arousal scale. This measure is routinely used to assess affective reactions to pictorial and other stimuli (Bradley & Lang, 1994). In the current study, it was used as a more general measure of current affective state, which, because of its shortness, could easily be administered several times over the course of the experiments.

Hunger, Satiety, Craving, Body Image

During the second experimental session participants were repeatedly asked to indicate their current level of hunger, satiety, food craving, and satisfaction with shape and weight. Ratings were given on 11-point Likert scales ranging from 0% (*not at all*) to 100% (*highest level of hunger, etc,. imaginable*).

BodyImage Programme

A digital computer programme which gradually distorts a front-view photograph of the participant was used in order to assess body image distortion (Shibata, 2002). Participants were asked to adjust the provided image according to the following instructions: "How do you think you look like?" corresponding to size estimation; "How would you like to look like?"

corresponding to ideal body image; “What is the largest body you could imagine for yourself?” corresponding to maximally acceptable body image; “What is the thinnest body you could imagine for yourself?” corresponding to minimally acceptable body image. For each question the participant adjusted four images of which two were twice the real size and two were half the real size of the participant’s picture. The final indices were calculated as means of the four adjustments.

3.2.5. Equipment

Psychophysiological monitoring equipment involved a 64-channel actiCAP active electrode EEG-system with two BrainAmp DC amplifiers for EEG channels and one BrainAmp ExG amplifier for non-EEG channels (all from Brain Products, Gilching, Germany). Ag/AgCl EEG electrodes were arranged according to the 10/20-system with FCz as reference and AFz as ground electrode, as displayed in Figure 11. Impedances were kept below 20 kΩ. ExG channels were recorded with bipolar reference. Vertical electrooculogram (VEOG) electrodes were placed above and below the right eye, horizontal EOG (HEOG) electrodes at the outer canthi of the eyes and electromyogram (EMG) electrodes on the orbicularis oculi muscle below the left eye. Electrocardiogram (ECG) electrodes were attached according to Einthoven lead II on the participant’s chest. For recording the software BrainVision Recorder (Brain Products, Gilching, Germany) was used. Data were sampled at a rate of 1000 Hz, with a resolution of 0.1 μV for all channels except for ECG (0.5 μV). Recording filters were set to a time constant of 10 s for the high-pass filter and 1000 Hz for the low-pass filter. Psychophysiological data were analysed with BrainVision Analyzer (Brain Products, Gilching, Germany). Visual and auditory stimuli were presented with E-Prime (version 2.0; Psychology Software Tools, Inc., Sharpsburg, PA, United States of America). Statistical analyses were calculated using SPSS (version 21; IBM SPSS Statistics, New York, NY, United States of America). For all analyses, the level of significance was set to $\alpha = .05$.

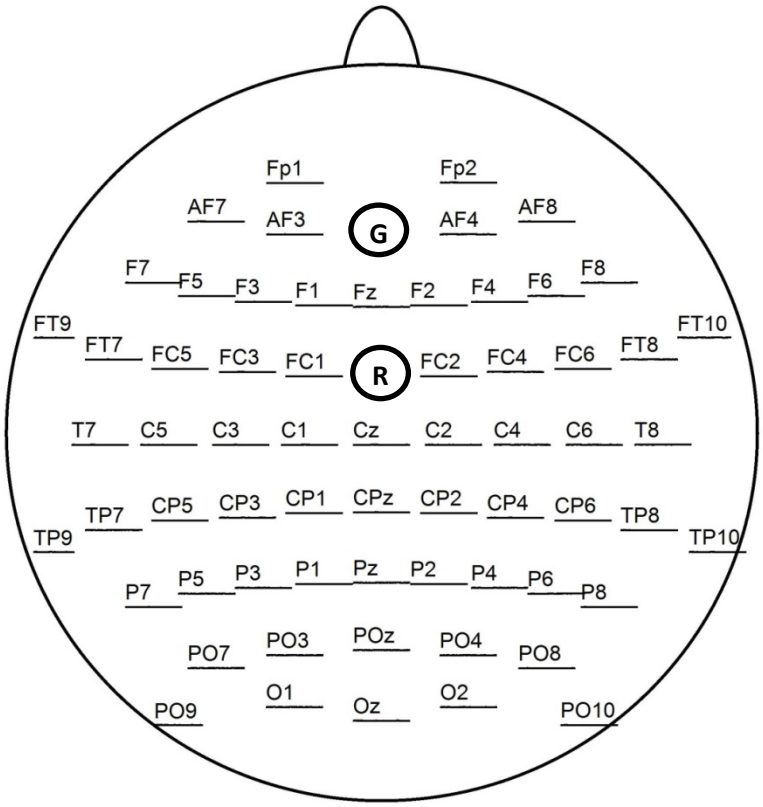

Figure 11. Electrode configuration for the recording of event-related scalp potentials. G = ground electrode (AFz); R = reference electrode (FCz).

3.3. Implicit and Explicit Affective Evaluation of Body Images in Anorexia Nervosa (Study 2)

3.3.1. Abstract

Drive for thinness and fear of fatness are major motivational factors and diagnostic criteria for AN. Neuroimaging studies suggest alterations in fear and reward circuits for the processing of fat and thin body images, respectively. These alterations can be targeted with the affective startle modulation paradigm, as the startle reflex is sensitive to avoidance and approach motivation. We employed this paradigm in order to systematically investigate effects of thin- and fat-distorted body images of oneself and another person, in a sample of 18 women with AN and 20 healthy control women. Results show no modulation of startle by the presentation of body images, despite more negative subjective ratings for thin- and fat-distorted bodies in general, and more negative valence ratings for body pictures in the AN than in the control group. Analysis of positive, negative, and neutral normative pictures revealed a typical affective startle modulation effect in the control group and a possible failure of activating approach motivation in AN. In conclusion, the body photographs used in our study, which highlighted general body shape more than details, did not activate differential implicit motivational states in individuals with AN, although they affected subjective ratings. These results highlight the importance of distinguishing between cognitive and affective evaluative processes. While cognitive evaluation may be more global, implicit affective processes related to body image might only be activated by more explicit stimuli and only in subgroups of AN patients.

3.3.2. The Affective Startle Modulation Paradigm

The Startle Reflex

The startle reflex is a response to sudden, potentially threatening events and includes a variety of muscular contractions that serve to protect the body from potential harm. The most consistently evoked response is a contraction of the orbicularis oculi muscle, which results in eye-lid closure. This blink reflex occurs approximately 30 to 50 ms after onset of a startling event, for example, a sudden loud noise (Lang, Bradley, & Cuthbert, 1990). The primary pathway of the acoustic startle reflex begins at the ear, where sound is received, after which the signal is transmitted via the cochlear nerve to the cochlear root neurons where the first

synapse is located. The signal then continues to the nucleus reticularis pontis caudalis from where, after a second synapse, neurons project to the facial motor nucleus where the third synapse is located. The facial nerve, arising from the facial motor nucleus, is responsible for the pinna reflex in the rat and most likely also for the eye blink reflex in humans (Davis, Walker, & Lee, 1999; Koch, 1999). Other structures in the brainstem may also be involved in signal transmission to the nucleus reticularis pontis caudalis, that is, the dorsal and ventral cochlear nuclei, the lateral superior olive, and the ventrolateral tegmental nucleus (Koch, 1999).

From a psychological point of view, the startle reflex is particularly interesting because it can be modulated, among others, by the motivational state of the organism, that is, approach or avoidance motivation. The motivational state in turn can be manipulated with emotionally charged foreground stimuli, such as pictures or videos with positive or negative emotional content. Presentation of negative foreground stimuli produces a potentiation of the startle response, while positive foreground stimuli lead to attenuation (Lang et al., 1990; Lang, 1995). While the startle reflex is potentiated when the aversive motivational state of the organism matches the defensive nature of the startle reflex, it is attenuated under conditions of an appetitive motivational state because this state represents an opposing motivational tendency (Lang et al., 1990). In the neural network involved in fear-potentiated startle the central nucleus of the amygdala plays a major role with its direct and indirect connections to the nucleus reticularis pontis caudalis. The central amygdaloid nucleus receives input from the lateral and basal amygdaloid nuclei, which in turn is fed with information from thalamic sensory regions and cortical areas, among others (Koch, 1999). The neural network causing startle attenuation in an appetitive motivational state has been less extensively explored, but has been suggested to involve the nucleus accumbens, a brain area associated with reward processing (Birbaumer & Schmidt, 2006; Koch, 1999).

As the startle reflex is sensitive to approach and avoidance motivation induced by affectively charged stimuli, it lends itself to the investigation of fear of fatness and drive for thinness in AN. These two characteristics are part of the diagnostic criteria for AN according to DSM-V (American Psychiatric Association, 2013) and have been proposed to represent avoidance and approach motivation for weight loss, respectively (Levitt, 2003). Moreover, previous research indicates that brain areas involved in affective startle modulation might also be involved in the processing of thin and fat body images, representing drive for thinness and fear of fatness, respectively.

A Possible Role of the Amygdala in Fear of Fatness

The amygdala has been described as "the centerpiece of the subcortical networks involved in detecting and responding to threats" (LeDoux, 2003; p.733) and plays a central role in fear-potentiation of startle, as detailed above. Accordingly, if fear of fatness, which is a characteristic of AN by definition (American Psychiatric Association, 2013), is associated with an immediate fear response in the presence of stimuli signalling weight gain, it is expected to be reflected in increased amygdala activity.

Two studies have reported activation of the amygdala when individuals with AN were confronted with manipulated photographs of their own bodies, which had been distorted to look fatter (Miyake, Okamoto, Onoda, Kurosaki, et al., 2010; Seeger et al., 2002). Moreover, amygdala activation has been reported in persons with AN when reading unpleasant body-related words (Miyake, Okamoto, Onoda, Shirao, et al., 2010), although there are also reports of null-findings in studies using fat-distorted body pictures (Wagner et al., 2003) or unpleasant body-related words (Redgrave et al., 2010). A possible confounder in imaging research on body dissatisfaction is the fact that amygdala activation has also been reported in healthy females for fat self-body pictures (Kurosaki, Shirao, Yamashita, Okamoto, & Yamawaki, 2006), self-comparison to a slim model (Friederich et al., 2007) and unpleasant body-related words (Shirao, Okamoto, Mantani, Okamoto, & Yamawaki, 2005; Shirao, Okamoto, Okada, Okamoto, & Yamawaki, 2003). This phenomenon might be related to high levels of body dissatisfaction in the general population (Fallon, Harris, & Johnson, 2014). Moreover, an implicit affective bias against obese body shapes has been reported using event-related potentials (ERPs; Schupp & Renner, 2011). If overweight stimuli produce the same implicit negative evaluation in control persons, this may lead to null-findings when contrasting individuals with AN and healthy controls for amygdala activity. This methodological issue of imaging research can be overcome by an indirect investigation of amygdala activity through the affective startle modulation paradigm and within-groups comparisons between body images with varying degrees of thinness or fatness.

Drive for Thinness and the Reward System

As opposed to fear of fatness, drive for thinness has been described as an approach motivation for weight loss in AN (Levitt, 2003). It has been suggested that the reward system in individuals with AN is shifted from the goal of short-term reward, in the shape of enjoying food, towards the long-term reward of becoming or staying thin (Kaye et al., 2009).

Unfortunately, the neural circuits involved in motivation for thinness have been less well explored as aversion to fatness. Of the studies using thin-distorted images of the participants themselves, one report found no group differences between individuals with AN and healthy controls, with both groups showing activation in the occipito-temporal cortex, the right parietal cortex, and the right dorsolateral prefrontal cortex (Miyake, Okamoto, Onoda, Kurosaki, et al., 2010). Another study reported stronger activation of the insula and the lateral anterior prefrontal cortex in individuals with AN when rating their own thin-distorted body image for satisfaction (Mohr et al., 2010). Altered insula activity in this context might reflect altered interoceptive processing, and might also result in altered input to the ventral circuit of the reward system, through connections to the ventral striatum (Kaye et al., 2009). In this respect, one study found greater activation of the ventral striatum in women with AN when they processed underweight body shapes in a self-referential way, as compared to normal-weight body shapes and healthy controls (Fladung et al., 2010). This activation in the ventral reward circuit might reflect the motivation for thinness, which is so common in individuals with AN (Kaye et al., 2009). In summary, the neural basis of drive for thinness remains weakly explored. The likely involvement of the reward system indicates that it may be reflected in startle attenuation, in which the reward system appears to be involved, as detailed above.

The Affective Startle Modulation Paradigm in Body Image Research

Only a small number of studies have employed the affective startle modulation paradigm in body image research. Two studies have been conducted with college or university students, with the general result that increased startle responses for negative weight-related information are associated with higher levels of eating disorder symptoms. More precisely, one study (Spresser, Keune, Filion, & Lundgren, 2012) found that startle responses during presentation of a photograph of one's own face with simulated weight gain were positively correlated with the subscales Drive for Thinness and Body Dissatisfaction of the EDI-3 (Garner, 2004). Another study found scores on the subscale Body Dissatisfaction of the EDI (Garner et al., 1983) to be positively related to startle responses during reading of negative body-related words (Herbert, Kübler, & Vögele, 2013). A study not assessing eating disorder risk produced the result that startle magnitude during presentation of pictures of one's own body was reduced as compared to emotional normative pictures, suggesting a positive evaluation (Buck, Hillman, Evans, & Janelle, 2004).

With regard to samples with eating disorders, one study found no differences between patients with AN, patients with bulimia, and healthy controls for startle responses during presentation of body pictures, in this case photographs of slim fashion models (Friederich et al., 2006). Surprisingly, in this study patients with AN displayed an aversive response for positive pictures. Another study assessed startle responses during the presentation of pictures of emaciated women and was able to demonstrate an attenuation of the startle response for these pictures in patients with AN (Reichel et al., 2014). In conclusion, it appears that in AN approach motivation might be directed not towards a slim but an emaciated body.

Importantly, startle research on body image in AN has, up to now, only used photographs of other persons and not of the participant herself. Yet, the presentation of photographs depicting other persons might lead to different results than the presentation of self-pictures, as self-comparison to a slim model has been found to produce amygdala activation in healthy controls (Friederich et al., 2007), and individuals with AN have been reported to show stronger amygdala activation when looking at another woman's body than healthy controls (Vocks et al., 2010). Moreover, the presence of an attentional bias for self-body pictures in individuals with AN suggests that they process self-images differently from non-self-images (Blechert et al., 2010). Therefore, it appears mandatory to systematically investigate the affective evaluation of self- versus other-bodies in AN.

Another shortcoming in the literature is that effects of systematic image distortion in the thinner and heavier directions have not yet been studied with the affective startle modulation paradigm. Previous reports suggest that individuals with AN show an implicit positive evaluation of emaciated bodies (Reichel et al., 2014) and that eating disorder symptoms are associated with implicit negative evaluation of negative body-related information (Herbert et al., 2013; Spresser et al., 2012). It could be argued, therefore, that individuals with AN show startle attenuation to thin bodies and startle potentiation to fat bodies. However, the effect of startle attenuation for thin pictures might be limited to the participants' own photographs, as comparison with another person might induce amygdala activation, for thin as well as real pictures of other persons (Friederich et al., 2007; Vocks et al., 2010). Moreover, implicit negative evaluation of fat-distorted pictures might be present in healthy controls, as well (Kurosaki et al., 2006; Schupp & Renner, 2011). Accordingly, we presented participants with headless photographs of themselves and a BMI-matched unknown person, in the real version and digitally distorted thinner and heavier versions. In order to test for more general

alterations of emotional reactivity in AN (Friederich et al., 2006), positive, neutral, and negative emotional normative pictures were used, as well.

Hypotheses

Startle Response

Hyp. 1: Contrasts for the main effect picture category:

- Hyp. 1a: Positive pictures produce startle attenuation compared to neutral pictures (contrast 1; (Lang et al., 1990).
- Hyp. 1b: Negative pictures produce startle potentiation compared to neutral pictures (contrast 2; (Lang et al., 1990).
- Hyp. 1c: Self-thin body pictures produce startle attenuation compared to neutral pictures (contrast 3; (Fladung et al., 2010).
- Hyp. 1d: Self-real body pictures produce startle attenuation compared to neutral pictures (contrast 4; (Buck et al., 2004).
- Hyp. 1e: Self-fat body pictures produce startle potentiation compared to neutral pictures (contrast 5; (Kurosaki et al., 2006).
- Hyp. 1f: Other-thin body pictures produce a startle response different from neutral pictures (contrast 6; (Friederich et al., 2007; Reichel et al., 2014).
- Hyp. 1g: Other-real body pictures produce startle potentiation compared to neutral pictures (contrast 7; (Vocks et al., 2010).
- Hyp. 1h: Other-fat body pictures produce startle potentiation compared to neutral pictures (contrast 8; (Schupp & Renner, 2011).

Hyp. 2: Contrasts for the interaction group × picture category.

- Hyp. 2a: Individuals with AN and control persons differ in their startle response to positive relative to neutral pictures (contrast 9; (Friederich et al., 2006).
- Hyp. 2b: Thin self-body pictures elicit a smaller startle response than neutral pictures, but only in the AN group (contrast 11; (Reichel et al., 2014).
- Hyp. 2c: The startle potentiation caused by fat self-body pictures is larger in the AN group than in the control group (contrast 13; (Miyake, Okamoto, Onoda, Kurosaki, et al., 2010; Seeger et al., 2002).

Valence Ratings

The startle response modulation is expected to be reflected in the valence ratings with the exception that patients with AN are assumed to give negative explicit ratings for thin self-pictures, similar to the control group, in spite of startle attenuation, which reflects implicit positive evaluation. This discrepancy was reported in a previous study (Reichel et al., 2014).

Hyp. 3: Contrasts for the main effect picture category:

- Hyp. 3a: Positive pictures receive more positive ratings than neutral pictures (contrast 3).
- Hyp. 3b: Negative pictures receive more negative ratings than neutral pictures (contrast 2).
- Hyp. 3c: Self-thin body pictures receive more negative ratings than neutral pictures (contrast 3).
- Hyp. 3d: Self-real body pictures receive more positive ratings than neutral pictures (contrast 4).
- Hyp. 3e: Self-fat body pictures receive more negative ratings than neutral pictures (contrast 5).
- Hyp. 3f: Other-thin body pictures receive ratings different from neutral pictures (contrast 6).
- Hyp. 3g: Other-real body pictures receive more negative ratings than neutral pictures (contrast 7).
- Hyp. 3h: Other-fat body pictures receive more negative ratings than neutral pictures (contrast 8).

Hyp. 4: Contrasts for the interaction group × picture category.

- Hyp. 4a: Individuals with AN and control persons differ in their ratings for positive relative to neutral pictures (contrast 9).
- Hyp. 4b: Individuals with AN rate fat self-body pictures more negatively compared to neutral pictures than the control group (contrast 13).

Arousal Ratings

Hyp. 5: Positive and negative pictures are rated as more arousing than neutral pictures (contrasts 1, 2; (Lang, 1995).

Hyp. 6: Thin body pictures are rated as more arousing than neutral pictures (contrasts 3, 6; (Reichel et al., 2014).

Self-Resemblance Ratings

Hyp. 7: Self-pictures are rated as more self-resembling than other-pictures (main effect identity).

Hyp. 8: Thin- and fat-distorted pictures are rated as less self-resembling than real pictures (main effect distortion; cf. study 1).

Correlation Analysis

Hyp. 9: There are positive correlations between the startle magnitude for fat-distorted images and the EDI subscales Drive for Thinness and Body Dissatisfaction (Spresser et al., 2012)

3.3.3. Method

Stimulus Material

Of each participant, 12 pictures were taken in 12 standardized poses. The poses consisted of turning the body in steps of 30°. On each picture the feet were about hip-width apart and the hands placed on the back of the head. The resulting pictures were manipulated using GIMP 2[1]. First, the picture was cropped so that only the part of the body between the neck and ankles was visible. As a result of this process, all bodies had the same size. Second, images were distorted in width. For each image, a version 25% narrower than the original (thin picture) and a version 25% wider than the original (fat picture) were created (Kurosaki et al., 2006; Miyake, Okamoto, Onoda, Kurosaki, et al., 2010). Third, each image was set to a size of 1024 x 786 pixels. On each picture the background was a uniform grey (RGB: 126,126,126). In addition to the participant's own photographs, she was shown a set of real, thin and fat pictures of another participant, matched for BMI. This resulted in a total of 72 body pictures, 12 each of the following categories: self-thin, self-real, self-fat, other-thin, other-real, other-fat. Additionally, the participants were shown a set of affective normative

[1] GIMP 2 is an open source image manipulation programme which can be downloaded at http://www.gimp.org/.

pictures taken from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008). This set consisted of 12 positive, 12 neutral, and 12 negative pictures[2].

Startle Eye-Blink Modulation Paradigm

The 108 pictures were displayed in random order with the restriction that a picture of one category could not be directly followed by another picture of the same category. Presentation time was 6 seconds. Inter-stimulus intervals varied randomly between 4 and 8 seconds, with a mean of 6 seconds. Ten randomly chosen pictures of each category were paired with a short burst of white noise (50 ms, 105 dB[A]) presented via headphones. The tone occurred at a random interval between 3 and 5 seconds, in steps of 500 ms, after picture onset. Moreover, startle tones were presented in ten randomly selected inter-stimulus intervals. After completion of all trials, the pictures were again displayed in the same order as before and participants were asked to rate each picture for valence (1 = *positive*, 9 = *negative*) and arousal (1 = *high arousal*, 9 = *low arousal*) on nine-point SAM scales (Bradley & Lang, 1994). Arousal ratings were recoded before statistical analysis by subtracting each value from 10 so that higher numbers represent higher levels of arousal in the following. In addition, for all body pictures the participants were asked to indicate how much the person shown resembled themselves on a nine-point Likert scale (1 = *definitely me*, 9 = *definitely somebody else*). Total task duration for picture viewing was just over 20 minutes with the picture rating taking another 30 minutes.

Data Analysis

The EMG signal was first treated with BrainVision Analyzer (Brain Products, Gilching, Germany), applying a 28 to 499 Hz band-pass filter (van Boxtel, Boelhouwer, & Bos, 1998). The signal was then rectified and integrated using the moving average transformation with a time constant of 11 ms (Blumenthal, 1994). Stimulus onset markers were transformed to analogue markers, that is, displayed as a continuous signal, and the data was exported for further processing.

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[2] IAPS picture numbers: Positive: 1440, 1441, 1710, 1750, 2057, 2071, 4542, 4597, 5202, 5910, 8461, 8490
Neutral: 2191, 2377, 2393, 2411, 7001, 7025, 7033, 7175, 7493, 7547, 7595, 8312
Negative: 1300, 1525, 3550, 6230, 6313, 8485, 9250, 9301, 9341, 9571, 9900, 9925

In the next step, EMG responses were detected in a semiautomatic way using a customized C++ based computer programme (Clip 2.0.0). This programme automatically fixed a baseline period of 200 ms, starting from 250 ms before stimulus onset and ending 50 ms before stimulus onset. It further detected EMG peaks in a time window of 0 to 200 ms after stimulus onset. Baseline periods and EMG peaks were manually confirmed after automated detection. During manual confirmation, peak amplitudes were set to zero if no startle response was visible. Trials were treated as missing data in case of electrical and physiological artefacts (i.e., excessive background noise, coinciding blinks and other muscular activity, multiple peaks). The difference between peak and mean baseline voltage served as startle response amplitude. These raw values were then *T* scored across all blink responses of each individual participant, in order to minimise inter-individual variability (Cuthbert, Bradley, & Lang, 1996; Ferreira de Sá et al., 2014). *T*-scored startle amplitudes were then averaged across visual stimulus categories, including zero responses, resulting in startle response magnitudes.

Startle response and subjective ratings for valence and arousal were statistically tested using planned contrasts comparing each picture category with neutral pictures as reference category. This resulted in a total of 16 contrasts for the main effects of picture category and interactions between picture category and group, as listed in Table 8. Contrasts for which no specific hypotheses were formulated are also reported for completeness. Results of the omnibus mixed design 2 × 9 ANOVA with the factors group (AN vs. control) and picture category (neutral vs. positive vs. negative vs. self-thin vs. self-real vs. self-fat vs. other-thin vs. other-real vs. other-fat) are reported for completeness, but are not interpreted, as specific hypotheses have been formulated for the contrasts and a general effect of picture category, over the nine categories, would be meaningless.[3] Moreover, the main effect of group is not reported for startle magnitudes, as between-groups comparisons of *T*-scored data are meaningless. The critical level of significance was set to $\alpha = .05$ for all analyses. Partial eta squared is reported as a measure of effect size. Correlational analyses were performed using Pearson's *r* with $\alpha = .05$. The EDI subscales Drive for Thinness and Body Dissatisfaction were correlated with

[3] The 2 × 9 ANOVA design with planned contrasts as main hypothesis test was chosen as the design was not fully crossed for the picture categories. It was not feasible to analyse IAPS and body pictures in separate ANOVA models, as the neutral reference category is required in order to draw conclusions about the absolute implicit valence of the body pictures (i.e., positive vs. negative). A comparison across two ANOVA models was, furthermore, not possible because of the *T* scoring of the startle data, which requires that all dependent variables across which the *T* scoring is applied be analysed in the same statistical model.

startle magnitudes for body pictures. *T*-scored startle magnitudes were used in order to avoid artificial correlations caused by single participants with large absolute startle magnitudes.

Table 8

List of Contrasts Performed for the Factor Picture Category

Contrast	Effect	Category	Reference Category	Hypothesis
1	Main Effect	Positive	Neutral	1a
2	Main Effect	Negative	Neutral	1b
3	Main Effect	Self-Thin	Neutral	1c
4	Main Effect	Self-Real	Neutral	1d
5	Main Effect	Self-Fat	Neutral	1e
6	Main Effect	Other-Thin	Neutral	1f
7	Main Effect	Other-Real	Neutral	1g
8	Main Effect	Other-Fat	Neutral	1h
9	Interaction with Group	Positive	Neutral	2a
10	Interaction with Group	Negative	Neutral	
11	Interaction with Group	Self-Thin	Neutral	2b
12	Interaction with Group	Self-Real	Neutral	
13	Interaction with Group	Self-Fat	Neutral	2c
14	Interaction with Group	Other-Thin	Neutral	
15	Interaction with Group	Other-Real	Neutral	
16	Interaction with Group	Other-Fat	Neutral	

Subjective ratings for self-resemblance were analysed using a mixed design 2 × 2 × 3 ANOVA with the between factor group (control vs. AN) and the within factors identity (self vs. other) and distortion (thin vs. real vs. fat). Greenhouse-Geisser adjustment for degrees of freedom was used when applicable. A significant main effect of distortion was followed up with planned contrasts, comparing thin and fat pictures with real pictures. Significant interactions were further investigated using post hoc *t* tests. The critical level of significance was set to $\alpha = .05$ for ANOVA results on self-resemblance ratings. For all follow-up tests, the α-level was adjusted according to Bonferroni, that is, the original α-level was divided by the number of tests. As measures of effect size, partial eta squared was calculated for ANOVA results, while Cohen's *d* was calculated for post hoc *t* tests. Correlational analyses were performed using Pearson's *r* with $\alpha = .05$. The EDI subscales Drive for Thinness and Body Dissatisfaction were correlated with startle magnitudes for body pictures. *T*-scored startle magnitudes were used in order to avoid artificial correlations caused by single participants with large absolute startle magnitudes.

One participant was excluded from the analyses as 96.7 % of her startle responses were scored as missing, that is, invalid trials. Another participant was classified as startle non-responder, as 71.1 % of her reactions were null-responses, and therefore also excluded from further analysis. This resulted in a final $N = 38$ for the startle analysis, with $n = 20$ participants in the control group and $n = 18$ participants in the AN group.

3.3.4. Results

Startle Eye-Blink Response

Planned contrasts for picture category showed a significant effect only for the comparison of negative and neutral pictures (contrast 2), $F(1, 36) = 8.53$, $p = .0060$, $\eta_p^2 = .19$, all other ps > .42. Negative pictures produced larger startle magnitudes ($M = 52.07$, $SD = 3.58$) than neutral pictures ($M = 49.75$, $SD = 3.36$). For the interaction between group and picture category only contrast 9 (positive vs. neutral pictures) was significant, $F(1, 36) = 6.56$, $p = .015$, $\eta_p^2 = .15$, all other ps > .14. While the control group showed the expected startle attenuation for positive compared to neutral pictures, this pattern was reversed in the AN group. Contrast results are summarised in Table 9 and Figure 12. Results of the omnibus ANOVA showed a significant main effect for picture category, $F(5.80, 208.87) = 2.72$, $p = .016$, $\eta_p^2 = .070$, and no significant interaction between group and picture category, $F(5.80, 208.87) = 1.51$, $p = .18$, $\eta_p^2 = .040$.

Table 9

Results of Planned Contrasts for the Comparison of Affective and Body Pictures with Neutral Pictures and Interaction Effects with the Group Factor on Startle Magnitudes

Effect	Contrast	*df*1, *df*2	*F*	*p*	η_p^2
Picture Category	1. pos-neu	1, 36	0.64	.43	.017
	2. neg-neu	1, 36	8.53	.006	.19
	3. st-neu	1, 36	0.016	.90	< .001
	4. sr-neu	1, 36	0.079	.78	.002
	5. sf-neu	1, 36	0.088	.77	.002
	6. ot-neu	1, 36	0.32	.57	.009
	7. or-neu	1, 36	0.079	.78	.002
	8. of-neu	1, 36	0.071	.79	.002
Picture Category × Group	9. pos-neu	1, 36	6.56	.015	.15
	10. neg-neu	1, 36	1.14	.29	.031
	11. st-neu	1, 36	0.058	.81	.002
	12. sr-neu	1, 36	0.13	.73	.003
	13. sf-neu	1, 36	0.43	.52	.012
	14. ot-neu	1, 36	0.005	.94	< .001
	15. or-neu	1, 36	2.20	.15	.058
	16. of-neu	1, 36	< 0.001	> .99	< .001

Note. neu = neutral pictures; pos = positive pictures; neg = negative pictures; st = self-thin body pictures; sr = self-real body pictures; sf = self-fat body pictures; ot = other-thin body pictures; or = other-real body pictures; of = other-fat body pictures.

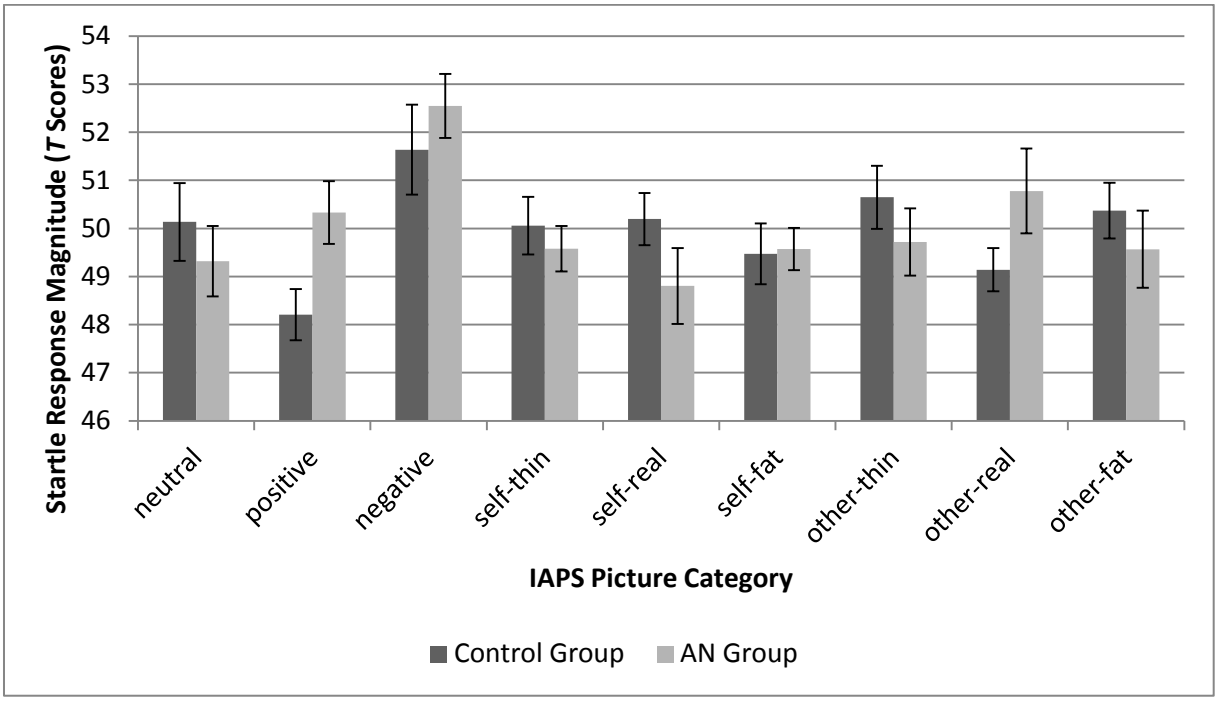

Figure 12. Mean *T*-scored startle response magnitudes for all picture categories in the control group (dark grey bars) and the AN group (light grey bars). AN = anorexia nervosa. Error bars represent +/- 1 *SEM*.

Valence Ratings

Positive pictures were rated more positively (M = 2.71, SD = 0.89) than neutral pictures (M = 4.80, SD = 0.57), $p < .001$. Negative pictures (M = 7.70, SD = 0.87), self-thin body pictures (M = 5.83, SD = 1.88), self-fat body pictures (M = 6.41, SD = 1.56), other-thin body pictures (M = 6.16, SD = 1.81), other-real body pictures (M = 5.21, SD = 1.35), and other-fat body pictures (M = 6.01, SD = 1.50) were rated more negatively than neutral pictures, all ps < .04. Self-real body pictures (M = 5.11, SD = 1.66) did not differ significantly from neutral pictures, p = .23. The interaction between picture category and group was significant for the contrasts self-fat pictures versus neutral pictures, other-thin pictures versus neutral pictures, and other-real pictures versus neutral pictures, all ps < .003, all other ps > .14. Contrast results are summarised in Table 10 and Figure 13. The omnibus ANOVA showed a significant main effect for picture category, $F(3.56, 128.32) = 49.66$, $p < .001$, $\eta_p^2 = .58$, and a trend for an interaction between group and picture category, $F(3.56, 128.32) = 2.20$, $p = .080$, $\eta_p^2 = .058$. There was, furthermore, a significant main effect for group, $F(1, 36) = 14.60$, $p < .001$, $\eta_p^2 = .30$.

Table 10

Results of Planned Contrasts for the Comparison of Affective and Body Pictures with Neutral Pictures and Interaction Effects with the Group Factor on Valence Ratings

Effect	Contrast	*df*1. *df*2	*F*	*p*	η_p^2
Picture Category	1. pos-neu	1. 36	189.69	< .001	.84
	2. neg-neu	1. 36	301.39	< .001	.89
	3. st-neu	1. 36	11.28	.002	.24
	4. sr-neu	1. 36	1.49	.23	.040
	5. sf-neu	1. 36	49.65	< .001	.58
	6. ot-neu	1. 36	29.09	< .001	.45
	7. or-neu	1. 36	4.60	.039	.11
	8. of-neu	1. 36	29.08	< .001	.45
Picture Category × Group	9. pos-neu	1. 36	2.14	.15	.056
	10. neg-neu	1. 36	0.16	.69	.004
	11. st-neu	1. 36	1.47	.23	.039
	12. sr-neu	1. 36	1.62	.21	.043
	13. sf-neu	1. 36	189.69	< .001	.84
	14. ot-neu	1. 36	301.39	< .001	.89
	15. or-neu	1. 36	11.28	.002	.24
	16. of-neu	1. 36	1.49	.23	.040

Note. neu = neutral pictures; pos = positive pictures; neg = negative pictures; st = self-thin body pictures; sr = self-real body pictures; sf = self-fat body pictures; ot = other-thin body pictures; or = other-real body pictures; of = other-fat body pictures.

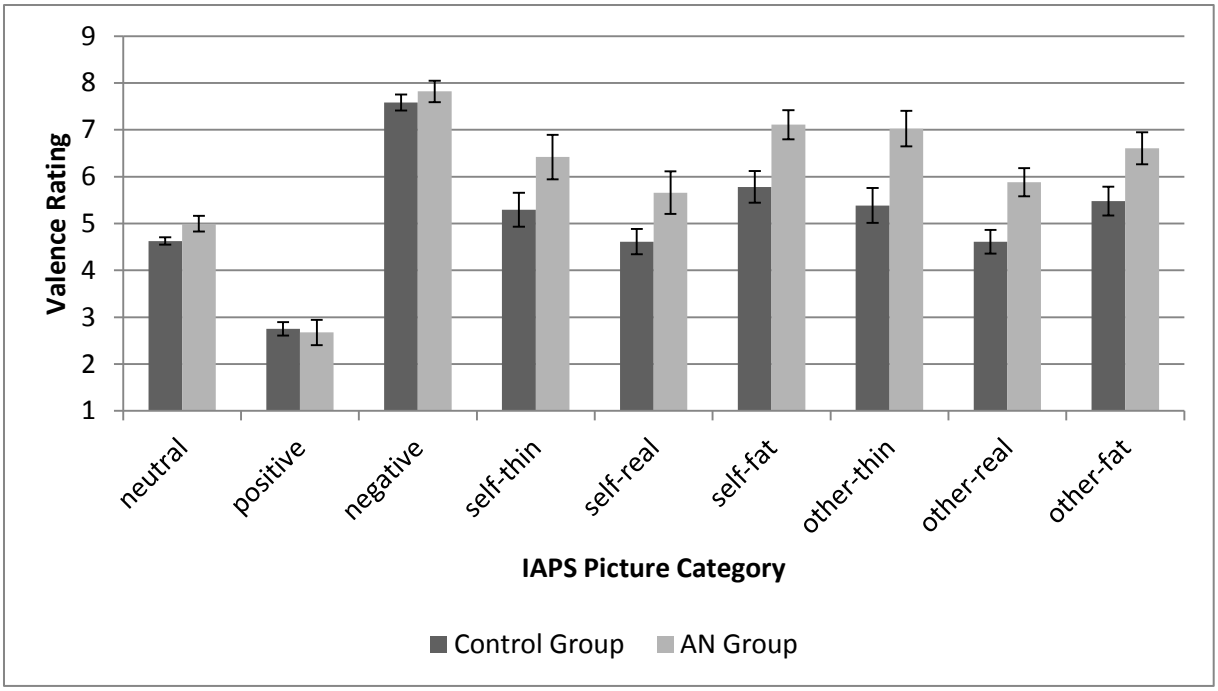

Figure 13. Valence ratings for all picture categories in the control group (dark grey bars) and the AN group (light grey bars). The scale ranged from 1 to 9 with lower numbers indicating increasingly positive affect and higher numbers indicating increasingly negative affect. AN = anorexia nervosa. Error bars represent +/- 1 *SEM*.

Arousal Ratings

All picture categories, that is, positive pictures (M = 4.06, SD = 1.90), negative pictures (M = 4.68, SD = 2.05), self-thin body pictures (M = 4.73, SD = 2.40), self-real body pictures (M = 4.21, SD = 2.16), self-fat body pictures (M = 4.51, SD = 2.05), other-thin body pictures (M = 4.47, SD = 2.51), other-real body pictures (M = 3.62, SD = 2.00), other-fat body pictures (M = 4.00, SD = 2.17) received higher arousal ratings than neutral pictures (M = 2.35, SD = 1.37), all ps < .001. The interaction between picture category and group was significant for the contrasts self-thin bodies versus neutral, self-real bodies versus neutral, self-fat bodies versus neutral, other-thin bodies versus neutral, other-fat bodies versus neutral, all ps < .005, all other ps > .15. Contrast results are summarised in Table 11 and Figure 14. The omnibus ANOVA showed significant main effects of picture category, $F(4.14, 148.99) = 18.10$, $p <$ .001, $\eta_p^2 = .34$, and group , $F(1, 36) = 20.14$, $p < .001$, $\eta_p^2 = .36$, as well as a significant interaction between group and picture category, $F(4.14, 148.99) = 4.78$, $p = .001$, $\eta_p^2 = .12$.

Table 11

Results of Planned Contrasts for the Comparison of Affective and Body Pictures with Neutral Pictures and Interaction Effects with the Group Factor on Arousal Ratings

Effect	Contrast	*df*1. *df*2	*F*	*p*	η_p^2
Picture Category	1. pos-neu	1. 36	52.15	< .001	.59
	2. neg-neu	1. 36	57.80	< .001	.62
	3. st-neu	1. 36	83.70	< .001	.70
	4. sr-neu	1. 36	66.60	< .001	.65
	5. sf-neu	1. 36	98.86	< .001	.73
	6. ot-neu	1. 36	57.85	< .001	.62
	7. or-neu	1. 36	21.20	< .001	.37
	8. of-neu	1. 36	40.11	< .001	.53
Picture Category × Group	9. pos-neu	1. 36	3.29	.078	.084
	10. neg-neu	1. 36	1.19	.28	.032
	11. st-neu	1. 36	18.30	< .001	.34
	12. sr-neu	1. 36	14.87	< .001	.29
	13. sf-neu	1. 36	17.65	< .001	.33
	14. ot-neu	1. 36	13.69	.001	.28
	15. or-neu	1. 36	2.07	.16	.054
	16. of-neu	1. 36	9.24	.004	.20

Note. neu = neutral pictures; pos = positive pictures; neg = negative pictures; st = self-thin body pictures; sr = self-real body pictures; sf = self-fat body pictures; ot = other-thin body pictures; or = other-real body pictures; of = other-fat body pictures.

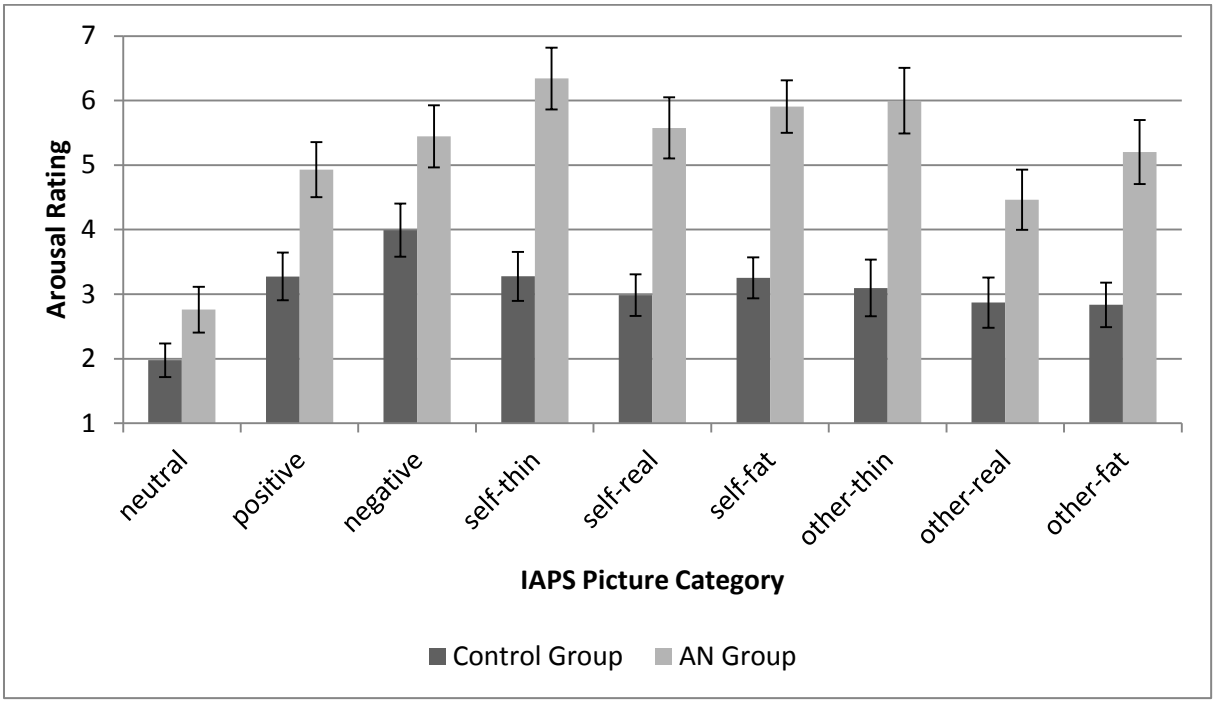

Figure 14. Arousal ratings for all picture categories in the control group (dark grey bars) and the AN group (light grey bars). The scale ranged from 1 to 9 with higher numbers indicating higher arousal. AN = anorexia nervosa. Error bars represent +/- 1 *SEM*.

Self-Resemblance

There was a significant main effect for group, $F(1, 36) = 14.80$, $p < .001$, $\eta_p^2 = .29$. The AN group rated the pictures as more resembling another person ($M = 6.02$, $SD = 1.16$) than the control group ($M = 4.77$, $SD = 0.82$). The main effect for identity was not significant, $F(1, 36) = 0.004$, $p = .95$, $\eta_p^2 < .001$, as was the interaction between identity and group, $F(1, 36) = 0.46$, $p = .50$, $\eta_p^2 = .013$. There was a significant main effect for distortion, $F(1.45, 52.12) = 6.76$, $p = .006$, $\eta_p^2 = .16$. At $\alpha' = .017$, thin-distorted pictures ($M = 5.59$, $SD = 1.70$) differed significantly from real pictures ($M = 4.80$, $SD = 1.36$), $t(37) = 2.85$, $p = .007$, $d = 0.51$, and fat-distorted pictures ($M = 5.70$, $SD = 1.39$) differed significantly from real pictures, $t(37) = 5.23$, $p < .001$, $d = 0.65$, while thin- and fat-distorted pictures did not differ significantly from each other, $t(37) = -0.33$, $p = .75$, $d = 0.064$. The interaction between distortion and group was not significant, $F(1.45, 52.12) = 0.041$, $p = .92$, $\eta_p^2 = .001$. There was a significant interaction between identity and distortion, $F(2, 72) = 3.29$, $p = .043$, $\eta_p^2 = .084$. However, none of the post hoc *t* tests reached statistical significance at $\alpha' = .017$, all *p*s > .20. The interaction between group, identity and distortion was not significant, $F(2, 72) = 0.20$, $p = .82$, $\eta_p^2 = .006$.

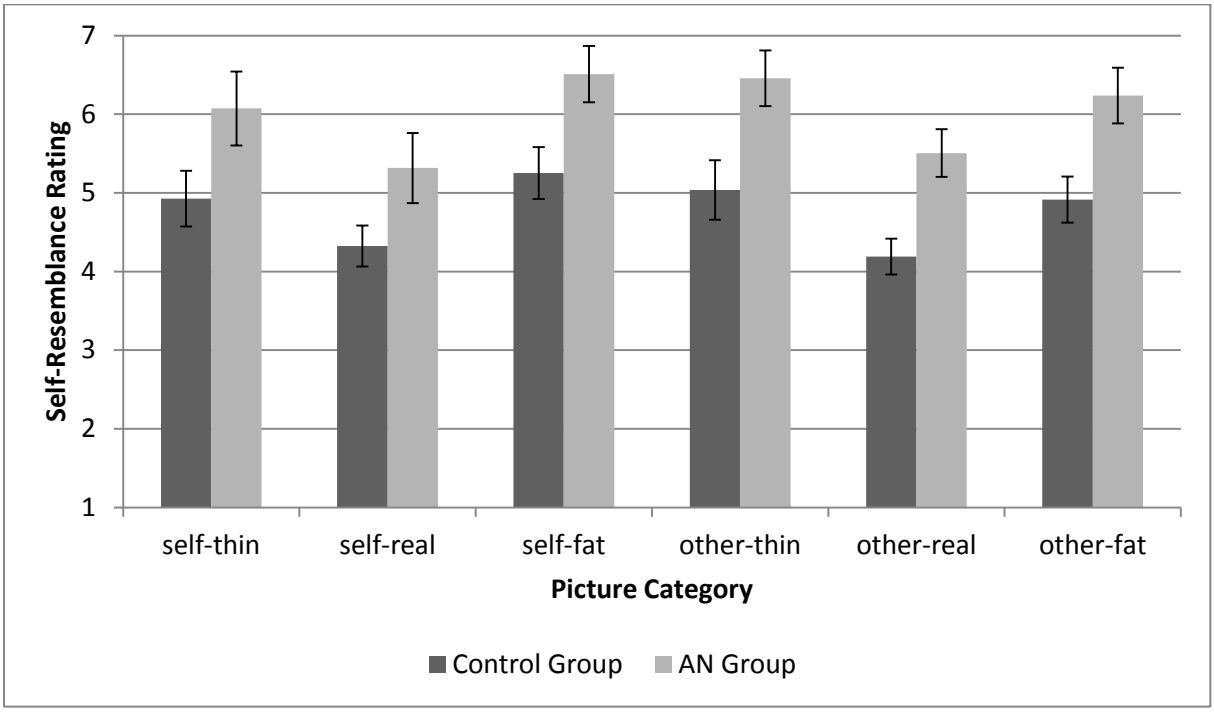

Figure 15. Self-resemblance ratings for body pictures in the control group (dark grey bars) and the AN group (light grey bars). The scale ranged from 1 to 9 with lower numbers indicating stronger resemblance to one's own person and higher numbers indicating stronger resemblance to another person. AN = anorexia nervosa. Error bars represent +/- 1 *SEM*.

Correlation Analysis

Startle magnitudes during the presentation of self-real body pictures were negatively related to the EDI subscale Drive for Thinness, r = -.32, p = .048, that is, persons with higher levels of drive for thinness showed startle attenuation for real self-pictures. There were trends for a negative correlation between startle magnitudes for thin self-bodies and the EDI subscales Drive for Thinness, r = -.27, p = .098, and Body Dissatisfaction, r = -.29, p = .073, that is, persons with higher questionnaire scores on these subscales showed startle attenuation for thin self-bodies.

Table 12

Pearson Correlations Between Startle Magnitudes for Body Pictures and EDI Subscales

	Startle Magnitudes					
	Self			Other		
EDI Subscale	Thin	Real	Fat	Thin	Real	Fat
Drive for Thinness	-.27†	-.32*	-.072	.11	.26	-.11
Body Dissatisfaction	-.29†	-.058	-.22	.16	.21	-.035

Note. EDI = Eating Disorder Inventory.

† $p < .10$. * $p < .05$.

3.3.5. Discussion

We investigated the implicit affective evaluation of body images in AN, employing an affective startle modulation paradigm. We hypothesised that individuals with AN would display a response pattern characterised by attenuation of startle for thin self-pictures (Hyp. 2b) and potentiation of startle for fat self-pictures (Hyp. 2c). We further expected this pattern to be reflected in negative valence ratings for fat self-pictures (Hyp. 4b) in individuals with AN, but expected a discrepancy between implicit and explicit valuation in terms of negative subjective ratings for thin self-pictures (Hyp. 3c). Moreover, we used positive, negative, and neutral normative pictures in order to investigate general emotional processing in AN (Hyp. 2a).

Summary and Interpretation of Results

Affective Normative Pictures

The investigation of positive, negative, and neutral affective normative pictures demonstrated the typical effect of increased startle magnitude for negative pictures (Hyp. 1b; Lang et al.,

1990; Lang, 1995). Yet, startle attenuation for positive pictures was only present in the control group, but not in the AN group, as predicted by hypothesis 2a. This is in line with previous studies, which even reported startle potentiation for positive normative pictures in AN (Friederich et al., 2006). Friederich et al. (2006) interpreted this phenomenon as an inability of patients with AN to activate their appetitive motivational system. In a similar vein, it has been suggested that alterations in ventral-striatal circuits in AN are related to difficulties in the processing of emotions and thereby underlie symptoms such as anhedonia (Kaye et al., 2009). As it is assumed that areas involved in the ventral-striatal reward circuit, such as the nucleus accumbens, are also implicated in pleasure-attenuation of the startle reflex (Birbaumer & Schmidt, 2006; Koch, 1999), altered reward processing in AN might well be responsible for the present findings (Wagner et al., 2007). It should be noted, however, that in the study by Reichel et al. (2014), patients with AN did show startle attenuation to positive pictures. One difference between the present study and the study by Reichel et al. (2014) concerns illness duration, which was considerably longer in the present study (9.5 vs. 1.3 years). It is possible that failure to activate the approach system is a long-term consequence of AN related to a narrowing of interests and other symptoms of the disorder (Fairburn et al., 1999).

Notably, the subjective valence ratings for affective normative pictures did not entirely mirror the results of the affective startle modulation paradigm. Here, individuals with AN rated positive pictures as pleasant, as did healthy controls (Hyp. 3a, Hyp. 3b, Hyp. 4a). This discrepancy of explicit (ratings) and implicit (startle) evaluation might be attributed to the fact that participants were told beforehand that they were going to see positive, negative and neutral pictures. In consequence, individuals with AN might have rated pictures more positively when they believed that the pictures belonged to the positive category and that they were, therefore, expected to give more positive ratings. Thus, the ratings might have been influenced by cognitive deliberation and not merely by pre-attentive affective processes.

Body Pictures

The analysis of startle magnitudes did not reveal any significant effects for body pictures. This was contrary to our hypotheses that self-pictures would produce startle attenuation (Hyp. 1d; Buck et al., 2004), that thin-distorted self-pictures would produce startle attenuation (Hyp. 1c; Fladung et al., 2010) and that fat-distorted self-pictures would produce startle potentiation (Hyp. 1e; Kurosaki et al., 2006). Similarly, our expectations of differential startle modulation

by other-thin, other-real, and other-fat body pictures were not confirmed (Hyp. 1f, Hyp. 1g, Hyp. 1h). Moreover, we were unable to confirm our hypotheses with regard to the AN group, that is, that individuals with AN would display startle attenuation for thin self-pictures (Hyp. 2b) and startle potentiation for fat self-pictures (Hyp. 2c).

These findings concerning an implicit measure of affect are contrasted by the results for subjective ratings. Valence ratings were generally more negative for thin- and fat-distorted pictures, as well as for other-real pictures, which was in line with our expectations (Hyp. 3c, Hyp. 3e, Hyp. 3f, Hyp. 3h, Hyp. 3g). While thin and fat distorted pictures might simply appear unnatural to the viewer, other real pictures might induce a comparison with the other person, which may elicit negative affect (Friederich et al., 2007). The AN group gave relatively more negative ratings compared to the control group for self-fat body pictures, as predicted by hypothesis 4b. In addition, the AN group gave relatively more negative ratings for other-thin, and other-real pictures versus neutral pictures, which is in line with the idea that these pictures might elicit a social comparison process associated with negative affect in individuals with AN (Vocks et al., 2010). Furthermore, we did not find a positive evaluation of real self-pictures (Hyp. 3c), which might be attributed to the standardised and rather artificial manner in which the body pictures were taken in our study, thereby possibly eliminating any positive bias for self-pictures, which has been found in other studies (Buck et al., 2004).

Concerning arousal ratings, all affective and body pictures were rated as more arousing than neutral pictures, which is in line with our hypotheses 5 and 6. These results expand previous findings on higher arousal ratings for thin body-pictures (Reichel et al., 2014) by showing that fat and real body pictures may also be experienced as arousing. Again, this might be a consequence of the highly standardised composition of our photographs, which might appear unnatural to the participants. The interaction between group and picture category was significant for all body pictures, except for other-real bodies. This suggests that individuals with AN experienced almost all body pictures as more arousing than the control group, which may be an expression of the high importance these individuals place on body shape and weight (Fairburn et al., 1999), combined with a strong association between body shape and weight and general self-esteem (Blechert et al., 2011).

In summary, although distorted body images received more negative valence ratings than neutral pictures and patients with AN had a general tendency towards negative valence and

higher arousal ratings for body pictures, none of these subjective ratings was reflected in startle potentiation. It is known that high arousal ratings are necessary for negative affective pictures to produce startle potentiation (Lang, 1995). Yet, arousal ratings in the AN group appeared similar for negative normative pictures, which produced startle potentiation, and body pictures, which did not produce startle potentiation despite negative valence ratings. It appears, therefore, that valence and arousal ratings in the AN group might not have been based on the same implicit emotional processes that drive affective startle modification (Koch, 1999; Lang, 1995). Discrepancies between startle amplitudes and subjective ratings are known from the addiction literature, but usually with the result that an implicit positive evaluation of consumption of the addictive substance is uncovered by startle modulation and is not present in subjective ratings (e.g., Mucha, Geier, Stuhlinger, & Mundle, 2000). However, in our study the result was such that an effect was present in subjective ratings but not in an implicit measure. A similar discrepancy between subjective and physiological measures of negative affect and arousal has been described during mirror exposure in women with eating disorders (Vocks et al., 2007). It appears, therefore, that ratings of negative affect and high arousal for body pictures in the AN group were not merely based on implicit affective processes, but might have been influenced by higher cognitive processes.

In addition, and contrary to our expectations, the self-resemblance ratings did not differ between self- and other-pictures (Hyp. 6), indicating that participants most likely did not identify themselves with their own pictures. As expected, thin- and fat-distorted pictures were rated as more resembling another person than oneself (Hyp. 7). The latter finding is in line with the results of study 1, which showed that distorted pictures of one's own body are more difficult to recognise and where participants displayed a reaction bias towards classifying distorted body images as depicting another person. Moreover, the AN group reported less self-resemblance for all body images than the control group, which might be explained by their aversive experience of body pictures as evidenced in valence ratings. The generally low identification with self-pictures might have masked possible differences in the processing of self- and other-pictures (Vocks et al., 2010).

Strikingly, we did not find an attenuation of startle for thin-distorted bodies in the AN group as would have been expected from the results by Reichel et al. (2014). The nature of the stimulus material might be a relevant factor in the explanation for this discrepancy. While Reichel et al. (2014) selected pictures from pro-anorexic websites depicting clear signs of cachexia, our pictures were highly standardised photographs taken in the laboratory with a

focus more on general body shape than specific features, such as a protruding rib cage. As it is well known that many individuals with AN engage in body checking behaviours and use indicators such as the visibility of the ribs in order to determine their dieting success (Shafran et al., 2004), these specific features might be more important for them than general body shape when judging the valence of a given body. Accordingly, our pictures might not have been as emotionally charged as those used in the study by Reichel et al. (2014). Our results are more in line with the those of Friederich et al. (2006), who did not find significant differences between persons with AN and a healthy control group in startle responses during presentation of photographs depicting slim fashion models. This finding adds to the idea that slim body shapes in general might not have the same emotional and motivational connotation for individuals with AN as clear signs of emaciation. This hypothesis would have to be tested in a direct comparison of the implicit affective evaluation of pictures emphasizing a slim body shape and those highlighting specific marks of cachexia.

Alternatively, if our patients were indeed unable to activate their appetitive motivational system, as suggested by the absence of startle attenuation for positive normative pictures, this might account for the absence of startle attenuation for thin-distorted self-bodies. Yet, a thin body is believed to be the long-term appetitive goal of individuals with AN and has been suggested to replace short-term rewards, such as might have been represented by our positive pictures (Kaye et al., 2009). Our finding of a negative trend in the correlation between startle magnitudes for thin self-pictures and drive for thinness and body dissatisfaction suggests that at least participants with higher levels of body image disturbance showed an approach motivation towards their own thin-distorted body shape. The absence of a group effect might also be explained by the fact that our thin-body stimuli were not necessarily underweight, but merely 25% slimmer than the participant. In Reichel et al. (2014)'s study participants were shown pictures of emaciated women, which were associated with negative evaluation in the control group. It might have been the case that participants with higher levels of body dissatisfaction in our control group showed an approach motivation towards a thinner, but not emaciated, version of themselves. It must, therefore, be noted that we did not explicitly test affective evaluation of underweight bodies, but of thinner versions of oneself, which were most likely not underweight for most control participants. Additional research is needed to systematically investigate effects of varying degrees of thinness on the implicit affective evaluation of body pictures. One may hypothesise that individuals with AN would show maximally positive evaluation for emaciated body shapes (Reichel et al., 2014), while control

participants would show a preference for slim, but not emaciated, body shapes (cf. study 1). A preference for emaciated rather than slim body shapes might be a hypothetical risk factor for the development of AN.

Importantly, we did not find a potentiation of startle for fat-distorted pictures, neither in the AN nor in the control group. Startle potentiation for aversive foreground stimuli is largely mediated by the amygdala (Koch, 1999). Amygdala activation for own fat-distorted body images has been shown for healthy females (Kurosaki et al., 2006) and for individuals with AN in some studies (Miyake, Okamoto, Onoda, Kurosaki, et al., 2010; Seeger et al., 2002), but not in others (Wagner et al., 2003). One study reported that a subgroup of their participants with AN was characterised by increased amygdala response to fat body drawings and severe body image disturbance (Uher et al., 2005). Accordingly, it might be the case that amygdala activation in response to fat body images is a variable phenomenon among persons with AN and that it only occurs in some patients, but not in others. Yet, we did not find any significant correlations of startle modulation by fat self-images with drive for thinness or body dissatisfaction. It remains, therefore, to be elucidated, which personal characteristics predispose individuals to immediate fear reactions in the presence of fat-distorted self-body images and which characteristics of body-image stimuli, such as visibility of certain body parts, activate these predispositions. An understanding of the exact conditions under which fear responses are evoked could help to fine-tune intervention techniques aiming at a reduction of body-related fear responses, such as body image exposure interventions (Vocks et al., 2006).

Limitations

The stimulus material employed in the current study was highly standardised. All participants wore identical figure-hugging clothing and heads were not visible. This type of clothing may have hidden prominent signs of emaciation in the AN group, which might account for discrepant findings with the study by Reichel et al. (2014). Nevertheless, a study reporting amygdala activation for fat self-bodies used jeans and T-shirt as standardised clothing, which can be assumed to have hidden even more body shape details than our clothing (Miyake, Okamoto, Onoda, Kurosaki, et al., 2010). These latter findings suggest that even less detailed body pictures may elicit implicit emotional processes. It should be mentioned, however, that Miyake, Okamoto, Onoda, Kurosaki et al. (2010) did not digitally remove the faces of their participants on the photographs, which is why influences of face-specific processing cannot

be excluded. Furthermore, the visibility of the face might have fostered self-identification. Nevertheless, our stimulus material had the advantage of being very specific for body processing, as no faces were visible, and for body-shape processing, as no other physical features, such as skin texture, were visible. Future studies should investigate the relative emotional significance of different body parts, including the face, for individuals with AN.

The general similarity of effects for thin and fat-distorted pictures across analyses suggests that there might be a general effect for distortion, that is, the fact that the picture has been distorted, rather than the fact that the depicted body is thinner or fatter than one's real body. Unfortunately, at the time of data acquisition no computer programme was available that would have allowed us to distort photographs of different body positions in a way that mimics weight loss or gain in a realistic way. Commonly used distortion programmes (cf. chapter 3.1.3) only distort front-view photographs. We decided to present various pictures of each participant instead of only one picture in order to prevent an habituation of startle modification, which may be reduced in startle paradigms relative to other psychophysiological measures of emotional reactivity but is, nevertheless, present (Bradley, Lang, & Cuthbert, 1993). Accordingly, we simply distorted the images in width for the creation of thin and fat images, which has been shown to be sufficient to elicit amygdala activation in previous studies (Miyake, Okamoto, Onoda, Kurosaki, et al., 2010). Nevertheless, it would be desirable to more realistically mimic weight gain and weight loss of the participant's own body in future studies.

Conclusion

In conclusion, we did not find affective startle-reflex modulation for thin- and fat-distorted body pictures. This suggests that thinness per se might not be of major emotional relevance to patients with AN, but rather specific signs of cachexia. Moreover, individuals with AN might have a more general difficulty in activating the appetitive motivational system. Amygdala activation in response to fat body images might be a phenomenon specific to subgroups of patients with AN, or limited to specific stimuli. While body shapes in general are associated with subjective negative valence and high arousal in individuals with AN, these ratings appear to be grounded on cognitive distortion rather than implicit affective processes. Investigations are called for which specify the conditions under which implicit approach and avoidance motivation for body shapes of varying sizes are elicited and whether there are subgroups of AN patients in whom these implicit processes are particularly pronounced. The distinction

between cognitive and affective processes is essential for the choice of adequate intervention techniques, such as cognitive therapy or in vivo exposure, and further research in this area will help to fine-tune treatment programmes to the specific needs of individual AN patients.

3.4. Visual Perception of the Body in Anorexia Nervosa (Study 3)

3.4.1. Abstract

Overestimation of body size is a prominent symptom of AN. Structural and functional alterations of brain areas crucial for visual body shape processing, such as the EBA, provide a neuronal basis for altered visual body perception. Yet, it remains unclear at which time point in the visual processing stream these alterations become apparent. Of special interest is if these neuronal alterations are reflected in changes in the featural and configural processing of body shapes, as reflected by early ERP components. We investigated ERPs elicited by pictures of one's own body, of another person's body, of one's own cup and of another person's cup in 16 women with AN and 17 healthy control women. Participants with AN showed reduced differentiation between pictures of self-body and self-cup in the P1 component (105 – 160 ms) and increased differentiation between pictures of bodies and cups in the N1 component (160 – 225 ms), compared with controls. This is indicative of a shift in body-related processing from featural to configural processing of body images relative to the control group. These results demonstrate profound changes in the visual processing of body images in AN during the earliest ERPs (i.e. 100 ms after stimulus onset) for which category-specific modulation effects have been established. The significance of these alterations for the aetiology and treatment of AN remains to be elucidated.

3.4.2. Event-Related Brain Activity of Visual Body Processing

Women with AN consistently overestimate their body size and show concomitant alterations in the activity of the EBA, a brain area involved in the visual perception of bodies (cf. chapter 2.2.3). Yet, it remains unclear if these alterations reflect changes in perceptive processes or if they are caused by cognitive distortions (Gardner & Moncrieff, 1988). In order to further elucidate this question, we employed visual ERPs, as they offer the unique possibility of assessing possible alterations, which occur early in the processing stream and reflect processing of image features (P1) and the configuration of those features (N1) in which human bodies and faces appear to receive preferential processing.

Configural Body Processing and the N1 Component

Human bodies, as well as human faces, are stimuli of major significance to the social human being (Slaughter, Stone, & Reed, 2004). In social interactions, they convey a wealth of information about who we are dealing with and if that person may be friend or foe. In accordance with this assumption, an attentional bias for human body forms has been found. For example, human body forms are detected more easily than control stimuli in an in-attentional blindness paradigm (Downing, Bray, Rogers, & Childs, 2004). This has led to the conclusion that human bodies are processed preferentially, similar to human faces. The restrictions of gravity and anatomy produce a typical configuration of body parts, which we are likely to encounter in most cases when we see another person, that is, the person is standing on his/her legs on the ground, with an upper body and head on top. In experimental investigations this typical configuration can be altered by turning photographs of human bodies upside down, with the results that the head is nearest to the ground and the legs point upwards. This inversion of bodies produces an impairment in their recognition, an effect, which has also been found for faces and is interpreted as a marker of configural processing, that is, processing that depends on a certain configuration of parts and that is holistic in nature (Peelen & Downing, 2007; Reed, Stone, Bozova, & Tanaka, 2003).

In event-related potentials, the configural processing of bodies is reflected in a negative waveform peaking at around 170 ms after stimulus onset. This peak has been labelled N1, N170, or N190 and will be referred to as N1 in the following. Although initially studied in the context of face processing, the N1 component has also been shown to be sensitive to the inversion of human body shapes. Body inversion increases peak amplitude and latency, an effect which is likely to be caused by a disruption of configural processing (Stekelenburg & de Gelder, 2004). This effect might be different for headless bodies (Minnebusch, Suchan, & Daum, 2009; Yovel, Pelc, & Lubetzky, 2010), but identical inversion effects for bodies with and without heads have also been reported (Minnebusch, Keune, Suchan, & Daum, 2010). In addition to inversion effects, the N1 component has been shown to have larger amplitudes for faces and bodies than for objects (Gliga & Dehaene-Lambertz, 2005). Amplitudes appear to be similar for faces and bodies and similarly affected by scrambling of face or body parts, while latencies and scalp topographies may differ slightly between faces and bodies (Gliga & Dehaene-Lambertz, 2005). The body-sensitivity of the N1 component has been found to generalise to silhouettes and stick figures (Thierry et al., 2006). Moreover, N1 is enhanced for nude bodies, an effect which might be related to the evolutionary significance of nude vs.

clothed bodies (Hietanen & Nummenmaa, 2011). Taken together, these findings suggest that N1 reflects the configural processing of human faces and bodies (for reviews see: De Gelder et al., 2010; Minnebusch & Daum, 2009; Peelen & Downing, 2007).

Several studies have located the source of the N1 component in the EBA. The EBA is a brain area in the temporo-occipital cortex and assumed to be primarily involved in the visual processing of human bodies (cf. chapter 2.2.3). N1 amplitudes seem to covary with activity in this brain area (Taylor, Roberts, Downing, & Thierry, 2010). Moreover, stimulation of the EBA with transcranial magnetic stimulation (TMS) has been reported to selectively increase N1 amplitudes for bodies (Sadeh et al., 2011). A component similar to N1 has been found for intracranial EEG recording from the EBA (Pourtois, Peelen, Spinelli, Seeck, & Vuilleumier, 2007) and in magnetoencephalographic (MEG) activity of the same brain area (Ishizu, Amemiya, Yumoto, & Kojima, 2010).

Unfortunately, most studies on body-related N1 activity have not assessed differences between the viewing of photographs of one's own body and of photographs of another person's body. To our knowledge, only one study has explored this effect and found higher N1 amplitudes for self- vs. other-bodies. In addition, this study reported differences between self- and other-bodies for an even earlier component, the P1, with, again, higher amplitudes for self-bodies (Li & Zhan, 2008). Nevertheless, several studies have investigated familiarity effects of the N1 component for faces and yielded mixed results. While some report larger N1 amplitudes for one's own face than for unfamiliar faces (Caharel et al., 2002; Keyes, Brady, Reilly, & Foxe, 2010; Scott, Luciana, Wewerka, & Nelson, 2005), others found no familiarity effect for N1 (Gunji, Inagaki, Inoue, Takeshima, & Kaga, 2009; Sui et al., 2006; James Tanaka, Curran, Porterfield, & Collins, 2006). Moreover, there seems to be no familiarity effect in the N1 component for the processing of object stimuli (Miyakoshi, Nomura, & Ohira, 2007).

The P1 Component

It has recently been suggested that category specific processing occurs already before the N1 component, at around 100 ms after visual stimulus onset (Meeren, Hadjikhani, Ahlfors, Hämäläinen, & de Gelder, 2008). This ERP component, the P1, has been shown to be sensitive to faces in a similar way as N1 (Dering, Martin, Moro, Pegna, & Thierry, 2011). With regard to bodies findings are less clear. While some studies could not find body

inversion effects for the P1 (Righart & de Gelder, 2007), others report body inversion effects for the P1 in neuronal sources of this component, namely the precuneus and posterior cingulate (Meeren et al., 2008). Some studies found graded body (Minnebusch et al., 2010) and face (Jacques & Rossion, 2007) rotation to affect P1 and N1 amplitudes, but only N1 amplitudes to be correlated with behavioural rotation effects. As the P1 is sensitive to low-level image properties, such as luminance, contrast, and spatial frequencies (Johannes, Münte, Heinze, & Mangun, 1995; Kenemans, Baas, Mangun, Lijffijt, & Verbaten, 2000), it remains difficult to disentangle the effects of low-level stimulus properties versus semantic categories. In the current study, we aimed at solving this problem by adjusting low-level properties across stimuli with the SHINE toolbox (Willenbockel et al., 2010). The neuronal sources of the P1 for faces have been localised in the fusiform gyrus (Herrmann, Ehlis, Muehlberger, & Fallgatter, 2005). Furthermore, the MEG counterpart of the P1, the M100, has been shown to be related to performance in a face recognition task (Liu, Harris, & Kanwisher, 2002), supporting the view of early category specific processing.

P1 and N1 in Eating Disorder Research

As the N1 sources for the processing of body images have been localised in the EBA (Ishizu et al., 2010; Pourtois et al., 2007; Sadeh et al., 2011; Taylor et al., 2010) and this brain area shows structural and functional alterations in AN (Suchan et al., 2010, 2012; Uher et al., 2005), it may be hypothesized that these neuronal abnormalities are reflected in N1 alterations during the visual processing of bodies in AN. Recently, two abstracts have been published in conference proceedings presenting first findings on N1 alterations in AN, for the processing of houses (Banscherus, Suchan, & Herpertz, 2012) and in terms of an absence of the inversion effect for bodies with heads (Suchan, 2014). While these preliminary findings are encouraging, possible differences in the processing of one's own body versus other bodies (Li & Zhan, 2008) remain unexplored. While it has been reported that individuals with AN show specific changes in brain activation compared to other eating-disordered patients and healthy controls when viewing their own versus another body (Vocks et al., 2010), due to the research method used in previous studies (i.e., fMRI) the time course of these alterations remains unexplored. Furthermore, we investigated whether possible alterations in body picture processing in AN occur at the earliest time point for which category specific processing has been reported and which is associated with the processing of image features (P1) or if possible alterations are specific to the processing of the configural relationship of body features (N1).

Hypotheses

N1 Component

Hyp. 1: Bodies elicit a larger N1 component than cups (main effect stimulus type) (Gliga & Dehaene-Lambertz, 2005).

Hyp. 2: Self-bodies elicit larger N1 mean amplitudes than other-bodies (interaction self-reference × stimulus type) (Li & Zhan, 2008).

Hyp. 3: The N1 component for bodies is reduced in the AN group compared with the control group (interaction group × stimulus type).

Hyp. 4: This effect is only present for pictures of the patients' own bodies (interaction group × stimulus type × self-reference).

P1 Component

Hyp. 5: Bodies elicit a larger P1 component than cups (main effect stimulus type) (Dering et al., 2011).

Hyp. 6: Self-bodies elicit larger P1 mean amplitudes than other-bodies (interaction self-reference × stimulus type) (Li & Zhan, 2008).

Hyp. 7: The P1 component for bodies is reduced in the AN group compared with the control group (interaction group × stimulus type).

Hyp. 8: This effect is only present for pictures of the patients' own bodies (interaction group × stimulus type × self-reference).

Behavioural Task

Hyp. 9: Bodies are recognised faster and with higher accuracy than cups (main effect stimulus type) (Downing et al., 2004).

Hyp. 10: Self-related stimuli are recognised faster than non-self-stimuli (main effect self-reference) (Sui et al., 2006; Tacikowski & Nowicka, 2010).

Subjective Ratings

Hyp. 11: Individuals with AN rate body images as more negative and more arousing than the control group (interaction group × stimulus type; cf. study 2).

3.4.3. Method

Stimulus Materials

A front-view photograph was taken of each participant with the feet about hip-width apart and the arms just a little bit apart from the body so as not to cover any body part. This photograph served as the self-body stimulus. A photograph of another participant with similar BMI served as the other-body stimulus. To obtain a self-object stimulus, participants were asked to paint on a coffee cup during the first session in a way that makes it individual and recognizable[4] and received this cup as a gift after the first session. Each participant's cup was photographed and used as the self-object stimulus (Miyakoshi, Kanayama, Iidaka, & Ohira, 2010). As the other-object stimulus, a cup decorated with a similar theme was chosen from among the other participants' cups (e.g., both cups had flowers on them)[5]. There were two different kinds of cups in terms of shape and for each participant one shape was used as their own cup whereas the other shape was used as the other-object stimulus. This procedure was chosen in order to create a parallel to the difference in body shape outlines which was to be expected for the body pictures. Cup shapes were counterbalanced across participants.

All pictures were first manipulated with GIMP 2 image manipulation software. Body pictures were cropped so as to only show the part of the body between the neck and ankles. Thereby, it was assured that all bodies would have the same height on the final photographs. Cup pictures were cropped from the upper to the lower edge of the cup. All colours were converted to shades of grey and the background was set to a uniform grey (RGB: 126,126,126). The pictures were resized to 1024 x 786 pixels. In a second step, all pictures used for one participant were equated in Fourier amplitude spectra and luminance histograms in order to minimize differences in physical stimulus characteristics. This operation was performed with the SHINE toolbox (Willenbockel et al., 2010) for MATLAB (MathWorks Inc., Natick, MA, United States of America). The final stimulus set for each participant consisted of four

[4] Participants were asked not to paint humans, even in the form of smileys or stick figures, which produce N1 amplitudes similar to those for bodies (Thierry et al., 2006), or any human body parts, and to refrain from writing letters or numbers on the cup.

[5] For patients from the psychosomatic hospital the other-object stimulus was always a cup from the healthy control group as we could not rule out that the patients would see each other's cups when using them in the public places of the hospital. Thereby, it was assured that each participant had never seen her other-object stimulus before the experiment.

pictures: self-body, self-cup, other-body, and other-cup. Exemplary photos are displayed in the Appendix.

Paradigm

Pictures were presented in random order with the restriction that the same picture could not be repeated in direct succession. Each picture was repeated 60 times and displayed for two seconds with inter-stimulus intervals randomly varying between one and two seconds, with a mean of 1.5 s. During presentation of the pictures it was the participant's task to decide whether a picture was related to her, that is, self-body and self-object, or unrelated to her, that is, other-body and other-object. One half of the participants pressed the left mouse button of the laptop for self-pictures and the right for other-pictures. The association between buttons and stimulus categories was reversed for the other half of the participants. Button-stimulus associations were randomly allocated to participants. As handedness was equally distributed across groups, we assume that it did not have a major influence on reaction times. After completion of all trials, participants were asked to rate each picture for valence (1 = *positive*, 9 = *negative*) and arousal (1 = *high arousal*, 9 = *low arousal*) on nine-point SAM scales (Bradley & Lang, 1994). Arousal ratings were recoded before statistical analysis by subtracting each value from 10 so that higher numbers represent higher levels of arousal in the following.

Data Analysis

Six persons were excluded from statistical analyses as they had less than 50% correct responses for their own body picture. This suggests that they mistook their own photograph for that of the other person and did not recognise their own body. Another person was excluded because of too many artefacts in the EEG data. This resulted in a final sample of N = 33, with n = 17 participants in the control group and n = 16 participants in the AN group.

EEG Data

EEG recordings were processed with BrainVision Analyzer (Brain Products, Gilching, Germany). The EEG measurements were re-referenced to average reference. The channel previously serving as reference (FCz) was reused. The channel configuration after re-referencing is displayed in Figure 16. Then, a band-pass filter of 0.1 to 35 Hz was applied. Eye movements and blinks were corrected with the Gratton-Coles algorithm (Gratton, Coles, & Donchin, 1983). Subsequently, the data was visually inspected and remaining artefacts

marked with the semiautomatic raw data inspection function of BrainVision Analyzer. The data was then segmented from 200 ms before stimulus presentation to 2000 ms after stimulus presentation. The resulting segments were baseline corrected and averaged for stimulus categories. The P1 was expressed as mean amplitude (Gliga & Dehaene-Lambertz, 2005; Taylor et al., 2010) between 105-160 ms and the N1 as mean amplitude between 160-225 ms. For both the P1 and the N1 the channels P7, P8, PO7, and PO8 were analysed (Bauser, Mayer, Daum, & Suchan, 2011; Minnebusch et al., 2010; Sadeh et al., 2011; Thierry et al., 2006; van Heijnsbergen, Meeren, Grèzes, & de Gelder, 2007). It was confirmed by visual inspection that P1 and N1 peaks were maximal at these electrode positions.

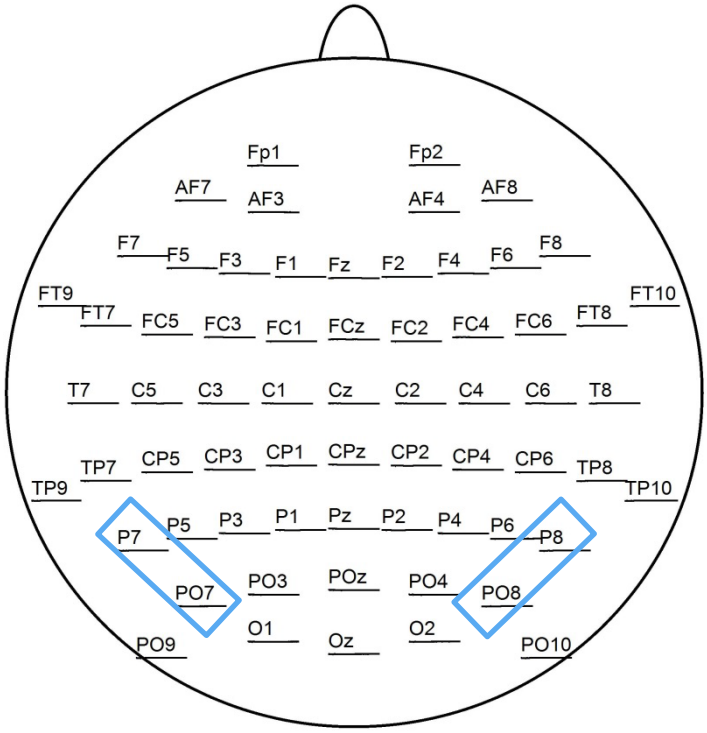

Figure 16. Electrode scalp locations. Electrodes from which P1 and N1 mean amplitudes were extracted are marked by blue rectangles (P7, PO7, P8, PO8).

EEG data were statistically analysed using a mixed-design 2 × 2 × 2 × 2 × 2 ANOVA with the between factor group (control vs. clinical) and the within factors stimulus type (body vs. object), self-reference (self vs. other), laterality (left vs. right), and scalp location (parietal vs. parieto-occipital). Significant interaction effects of ANOVAs were followed up with post hoc *t* tests. Effect sizes reported are partial eta squared for ANOVAs and Cohen's *d* (pooled standard deviations) for post hoc tests. Alpha level was set to $\alpha = .05$ and was Bonferroni corrected for post hoc tests.

Behavioural Data

Mean reaction times and percentage of correct responses were calculated for each stimulus category, that is, self-body, self-cup, other-body, other-cup. Reactions were only analysed for true reactions, that is, if reaction time was > 150 ms. As percent correct reactions were not normally distributed across all picture categories, the data were transformed according to Equation 3, with X_i representing the individual data points.

$$X_i' = \ln(100 - X_i + 1)$$

Equation 3

For ease of interpretation, descriptive statistics are reported as raw data. Reaction times and percentages of correct responses were analysed using a 2 × 2 × 2 mixed-design ANOVA with the between factor group (control vs. clinical) and the within factors stimulus type (body vs. object) and self-reference (self vs. other). Significant interaction effects of ANOVAs were followed up with post hoc *t* tests. Effect sizes reported are partial eta squared for ANOVAs and Cohen's *d* (pooled standard deviations) for post hoc tests. Alpha level was set to $\alpha = .05$ and was Bonferroni corrected for post hoc tests.

Subjective Ratings

Subjective ratings on the dimensions valence and arousal were analysed using a 2 × 2 × 2 mixed-design ANOVA with the between factor group (control vs. clinical) and the within factors stimulus type (body vs. object) and self-reference (self vs. other). Kolmogorov-Smirnov tests for normal distribution were significant for other-body ($Z = 1.27$, $p = .081$) and other-cup valence ($Z = 1.61$, $p = .011$) ratings and for other-cup arousal ratings ($Z = 1.63$, $p = .010$). Visual inspection showed no clear skew in the distribution of these ratings, however. As no transformation for the normalisation of these data was available, and the analysis of within-between interactions with non-parametric tests is considered problematic, we followed current recommendations and conducted an ANOVA in spite of the violation of normality, as ANOVAs are robust against a violation of normality if $N > 30$ (Bortz, 2005), as was the case in the present study. Significant interaction effects of ANOVAs were followed up with post hoc *t* tests. Effect sizes reported are partial eta squared for ANOVAs and Cohen's *d* (pooled standard deviations) for post hoc tests. Alpha level was set to $\alpha = .05$ and was Bonferroni corrected for post hoc tests.

3.4.4. Results

EEG Data

EEG-ERP results are first presented for the N1 component (160 – 225 ms) and followed by the P1 component (105 – 225 ms) as the N1 component is of major significance in the current context, as derived from the extant literature.

N1

Main Effect Stimulus Type (Hyp. 1)

There was a significant main effect for stimulus type, $F(1, 31) = 247.29$, $p < .001$, $\eta_p^2 = .89$. Pictures of bodies produced larger negative amplitudes ($M = -0.92$, $SD = 3.23$) than cups ($M = 2.39$, $SD = 3.04$).

Interaction Self-Reference × Stimulus Type (Hyp. 2)

There was no significant interaction between self-reference and stimulus type, $F(1, 31) < 0.001$, $p = .99$, $\eta_p^2 < .001$.

Interaction Group × Stimulus Type (Hyp. 3)

There was no significant interaction between group and stimulus type, $F(1, 31) = 0.94$, $p = .34$, $\eta_p^2 = .029$. However, there was a significant three-way interaction between group, stimulus type, and scalp location, $F(1, 31) = 4.72$, $p = .038$, $\eta_p^2 = .13$. There was also a significant four-way interaction between laterality, scalp location, stimulus type and group, $F(1, 31) = 5.16$, $p = .030$, $\eta_p^2 = .14$. Post hoc tests showed that, at $\alpha' = .0125$, the AN group had a larger difference between N1 mean amplitudes for body pictures versus cup pictures than the control group at PO8 ($p = .012$), but not at any other electrode location ($ps > .41$).

Interaction Group × Stimulus Type × Self-Reference (Hyp. 4)

There was a significant interaction between group, stimulus type, and self-reference, $F(1, 31) = 5.43$, $p = .027$, $\eta_p^2 = .15$. The difference between self- and other-cup stimuli was larger in the AN group ($M = 0.51$, $SD = 0.91$) than in the control group ($M = -0.43$, $SD = 0.93$), $t(31) = -2.93$, $p = .006$, $d = 1.02$. In addition, the direction of the difference was reversed as the control group showed larger N1 amplitudes to self- than other-cups, whereas the AN group showed larger N1 amplitudes to other-cups. The groups did not differ significantly regarding the difference between self- and other-body stimuli, $t(31) = -0.18$, $p = .86$, $d = 0.062$.

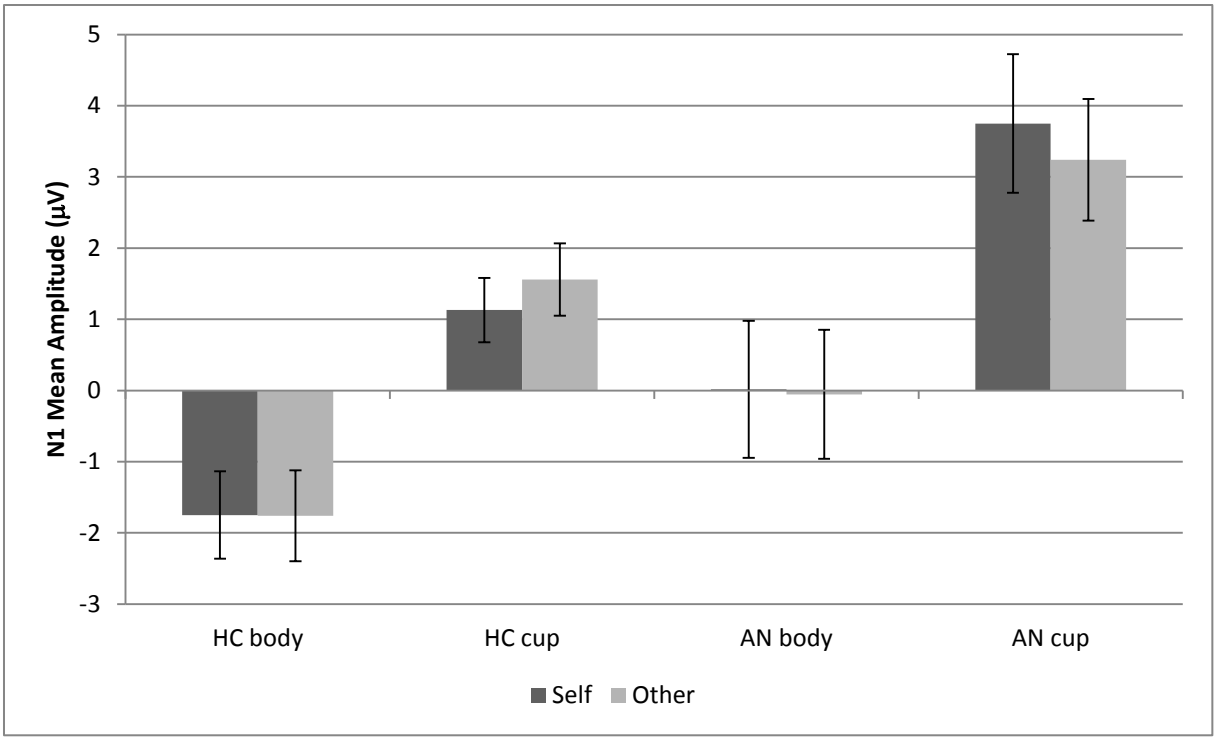

Figure 17. N1 mean amplitudes separated by groups and conditions. HC = healthy control group; AN = anorexia nervosa group. Error bars represent +/- 1 *SEM*.

Other Effects

There was a trend for a group difference with larger negative amplitudes in the control than in the AN group, $F(1, 31) = 3.54$, $p = .069$, $\eta_p^2 = .10$. This group difference was more pronounced at parieto-occipital than parietal locations (interaction scalp location × group), $F(1, 31) = 46.69$, $p < .001$, $\eta_p^2 = .60$. There was also a significant three-way interaction of laterality × scalp location × group, $F(1, 31) = 29.55$, $p < .001$, $\eta_p^2 = .49$. Post hoc tests showed that, at $\alpha' = .0125$, the groups differed significantly, with larger N1 amplitudes in the control group than in the AN group, at PO7 ($p = .004$) and at PO8 ($p = .011$), but not at P7 ($p = .036$) or at P8 ($p = .17$). In addition, there was a trend for an interaction between self-reference and group, $F(1, 31) = 3.53$, $p = .070$, $\eta_p^2 = .10$. Yet, none of the post hoc tests reached statistical significance, all *p*s > .05.

Furthermore, there was a significant main effect for scalp location with larger negative amplitudes at parietal than parieto-occipital locations, $F(1, 31) = 26.46$, $p < .001$, $\eta_p^2 = .46$. In addition, there was a trend towards a main effect for laterality with larger negative amplitudes in the left than in the right hemisphere, $F(1,31) = 3.56$, $p = .069$, $\eta_p^2 = .10$. Lateralisation was stronger at parietal than parieto-occipital locations (interaction laterality × scalp location), $F(1, 31) = 30.66$, $p < .001$, $\eta_p^2 = .50$. There were significant interactions between laterality

and stimulus type, $F(1, 31) = 58.62$, $p < .001$, $\eta_p^2 = .65$, and scalp location and stimulus type, $F(1,31) = 8.34$, $p = .007$, $\eta_p^2 = .21$, as well as a three-way interaction between laterality, scalp location, and stimulus type, $F(1, 31) = 4.10$, $p = .052$, $\eta_p^2 = .12$. N1 amplitude differences between bodies and cups were largest over PO8, followed by P8, PO7, and finally, P7.

There were no other significant effects or trends, all *p*s > .10. A summary of all ANOVA results can be found in the Appendix. The scalp distribution of the N1 is visualised in Figure 18.

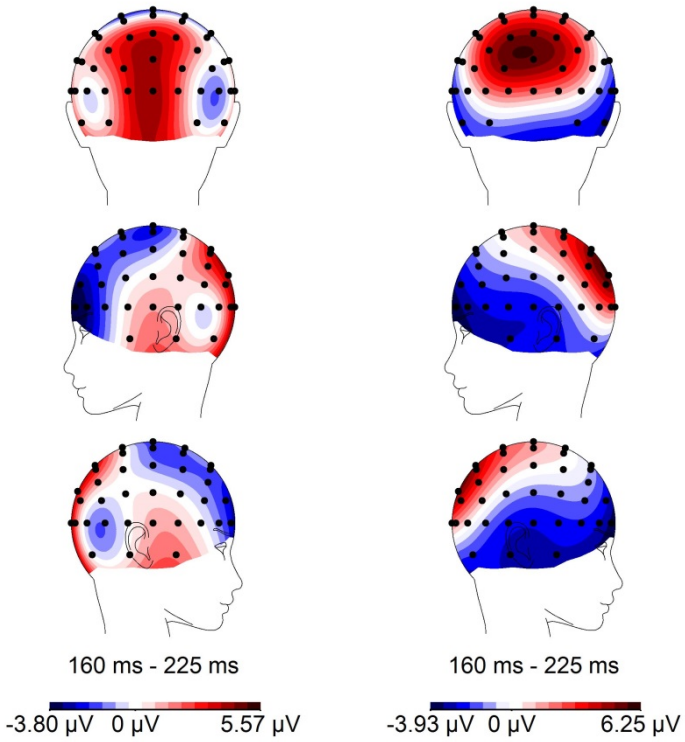

Figure 18. Head view of voltage distribution for self-bodies during the N1 time window for the control group (left) and the AN group (right).

P1

Main Effect Stimulus Type (Hyp. 5)

There was a significant main effect for stimulus type, $F(1, 31) = 13.62$, $p = .001$, $\eta_p^2 = .31$. P1 mean amplitudes were larger for pictures of bodies ($M = 3.88$, $SD = 2.13$) than for pictures of cups ($M = 3.33$, $SD = 1.96$).

Interaction Self-Reference × Stimulus Type (Hyp. 6)

There was no significant interaction between self-reference and stimulus type, $F(1, 31) = 0.66$, $p = .42$, $\eta_p^2 = .021$.

Interaction Group × Stimulus Type (Hyp. 7)

There was no significant interaction between group and stimulus type, $F(1, 31) = 1.61$, $p = .21$, $\eta_p^2 = .049$. Nevertheless, there was a significant interaction between group, stimulus type, and scalp location, $F(1, 31) = 7.12$, $p = .012$, $\eta_p^2 = .19$, and a trend for an interaction between group, stimulus type, and laterality, $F(1, 31) = 3.73$, $p = .063$, $\eta_p^2 = .11$. There was also a trend towards a four-way interaction between laterality, scalp location, self-reference, and group, $F(1, 31) = 2.97$, $p = .095$, $\eta_p^2 = .087$. Post hoc tests showed that, at $\alpha' = .0125$, the control group had a significantly larger difference between P1 mean amplitudes for body pictures versus cup pictures than the AN group at P7 ($p = .001$), but not at any other electrode location ($ps > .37$).

Interaction Group × Stimulus Type × Self-Reference (Hyp. 8)

There was a significant interaction between group, stimulus type, and self-reference, $F(1, 31) = 6.99$, $p = .013$, $\eta_p^2 = .18$. Post hoc tests revealed that, at $\alpha' = .0125$, in the control group, self-body amplitudes ($M = 3.44$, $SD = 2.06$) were larger than self-cup amplitudes ($M = 2.54$, $SD = 1.74$), $t(16) = 4.06$, $p = .001$, $d = 0.47$, while there was no significant difference between other-body amplitudes ($M = 3.21$, $SD = 2.25$) and other-cup amplitudes ($M = 2.66$, $SD = 1.70$), $t(16) = 1.98$, $p = .065$, $d = 0.28$. In the AN group, other-body amplitudes ($M = 4.57$, $SD = 2.12$) were larger than other-cup amplitudes ($M = 3.89$, $SD = 2.00$), $t(15) = 3.14$, $p = .007$, $d = 0.33$, but there was no significant difference between self-body amplitudes ($M = 4.35$, $SD = 2.02$) and self-cup amplitudes ($M = 4.32$, $SD = 2.02$), $t(15) = 0.10$, $p = .92$, $d = 0.013$.

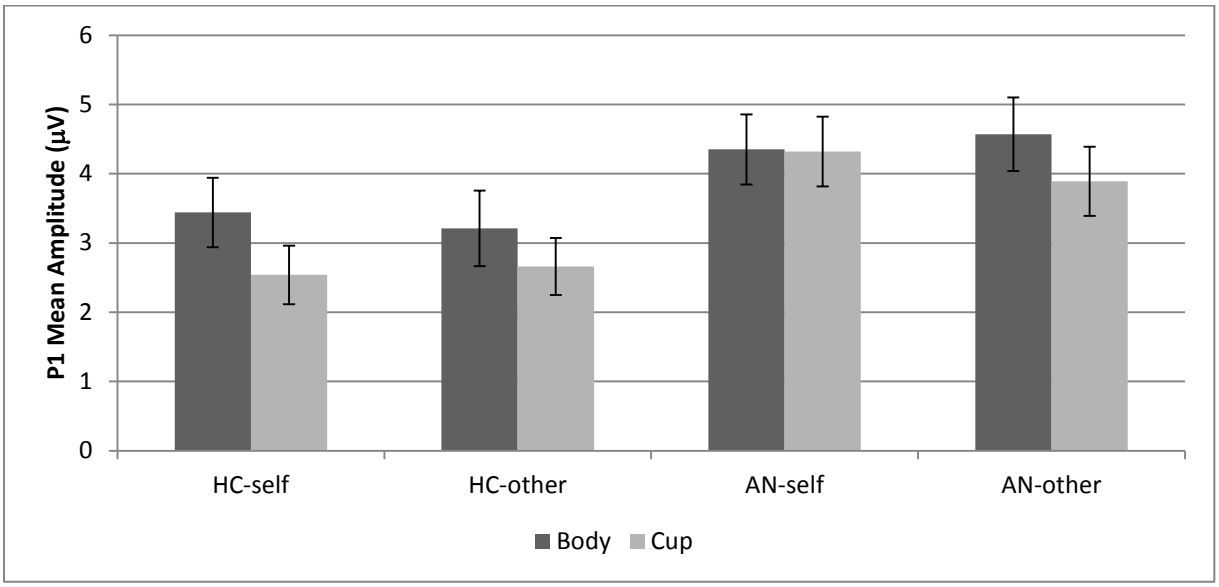

Figure 19. P1 mean amplitudes separated by groups and conditions. HC = healthy control group; AN = anorexia nervosa group. Error bars represent +/- 1 *SEM*.

Other Effects

There was a trend towards a main effect of group with larger P1 amplitudes in the AN than in the control group, $F(1, 31) = 3.94$, $p = .056$, $\eta_p^2 = .11$. Moreover, there was a significant interaction between laterality and group, $F(1, 31) = 16.88$, $p < .001$, $\eta_p^2 = .35$, and a significant interaction between laterality, scalp location, and group, $F(1, 31) = 18.48$, $p < .001$, $\eta_p^2 = .37$. Post hoc tests showed that, at $\alpha' = .0125$, the groups differed significantly at P7 ($p < .001$), with larger P1 amplitudes in the AN group than in the control group, but not at the other electrode sites (ps > .05).

P1 mean amplitudes were larger over parieto-occipital than over parietal sites, $F(1, 31) = 49.98$, $p < .001$, $\eta_p^2 = .62$. This effect was more pronounced over the left than over the right hemisphere (interaction scalp location × laterality), $F(1, 31) = 53.40$, $p < .001$, $\eta_p^2 = .63$. There was a trend towards a larger difference between self- and other-stimuli over the left than over the right hemisphere (interaction laterality × self-reference), $F(1, 31) = 4.04$, $p = .053$, $\eta_p^2 = .12$. There were significant interactions between laterality and stimulus type, $F(1, 31) = 13.18$, $p = .001$, $\eta_p^2 = .30$, and scalp location and stimulus type, $F(1, 31) = 4.53$, $p = .041$, $\eta_p^2 = .13$, as well as a three-way interaction between laterality, scalp location, and stimulus type, $F(1, 31) = 6.22$, $p = .018$, $\eta_p^2 = .17$. In summary, the difference between body and cup stimuli was larger at P8 and PO8 than at P7 and reversed at PO7.

There were no other significant effects or trends, all ps > .10. A summary of all ANOVA results can be found in the Appendix. The scalp distribution of P1 is visualised in Figure 20. Grand average waveforms for N1 and P1 results are displayed in Figure 21.

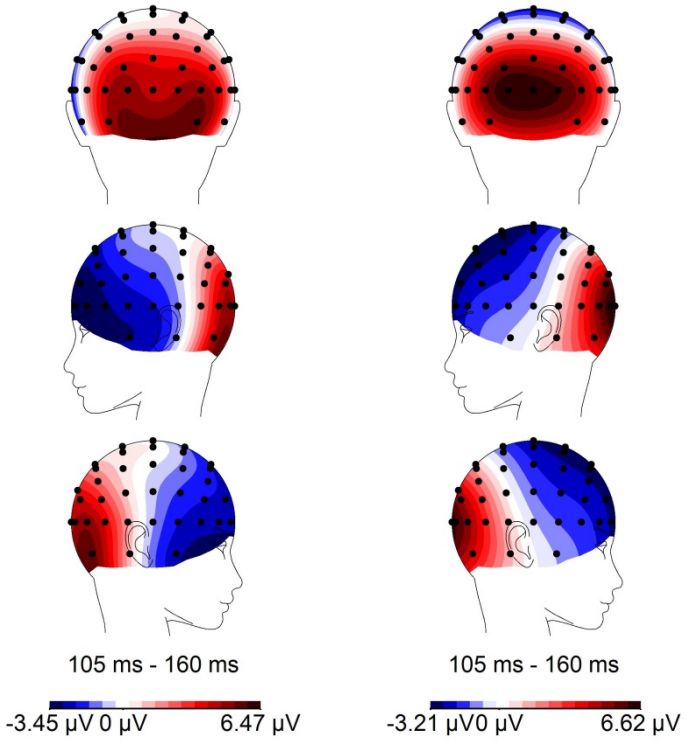

Figure 20. Head view of mean voltages for self-bodies during the P1 time window for the control group (left) and the AN group (right).

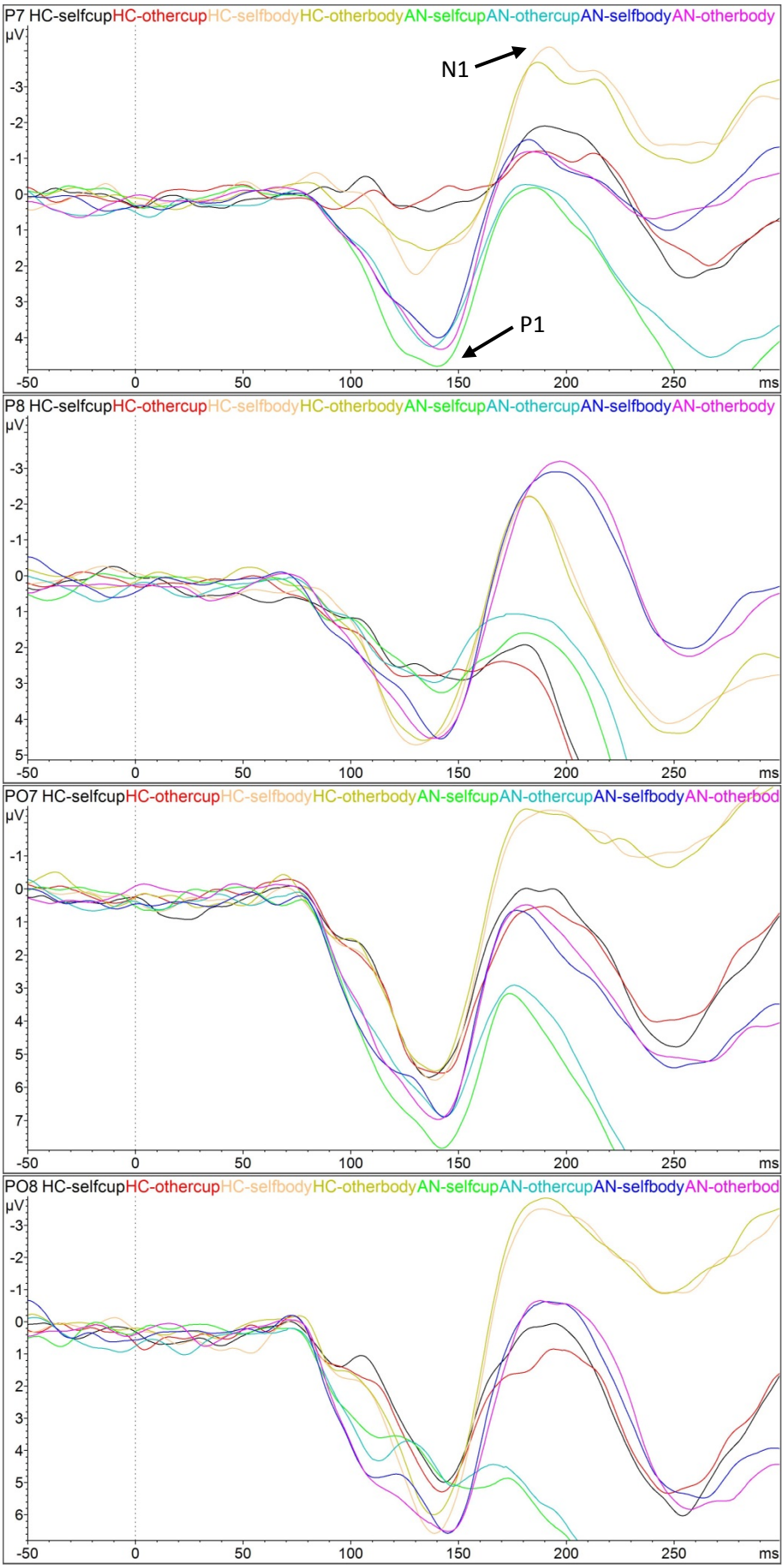

Figure 21. Grand average ERPs at P7, P8, PO7, and PO8, for all conditions and groups.

Behavioural Data

Reaction Times (Hyp. 9, Hyp. 10)

Reaction times were longer for body pictures (M = 946.26, SD = 167.20) than for cup pictures (M = 778.61, SD = 101.09), $F(1, 31) = 70.17$, $p < .001$, $\eta_p^2 = .69$. Responses were faster for pictures with self-reference (M = 852.19, SD = 133.83) than for other pictures (M = 872.68, SD = 121.50), $F(1, 31) = 6.28$, $p = .018$, $\eta_p^2 = .17$. In addition, there was a trend for an interaction effect between stimulus type and self-reference, $F(1, 31) = 3.42$, $p = .074$, $\eta_p^2 = .099$. Results point towards a larger difference between reaction times for self-bodies and other-bodies than between self-cups and other-cups. Finally, there was a trend for the AN group (M = 900.57, SD = 113.77) to respond more slowly than the control group (M = 826.54, SD = 128.90), $F(1, 31) = 3.05$, $p = .091$, $\eta_p^2 = .089$. No other significant effects or trends were observed, all ps > .17. A summary of all ANOVA results can be found in the Appendix.

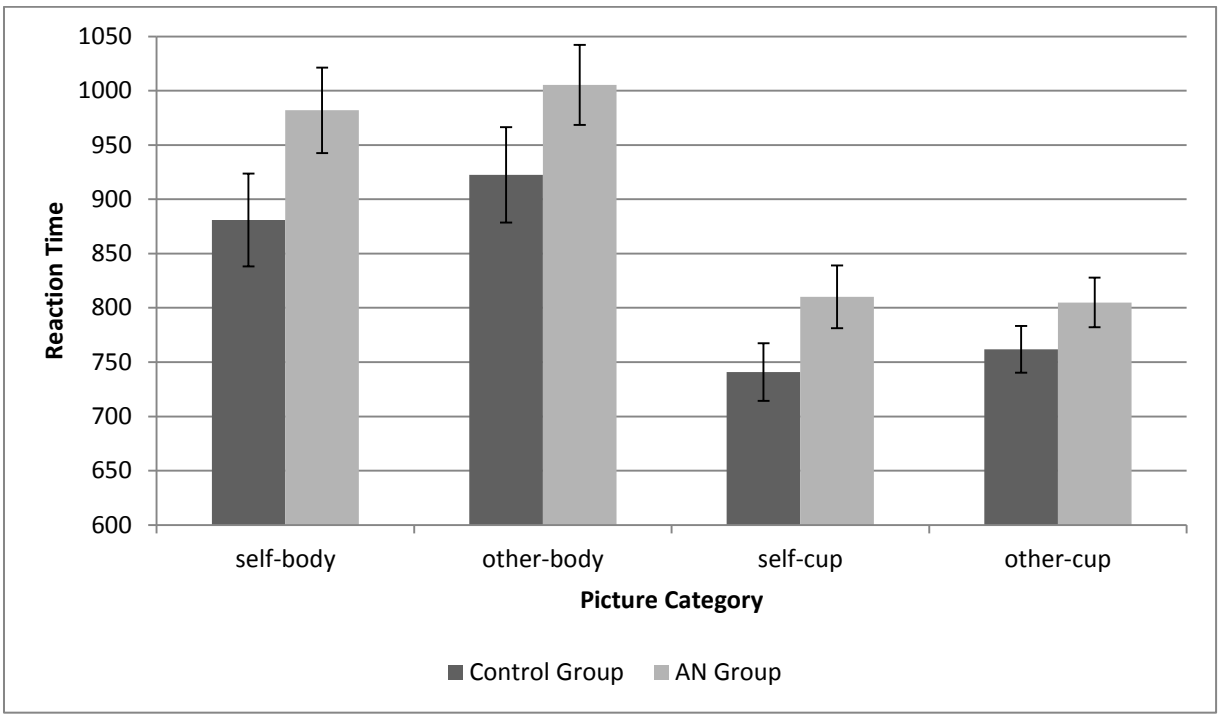

Figure 22. Mean reaction times for self- and other-body pictures and self- and other-cup pictures, separated by group. AN = anorexia nervosa. Error bars represent +/- 1 *SEM*.

Reaction Accuracy (Hyp. 9)

Percentage of correct responses was higher for cup pictures (M = 97.53, SD = 2.52) than for body pictures (M = 91.97, SD = 6.77), $F(1, 31) = 37.49$, $p < .001$, $\eta_p^2 = .55$. There was a trend towards an interaction of group, stimulus type and self-reference, $F(1, 31) = 3.35$, $p = .077$, $\eta_p^2 = .097$. However, none of the post hoc tests revealed statistical significance, all ps > .10.

There were no other significant effects or trends, all *p*s > .17. A summary of all ANOVA results can be found in the Appendix.

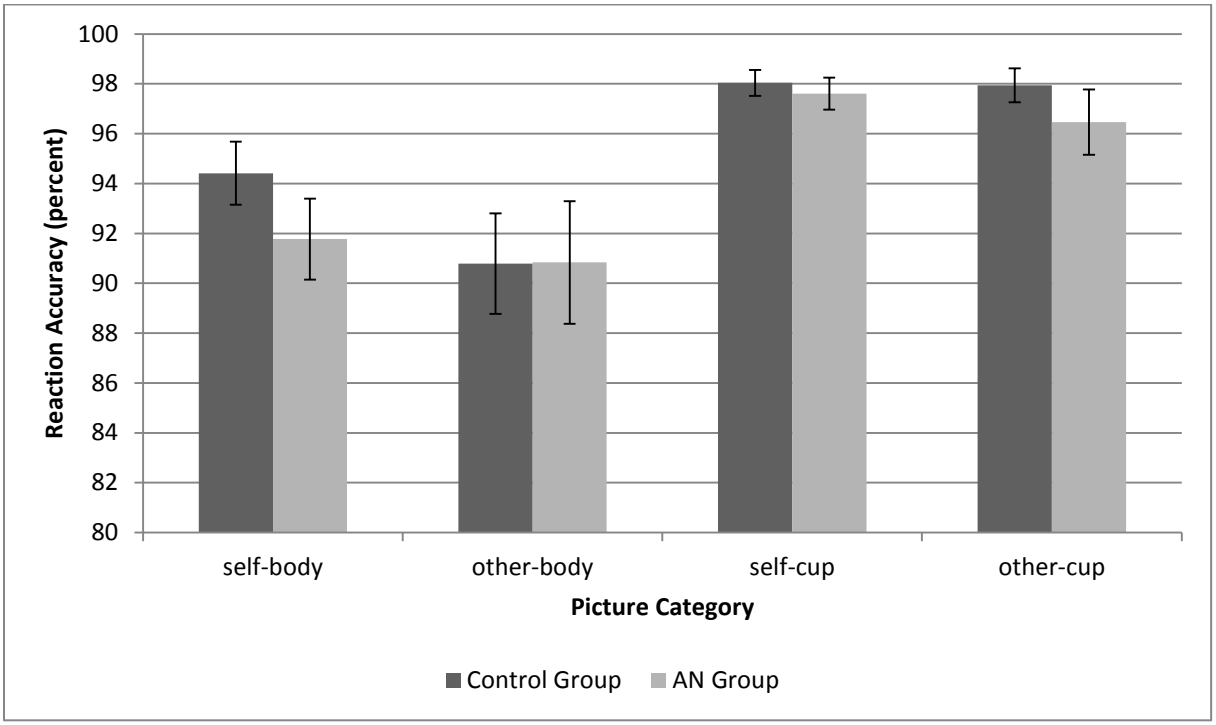

Figure 23. Mean percentage of correct reactions for self- and other-body pictures and self- and other-cup pictures, separated by group. AN = anorexia nervosa. Error bars represent +/- 1 *SEM*.

Subjective Ratings

Valence (Hyp. 11)

The AN group reported more negative ratings than the control group, $F(1, 31) = 5.13$, $p = .031$, $\eta_p^2 = .14$. Body stimuli received more negative valence ratings than cup stimuli, $F(1, 31) = 31.36$, $p < .001$, $\eta_p^2 = .50$. Furthermore, there was a trend towards more positive ratings for self-pictures than for other-pictures, $F(1, 31) = 3.28$, $p = .080$, $\eta_p^2 = .096$. This difference was larger in the control group than in the AN group, $F(1, 31) = 5.48$, $p = .026$, $\eta_p^2 = .15$. It was also larger for cup than for body pictures, $F(1, 31) = 3.69$, $p < .001$, $\eta_p^2 = .38$. There was a trend towards an interaction between group, stimulus type, and self-reference, $F(1, 31) = 3.69$, $p = .064$, $\eta_p^2 = .11$. The interaction between group and stimulus type was not significant, $F(1, 31) = 2.55$, $p = .12$, $\eta_p^2 = .076$.

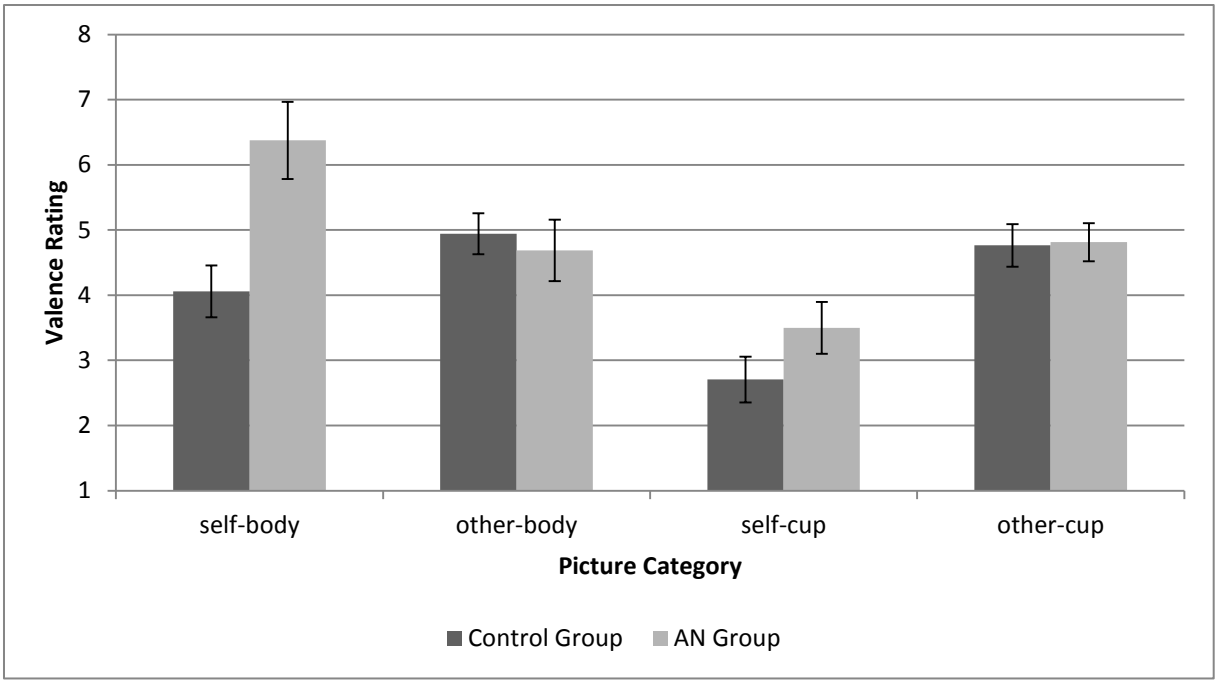

Figure 24. Mean valence ratings (1 = *positive*, 9 = *negative*) for self- and other-body pictures and self- and other-cup pictures, separated by group. AN = anorexia nervosa. Error bars represent +/- 1 *SEM*.

Arousal (Hyp. 12)

The AN group reported higher subjective arousal ratings than the control group, $F(1, 31) = 8.94$, $p = .005$, $\eta_p^2 = .22$. Body pictures were rated as more arousing than cup pictures, $F(1, 31) = 22.73$, $p < .001$, $\eta_p^2 = .42$. This difference was larger in the AN group than in the control group, $F(1, 31) = 7.12$, $p = .012$, $\eta_p^2 = .19$. Furthermore, self-related stimuli were rated as more arousing than other stimuli, $F(1, 31) = 33.61$, $p < .001$, $\eta_p^2 = .52$. This difference was larger in the AN group than in the control group, $F(1, 31) = 5.56$, $p = .025$, $\eta_p^2 = .15$. The interaction between stimulus type and self-reference was not significant, $F(1, 31) = 0.004$, $p = .95$, $\eta_p^2 < .001$. There was a trend towards an interaction between group, stimulus type, and self-reference, $F(1, 31) = 3.00$, $p = .093$, $\eta_p^2 = .088$.

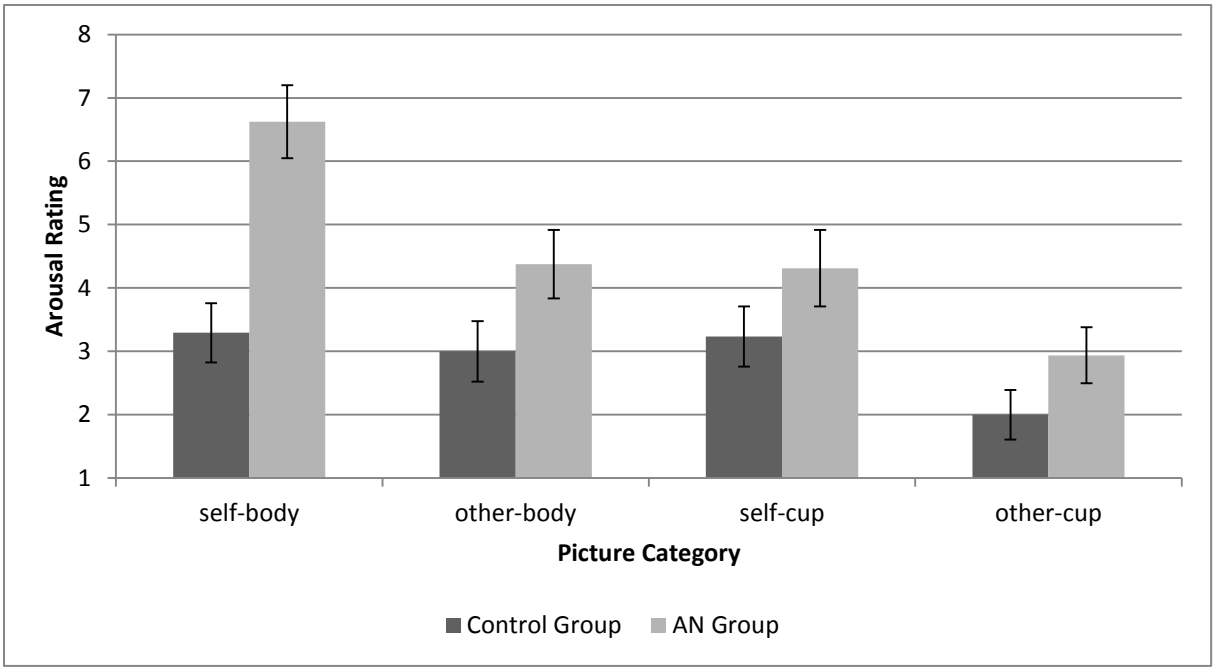

Figure 25. Mean arousal ratings (1 = *low arousal*, 9 = *high arousal*) for self- and other-body pictures and self- and other-cup pictures, separated by group. AN = anorexia nervosa. Error bars represent +/- 1 *SEM*.

3.4.5. Discussion

The aim of the current study was to investigate visual processing of pictures of one's own body in individuals with AN. We examined two early visual ERPs, the P1 and N1 component, which reflect featural and configural stimulus processing, respectively. The results suggest a complex pattern of alterations in the AN group.

Summary and Interpretation of Results

N1 Component

The current findings replicate the typical effect of larger N1 amplitudes for body stimuli than for objects (Hyp. 1; Gliga & Dehaene-Lambertz, 2005). This effect is assumed to be related to a configural processing advantage for bodies and faces over objects. However, we were unable to replicate previous findings of larger N1 amplitudes for one's own versus another person's body (Hyp. 2; Li & Zhan, 2008). This discrepancy might be due to the fact that we used a different design, including body and cup stimuli, while Li and Zhan (2008) only used body pictures. Moreover, the body pictures used in the present study were highly standardised, which might have reduced implicit and explicit associations with oneself. The

present findings are in line with previous inconsistent findings regarding N1 sensitivity for self- versus other faces, with enhanced N1 amplitudes for one's own face in some studies (Caharel et al., 2002; Keyes et al., 2010; Scott et al., 2005), however not in others (Gunji et al., 2009; Sui et al., 2006; Tanaka et al., 2006). It, therefore, remains for further research to explore the exact conditions under which N1 differences between self- and other-bodies emerge.

We did not find the hypothesised absence of N1 differentiation between body- and cup-pictures in patients with AN (Hyp. 3). Instead, we found a larger difference between N1 amplitudes for pictures of bodies versus pictures of cups in the AN group, but only at one of the tested electrode sites. The difference pointed in the same direction in both groups, that is, with larger N1 for body than for cup pictures, suggesting enhanced configural processing of body stimuli in AN. This finding is surprising, considering that the neuronal generators of N1 for the perception of bodies have been localised in the EBA (Ishizu et al., 2010; Pourtois et al., 2007; Sadeh et al., 2011; Taylor et al., 2010), a brain area which has been found to be structurally and functionally altered in patients with AN (Suchan et al., 2010, 2012; Uher et al., 2005). It is possible that individuals with AN recruit additional brain areas in order to compensate for deficits in EBA functionality, which would lead to an alteration in the neuronal sources of the N1 component. The idea of alterations in neuronal sources is in line with our finding of a globally reduced N1 component at some, but not all, of the investigated electrode sites, although scalp distribution of a component does not necessarily provide information about the underlying sources. The future investigation of alterations in neuronal source generators would require a detailed source localisation analysis, preferably with high-density electrode array.

With regard to self-reference, the AN group differed from the control group in terms of a larger and reversed difference between self- and other-cups, which was not in line with our expectation of an effect for self-bodies (Hyp. 4). Whereas the processing for self-cups was enhanced compared to other-cups in healthy controls, it appears that the reverse was true for the AN group with a relative deficit in the processing of self-cups compared to other-cups. This result suggests a more general processing deficit for self-related information in AN, which is in line with findings of a weak self-concept in eating disorders (Farchaus Stein & Corte, 2007). Nevertheless, the importance of such altered processing of self-related objects for eating disorder pathology remains to be examined in the future.

In summary, the N1 component showed a complex pattern of global reduction, specific reduction for self-related objects, and specific enhancement for pictures of bodies in AN. This pattern does not indicate a deficit in configural processing of one's own body in AN. Instead, it points towards improved configural processing for bodies but impaired configural processing for self-related objects.

P1 Component

For the P1 component we also found differential processing of body versus cup pictures, with those of bodies eliciting larger P1 mean amplitudes than for cups (Hyp. 5), which parallels findings of larger P1 for faces than for objects (Dering et al., 2011). We did not find significant differences in P1 mean amplitudes for the processing of self- versus other-body pictures (Hyp. 6), which is contrary to a previous report (Li & Zhan, 2008). Yet, it appears that an enhanced P1 for pictures of self-bodies was present in the control group, but not in the AN group, as discussed below.

With regard to group differences, we found a generally enlarged P1 component in the AN group at one electrode site. At the same site (P7) the AN group showed reduced discrimination between body and cup stimuli, which was in line with our expectations (Hyp. 7). In particular, in the AN group the P1 did not significantly differentiate between self-bodies and self-cups across electrode sites, although a differentiation was present for pictures of other bodies and cups. This confirms our hypothesis 8. These results demonstrate alterations in an early ERP component, beginning approximately 100 ms after stimulus onset. This phase of stimulus processing is characterised by processing of low-level physical characteristics of the picture, such as luminance and contrasts (Johannes et al., 1995; Kenemans et al., 2000). As we standardised these characteristics across stimuli for each participant, effects of low-level physical characteristics on the P1 can be ruled out, and the findings can be interpreted with regard to image content specific features.

Generally enlarged P1 components have also been found in individuals with social phobia (Kolassa et al., 2009; Kolassa, Kolassa, Musial, & Miltner, 2007) and spider phobia (Michalowski et al., 2009). Kolassa et al. (2007) attribute this finding to hypervigilance in persons with social phobia, which would be in line with previously reported attention effects on the P1, and the notion of involvement sensory gating processes in this component (Mangun, 1995). As general anxiety disorder and social phobia are the most prevalent co-morbid anxiety diagnoses among patients with AN (Kaye, Bulik, Thornton, Barbarich, &

Masters, 2004), and eating disorders and anxiety disorders may share underlying psychopathological features, such as harm avoidance (Pallister & Waller, 2008), it could be argued that similar processes might be at work in individuals with AN. In our experiment the hypervigilance might have been caused by the expectation of seeing threatening body pictures during the experiment (Kolassa et al., 2007). Nevertheless, the exact role of anxiety for early visual processing remains poorly understood and further research on basic mechanisms is warranted. In addition, anxiety and hypervigilance in AN are not only global phenomena, but are specifically enhanced for one's own body. For example, hypervigilant body checking is an important factor in current cognitive behavioural models of eating disorders (Fairburn et al., 1999). Moreover, individuals with AN have been shown to display an attentional bias towards their own body (Blechert et al., 2010). In line with the hypervigilance theory of enhanced P1, these characteristics of individuals with AN should produce increased P1 amplitudes for self-bodies. Yet, in the current study we found a lack of discrimination between self-bodies and self-cups for P1, while the control group showed enhanced P1 processing for self-bodies. This pattern matches the pattern of reaction accuracy for self-bodies, which showed a trend towards better recognition of self- than other-bodies in the control group but not in the AN group. In line with this finding, it has been shown that featural processing as reflected by P1 amplitude is important for face recognition, in addition to configural processing (Cabeza & Kato, 2000). These findings raise the question if there might be a self-body bias during featural processing in healthy controls, which is absent in individuals with AN.

Previous research has shown that the P1 is enlarged for disliked versus liked faces (Pizzagalli et al., 2002) and that its latency is reduced for fearful body expressions (van Heijnsbergen et al., 2007). These findings suggest that the P1 is enhanced by the negative affective contents of pictures. This enhancement appears to be specific to negative information contained in faces and bodies as no effect on the P1 has been found for more general affective pictures (Keil et al., 2002). It has been shown that the differential processing of fearful faces in the P1 component relies on coarse, low spatial frequency features with a neuronal source in the extrastriate cortex (Pourtois, Dan, Grandjean, Sander, & Vuilleumier, 2005). As control participants in our study rated self-bodies as mildly pleasant and low arousing, we may assume that their enhanced P1 amplitudes for self-bodies were not due to negative affective content. Unfortunately, reports on self-other differences in the P1 component remain scarce. Enhanced P1 for self-bodies has been reported in one study (Li & Zhan, 2008), while two studies on face processing did not find a corresponding effect for self-faces (Butler,

Mattingley, Cunnington, & Suddendorf, 2012; Keyes et al., 2010). The exact nature of self-related effects on the P1 remains therefore to be explored. In any case, the AN group did not show the same differential processing of one's own body, which was present in the P1 amplitudes of the control group. Instead, individuals with AN showed similar featural processing for self-bodies and self-cups.

In consequence, one might speculate that early visual body processing is influenced by attentional mechanisms of avoidance of self-body images in AN. Although such a speculation may sound surprising for an early, exogenous ERP component, it has been suggested that cognitive biases with regard to body image may exert a top-down influence on visual processing (Farrell et al., 2005). This is in line with the well-established finding of a modulation of P1 by spatial attention, indicating that this component may indeed be influenced by higher order attentional processes (Mangun, 1995). The thought of a modulation of early ERP components by body-related attentional biases is intriguing, as it would signify that these attentional biases have an impact on which kind of information enters the processing stream, an effect which has been termed sensory gating or sensory gain control (Hillyard, Vogel, & Luck, 1998). Studies are called for which investigate the link between body-related attentional biases and early visual processing of body images.

Our finding of reduced discrimination between self-body and self-cup at the level of the P1 component is intriguing, as it suggests that alterations in the visual processing stream occur already approximately 100 ms after stimulus onset in persons with AN. It could be argued that such effects are driven by semantically meaningless differences in low-level features between images. Yet, category specific brain activation that occurs outside of primary visual areas has been reported for the P1 (Meeren et al., 2008) and P1 alterations are well established for social and spider phobia (Kolassa et al., 2009, 2007; Michalowski et al., 2009). The P1 component is thereby the earliest component for which category specific effects have been demonstrated. Unfortunately, this component remains weakly explored in the body perception literature and implications of its alteration in this context remain to be explored.

Response Measures and Subjective Ratings

From the behavioural data it appears that classifying body pictures was more difficult than classifying cup pictures, as indexed by reduced accuracy and prolonged reaction times. This finding was contrary to our expectations (Hyp. 9) and previous findings of preferential processing of human body shapes (Paul Downing et al., 2004). The effect might be explained

by the fact that the cups had been painted by the participants and, therefore, bore clear marks that could be used as indicators for recognition. In contrast, bodies did not display very obvious marks that could have eased recognition, as participants wore whole-body suits that emphasised global body shape more than details. Furthermore, we were able to confirm hypothesis 10 and replicate previous findings of a reaction time advantage for self-related information (Sui et al., 2006; Tacikowski & Nowicka, 2010).

With regard to group differences, we found a trend for slower reaction times in the AN group. This finding might be accounted for by the fact that our control sample consisted mainly of psychology students who participate in a large number of experiments and are, therefore, more used to performing reaction time tasks. In addition, medication effects cannot be ruled out, as six of the 16 patients in the current study were under, mainly antidepressant, medication. Nevertheless, as a recent review reported no consistent effects of SSRIs on motor reaction time (Dumont, De Visser, Cohen, & Van Gerven, 2005), we would expect this effect to have been minimal. Furthermore, there was a trend towards worse recognition for one's own body in the AN group. Together with particularly negative valence ratings and high arousal ratings for self-body images (Hyp. 11), this suggests a general aversion against self-body images in AN, which is in line with the high levels of body dissatisfaction present in the current sample of AN patients (cf. 3.2.1).

General Discussion

The current study demonstrates deficits in the visual perception of one's own body in AN at 105 to 160 ms after stimulus onset (P1). In contrast, the processing of body images was enhanced in individuals with AN at 160 to 225 ms after stimulus onset (N1). These results indicate reduced featural and enhanced configural processing of body images in AN. Similarly to our findings of reduced differentiation between self-body and self-cup pictures at P1 for individuals with AN, a study with individuals with developmental prosopagnosia found a reduced inversion effect for pictures of faces and bodies at P1, but also at N1 (Righart & de Gelder, 2007). A failure to discriminate between self-body and self-object at P1 might, therefore, be related to a specific processing deficit for self-bodies at this component. Yet, contrary to persons with developmental prosopagnosia, individuals with AN did not show deficits throughout the processing stream. Instead, they showed an imbalance in featural versus configural processing with decreased featural and enhanced configural processing for pictures of bodies. As humans show a developmental trajectory of increasing reliance on

configural processing and decreasing reliance on featural processing with maturation (De Sonneville et al., 2002), a shift in processing strategies in AN might be related to increased expertise for the visual processing of bodies. This is in line with findings of enhanced N1 amplitudes for stimuli in which one is an expert, but which are not human faces or bodies, such as pictures of dogs in dog experts (Tanaka & Curran, 2001). An opposite shift in processing strategies seems to be present in individuals with autism who rely to a greater degree on featural processing and show impairments in the configural processing of faces (Dawson, Webb, & McPartland, 2005). Moreover, if attentional top-down modulation plays a role in P1 and N1 modulations, as argued above, it is not surprising that the two components should diverge, as they have been shown to be differentially modulated by attention effects (Hillyard et al., 1998). How exactly a shift in processing strategies for bodies relates to attention effects and to AN symptoms, or if it is merely an epiphenomenon of the disorder resulting from increased concern for and occupation with body shapes, remains to be elucidated by further research.

Limitations

The reaction time task employed in the current study asked participants to discriminate between self-related and self-unrelated images. This might have artificially enhanced their discrimination between self- and other-stimuli at an electrophysiological level, as attention effects are well established for the P1 (Mangun, 1995). However, when investigating self-other differences it is essential to check if participants recognised themselves and consequently, if one is indeed investigating self-other differences (cf. study 1). Ideally, future studies would operationalize control conditions with passive viewing or reaction time tasks requesting the discrimination of features not directly related to self-other distinctions, such as orientation of the image or colour of a frame surrounding the image.

Reaction time and accuracy measures suggest that cup stimuli were easier to recognise than body pictures. This was most likely due to the highly standardised set-up of our body pictures and the focus on global body shape which left a smaller number of details for classification than the painted cups. Nevertheless, the high degree of standardisation in our study allows us to draw precise conclusions about the perception of body shapes in AN and participants were well able to distinguish between their own body and the other body, on a behavioural (reaction time, accuracy) and psychophysiological level (P1). It remains for future studies to specifically investigate differences between bodies with varying degrees of detail.

Furthermore, we did not standardise low-level stimulus characteristics across participants, but only within participants. This limits the comparability of global P1 and N1 amplitudes between groups, but does not affect the comparison of within-participant effects or within-between interactions, which were of major interest in the current study. Furthermore, it has been shown that the P1 and N1 are similarly affected by changes in low-level stimulus characteristics, for example, they are both enhanced when luminance of a stimulus is increased (Johannes et al., 1995). It is, therefore, unlikely that the present finding of increased P1 and reduced N1 in the AN group can be explained by differences in low-level image characteristics. In addition, we took great care to standardise the conditions under which photographs were taken and manipulated, thereby reducing differences between participant stimulus sets to a minimum.

Conclusion

Taking together findings on N1 and P1, a picture emerges in which individuals with AN show a deficit in the *featural* processing of pictures of their own body, but an enhanced *configural* processing of body pictures in general. This finding demonstrates complex alterations in visual body perception in AN. It should be noted that the present sample of AN patients did not show body size overestimation to a greater degree than the control group (cf. chapter 3.2.1). Moreover, study 2 showed that the body images employed in the current project did not evoke implicit affective evaluations in either the negative or positive direction, which rules out implicit affect as contributing to the present results. Still, the patients with AN in our study showed profound alterations in visual body processing. We suggest the possibility that these early processing alterations are a consequence of attentional bias. It remains for further research to elucidate the significance of these alterations for clinical symptoms of AN and their modifiability through treatment.

3.5. Perception of Visceral Body Information in Anorexia Nervosa (Study 4)

3.5.1. Abstract

Deficits in interoception have previously been discussed with regard to their role in the aetiology of AN. It remains unclear, however, whether altered interoception can be attributed to starvation-related changes in visceral signals, the CNS representation of visceral signals, or the conscious perception and interpretation of these signals, including attention allocation. We, therefore, investigated alterations in heart rate variability (HRV), heartbeat evoked brain potentials (HEP), and interoceptive sensitivity, assessed with a heartbeat perception task, in 19 patients with AN and 19 healthy control persons. Patients with AN displayed larger HEPs and a trend to perform better in the heartbeat perception task compared with controls. Two alternative conclusions may be derived from these results. Firstly, heightened interoception may be a sign of eating disorder pathology related to the prediction of future aversive body states. Secondly, improved interoception may be an indicator of treatment response.

3.5.2. Heartbeat Perception and Heartbeat Evoked Brain Potentials

As outlined in chapter 2.2.4, individuals with AN show alterations in the processing of hunger and satiety, as documented at self-report and neuronal levels. Perception of heartbeats has been found to be reduced as well (Pollatos et al., 2008), possibly indicating a more general deficit in interoception, as proposed by Bruch (1962). Despite a wealth of findings in this area, it remains unclear whether alterations in visceral signals, their CNS representation, or their conscious perception, as proposed in the model by Vaitl (1996) described in chapter 2.2.4, are responsible for these alterations. The present study aimed to clarify the differential role of these processes in explaining alterations in interoception in AN. Heart rate was chosen as an example of visceral signals for this investigation, as alterations in visceral signals and their processing have previously been investigated using this biosignal, however, only partly in persons with AN. Moreover, it has been suggested that cardiac perception may serve as a general indicator for visceral perception, as it is correlated with gastric perception (Herbert, Muth, Pollatos, & Herbert, 2012; Whitehead & Drescher, 1980). In addition, cardiac perception plays a particular role in the experience of emotions, as outlined below. Deficits in identifying and describing emotions in AN have been addressed in chapter 2.2.3. The practical relevance of cardiac perception, therefore, lies in (a) its possible relationship with

gastric perceptions and (b) its relevance for emotional functioning, both of which appear to be altered in AN.

Interoceptive Accuracy and Heartbeat Perception

A commonly used task for the assessment of interoceptive accuracy, that is, the accuracy of visceral perceptions, is the heartbeat tracking or heartbeat perception task developed by Schandry (1981). In this task, participants are asked to count all heartbeats they perceive during a given time interval. The number of counted heartbeats is then compared to the number of actually recorded heartbeats from the ECG. Performance on this task strongly depends on heart dynamics, such as stroke volume, with higher stroke volume being associated with better heartbeat detection (Schandry, Bestler, & Montoya, 1993).

Using this task, researchers have been able to establish a link between the processing of cardiac signals, and emotion and decision making processes, as proposed by the somatic marker hypothesis (Damasio, 1996). For example, there seems to be a positive relationship between heartbeat perception and state anxiety (Schandry, 1981). Heartbeat perception has, moreover, been found to be positively related to cortical processing of emotional pictures and their respective arousal ratings (Herbert, Pollatos, & Schandry, 2007; Pollatos, Kirsch, & Schandry, 2005). Good heartbeat perception appears to be associated with stronger heart rate responses during exposure to emotional pictures (Pollatos, Herbert, Matthias, & Schandry, 2007), and to higher reactivity in physical stress tasks and higher trait anxiety (Pollatos, Herbert, Kaufmann, Auer, & Schandry, 2007). Moreover, good heartbeat perceivers have been demonstrated to show stronger autonomic reactivity in stressful and emotional situations (Herbert, Pollatos, Flor, Enck, & Schandry, 2010). Next to these experimental findings on acute reactivity, one study found a negative relationship between depressive symptoms as a trait variable and heartbeat perception, especially in those with high levels of anxiety (Pollatos, Traut-Mattausch, & Schandry, 2009). Heartbeat perception is positively related to trait anxiety (Pollatos, Traut-Mattausch, Schroeder, & Schandry, 2007). While, on the one hand, good heartbeat perception is related to stronger emotional reactivity, it is, on the other hand, also associated with benefits in the regulation of emotions through reappraisal (Füstös, Gramann, Herbert, & Pollatos, 2012). In line with the somatic marker hypothesis, good heartbeat perceivers have also been found to perform better in decision making in ambiguous situations, that is, in the Iowa Gambling Task (Werner, Jung, Duschek, & Schandry, 2009). In

sum, it appears that good heartbeat perception fosters the experience of emotions, their regulation, and intuitive decision making.

At a neuronal level, heartbeat perception is related to activity in the right anterior insula, an indication for this area's major role in the conscious perception of visceral signals (Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004; Pollatos, Kirsch, & Schandry, 2005a). Additional brain areas involved in heartbeat perception are the somatomotor and cingulate cortices (Critchley et al., 2004; Pollatos, Schandry, Auer, & Kaufmann, 2007), and the thalamus and the inferior frontal gyrus (Pollatos, Schandry, et al., 2007). The latter study found overlapping activations between the conditions of interoceptive focus and cardiovascular arousal in the right thalamus, insula, somatomotor cortex, dorsal cingulate, and medial frontal gyrus, thus providing evidence for a link between interoception and emotions at the neuronal level (Pollatos, Schandry, et al., 2007). Furthermore, performance in heartbeat perception tasks has been shown to be related to activity in the insula, somatosensory cortex, anterior cingulate, and prefrontal cortex when viewing emotional pictures, providing further evidence for the close relationship of interoception and emotion (Pollatos, Gramann, & Schandry, 2007). Importantly, the insula, which is crucial for interoceptive accuracy, displays structural and functional alterations in individuals with AN, as discussed in chapter 2.3.2.

With regard to nutrition and eating behaviour, it has been shown that short-term fasting may increase cardiac perception, an effect that seems to be linked to fasting-related effects on cardiac autonomic activation (Herbert et al., 2012). An intuitive eating style, that is, eating in response to hunger and satiety rather than eating according to dieting rules, external events or emotions, seems to be positively related to heartbeat perception (Herbert, Blechert, Hautzinger, Matthias, & Herbert, 2013).

The investigation of heartbeat perception in individuals with eating disorders has yielded mixed results. Using the Schandry (1981) task Pollatos et al. (2008) found reduced performance in heartbeat perception in individuals with AN as compared to healthy controls. The same finding has been reported for women recovered from BN (Klabunde, Acheson, Boutelle, Matthews, & Kaye, 2013). Contrarily, a study by Eshkevari, Rieger, Musiat, and Treasure (2014) was unable to find significant differences between a sample with eating disorders and a healthy control group. It should be noted, however, that Eshkevari et al. (2014) found a generally low performance on the heartbeat detection task they had employed (by Wiens, Mezzacappa, & Katkin, 2000) , which was not significantly different from chance.

In light of these mixed results, further investigations and replications are necessary to form a clearer picture of interoceptive accuracy in AN.

Heartbeat Evoked Brain Potentials

With accumulating (self-report based) evidence for the representation of heartbeat activity at CNS level, the investigation of heartbeat contingent scalp potentials soon followed the development of heartbeat perception tasks (Schandry, Sparrer, & Weitkunat, 1986). A major problem in the investigation of these potentials is the fact that the heart creates a strong electrical field, which is also registered by scalp electrodes as a *cardiac field artefact*. It is possible to either remove this artefact (e.g., Dirlich, Vogl, Plaschke, & Strian, 1997) or to analyse a later time window (455-595 ms post R-peak) in which cardiac field artefacts are minimal (Gray et al., 2007; Schulz et al., 2013, 2014) so that the analysis of heartbeat related brain processes is possible despite cardiac artefacts.

Heartbeat evoked potentials (HEP) reflect the CNS processing of afferent signals related to heart action (Schandry et al., 1986). More precisely, the systolic contraction of the heart causes vibrations, especially in the left chest wall, which are most likely registered by mechanoreceptors. Information from these (and possibly other receptors in the cardiovascular system) is transmitted to the CNS and reflected in the HEPs. Thereby, information about current heart activity is available to higher cognitive processes at all times (Birbaumer & Schmidt, 2006). Sources of HEPs have been reported to lie in the anterior cingulate, the right insula, the prefrontal cortex, and the left secondary somatosensory cortex (Pollatos et al., 2005a), which is consistent with findings on brain areas involved in conscious heartbeat perception, as described above. Importantly, HEPs may constitute an easily measurable index for the functionality of brain regions that are discussed as playing a major role in the aetiology of AN, especially the insular cortex (Kaye et al., 2009, 2013; Nunn et al., 2011; Nunn & Frampton, 2008; cf. chapter 2.3.2).

In line with findings on overlapping brain regions, the HEP has repeatedly been shown to be related to the performance in heartbeat perception tasks (Montoya, Schandry, & Müller, 1993; Pollatos & Schandry, 2004; Schandry et al., 1986) and to be sensitive to cardiac awareness training (Schandry & Weitkunat, 1990). Furthermore, HEPs are affected by attention (Montoya et al., 1993) and motivation (Schandry & Montoya, 1996). The investigation of individuals with depression yielded the result that they not only perform worse in a heartbeat

perception task, but that this interoceptive deficit is reflected in reduced HEP amplitudes, as compared to a healthy control group (Terhaar, Viola, Bär, & Debener, 2012). With regard to nutrition, short-term food deprivation has been found to increase HEPs (Schulz et al., 2014), which is in line with the previously reported improvement in interoceptive accuracy during short-term fasting (Herbert et al., 2012).

Cardiac Autonomic Modulation in Anorexia Nervosa

The investigation of cardiac processes in AN needs to take possible consequences of malnutrition into account. There have been numerous reports on alterations in autonomic and cardiac functioning in AN, including bradycardia and low cardiac output (Casiero & Frishman, 2006), with the latter being a relevant factor in heartbeat perception (Schandry et al., 1993). Several studies have examined heart rate variability (HRV) in patients with AN. HRV refers to the variation of consecutive intervals between heartbeats (Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology, 1996). There are several indices of HRV, which may be calculated in the time and frequency domains. High frequency (HF) power is related to parasympathetic activity (Akselrod et al., 1981; Malliani, Pagani, Lombardi, & Cerutti, 1991; Pomeranz et al., 1985), while it remains debated if low frequency (LF) power is associated with sympathetic activity, especially when expressed in normalised units (Malliani et al., 1991; Montano et al., 1994), or with both sympathetic and parasympathetic activity (Akselrod et al., 1981; Appel, Berger, Saul, Smith, & Cohen, 1989). In any case, measures of HRV serve as indicators for autonomic modulation of heart rate (Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology, 1996). Using these indices, the most frequent finding in samples with AN has been an increased HF power indicating vagal hyperactivity (Cong, 2004; Galetta et al., 2003; Ishizawa, Yoshiuchi, Takimoto, Yamamoto, & Akabayashi, 2008; Kreipe, Goldstein, DeKing, Tipton, & Kempski, 1994; Murialdo et al., 2007; Petretta et al., 1997). HF power was directly associated with the amount of weight loss in one study (Kollai, Bonyhay, Jokkel, & Szonyi, 1994). A recent review paper (Mazurak, Enck, Muth, Teufel, & Zipfel, 2011) concludes that the majority of papers on autonomic function in AN report parasympathetic dominance and reduced sympathetic modulation, although other papers report non-significant or opposite findings (e.g., Melanson, Donahoo, Krantz, Poirier, & Mehler, 2004; Vigo et al., 2008). The results of one study suggest that the duration of starvation might play a role in autonomic functioning, as increased

parasympathetic modulation of HRV was only present in cases with shorter duration of AN, that is, 12 months on average (Platisa, Nestorovic, Damjanovic, & Gal, 2006). After re-feeding, cardiac parameters have been shown to improve markedly and return to normal (Mont et al., 2003; Rechlin, Weis, Ott, Bleichner, & Joraschky, 1998).

Summary

In order to expand previous findings of reduced interoceptive accuracy in AN, we complemented our investigation of heartbeat perception with an investigation of HEPs, thereby adding an indicator of central nervous processing of afferent signals from the heart to the analysis. With regard to attention effects on HEPs, we included a resting and a heartbeat tracking condition. These conditions furthermore served to control for effects of alterations in cardiac activation in the patient group by enabling a within-participants analysis approach. We additionally assessed cardiac activation via heart rate and HRV. Accordingly, we investigated possible alterations in (1) the visceral process from which the biosignal originates, that is, heart rate and HRV, (2) its CNS representation, that is, HEPs, and (3) conscious awareness of the signal, that is, interoceptive accuracy as assessed by a heartbeat perception task.

Hypotheses

Hypotheses for the current study have been formulated for three levels of interoceptive processing, that is, the visceral process, its CNS representation, and conscious processing (interoceptive accuracy). At the level of interoceptive accuracy, there are two indicators that serve as dependent variables, HEPs during conscious attention to heartbeats versus rest, and the heartbeat perception score. Table 13 lists all hypotheses grouped by level of interoceptive processing.

Table 13
Hypotheses in Relation to Level of Interoceptive Processing and Dependent Variables.

	Level of Interoceptive Processing	Dependent Variable	Hypothesis
Hyp. 1	Visceral Process	Heart Rate, HRV	Patients with AN show alterations in cardiac activity marked by lower heart rate and higher vagally-mediated HRV (main effect: group).
Hyp. 2a	CNS Representation	HEP	Patients with AN display smaller HEP amplitudes than healthy controls (main effect group).
Hyp. 2b		HEP	This effect is specific for the HEP time window and not present in the baseline time window (interaction time window × group).
Hyp. 3a	Interoceptive Accuracy	HEP	Patients with AN display smaller HEP amplitudes during the heartbeat perception task than control participants (interaction group × condition).
Hyp. 3b		HEP	This effect is specific for the HEP time window and not present in the baseline time window (interaction time window × group × condition).
Hyp. 3c		Heartbeat Perception Score	Patients with AN perform worse in the heartbeat perception task than healthy controls (main effect: group).

3.5.3. Method

Paradigm: Heartbeat Perception Task

The heartbeat perception task was built on the task proposed by Schandry (1981). Participants were asked to silently count their own heartbeats during fixed intervals (25 s, 35 s, 45 s, and 55 s, in random order) without explicitly feeling their pulse. The duration of each counting interval was indicated on screen by the appearance and disappearance of a fixation cross, that is, the interval lasted as long as the fixation cross was displayed on the screen. After each trial, participants were asked to enter the number of heartbeats counted ("How many heartbeats did you count during the interval?") and to indicate how certain they feel about their result ("How certain are you?") on a 9-point Likert scale from 0 (*very uncertain*) to 8 (*very certain*). Responses to the latter question were used as an indicator of metacognitive interoceptive awareness, according to the taxonomy suggested by Garfinkel and collaborators (Garfinkel & Critchley, 2013; Garfinkel et al., 2014). There was a training interval with a duration of 25 s before the beginning of the actual task.

Data Analysis

Heart Rate Variability

As previous research has shown that cardiac perception may be influenced by food deprivation related autonomic changes (Herbert et al., 2012), we used heart rate and HRV in order to investigate possible differences between groups in autonomic modulation of heart rate. Measures of HRV were calculated for the five-minute rest period, which took place at the beginning of the experimental session (cf. chapter 3.2.3). R-peak detection, calculation of interbeat-intervals, artefact correction, and calculation of HRV indices was performed with the Matlab based computer programme Artiifact (version 2.07; Kaufmann, Sütterlin, Schulz, & Vögele, 2011). Default settings of the programme were used for the calculation of HRV indices. We used mean heart rate and LF in normalised units (LF n.u.) in order to test for alterations in sympathetic activity, which might influence heartbeat perception and HEPs (Schulz et al., 2014). Additionally, we analysed possible differences between the clinical and control groups in HF power, as this parameter has repeatedly been shown to be reduced in AN (Mazurak et al., 2011). HF power was not normally distributed, Kolmogorov-Smirnov $Z = 2.80$, $p < .001$. Therefore, we transformed HF and LF absolute power with natural logarithm (ln) and performed statistical analyses using ln-transformed HF (ln HF) and ln-transformed

LF (ln LF). Group differences were analysed using one-way ANOVA, with group (clinical vs. control) as between-participants factor.

Heartbeat Perception Task

A heartbeat perception score was calculated according to Equation 4 from the number of counted and the number of recorded heartbeats, averaged over the four counting intervals.

$$\frac{1}{4}\sum\left(1-\frac{|recorded\ heartbeats-counted\ heartbeats|}{recorded\ heartbeats}\right)$$

Equation 4

Moreover, answers to the question "How certain are you?" were averaged across trials in order to form a judgement score. Group differences on perception and judgement scores were analysed using one-way ANOVA, with group (clinical vs. control) as between-participants factor.

EEG Data

Evoked potentials were calculated for two experimental conditions. Firstly, the intervals of the heartbeat perception task in which participants were asked to focus on their own heartbeats were calculated (condition: task). Secondly, an interval of a resting measurement from the beginning of the experimental session (cf. chapter 3.2.3 for the entire session procedure) which was of equal length as the cumulated duration of the counting intervals (i.e., 160 s) was calculated (condition: rest). Participants kept their eyes open during both the counting task and the resting measurement.

EEG measurements were re-referenced to linked mastoids (TP9, TP10), thereby re-using the old reference channel (FCz). Then, a bandpass filter of 0.1 to 35 Hz was applied. Eye movements and blinks were corrected with Gratton-Coles algorithm (Gratton et al., 1983). Subsequently, the data was visually inspected and remaining artefacts excluded from further analysis. R-peaks were automatically detected and confirmed by visual inspection. EEG data were segmented from 200 ms before to 1000 ms after each R-peak. The resulting segments were averaged with R-peaks serving as trigger. Mean HEP amplitudes were exported for a time window of 455 to 595 ms after the R-peak of the ECG, in order to minimise effects of the cardiac field artefact (Gray et al., 2007; Schulz et al., 2013, 2014). In order to investigate possible effects of baseline differences between groups, mean baseline amplitudes were exported for a time window of 200 to 60 ms before the R-peak of the ECG. The 63 electrode positions were aggregated into 9 scalp sectors, in order to test for gross effects of laterality

and scalp location, as displayed in Figure 26 (Pollatos & Schandry, 2004; Schulz et al., 2014; Shao, Shen, Wilder-Smith, & Li, 2011).

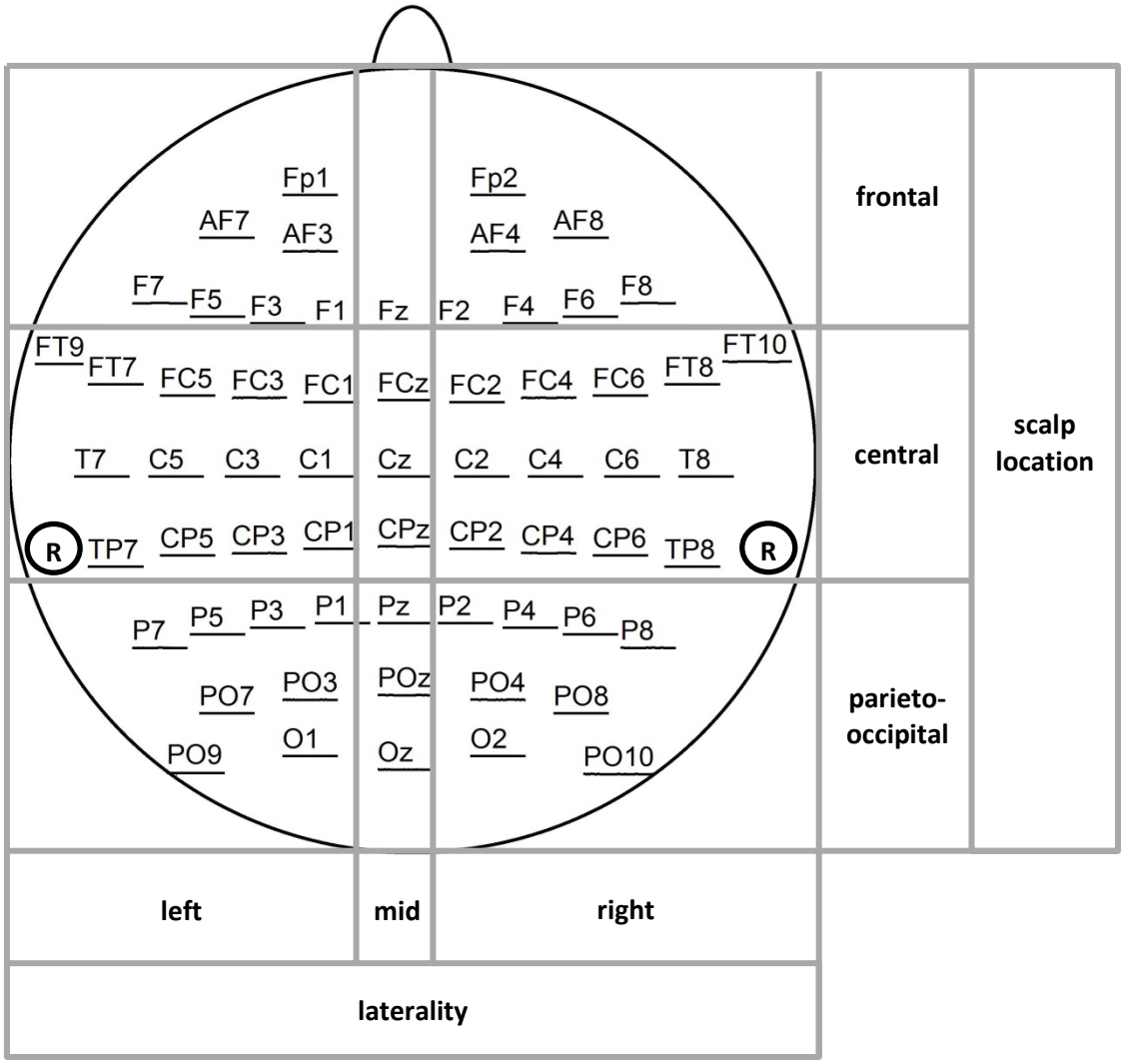

Figure 26. Aggregation of scalp electrodes into 9 scalp sectors. Boundaries between the sectors are indicated by grey lines. Linked reference electrodes are shown in circles (TP9, TP10). R = reference.

Two participants had to be excluded due to a large number of artefacts in the EEG data. The analysis of EEG data was, therefore, based on two groups of $n = 19$ participants, corresponding to a total sample size of $N = 38$. A mixed-design 2 × 3 × 3 × 2 × 2 ANOVA was computed with the within-factors time window (baseline vs. HEP), laterality (left vs. midline vs. right), scalp location (frontal vs. central vs. parieto-occipital), and experimental condition (rest vs. task), and the between-factor group (clinical vs. control). Greenhouse-Geisser correction for degrees of freedom was applied where the sphericity assumption was

not met, as indicated by Mauchley's test of sphericity. Significant interaction effects were followed up with post hoc *t* tests. Effect sizes reported are partial eta squared for ANOVAs and Cohen's *d* (pooled standard deviations) for post hoc tests. Alpha level was set to $\alpha = .05$ and was Bonferroni corrected for post hoc tests.

Exploratory Correlational Analyses

In order to further explore possible effects, Pearson correlations were calculated between the different indicators of interoceptive processing, between indicators of interoceptive processes and several state and trait variables, as well as characteristics of the clinical sample.

3.5.4. Results

Heart Rate Variability (H1)

There were no statistically significant differences between the AN group and the control group in mean heart rate, LF n.u., ln LF, or ln HF. A trend was observed for higher ln LF in the control group. Group statistics are displayed in Table 14.

Table 14

Means, Standard Deviations, and F-Statistics for Heart Rate and Heart Rate Variability

	Group				
	Clinical	Control			
Parameter	*M*(*SD*)	*M*(*SD*)	*F*(1, 38)	*p*	η_p^2
Mean heart rate	76.29 (9.12)	73.16 (7.68)	1.38	.25	.035
LF n.u.	56.39 (18.55)	59.98 (17.61)	0.39	.54	.010
ln LF	6.08 (1.23)	6.67 (0.17)	3.43	.071	.083
ln HF	5.76 (1.42)	6.22 (0.91)	1.49	.23	.038

Note. LF n.u. = normalised low frequency; ln LF = ln-transformed low frequency; ln HF = ln-transformed high frequency

Heartbeat Perception Task (H3c)

We found a non-significant tendency of small effect size for the AN group ($M = 0.76$, $SD = 0.18$) to perform better in the heartbeat perception task than the control group ($M = 0.66$, $SD = 0.19$), $F(1, 38) = 2.89$, $p = .097$, $\eta_p^2 = .071$. This effect is displayed in Figure 27. There was no significant difference between groups for certainty judgements about the counted heartbeats, $F(1, 38) = 0.20$, $p = .66$, $\eta_p^2 = .005$.

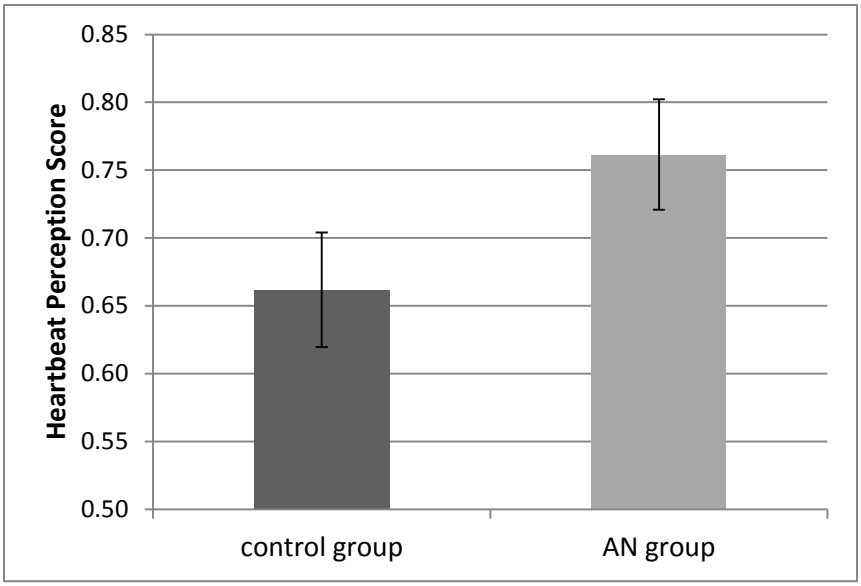

Figure 27. Mean heartbeat perception scores in the control and AN groups. Higher values indicate greater accuracy. Error bars represent +/- 1 *SEM*.

Heartbeat Evoked Brain Potentials (H2a, H2b, H3a, H3b)

The distribution of HEPs across the scalp is displayed in Figure 28.

Main Effect Group (H2a) and Interaction Time Window × Group (H2b)

There was a significant main effect for group, $F(1, 36) = 6.41$, $p = .016$, $\eta^2 = .15$, and a significant interaction effect between time window and group, $F(1, 36) = 6.43$, $p = .016$, $\eta^2 = .15$, suggesting higher HEP amplitudes in the AN group ($M = -0.034$, $SD = 0.22$) compared to the control group during the HEP time window ($M = -0.27$, $SD = 0.29$), $t(36) = -2.78$, $p = .009$, $d = 0.90$. There was no significant difference in baseline amplitudes, $t(36) = -0.043$, $p = .97$, $d = 0.014$.

Interaction Group × Condition (H3a) and Interaction Time Window × Group × Condition (H3b)

There was no significant interaction between group and condition, $F(1, 36) = 0.22$, $p = .65$, $\eta_p^2 = .006$. Neither was there a significant interaction between time window, group, and condition, $F(1,36) = 0.12$, $p = .74$, $\eta_p^2 = .003$.

Other Effects

There was a significant main effect of scalp location, $F(1.48, 53.27) = 17.34$, $p = <.001$, $\eta_p^2 = .33$. Frontal and central locations had higher amplitudes than parieto-occipital locations (ps < .001 but did not differ from each other ($p = .44$). This effect was qualified by a significant

interaction with time window, $F(1.37, 49.14) = 7.27$, $p = .005$, $\eta_p^2 = .17$. Frontal amplitudes were larger than central amplitudes, which in turn were larger than parieto-occipital amplitudes at baseline (ps < .005), while during the HEP time window only central amplitudes were significantly larger than parieto-occipital amplitudes ($p < .001$; all other ps > .0083). There was also a significant main effect for laterality, $F(2, 72) = 18.02$, $p < .001$, $\eta_p^2 = .33$. Amplitudes were higher at midline than left and right locations (ps < .001), which did not differ from each other ($p = .33$). This effect was only present in the clinical, but not in the control group, $F(1, 72) = 4.18$, $p = .019$, $\eta_p^2 = .10$. Furthermore, the laterality effect and the interaction between laterality and group were only present in the HEP time window, but not in the baseline time window, interaction time window × laterality: $F(1.65, 59.30) = 14.41$, $p < .001$, $\eta_p^2 = .29$; interaction time window × laterality × group: $F(1.65, 59.30) = 3.80$, $p = .036$, $\eta_p^2 = .095$.

Furthermore, there was a significant interaction between scalp location and laterality, $F(1.89, 68.13) = 4.28$, $p = .019$, $\eta_p^2 = .11$. There were no significant differences between left, right and midline in frontal scalp locations (all ps > .0056). In central scalp locations, midline amplitudes were significantly higher than left and right amplitudes (ps < .001), which did not differ from each other ($p = .032$). In parieto-occipital scalp locations, left amplitudes were significantly lower than right and midline amplitudes ($p < .004$), which did not differ from each other ($p = .15$). Altogether, amplitude maxima were observed in mid-frontal and mid-central scalp sectors. This pattern was more pronounced in the clinical than in the control group, $F(1.89, 68.13) = 7.34$, $p = .002$, $\eta_p^2 = .17$, an effect which was only present in the HEP time window and not at baseline, $F(3.04, 109.25) = 7.19$, $p < .001$, $\eta_p^2 = .17$.

A table summarising all effects and interactions of the mixed-design 2 × 3 × 3 × 2 × 2 ANOVA is displayed in the Appendix. Scalp distribution of HEPs is visualised in Figure 28.

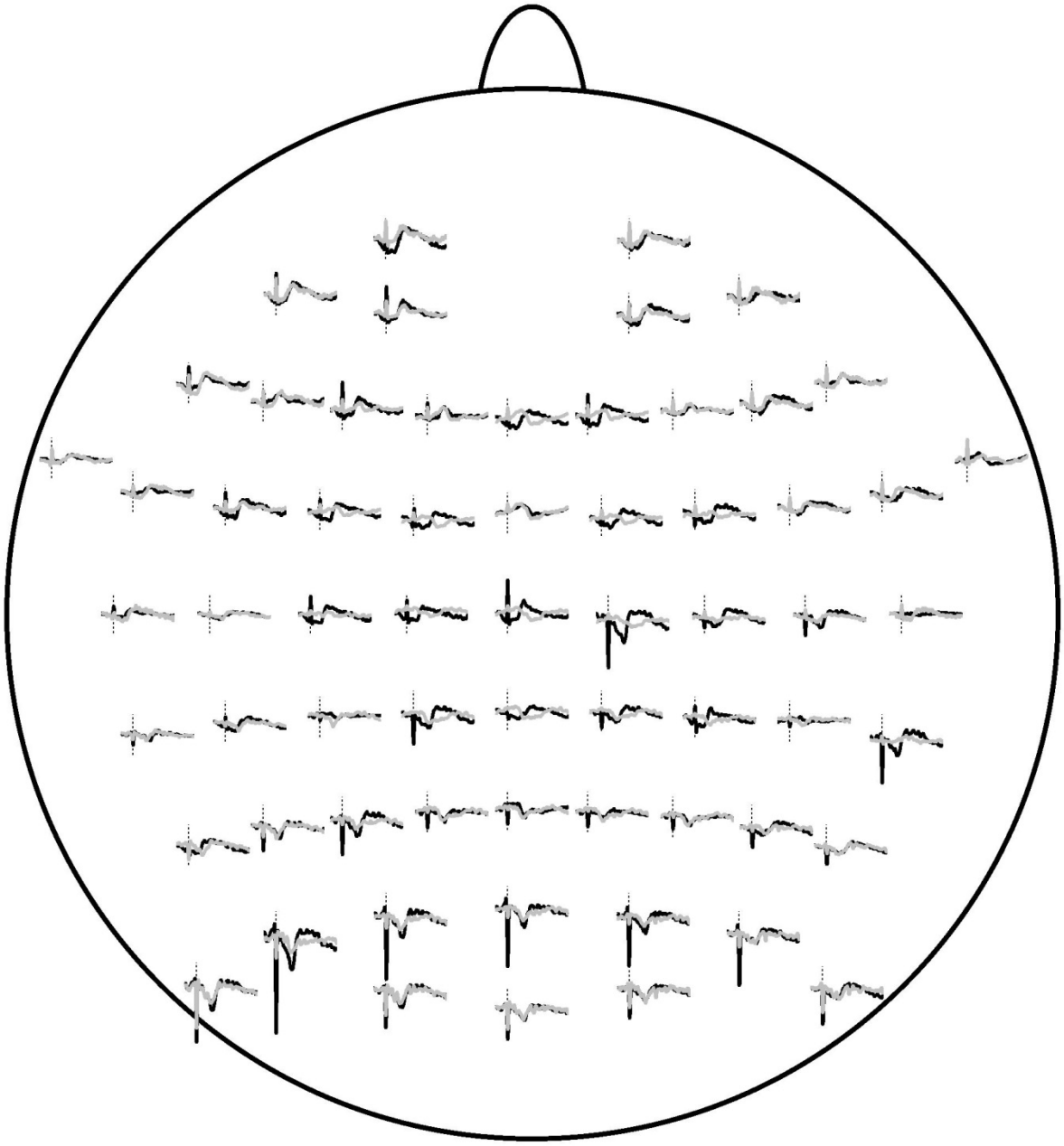

Figure 28. Waveforms of heartbeat evoked potentials (HEPs) averaged over the two experimental conditions for the clinical (grey line) and the control group (black line). The interval shown ranges from -200 ms until +1000 ms relative to the R-peak of the ECG. The y-axis is scaled positive down from -1.8 to +1.8 μV.

Exploratory Correlational Analyses

Relationships between Levels of Interoceptive Processing

In order to explore if the different levels of interoceptive processing assessed in this study are related, correlations were calculated between LF n.u. and ln LF as indicators for the visceral signal because of their relationship with cardiac output (Herbert et al., 2012), mean HEP amplitudes averaged across the two conditions as an indicator of CNS representation, heartbeat perception scores as an indicator of interoceptive accuracy, the certainty rating of the heartbeat perception task as an indicator of interoceptive awareness and the EDI subscale Interoceptive Awareness as an indicator of interoceptive sensibility (cf. Table 15). There were no significant correlations, all *p*s > .05. Yet, trends emerged for an association of high scores on the EDI Interoceptive Awareness subscale with lower cardiac sympathetic modulation (ln LF) and higher HEPs, *p*s < .10.

Table 15

Intercorrelations Between Variables Representing Different Levels of Interoceptive Processing.

Measure	1	2	3	4	5
1. LF n.u.	–				
2. ln LF	.18	–			
3. Mean HEP	-.075	-.066	–		
4. Heartbeat Perception	-.24	-.032	.090	–	
5. Certainty Rating	.043	.009	-.27	.24	–
6. EDI Interoceptive Awareness	-.036	-.28†	.30†	.17	-.045

Note. Mean HEP = heartbeat evoked scalp potential, averaged over all electrodes and conditions; LF n.u. = low frequency heart rate variability expressed in normalised units; ln LF = natural logarithm of low frequency heart rate variability; EDI = Eating Disorder Inventory.

† $p < .10$.

Correlations with State Variables

We further tested possible relationships of HEPs, heartbeat perception, and sympathetic cardiac modulation with state anxiety and the time which had elapsed since the participant had last eaten (cf. Table 16). Significant associations were found between higher state anxiety and higher HEPs, as well as lower cardiac sympathetic modulation (ln LF), *p*s < .05. Furthermore, a trend emerged for an association between higher HEP amplitudes and a shorter time span that had passed since the last meal before the experiment, $p < .10$.

Table 16

Correlations of Interoceptive and Sympathetic Indicators with State Anxiety and Time Elapsed since the Last Meal.

Measure	Mean HEP	Heartbeat Perception	LF n.u.	ln LF
STAI-State	.33*	.076	-.29†	-.45**
Minutes Since Last Meal	-.32†	-.097	.091	.16

Note. Mean HEP = heartbeat evoked scalp potential, averaged over all electrodes and conditions; LF n.u. = low frequency heart rate variability expressed in normalised units; ln LF = natural logarithm of low frequency heart rate variability; STAI-State = State and Trait Anxiety Inventory – State Version.

† $p < .10$. * $p < .05$. ** $p < .01$.

Correlations with Trait Variables

In addition, we performed correlations of HEPs, heartbeat perception, and sympathetic cardiac modulation with several trait characteristics, such as age, BMI, level of exercise, eating disorder symptoms assessed via EDI, depressive symptoms (BDI-II), trait anxiety (STAI-Trait), and visual body size estimation (cf. Table 17). Significant associations ($p < .05$) and trends ($p < .10$) were found for a positive relationship between HEPs and eating disorder and depressive symptoms. HEPs were negatively related to physical activity, $p < .05$. Furthermore, cardiac sympathetic modulation as indexed by ln LF was negatively related to anxiety and depression, *p*s < .01, and there were trends for a negative association with eating disorder symptoms and a positive association with BMI, *p*s < .10. Visual body size estimation was unrelated to HEPs, heartbeat perception, or HRV, *p*s > .10.

Table 17

Correlations of Interoceptive and Sympathetic Indicators with Trait Variables.

Measure	Mean HEP	Heartbeat Perception	LF n.u.	ln LF
Age	.16	.085	-.099	-.17
BMI	-.22	-.19	.081	.27†
Exercise (MET-Minutes per Week)	-.39*	-.14	-.090	-.15
EDI Drive for Thinness	.39*	.17	-.027	-.29†
EDI Bulimia	.25	.25	-.14	-.071
EDI Body Dissatisfaction	.26	-.039	-.071	-.11
EDI Interoceptive Awareness	.30†	.17	-.036	-.28†
BDI-II	.19	.13	-.26	-.50**
STAI-Trait	.31†	.19	-.19	-.41**
Visual Body Size Estimation	-.002	-.22	-.016	.19

Note. Mean HEP = heartbeat evoked scalp potential, averaged over all electrodes and conditions; LF n.u. = low frequency heart rate variability expressed in normalised units; ln LF = natural logarithm of low frequency heart rate variability; BMI = body mass index; MET = metabolic equivalent of task; EDI = Eating Disorder Inventory; STAI-Trait = State and Trait Anxiety Inventory – Trait Version.

† $p < .10$. * $p < .05$. ** $p < .01$.

Correlations with Clinical Variables

For the patients, we related HEPs, heartbeat perception, and sympathetic cardiac modulation to measures of eating disorder and treatment duration (cf. Table 18). The only trend appeared in a positive association of HEPs with the duration of the current in-patient treatment, $p < .10$. There were no significant correlations or trends between symptom or treatment duration and heartbeat perception or HRV.

Table 18

Correlations of Interoceptive and Sympathetic Indicators with Clinical Variables for the Patient Sample.

Measure	Mean HEP	Heartbeat Perception	LF n.u.	ln LF
Years since symptom onset	-.007	-.22	.009	-.036
Years since first in-patient treatment	-.027	-.007	.022	.086
Number of in-patient treatments	.17	.007	-.35	.019
Duration of current in-patient treatment up to second session	.45†	-.37	-.17	.015

Note. Mean HEP = heartbeat evoked scalp potential, averaged over all electrodes and conditions; LF n.u. = low frequency heart rate variability expressed in normalised units; ln LF = natural logarithm of low frequency heart rate variability.

† $p < .10$.

3.5.5. Discussion

Summary and Interpretation of Results

Heart Rate Variability

Indicators of sympathetic and parasympathetic activation did not differ significantly between the clinical and control groups. Nevertheless, there was a non-significant tendency for the AN group to have lower levels of ln LF. It is being debated if LF as absolute power represents a good indicator of sympathetic modulation, as it is influenced by the amount of total power and might therefore change in a counter-intuitive way under some conditions, such as physical exercise (Arai et al., 1989; Malliani et al., 1991). Other researchers have argued that LF is influenced by both sympathetic and parasympathetic modulations (Akselrod et al., 1981; Appel et al., 1989). It has therefore been suggested to use LF n.u., which represents the LF proportion of the total power minus the very low frequency, as an indicator of sympathetic modulation of heart rate (Malliani et al., 1991; Montano et al., 1994). As neither LF n.u., nor ln HF, nor mean heart rate, showed statistically significant differences between individuals with AN and healthy control persons, we conclude that there were no striking differences in autonomic heart rate modulation between the two groups. This finding is contrary to several studies reporting higher vagal tone in individuals with AN (Cong, 2004; Galetta et al., 2003; Ishizawa et al., 2008; Kreipe et al., 1994; Murialdo et al., 2007; Petretta et al., 1997). Yet, there are also studies reporting no differences in vagal tone in patients with AN (Melanson et al., 2004; Vigo et al., 2008). Vigo et al. (2008), for example, found no significant effect of clinical status on HF, but significantly reduced LF in individuals with AN, pointing in the same direction as in the current study. Another study found decreased HF and LF in patients with AN who had been fasting for an average of three years as compared to healthy controls and patients who had been fasting for an average of one year (Platisa et al., 2006). The patients in our study had been receiving treatment for more than five years on average at the time of investigation and reported symptom onset more than nine years ago. As the long-term development of cardiac autonomic alterations in AN is not fully understood, we cannot exclude effects of illness duration. Additionally, at the time of testing patients had been in in-patient treatment for an average of 27 days. Therefore, cardiac autonomic parameters might have improved since admission. Although it has been shown that cardiac alterations are reversible after refeeding (Mont et al., 2003; Rechlin et al., 1998), it remains unclear at which point in the refeeding period cardiac autonomic parameters return to normal values.

Furthermore, seven patients in our study were currently under medication, the majority with SSRIs, which might have influenced results. Nevertheless, this seems rather unlikely, as a recent meta-analysis concluded that SSRIs do not significantly influence HRV (Kemp et al., 2010).

Heartbeat Perception Task

We found a trend of small effect size for individuals with AN to perform better in the heartbeat perception task than control participants. This finding is opposed to Pollatos et al. (2008)'s result of reduced heartbeat perception in AN. Our result cannot be explained by *higher* sympathetic tone (Herbert et al., 2012) in the AN group, as there were no significant differences in heart rate or HRV between the groups. A non-significant tendency even pointed towards *lower* sympathetic modulation in the AN group. Although stronger cardiac activation has been associated with improved heartbeat perception (Schandry et al., 1993), other researchers found reduced heartbeat detection during stress in women (Fairclough & Goodwin, 2007) and reduced HEP amplitudes associated with stronger cardiac output during stress (Gray et al., 2007). We would argue, therefore, that the relationship between heartbeat perception and cardiac sympathetic activation is a non-linear one, with the best performance occurring at medium levels of arousal and worst performance at very low and very high levels of arousal, according to the Yerkes-Dodson law (Yerkes & Dodson, 1908). This might account for better heartbeat perception in the AN group with slightly lower levels of sympathetic arousal than in the control group. Nevertheless, there were no significant correlations between heartbeat perception and indicators of cardiac sympathetic modulation in the current sample. Accordingly, it appears rather unlikely that the trend for better interoceptive accuracy in patients with AN was caused by differences in cardiac sympathetic activation.

Corroborating these results, the analysis of HEP amplitudes did not reveal a significant interaction between experimental condition and group. We had expected that deficits in the heartbeat perception task in individuals with AN would be reflected in reduced HEPs during attentional focus on internal sensations, thereby marking a specific deficit of focusing attention on visceroceptive information. Yet, the present group of patients with AN did not experience specific problems with attentional allocation to interoceptive signals. In fact, there was no significant correlation between HEPs and heartbeat perception in the present sample. This is contrary to the results of other studies which found positive correlations between

HEPs and heartbeat perception (Montoya et al., 1993; Pollatos & Schandry, 2004; Schandry et al., 1986). Yet, these studies did not assess clinical samples and it is possible that in certain clinical populations a decoupling of the CNS representation of a visceral signal and its conscious processing takes place. In AN visceral signals, especially those relating to hunger and satiety, might be perceived but at the same time ignored or distorted. For example, it is known that individuals with AN terminate their meals when they reach their cognitively determined diet boundary, independent of visceral signals (Garfinkel, 1974). Moreover, a strong influence of external cues on satiety ratings has been reported, such as the sight of food (Herpertz et al., 2008) or the calorie content (Garfinkel et al., 1978) and amount (Herpertz et al., 2008) of the food consumed. We may therefore assume that self-reports of visceral signal perception in AN are affected by factors other than pure perception, in terms of the CNS representation of the visceral signal. What these factors are and how exactly they relate to self-reports about visceral signals in AN remains to be determined by future research.

Heartbeat Evoked Scalp Potentials

In our study, patients with AN displayed significantly higher HEPs than control participants, an effect which was only present during the HEP interval and not during the baseline time window of the evoked potential. Global differences in cortical excitability (Khedr, El Fetoh, El Bieh, Ali, & Karim, 2014) are, therefore, unlikely to explain the present results. Higher HEP amplitudes are in line with the tendency to perform better in the heartbeat perception task, but seem not to be limited to conditions of attentional focus on heartbeats, as there were no significant differences between the experimental conditions. Moreover, higher HEP amplitudes cannot be explained by stronger cardiac sympathetic activation. We may therefore conclude that our sample of patients with AN showed a stronger CNS representation of visceral signals than the control group.

There were no significant differences in HEP amplitudes between the resting measurement and the heartbeat perception task, a result which differs from previously reported effects of attention on HEP amplitudes (Montoya et al., 1993) and latencies (Schandry et al., 1986). In the study by Montoya et al. participants were actively distracted from focusing on their heartbeats while in the present study we used a simple resting condition. Therefore, we cannot rule out the possibility that participants focused on internal body sensations during the resting condition, in the absence of an explicit instruction not to do so. In that case, differences

between the resting condition and the condition of explicit focus on heartbeat counting might have been obscured.

In our sample, HEP amplitude maxima where located in mid-frontal and mid-central scalp sectors. Other studies have reported maxima over midline and right hemisphere locations (Leopold & Schandry, 2001; Montoya et al., 1993; Pollatos & Schandry, 2004; Schandry et al., 1986; Schulz et al., 2014). This slight shift in amplitude maxima may be accounted for by the low BMI of the present patient group, as BMI has been shown to be related to the electrical and anatomical axes of the heart (Engblom et al., 2005). An altered orientation of the heart axis might decrease the right hemisphere advantage in the processing of afferent cardiac signals.

Exploratory Correlational Analyses

Correlations between indicators of interoceptive processing at different levels were generally weak in our study. This is a common finding in interoception research and underlines the importance of distinguishing the different levels and of assessing possible alterations in mental disorders at different levels (Garfinkel & Critchley, 2013; Garfinkel et al., 2014). Furthermore, a higher level of eating disorder symptoms, including the EDI subscale Interoceptive Awareness, was positively related to HEPs and negatively to ln LF. This reflects the differences between the AN group and the control group in HEPs and ln LF, as discussed above. The generally elevated level of psychopathology in the patient group was also reflected in positive correlations of the HEP with state and trait anxiety and in negative correlations of ln LF with state and trait anxiety and symptoms of depression. Differences between the clinical and control groups also became evident in a negative correlation of HEP with level of exercise, as the patients in our sample refrained from any kind of exhausting exercise as part of their treatment and, therefore, reported significantly lower levels of exercise during the past week than the control group. Hospital routine also accounts for a group difference in the time which had elapsed since the last meal at the beginning of the testing session, with patients having eaten more recently than control persons. This effect is reflected in a negative correlation of HEP amplitudes with the time which had elapsed since the last meal. Altogether, the correlational findings undermine the difference between the groups in HEP amplitudes and link higher HEP amplitudes to eating disorder specific and unspecific (anxiety, depression) psychopathology. For additional information on characteristics of the clinical and the control sample, see chapter 3.2.1. Of note, neither HEPs

nor heartbeat perception showed a significant correlation with body size estimation, which stands against Bruch (1962)'s hypothesis of a general body perception deficit in AN spanning over different perceptual modalities (cf. chapter 2.2.1). Cross-modal comparisons of body perception remain rare in eating disorder research; we are aware of only one study, which explicitly compared viscerception and body size estimation (Garfinkel et al., 1978). On this note, the current study opens the door for future studies relating CNS processing of heartbeats to CNS processing of other visceral organs, of proprioceptive, and of exteroceptive body information in AN, in order to identify the processes responsible for altered body perception in AN.

General Discussion

While differences in cardiac autonomic modulation cannot account for the current results, there are two possible alternative explanations. The first is that heightened visceroceptive processing in AN is maladaptive and a symptom of the disorder. The second is that, considering the current in-patient setting, increased visceroceptive processing is a sign of successful treatment. Considering the first explanation, heightened interoceptive accuracy has been described in anxiety disorders, as well. A recent review reported a mean effect size of *d* = .52 for panic disorder (Domschke, Stevens, Pfleiderer, & Gerlach, 2010). In the theoretical framework of Paulus and Stein (2006) alterations in interoceptive accuracy are related to a heightened predictive signal of future aversive body states which is generated by the anterior insula. Findings of stronger insula response during anticipation of food pictures (Oberndorfer, Simmons, et al., 2013) and painful stimuli (Strigo et al., 2013) in AN suggests that similar processes might be at work in this disorder. Accordingly, increased interoceptive processing as found in the current study might be related to heightened prediction of aversive body states. The predictive signal is assumed to originate in the insula (Paulus & Stein, 2006), a brain structure which has been reported to be one of the sources of HEPs (Pollatos et al., 2005a). Moreover, HEP scores were positively related to state and trait anxiety in the current sample, lending support to the idea that a heightened predictive signal would be related to anxiety. Increased activity of the insula and related limbic areas have also been linked to negative feelings about one's body (Gaudio & Quattrocchi, 2012), which is in line with the positive correlation between HEPs and drive for thinness in the current sample. In summary, a hyperactivity of the insula under certain conditions and alterations in closely linked brain structures might be associated with eating disorder pathology (cf. chapter 2.3.2) and might

result in higher HEP amplitudes. This intriguing assumption needs to be followed up by further investigations of HEP sources and of a possible convergence of eating disorder symptoms in the insula (Nunn et al., 2011; Nunn & Frampton, 2008).

Nevertheless, the first explanation cannot account for our finding of increased interoceptive processing, contrasting previous reports on decreased interoceptive accuracy in AN (Pollatos et al., 2008). A possible explanation for these contradictory results might lie in differences in patient characteristics, i.e. the in-patient setting in the current study as compared to the ambulatory setting of Pollatos et al.'s (2008) study. All participants in the current study were in in-patient treatment at the time of data acquisition, and had been so for 27 days on average. It is, therefore, likely that they had undergone some sort of treatment aiming at an improvement of bodily awareness. Nevertheless, it remains doubtful that interventions as part of a standard treatment for AN are able to induce alterations in interoceptive processing, especially at the level of CNS representation of visceral signals. While a specific heartbeat awareness training has been shown to enhance both interoceptive accuracy and HEPs (Schandry & Weitkunat, 1990), less specific interventions, such as mindfulness meditation, appear not to improve heartbeat perception (Khalsa et al., 2009; Melloni et al., 2013; Parkin et al., 2014). To the best of our knowledge, effects of such interventions on HEPs remain unexplored, to date. A positive correlation between HEPs and the duration of the current treatment in our sample suggests the possibility that HEPs might be sensitive to treatment effects and might reflect changes in basal processing as a precursor to improvements in eating disorder symptoms. This hypothesis indicates the strong need for an exploration of possible treatment effects on interoception in prospective intervention studies.

Additionally, as a consequence of the in-patient setting of the current study, we can exclude effects of acute fasting on the present results. All patients in our study were strictly required to eat three meals a day as part of the hospital routine. In fact, all patients had eaten a full meal within the last two hours before the beginning of the experimental session. In contrast, Pollatos et al. (2008) recruited their individuals with AN from a self-help group, which makes it more likely that their participants had fasted prior to the experiment. Short-term fasting has been shown to increase HEP amplitudes (Schulz et al., 2014) and to improve heartbeat perception (Herbert et al., 2012) in healthy individuals. Yet, it remains for future research to elucidate effects of long-term fasting and of acute fasting in malnourished individuals with AN. Furthermore, as Pollatos et al. (2008) did not report indicators of cardiac autonomic modulation, one cannot rule out the possibility that their patients showed cardiac alterations

(e.g., increased cardiac vagal dominance), that were not present in our sample of patients but could account for lower levels of interoceptive accuracy. While our patients were in the process of re-feeding, this may not have been the case for Pollatos et al.'s participants who were recruited from a self-help group and not from an in-patient treatment unit. These obvious differences between the two studies strongly urge for comparisons between individuals with AN at different stages of the disorder and of treatment. Longitudinal investigations may help clarify the role of interoceptive processing throughout the course of AN and how it alters with treatment.

Limitations

The current study assessed interoceptive processing at different levels in a sample of patients diagnosed with AN and healthy control persons. We included patients with comorbid disorders, that is, affective and anxiety disorders, as well as patients receiving psychotropic medication. Therefore, we cannot exclude that comorbid disorders or medication influenced the current results. Nevertheless, the patients who participated in the current study are typical cases in a naturalistic setting, as affective and anxiety disorders are frequently comorbid in AN (Kaye et al., 2004), which are often treated with psychotropic medication. We would argue, therefore, that the participants with AN in the present study were representative for typical patients in an in-patient setting, which underlines the external validity of the study. It will be for future studies to explore the effects of, for example, comorbid anxiety on interoceptive processing in AN. Moreover, our participants with AN took part in the study at different stages of treatment. Consequently, some might have already benefited from treatment while others had been admitted to hospital only recently, which would lead to a rather heterogeneous sample in terms of disorder severity. Nevertheless, all patients currently met DSM-V criteria for AN (American Psychiatric Association, 2013). In addition, the variance in treatment duration allowed for the investigation of the association of HEP amplitudes with treatment duration, which implies the necessity of conducting longitudinal intervention research with HEP methodology.

Finally, our study was limited to the assessment of interoception in the domain of cardiac afferent signals. As outlined in chapter 2.2.4, the perception of information from the gastrointestinal tract may also be of critical importance in AN. Yet, as methodology for the assessment of interoception at different levels is more sophisticated with regard to cardiac interoception, the focus on this interoceptive domain allowed for the investigation of precise

research questions. Although cardiac perception is related to gastric perception (Herbert et al., 2012; Whitehead & Drescher, 1980), it will be a task for future research to establish additional methodologies for the assessment of gastric interoception at the levels of interoceptive accuracy and CNS representation, among others (Ceunen, Van Diest, & Vlaeyen, 2013).

Conclusion

We were able to demonstrate increased CNS representation of visceral signals, as indicated by HEPs, in patients with AN. This finding was contrary to our original hypothesis of reduced interoception in the clinical sample. We propose two explanatory hypotheses which guide the way for future research. The first is a possible relationship of stronger visceral CNS representation to heightened anxiety about future aversive body states, in terms of gastric fullness or weight gain, for example. This hypothesis calls for the investigation of gastrointestinal perceptions and the exploration of the precise role of the insular cortex in eating disorder symptomatology. The second hypothesis states that improved interoceptive processing might be a sign of remission. Longitudinal studies are essential in order to elucidate the possible utility of HEPs as an indicator of treatment effects.

4. General Discussion

The present project investigated three psychological dimensions of body image, that is, cognition, affect, and perception, including two modalities of perception, that is, visual perception and viscerception. This multidimensional approach allowed us to illustrate the high complexity of body image and its alterations in AN.

4.1. Summary of Findings

4.1.1. Cognitive Bias and Sensitivity for Self-Other Discrimination of Distorted Body Shapes in Healthy Females (Study 1)

The investigation of self-other discrimination of thin- and fat-distorted body images has shown that it is more difficult to recognise body pictures that have been strongly distorted in either direction, than only slightly distorted body images. This effect is related to a decrease in sensory sensitivity with increasing degrees of distortion, together with a response bias, which was evident in a tendency to classify slightly distorted body images as self and strongly distorted images as other, regardless of their actual identity. These results suggest that distorted, headless bodies may not be easily recognised and were, furthermore, subjectively perceived as negative. In addition, a response bias for classifying fat-distorted body pictures as self was related to body size overestimation, and a thin ideal body image was associated with better discrimination for strongly distorted body shapes. These correlations illustrate the complex relationship between perceptual (size estimation, discrimination) and cognitive/affective (response bias, body dissatisfaction) dimensions of body image. Moreover, the results indicate that alterations in these processes, suggestive of a negative and distorted body image, are not limited to eating disorders, but may also be at work in healthy women.

4.1.2. Implicit and Explicit Affective Evaluation of Body Images in Anorexia Nervosa (Study 2)

Using an affective startle eye-blink modulation paradigm, there was no evidence for differences in implicit affective evaluations of real, thin-distorted, and fat-distorted body shapes between persons with AN and healthy controls. This finding was contrasted by

negative subjective ratings for distorted body images in both groups and generally more negative ratings for body pictures in the AN group. The discrepancy between implicit and explicit measures suggests a prevailing influence of cognitive factors rather than implicit affect, such as a fear response to fat body shapes, on negative subjective evaluation of body shapes in AN and healthy controls. Together with previous results (Reichel et al., 2014) this suggests that details of the body, which provide information about weight status, such as a protruding rib cage, might be more of immediate affective relevance in AN than general body shape. Moreover, a tendency towards startle attenuation for thin-distorted self-body pictures in persons with high levels of drive for thinness indicates that the implicit positive evaluation of thin body shapes might only be of relevance for a subgroup of patients.

Complementing these findings regarding body image, we found evidence for a general failure to activate the approach system in individuals with AN. This effect was visible in the absence of startle attenuation during the presentation of positive normative pictures, thereby replicating previous findings (Friederich et al., 2006).

4.1.3. Visual Perception of the Body in Anorexia Nervosa (Study 3)

The examination of early visual ERPs for body and cup pictures indicated a shift in processing strategies in AN from featural to configural processing of body images. This was evident in a lack of discrimination between self-body pictures and self-cup pictures on the P1 component (featural processing). At the same time, the N1 component (configural processing) was enhanced for body pictures relative to cup pictures. Whereas alterations in the P1 might be related to an attention-mediated avoidance of self-body pictures (Hillyard et al., 1998; Mangun, 1995), alterations in the N1 are assumed to reflect increased expertise with body shapes (De Sonneville et al., 2002; Tanaka & Curran, 2001). These findings demonstrate the complexity of visual body perception and suggest that perception might not be impaired per se, but that different alterations may occur at different levels of the processing stream.

In addition, we found a generally enlarged P1 component in participants with AN relative to controls. This phenomenon has previously been described in anxiety disorders and has been interpreted as hypervigilance (Kolassa et al., 2009, 2007; Michalowski et al., 2009).

4.1.4. Perception of Visceral Body Information in Anorexia Nervosa (Study 4)

Using a heartbeat perception task (Schandry, 1981) we were able to demonstrate a tendency for better interoceptive accuracy in patients with AN than in controls. This finding is corroborated by significantly larger HEPs in the AN group, indicating enhanced CNS representation of cardiac visceral signals. These results are diametrically opposed to previous findings of reduced heartbeat perception in AN (Pollatos et al., 2008). The present finding of enhanced cardioception in AN might be a pathological sign of comorbid anxiety, as anxiety disorders have been shown to be related to improved interoceptive accuracy (Domschke et al., 2010). Alternatively, an improvement in CNS processing of visceral signals might be a marker of treatment success.

4.1.5. Synthesis

The results of the present project are not in line with the idea of a global perceptual deficit in AN (Bruch, 1962). Instead, we found a complex picture of impairments in featural visual body processing, enhancements in configural visual body processing, and enhanced cardioceptive processing. In the light of these results it appears inevitable to reconceptualise the idea of global perceptual deficits. It seems possible that not only deficient, but enhanced perceptual processing in some domains might be pathological, such as increased interoception in anxiety disorders (Domschke et al., 2010). Indeed, we found links with comorbid anxiety symptoms (Kaye et al., 2004) in terms of increased processing of cardiac signals in the CNS (study 4), as well as a heightened P1 component of the visual ERPs (study 3), which has been suggested to reflect hypervigilance in anxiety disorders (Kolassa et al., 2009, 2007; Michalowski et al., 2009). Anxiety in the context of eating disorders might be related to the expectation of future negative body states, as has been suggested for anxiety disorders (Paulus & Stein, 2006), with the difference that the negative body states relevant for AN are states indicative of weight gain, such as a full stomach or increasing body fat. Individuals with AN might be hypersensitive to such perceptions and expectations and in order to avoid them choose to rely on cognitive rules and strategies rather than on body feedback, as has been reported for their eating behaviour (Garfinkel, 1974). This is in line with cognitive-behavioural theories of AN, which highlight the major importance these individuals bestow on control over eating, weight, and shape, as an index of general self-control (Fairburn et al., 1999). Cognitive attitudes also appeared to be the main factor underlying negative subjective

ratings for body pictures in study 2, as they diverged from the neutral implicit affect that the same pictures elicited in the startle modulation paradigm. Implicit preference for thin body shapes appeared to be present only in a subgroup of participants with very high levels of drive for thinness. We found no evidence of a pre-attentive fear reaction towards fat-distorted body images. In contrast, cognitive tests of implicit associations have shown implicit negative associations with overweight stimuli in AN (Cserjési et al., 2010; Spring & Bulik, 2014). Yet, they may address cognitive processes to a greater extent than the affective startle modulation paradigm employed in the current project. Furthermore, cognitive bias for fat body shapes was associated with body size overestimation in healthy women in study 1, supporting the idea of top-down modulation of visual body processing (Farrell et al., 2005). To what extent such top-down processes might have affected the visual ERP results of study 3, remains to be investigated by future research. Indeed, we have only just begun to explore the complex structure of body image, with its multiple dimensions and modalities and their interactions. The roles of anxiety and cognitive distortions appear to be especially prominent, particularly in their possible top-down effects on lower-order perceptive processes.

4.2. Implications

4.2.1. Implications for the Operationalization of Body Image

The multidimensional approach to body image applied in the current project (Cash & Green, 1986; Vocks, Legenbauer, Troje, & Schulte, 2006) was particularly successful in highlighting the fact that different processes must be at work in the different dimensions of body image, as they are differentially affected in individuals with AN. For example, body pictures were associated with negative explicit affect but neutral implicit affect in study 2. Moreover, we addressed another level of complexity by investigating different modalities of body perception, that is, visual and visceral perception. In both these perceptual processes we identified further sub-processes, such as the distinction between featural and configural processing in visual perception, and the distinction between visceral signal, CNS representation, and conscious perception of the signal in visceroception (cf. Figure 29). We demonstrated that even these sub-processes may be differentially affected in AN, as seen in impaired featural but enhanced configural processing of body shapes. As a result, it seems mandatory for a comprehensive understanding of body-image related alterations in AN to

directly investigate the processes and sub-processes underlying more global phenomena, such as body dissatisfaction or body size overestimation. In addition, interactions between the various processes, as well as possible alterations over time must be taken into account.

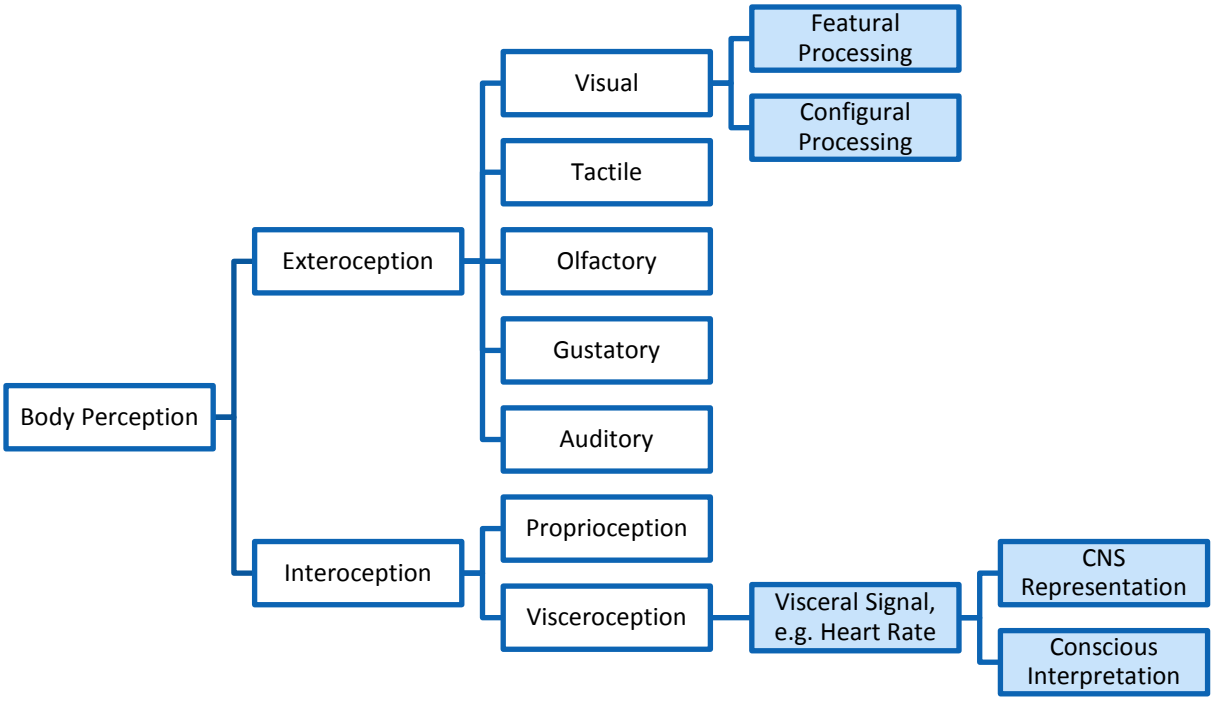

Figure 29. Extension of the initial model of body perception domains and modalities (Birbaumer & Schmidt, 2006; Schandry, 2003; Vaitl, 1996) by sub-processes for the visual and visceroceptive modalities (coloured rectangles).

Visual Body Perception

Perceptual measures of body image, such as the digital photograph distortion techniques applied in the current project, have been criticised for measuring memory of body size and attitudinal factors rather than perception per se (Smeets, 1997). This idea is corroborated by the findings from study 1, which demonstrated close interrelations between body size overestimation and cognitive bias for fat body shapes, as well as body dissatisfaction and enhanced sensory discrimination of distorted self- and other-body pictures. In light of this evidence one might rush to the conclusion that apparent distortions in visual body perception are entirely a function of cognitive bias. Yet, in study 3 we were able to demonstrate alterations of basic visual processes, that is, featural and configural processing, in individuals with AN. Other studies have shown alterations in the EBA (Suchan et al., 2010, 2012; Uher et al., 2005), a brain area crucially involved in the visual processing of body shapes (Downing et

al., 2001). Together these findings suggest that visual perceptive processes are altered in AN, but that direct measurement of CNS activity is necessary in order to isolate perception from higher order cognitive processes. Still, we may not rule out top-down influences on visual perception (Farrell et al., 2005). An exploration of these hypothesised top-down processes and their susceptibility to treatment appear to be promising topics for future research.

Interoception

For the investigation of interoception we chose a bio-signal, heart rate, whose CNS processing and conscious perception have been thoroughly explored (cf. chapter 3.5.2). Although alterations in this domain might be relevant for symptoms of anxiety in eating disorders, it is not as directly associated with core eating pathology as the gastrointestinal system (cf. chapter 2.2.4). Yet, studies on AN in the gastrointestinal domain of viscerception have mostly focused on either hunger and satiety ratings (Garfinkel et al., 1978; Garfinkel, 1974; Halmi et al., 1989; Halmi & Sunday, 1991; Herpertz et al., 2008) or alterations in the gastrointestinal tract itself (Crisp, 1965; Dubois et al., 1984; Holt et al., 1981; Hölzl & Lautenbacher, 1984; Silverstone & Russell, 1967). Consequently, there is a gap in the literature regarding the processes which mediate between the gastrointestinal tract and the conscious interpretation of signals from it. As study 4 demonstrated, it is important to assess indicators of the CNS representation of visceral signals, which are less prone to effects of reporting bias, in addition to their source and their conscious interpretation. Unfortunately, there is, to the best of our knowledge, no well-established method for assessing the CNS representation of gastrointestinal signals. The development of such a method remains a challenge for future research.

Furthermore, it has recently been shown that not only viscerception, but also altered proprioception plays a role in AN (Favaro et al., 2012; Metral et al., 2014). The continuing exploration of this second interoceptive modality and its role for the aetiology of eating disorders, as well the investigation of possible links between proprioception and viscerception, are tasks for future research.

4.2.2. Implications for Neurobiological Models on Body Image and Eating Disorders

Alterations of the EBA have been discussed as playing a central role in distortions of visual body perception in AN (Suchan et al., 2010, 2012; Uher et al., 2005). Although the source of the N1 ERP component has been located in the EBA (Ishizu et al., 2010; Pourtois et al., 2007; Sadeh et al., 2011; Taylor et al., 2010), we found an enhanced rather than impaired N1 component for body pictures in persons with AN (study 3). This intriguing finding calls for a further functional characterisation of the EBA in individuals with AN, and the investigation of possible compensatory activations in other brain areas. In contrast, we found impaired processing of self-body pictures in the P1 component, which is associated with featural image processing. Although the anatomical sources of body-related effects on P1 remain poorly explored, effects of spatial attention on P1 have been located in the extrastriate cortex (Hillyard et al., 1998). It is, therefore, possible that the EBA is also involved in the generation of the P1 component for bodies. Interestingly, the EBA has been shown to contain subpopulations of neurons that are selectively activated by photographs of one's own versus other's body parts (Myers & Sowden, 2008). Such identity specific subpopulations might be implicated in the discrimination between self- and other-body pictures in the wake of featural processing as indexed by the P1. Hypothetically, such neuronal subpopulations would provide a possible target for top-down modulation of attentional processes (Farrell et al., 2005), which might account for the present finding of a lack of discrimination for one's own body in P1 amplitudes in women with AN. These speculations highlight the need for further investigations of the neuronal basis underlying alterations in visual body processing in AN. In addition, alterations in areas associated with visual body processing must be incorporated into current neurobiological models of AN, which mostly focus on the insula and its possible role in multisensory integration of body-related information (Kaye et al., 2009; Nunn et al., 2011; Nunn & Frampton, 2008). Yet, the role of input from the visual system and possible effects of altered input regarding visual body perception remain to be investigated.

Furthermore, the results of study 4 suggest that altered insula functioning (Kaye et al., 2009; Nunn et al., 2011; Nunn & Frampton, 2008) might not be reflected in a deficit per se. AN patients in our study had larger HEPs, the sources of which have been located in the insula, among others (Pollatos et al., 2005a). Following an anxiety disorder approach (Paulus & Stein, 2006) increased interoceptive processing might be related to a heightened predictive signal for future aversive body states originating from the anterior insula. Imaging research

has shown complex modulations of the insula in AN, also in the perception of body photographs. For example, decreased insula activation has been found for self-pictures in individuals with AN (Sachdev et al., 2008) and increased insula activation has been associated with body dissatisfaction (Friederich et al., 2010; Mohr et al., 2010; Redgrave et al., 2010). These findings would be in line with a heightened predictive signal for future aversive body states, that is, fat body states. Further research is needed in order to explore the plausibility of this working hypothesis.

4.2.3. Implications for the Treatment of Body Image Disturbance in Anorexia Nervosa

Looking into a mirror elicits a range of negative thoughts and feelings in most women with eating disorders (Vocks et al., 2007). As their reactions appear similar to those of people with phobia when confronted with the phobic stimulus, exposure to one's body with the help of mirrors or video cameras has been implicated in many cognitive-behavioural treatment programmes (Farrell et al., 2006). Preliminary trials show an advantage of cognitive-behavioural therapy (CBT) with mirror exposure over standard CBT (Key et al., 2002). However, there is still a dearth of research on the effectiveness of mirror exposure (Farrell et al., 2006). If mirror exposure aims at a reduction of anxiety in confrontation with one's own body (Farrell et al., 2006), the results of study 2 suggest that this approach might not be of benefit to all patients, as the patients participating in the current project did not show an implicit fear response towards body shapes. In consequence, the prerequisites for benefitting from anxiety reduction through exposure and habituation must be established first, that is, that a patient displays a prominent fear reaction in response to his or her body shape or to specific body parts. Such fear responses to the phobic stimulus are a core symptom of anxiety disorders (Ohman & Mineka, 2001), for which CBT with exposure to the phobic stimulus has been shown to be effective (Deacon & Abramowitz, 2004). In the current patient sample there was, on average, no indication for exposure treatment with the aim of reducing anxiety, as AN patients did not display an implicit fear response when confronted with their own body image. Nevertheless, as suggested by the top-down interpretation of alterations in visual body perception (Farrell et al., 2005), which were present in the current sample (study 3) even in the absence of implicit affective reactions, mirror exposure may still be efficient in the treatment of cognitive bias. Accordingly, it has been suggested that mirror exposure is likely to be more successful if it includes cognitive modification and not merely habituation of

anxiety (Farrell et al., 2006). A recently published body image therapy programme (Vocks & Legenbauer, 2010) follows this recommendation and addresses two aspects during mirror exposure: habituation to negative affect and redirection of attentional bias from negative to positive body parts (Legenbauer et al., 2011; Vocks & Legenbauer, 2010). This programme has been shown to reduce eating disorder symptoms and distorted cognitions about body image and eating (Legenbauer et al., 2011). Moreover, patients with eating disorders displayed an increase of activity in the EBA after treatment, which suggests that attentional retraining or other factors of the treatment might enhance visual processing of body images (Vocks et al., 2010). In line with the idea that not all patients are likely to benefit from mirror exposure, it has been shown that women with eating disorders who frequently engage in body checking behaviour benefit less from mirror exposure, as they might already be habituated to their bodies (Vocks, Kosfelder, Wucherer, & Wächter, 2008). Further research is required to determine which participants benefit from anxiety habituation exercises and how exactly attentional retraining may affect visual perception of body images, at the levels of featural and configural processing.

4.3. Methodological Considerations

4.3.1. A Note on Body Images

In the current project we used highly standardised photographs of participants as stimulus material. On these photographs participants were fully dressed in figure-hugging, skin-coloured, standardised clothing. This approach allowed us to highlight the participant's body shape while ruling out effects of skin texture, tattoos, or other body characteristics not directly related to body shape. Moreover, we used digital image manipulation software to distort the body pictures in the thin and fat directions (Sands et al., 2004; Shibata, 2002). Results of the reaction time task in study 1 and the subjective ratings in studies 1 and 2 suggest that these distorted pictures did not have a strong association with the self and were perceived as negative, even by healthy women. Whenever pictures of this kind are used, it should be taken into account that, in most cases, they do not correspond to the mental representation of the body that participants have in mind, that is, their body image (Slade, 1994). Furthermore, these photos might lack the features that are of particular motivational salience to women with eating disorders, such as prominent signs of cachexia (Reichel et al., 2014).

Nevertheless, study 3 showed that in a simple design with only two undistorted body pictures and two object pictures, differentiation of self- and other-pictures is evident in the visual processing stream already 105 ms after picture onset. The complexity of the stimulus set might play a role in this context, as well as the task employed. The assignment to classify pictures as self- versus other-pictures might elicit attentional processes which enhance the distinction of these categories very early in the processing stream (Hillyard et al., 1998; Mangun, 1995).

Furthermore, we cropped the body pictures in such a way that the head of the participant was not visible. This is mandatory when investigating basic visual body shape processing, as faces and bodies are processed in similar, but not identical ways (Slaughter et al., 2004), and face and body processing cannot be disentangled otherwise. Yet, it has been argued that headless bodies are unnatural and that they are processed in a different way than bodies with heads (Minnebusch et al., 2009; Yovel et al., 2010). Indeed, a recent study identified neural subpopulations in fusiform and extrastriate areas, which selectively process whole individuals, that is, bodies with heads (Schmalzl, Zopf, & Williams, 2012). With regard to body dissatisfaction the face may also convey information about weight status and fat-distorted pictures of one's own face have been shown to elicit negative implicit affect in healthy individuals with high levels of body dissatisfaction (Spresser et al., 2012). Future research should take these considerations into account and additionally assess effects elicited by bodies with heads in the context of body image and eating disorders. Furthermore, while we chose a highly standardised, internally valid approach in the current project, future studies should aim at a gradual reduction of standardisation for the sake of external validity. As a reduction in standardisation poses a serious threat to the investigation of, for example, early visual ERPs (Johannes et al., 1995; Kenemans et al., 2000), it is important to first establish effects using internally valid methodology, but certain techniques, such as inversion or scrambling of photographs, render possible the investigation of early visual ERPs even with less standardised stimuli.

4.3.2. A Note on Sample Selection

The sample of individuals with AN participating in studies 2-4 was recruited at an in-patient treatment centre. Treatment routines usually impose rules on AN patients, such as regular meals and a ban on exercise. In consequence, in-patients might be different from out-patients, who do not abide to such rules, but engage in their habitual fasting and exercising behaviours.

Such differences may be of particular relevance in the assessment of psychophysiological parameters, for example, heartbeat perception and HEPs, which have been shown to be sensitive to short-term fasting manipulations (Herbert et al., 2012; Schulz et al., 2014). The effects of current fasting state in malnourished individuals with AN remain largely unexplored and should be subject to future research.

In addition, the current sample of AN patients reported that they had first developed symptoms of AN on average nine years before study participation. This suggests a chronic course of the disorder and might reflect quite a different state than the initial state of the disorder. The current findings should, therefore, not be prematurely generalised to individuals with AN in general. Instead, they should inspire studies which test the generalizability of the current results to individuals with AN at other stages of the disorder, that is, shortly after symptom development and after remission. In addition, long-term studies are needed in order to describe in detail the development of such processes as visual body perception and viscerocepti on, and, eventually, to determine whether they might constitute risk factors for disordered eating.

4.4. Outlook

The findings of the current project emphasise the need to assess basic processes of body image disturbance in AN, in order to arrive at a more comprehensive understanding of this puzzling symptom of the disorder. Whereas the present project focused entirely on individuals with AN, those with BN have been shown to have at least equal, if not higher degrees of body image distortion (Cash & Deagle, 1997). Yet, how exactly the two eating disorders differ or converge in alterations of basic body image related processes remains largely unexplored. Previous studies suggest that some alterations in body-related processing, such as attentional bias for self-body pictures, might even point in opposite directions in AN versus BN (Blechert et al., 2010). Therefore, it appears mandatory to further investigate the communalities and differences between the two disorders to be able to provide intervention techniques adapted to the specific needs of the two patient groups.

Furthermore, body image issues are of importance in other disorders as well. For example, although individuals with BED have been suggested to benefit from body image exposure (Hilbert, Tuschen-Caffier, & Vögele, 2002), there is still a lack of research in that area. Body image is primarily affected in persons with body dysmorphic disorder, who display an

excessive preoccupation with some aspects of their physical appearance (Rosen, Reiter, & Orosan, 1995). Alterations of body image in this disorder have been shown to be partly similar to and partly distinct from those found in eating disorders (Hrabosky et al., 2009). The establishment of paradigms assessing basic aspects of body-image related processing, as those employed in the current project, will also be of use for understanding body image disturbance in body dysmorphic disorder, and for further investigating the overlap and distinctness of body image disturbance in different mental disorders. Only a detailed understanding of the mechanisms underlying body image disturbance will allow us to optimise treatment approaches for each of the disorders.

Finally, study 1 showed that alterations in basic body image related processing may occur in healthy females. This finding points towards a dimensional view of body image disturbance in which eating disorders represent the pathological end of the continuum (Cornelissen et al., 2013). Yet, how exactly the transition between healthy and unhealthy body image is characterised, remains to be explored by future research. Again, it appears essential to include measures of basic body-image processing in order to achieve a more complete understanding of body image in mental health and disorder. The elucidation of the nature of body image in all its complexity remains a fascinating challenge for the future. Even more so when we consider the major relevance of body image, as the mental representation of our body, for the way we perceive ourselves and for how we move as entities in the world.

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Appendix

Study 1

Figure 30. Recruitment notice for study 1, which was posted on campus notice boards.

Demographische Fragen 1

__ __ __ __ ____ ____

Sehr geehrte Versuchsteilnehmerin,

bitte beantworten Sie die folgenden Fragen zu Ihrer Person. Ihre Daten werden absolut vertraulich behandelt und anonym abgespeichert.

Bitte schreiben Sie Ihre Antworten in die weißen Kästchen oder kreuzen Sie die auf Sie zutreffende Antwort an.

1. Allgemeines

Alter		Jahre	
Schulabschluss			
Berufsausbildung			
Derzeitige Tätigkeit			
Wenn Student/in:			
Studiengang			
Semesterzahl			
Familienstand			
Händigkeit	☐ Rechtshänder/in	☐ Linkshänder/in	☐ Beidhänder/in

2. Nationalität und Muttersprache

Staatsangehörigkeit	
Geburtsland	
In welchem Land leben Sie zurzeit? Wie lange schon?	
Herkunftsland der Mutter	
Herkunftsland des Vaters	
Muttersprache	
Bevorzugte Sprache	
Sprache, die in Ihrer Familie hauptsächlich gesprochen wird	

Figure 31. Socio-demographic self-report questionnaire, as used in study 1.

3. Allgemeine Gesundheit

Wie oft treiben Sie gewöhnlich Sport (Ausdauersport, Kraftsport, Ballspiele, etc.)?		mal in der Woche
Wie viele Zigaretten rauchen Sie durchschnittlich am Tag?		Stück am Tag
An wie vielen Tagen pro Woche trinken Sie durchschnittlich Alkohol?		Tage pro Woche
Welche Medikamente nehmen Sie momentan regelmäßig ein?		
Bitte geben Sie das Datum an, an dem Ihre letzte Periode begann:		
Wenden Sie momentan eine hormonelle Empfängnisverhütung (z.B. die Pille) an?	☐ ja	☐ nein
Sind Sie schwanger?	☐ ja	☐ nein
Leiden Sie an chronischen (länger andauernden) Erkrankungen?	☐ ja	☐ nein
Welche Erkrankung(en)?		
Wurde bei Ihnen jemals eine psychische Erkrankung diagnostiziert?	☐ ja	☐ nein
Welche Erkrankung?		
In welchem Jahr?		
Waren oder sind Sie aufgrund dieser Problematik in psychotherapeutischer Behandlung?	☐ ja	☐ nein
Wurde diese Behandlung erfolgreich abgeschlossen?	☐ ja	☐ nein
Nehmen Sie derzeit aufgrund der Problematik Psychopharmaka ein?	☐ ja	☐ nein

Bitte geben Sie Ihr <u>niedrigstes</u> (Erwachsenen-) Gewicht an:		kg
Das war vor		Jahren
Das war vor		Monaten
Bitte geben Sie Ihr <u>höchstes</u> Gewicht an:		kg
Das war vor		Jahren
Das war vor		Monaten

Study 2

Exemplary Body Images

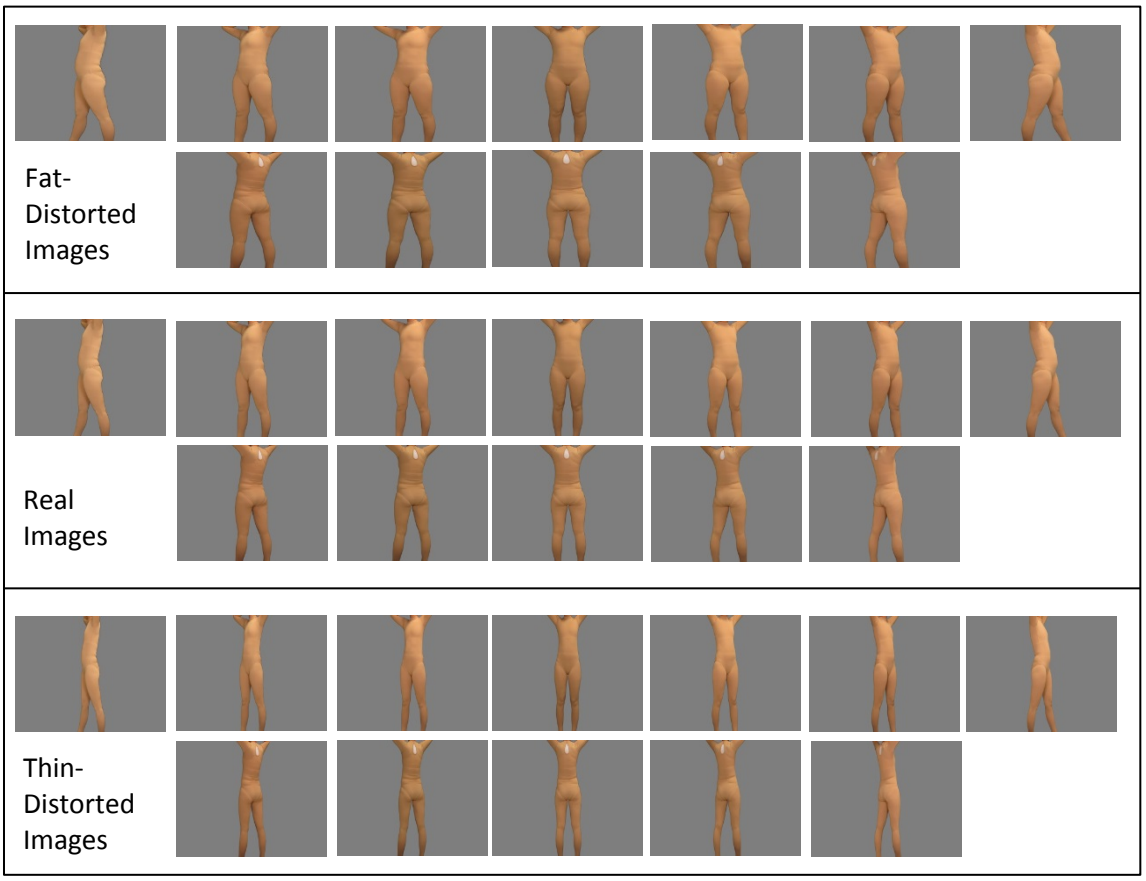


Figure 32. Exemplary picture set of a normal-weight woman from the affective startle modulation paradigm.

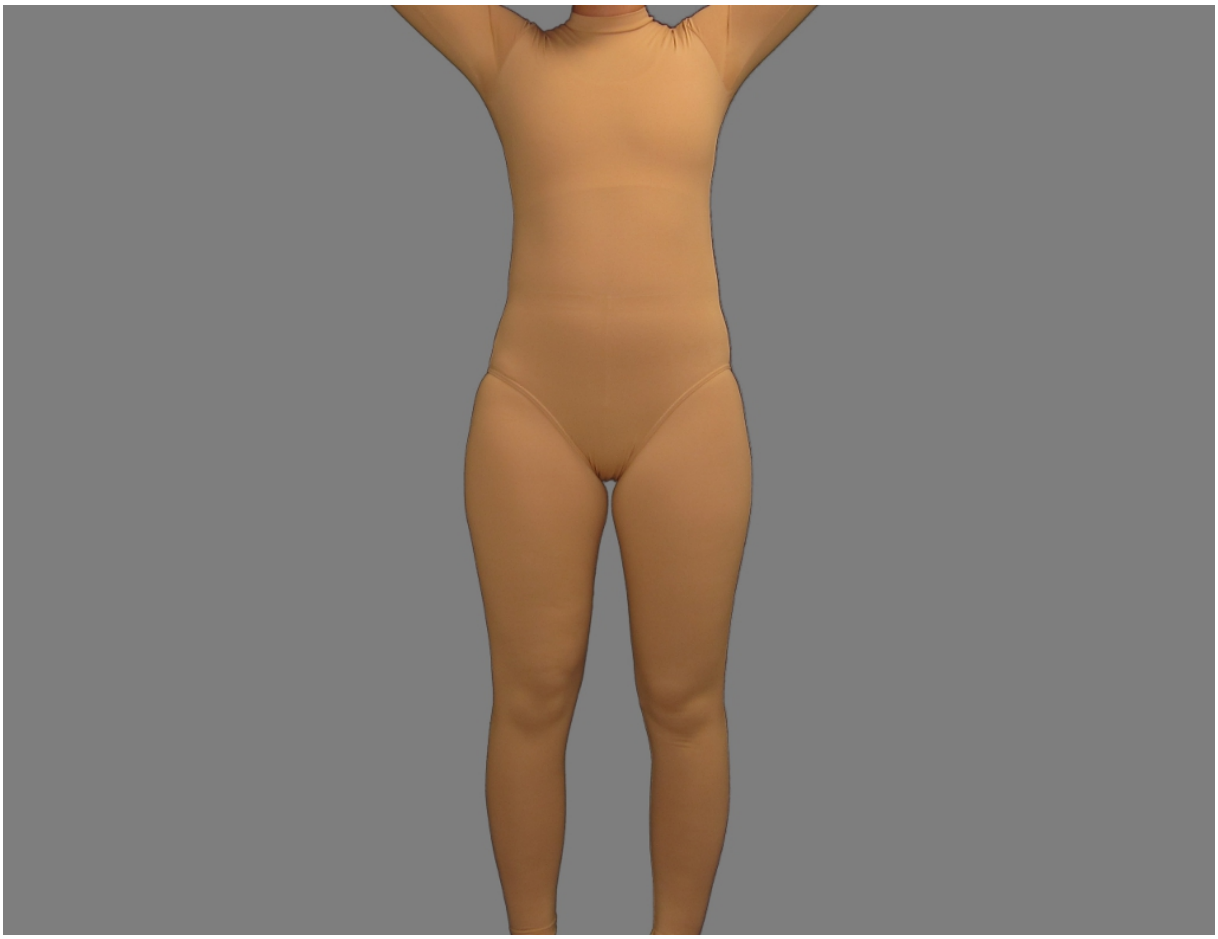


Figure 33. Exemplary undistorted front-view photograph taken from the picture set of a normal-weight woman from the affective startle modulation paradigm.

Study 3

Exemplary Body and Cup Pictures

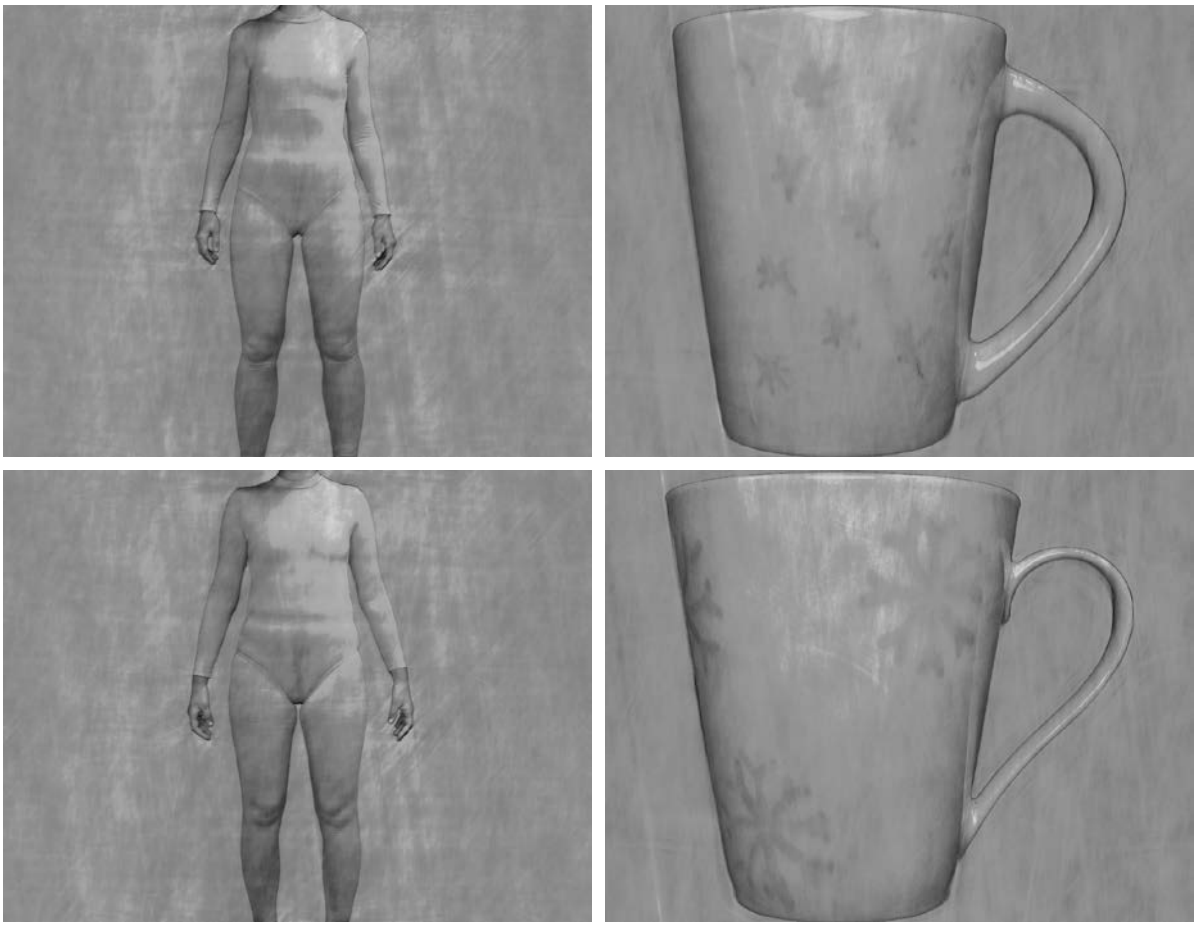


Figure 34. Exemplary picture set from the visual evoked potentials paradigm of a normal-weight woman. The set consists of self-body, self-cup, other-body, and other-cup pictures. The pictures have been treated with SHINE toolbox in order to match low-level stimulus properties.

Results

Table 19

ANOVA Results for the N1 Component

Effect	*df*1, *df*2	*F*	*p*	η_p^2
group	1, 31	3.54	.69	.10
stimulus type	1, 31	247.29	< .001	.89
stimulus type * group	1, 31	0.94	.34	.029
self-reference	1, 31	0.098	.76	.003
self-reference * group	1, 31	3.53	.070	.10
scalp location	1, 31	26.46	< .001	.46
scalp location * group	1, 31	46.69	< .001	.60
laterality	1, 31	3.56	.069	.10
laterality * group	1, 31	2.66	.11	.079
stimulus type * self-reference	1, 31	< 0.001	.99	< .001
stimulus type * self-reference * group	1, 31	5.43	.027	.15
stimulus type * scalp location	1, 31	8.34	.007	.21
stimulus type * scalp location * group	1, 31	4.72	.038	.13
self-reference * scalp location	1, 31	0.20	.66	.006
self-reference * scalp location * group	1, 31	0.048	.83	.002
stimulus type * self-reference * scalp location	1, 31	1.41	.24	.044
stimulus type * self-reference * scalp location * group	1, 31	0.31	.58	.010
stimulus type * laterality	1, 31	58.62	< .001	.65
stimulus type * laterality * group	1, 31	2.14	.15	.065
self-reference * laterality	1, 31	0.55	.46	.018
self-reference * laterality * group	1, 31	0.050	.83	.002
stimulus type * self-reference * laterality	1, 31	0.083	.78	.003
stimulus type * self-reference * laterality * group	1, 31	0.55	.46	.018
scalp location * laterality	1, 31	30.66	< .001	.50
scalp location * laterality * group	1, 31	29.55	< .001	.49
stimulus type * scalp location * laterality	1, 31	4.10	.052	.12
stimulus type * scalp location * laterality * group	1, 31	5.16	.030	.14
self-reference * scalp location * laterality	1, 31	2.64	.12	.078
self-reference * scalp location * laterality * group	1, 31	1.98	.17	.060
stimulus type * self-reference * scalp location * laterality	1, 31	0.34	.56	.011
stimulus type * self-reference * scalp location * laterality * group	1, 31	0.17	.68	.005

Table 20

ANOVA Results for the P1 Component

Effect	*df*1, *df*2	*F*	*p*	η_p^2
group	1, 31	3.94	.056	.11
stimulus type	1, 31	13.62	.001	.31
stimulus type * group	1, 31	1.61	.21	.049
self-reference	1, 31	0.74	.40	.023
self-reference * group	1, 31	0.065	.80	.002
scalp location	1, 31	49.98	< .001	.62
scalp location * group	1, 31	0.003	.96	< .001
laterality	1, 31	1.03	.32	.032
laterality * group	1, 31	16.88	< .001	.35
stimulus type * self-reference	1, 31	0.66	.42	.021
stimulus type * self-reference * group	1, 31	6.99	.013	.18
stimulus type * scalp location	1, 31	4.53	.041	.13
stimulus type * scalp location * group	1, 31	7.12	.012	.19
self-reference * scalp location	1, 31	0.065	.80	.002
self-reference * scalp location * group	1, 31	0.12	.73	.004
stimulus type * self-reference * scalp location	1, 31	1.16	.29	.036
stimulus type * self-reference * scalp location * group	1, 31	0.82	.37	.026
stimulus type * laterality	1, 31	13.18	.001	.30
stimulus type * laterality * group	1, 31	3.73	.063	.11
self-reference * laterality	1, 31	4.04	.053	.12
self-reference * laterality * group	1, 31	2.54	.12	.076
stimulus type * self-reference * laterality	1, 31	2.06	.162	.062
stimulus type * self-reference * laterality * group	1, 31	0.31	.58	.010
scalp location * laterality	1, 31	53.40	< .001	.63
scalp location * laterality * group	1, 31	18.48	< .001	.37
stimulus type * scalp location * laterality	1, 31	6.22	.018	.17
stimulus type * scalp location * laterality * group	1, 31	1.74	.20	.053
self-reference * scalp location * laterality	1, 31	0.50	.48	.016
self-reference * scalp location * laterality * group	1, 31	2.97	.095	.087
stimulus type * self-reference * scalp location * laterality	1, 31	0.44	.51	.014
stimulus type * self-reference * scalp location * laterality * group	1, 31	0.008	.93	< .001

Table 21

ANOVA Results for Reaction Times

Effect	*df*1, *df*2	*F*	*p*	η_p^2
stimulus type	1, 31	70.17	< .001	.69
stimulus type * group	1, 31	0.79	.38	.025
self-reference	1, 31	6.28	.018	.17
self-reference * group	1, 31	1.89	.18	.057
stimulus type * self-reference	1, 31	3.42	.074	.099
stimulus type * self-reference * group	1, 31	0.080	.78	.003
group	1, 31	3.05	.091	.089

Table 22

ANOVA Results for Response Accuracy

Effect	*df*1, *df*2	*F*	*p*	η_p^2
stimulus type	1, 31	37.49	< .001	.55
stimulus type * group	1, 31	.064	.80	.002
self-reference	1, 31	1.71	.20	.052
self-reference * group	1, 31	0.27	.61	.009
stimulus type * self-reference	1, 31	0.64	.43	.020
stimulus type * self-reference * group	1, 31	3.35	.077	.097
group	1, 31	1.20	.28	.037

Table 23

ANOVA Results for Valence Ratings

Effect	*df*1, *df*2	*F*	*p*	η_p^2
stimulus type	1, 31	31.36	< .001	.50
stimulus type * group	1, 31	2.55	.12	.076
self-reference	1, 31	3.28	.080	.096
self-reference * group	1, 31	5.48	.026	.15
stimulus type * self-reference	1, 31	19.34	< .001	.38
stimulus type * self-reference * group	1, 31	3.69	.064	.11
group	1, 31	5.13	.031	.14

Table 24

ANOVA Results for Arousal Ratings

Effect	*df*1, *df*2	*F*	*p*	η_p^2
stimulus type	1, 31	22.73	< .001	.42
stimulus type * group	1, 31	7.12	.012	.19
self-reference	1, 31	33.61	< .001	.52
self-reference * group	1, 31	5.56	.025	.15
stimulus type * self-reference	1, 31	.004	.95	< .001
stimulus type * self-reference * group	1, 31	3.00	.093	.088
group	1, 31	8.94	.005	.22

Study 4

Results

Table 25

F-Statistics for Main Effects and Interactions Not Forming Part of a Hypothesis

Effect	*df*1, *df*2	*F*	*p*	η_p^2
group	1, 36	6.41	.016	.15
time window	1, 36	2.24	.14	.058
time window × group	1, 36	6.43	.016	.15
condition	1, 36	0.72	.40	.020
condition × group	1, 36	0.22	.65	.006
scalp location	1.48, 53.27	17.34	< .001	.33
scalp location × group	1.48, 53.27	0.16	.79	.004
laterality	2, 72	18.02	< .001	.33
laterality × group	2, 72	4.18	.019	.10
time window × condition	1, 36	2.10	.16	.055
time window × condition × group	1, 36	0.12	.74	.003
time window × scalp location	1.37, 49.14	7.27	.005	.17
time window × scalp location × group	1.37, 49.14	0.08	.85	.002
condition × scalp location	1.42, 50.93	7.09	.005	.16
condition × scalp location × group	1.42, 50.93	1.13	.31	.031
time window × condition × scalp location	1.19, 42.98	0.12	.78	.003
time window × condition × scalp location × group	1.19, 42.98	0.80	.40	.022
time window × laterality	1.65, 59.30	14.41	< .001	.29
time window × laterality × group	1.65, 59.30	3.80	.036	.095
condition × laterality	1.50, 53.91	1.21	.30	.032
condition × laterality × group	1.50, 53.91	0.69	.47	.019
time window × condition × laterality	2, 72	0.35	.71	.010
time window × condition × laterality × group	2, 72	0.28	.76	.008
scalp location × laterality	1.89, 68.13	4.28	.019	.11
scalp location × laterality × group	1.89, 68.13	7.34	.002	.17
time window × scalp location × laterality	3.04, 109.25	0.72	.54	.020
time window × scalp location × laterality × group	3.04, 109.25	7.19	< .001	.17
condition × scalp location × laterality	4, 144	1.25	.29	.033
condition × scalp location × laterality × group	4, 144	0.22	.93	.006
time window × condition × scalp location × laterality	3.02, 108.61	1.97	.12	.052
time window × condition × scalp location × laterality × group	3.02, 108.61	0.20	.90	.005

Studies 2-4: Materials

Figure 35. Recruitment notice for studies 2-4, which was posted on campus notice boards in order to recruit control participants.

Figure 36. Information brochure, which was distributed to patients with anorexia nervosa at the psychosomatic hospital for the purpose of recruitment. A similar brochure was sent to control participants via e-mail before the first session.

Übersicht

Was ist der Inhalt der Studie?

Wir untersuchen die innere und äußere Wahrnehmung des Körpers, sowie Gefühle und Gedanken im Zusammenhang mit dem Körper (Bewertung des eigenen Körpers). Insbesondere interessiert uns, welche Prozesse bei Körperwahrnehmung und Körperbewertung im Gehirn ablaufen.

→ **Erforschung von psychologischen Prozessen der:**
Wahrnehmung der eigenen Figur
Wahrnehmung von Signalen aus dem Körperinneren
Bewertung des eigenen Körpers

Was ist das Ziel der Studie?

Wir möchten herausfinden, wie sich die Körperwahrnehmung und die Körperbewertung (Gedanken, Gefühle) zwischen Personen mit und ohne Anorexie (Magersucht) unterscheiden. Zusätzlich interessiert uns, ob und wie diese Unterschiede in der Gehirnaktivität sichtbar sind. Deshalb nehmen an unserer Studie Patientinnen teil, die aufgrund einer Anorexie ein Behandlungsangebot wahrnehmen, sowie Frauen, bei denen dies nicht der Fall ist.

→ **Unterschiede in der Körperwahrnehmung zwischen Frauen mit und ohne Anorexie**

Welchen Nutzen hat die Studie?

Durch die Ergebnisse dieser Studie werden wir neue Erkenntnisse über das Wesen und die Entstehungsbedingungen der Anorexie erhalten. Diese Erkenntnisse sind wichtig, um Behandlungsmöglichkeiten für Patienten mit Essstörungen zu verbessern. Zusätzlich können wir durch das gewonnene Wissen neue Ansätze zur Vorbeugung von Essstörungen entwickeln.
Essstörungen betreffen ca. 2-3% junger Mädchen und Frauen. Für die betroffenen Personen sind sie häufig mit schweren körperlichen Folgen aufgrund der Mangelernährung verbunden. Die Behandlung von Essstörungen ist schwierig und häufig dauert die Essstörung viele Jahre an. Deshalb ist es äußerst wichtig, die Behandlungsmöglichkeiten zu verbessern. Genauso wichtig ist die Entwicklung effektiver Präventionsmaßnahmen, sodass vielen Mädchen und Frauen ein langer Leidensweg erspart werden kann.
Bei Anorexie steht in erster Linie das geringe Körpergewicht und das Essverhalten im Vordergrund. Neuere Studien zeigen jedoch, wie wichtig es ist, auch das Körperbild zu berücksichtigen. Z.B. geben Personen mit Anorexie häufig an, dass sie ihren Körper als sehr dick wahrnehmen, obwohl außenstehende Personen diesen als sehr dünn beschreiben würden. Unsere Studie leistet einen wichtigen Beitrag zur Erforschung von körperbezogenen geistigen Prozessen bei Anorexie.

→ **Neue Erkenntnisse, die sehr wichtig für die Behandlung und Prävention von Essstörungen sind**

Wer führt die Studie durch?

Die Studie wird als Kooperation der Ludwig-Maximilians-Universität München, der Universität Luxemburg und der Schön-Klinik Roseneck (Prien am Chiemsee) durchgeführt. Die Datenerhebung erfolgt im Rahmen der Doktorarbeit von Frau Dipl.-Psych. Univ. Annika Lutz, welche durch den Fonds National de la Recherche Luxembourg (FNR) gefördert wird. Folgende Personen sind an dieser Studie beteiligt:

Studienleitung: Annika Lutz, Dipl.-Psych. Univ. (Universität Luxemburg)
Prof. Dr. Claus Vögele (Universität Luxemburg)
Dr. Sandra Schlegl, Dipl.-Psych. (Universität München)
Prof. Dr. Ulrich Voderholzer (Schön Klinik Roseneck)
Wissenschaftliche Berater: Dr. Stefan Koch (Schön Klinik Roseneck)
Dr. Cornelia Herbert (Deutsche Sporthochschule Köln)
Dr. André Schulz (Universität Luxemburg)

Hintergrund

Was ist das Körperbild?

Das Körperbild besteht aus verschiedenen Körperwahrnehmungen, die vom Gehirn zu einem umfassenden Bild des Körpers zusammengefügt werden. Die Wahrnehmungen werden anschließend gedanklich bewertet, z.B. als schön, hässlich, dünn, dick, etc. Aus der Bewertung folgen Handlungen, z.B. das Hervorheben von schönen Körperteilen oder eine Diät zur Gewichtsabnahme.

Äußere Wahrnehmung

→ Wahrnehmung mit den 5 Sinnen, v.a. Sehsinn
→ Findet meist bewusst statt
→ z.B. Betrachten des eigenen Körpers im Spiegel oder auf Fotos

Innere Wahrnehmung

→ Informationen aus den inneren Organen, z.B. Magen, Herz
→ Informationen aus Muskeln und Gelenken
→ wird meist nicht bewusst

Körperbewertung

→ Gedanken und Gefühle gegenüber dem Körper
→ z.B. „Ich bin dick/dünn" „Ich mag meinen Körper (nicht)."
→ können bewusst oder unbewusst sein

Körperbezogene Handlungen

→ z.B. sich schminken, sich wiegen, auf Diät gehen

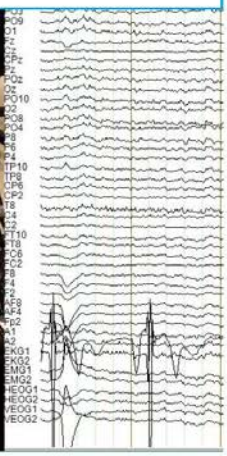
Was ist Anorexie?

Anorexie, auch als Magersucht bezeichnet, ist neben Bulimie und Binge-Eating-Störung eine von drei anerkannten Essstörungen. Essstörungen treten vorwiegend zum ersten Mal in der Jugend auf, bei ca. 2-3% junger Mädchen und Frauen. Die Anorexie tritt bei unter 1% der jungen Mädchen und Frauen auf. Jungen und Männer sind deutlich seltener betroffen als Mädchen und Frauen.
Anorexie ist gekennzeichnet durch ein sehr niedriges Körpergewicht, das von der betroffenen Person durch strenges Fasten und/oder andere Maßnahmen gehalten wird. Außerdem zeigt sich oft eine große Angst davor, dick zu werden. Darüber hinaus ist die Körperwahrnehmung der betroffenen Person verändert. So kann der Körperumfang, wie auch innere Körpersignale, nicht mehr so genau wahrgenommen werden.

Inhalt

Aus welchen Teilen/Aufgaben besteht die Studie?	Was müssen Sie dabei tun?	Was wird dabei gemessen?
Teil 1 **Äußere Wahrnehmung des Körpers** 	Sie betrachten Bilder am PC und reagieren auf diese, indem Sie bestimmte Tasten drücken.	Wir untersuchen Ihre Gehirnaktivität mithilfe eines Elektroenzephalogramms (EEG). Dies geschieht mit einer Art Badekappe, in der sich kleine Sensoren befinden. Mit diesen können wir von außen am Kopf elektrische Vorgänge im Gehirn wahrnehmen. Zusätzlich wird der Herzschlag gemessen.
Teil 2 **Innere Wahrnehmung des Körpers** 	Sie achten auf Ihren eigenen Herzschlag.	Wir messen Ihren Herzschlag mithilfe eines Elektrokardiogramms (EKG). Dies geschieht durch Sensoren, die unterhalb des Schlüsselbeins und am Bauch auf die Haut geklebt werden, ähnlich einem Pflaster. Zusätzlich wird die Gehirnaktivität aufgezeichnet.
Teil 3 **Bewertung des Körpers** 	Sie betrachten Bilder am PC. Gleichzeitig wird wiederholt über Kopfhörer ein kurzer, lauter Ton eingespielt.	Wir messen die Aktivität Ihrer Gesichtsmuskeln mithilfe eines Elektromyogramms (EMG). Hierfür werden Sensoren auf Wangen, Stirn und Schläfen geklebt. Zusätzlich werden die Gehirnaktivität und der Herzschlag aufgezeichnet.





Inhalt

Wie genau funktioniert das?

Wenn Sie einen Gegenstand betrachten, verarbeitet Ihr Gehirn zunächst einfache Informationen, wie Helligkeit, Kontraste, Farben und Kanten. Diese werden dann zu einem Bild zusammengefügt. Dieses Bild wird mit Gedächtnisinhalten abgeglichen und Sie erkennen z.B. eine Tasse. Daraufhin werden weitere Verknüpfungen aktiv: die Tasse ist schön/hässlich, aus ihr kann man Tee trinken oder Kaffee, etc.

Bei menschlichen Gesichtern und Körpern läuft das Zusammenfügen des geistigen Bildes wesentlich schneller ab, als bei Objekten.

Im EEG, also der Gehirnaktivität, können wir alle Verarbeitungsschritte sichtbar machen, die in Gang gesetzt werden, wenn man ein Bild betrachtet.

Jeder Vorgang im Körper wird an das Gehirn weitergeleitet. Auch bei jedem Herzschlag können wir eine Antwort in der Gehirnaktivität erkennen. Die Stärke dieser Antwort in der Gehirnaktivität sagt uns, **wie gut die Kommunikation vom Herzen zum Gehirn funktioniert.**

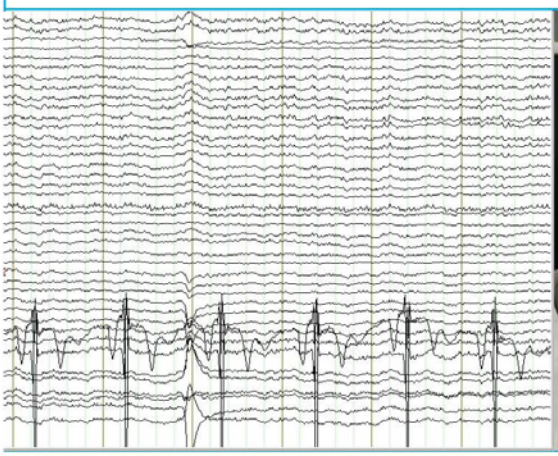
Eine gute Kommunikation vom Herzen und anderen Organen zum Gehirn ist die Voraussetzung dafür, dass wir Vorgänge in unserem Körper wahrnehmen können. Diese Wahrnehmung kann unbewusst oder bewusst sein. Sie ist wichtig, damit wir unser Verhalten an den Zustand unseres Körpers anpassen können. Z.B., damit wir beim Sport eine Pause einlegen, wenn die Anstrengung zu groß wird, das Herz zu schnell schlägt.

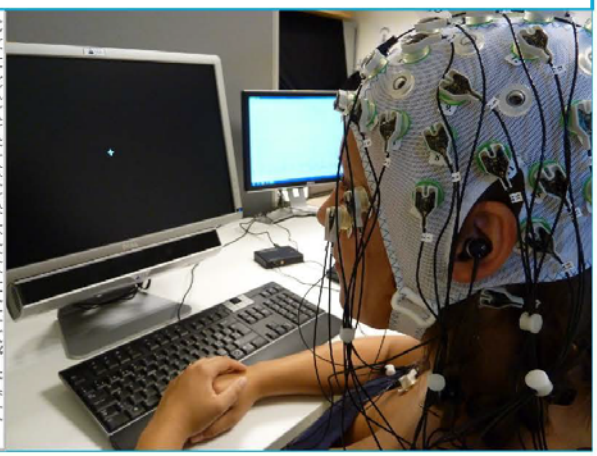
Beispiel 1: Ein dunkler Park mitten in der Nacht. Sie sind allein. Sie hören ein Rascheln im Gebüsch. Wie reagieren Sie?

Beispiel 2: Die Sonne scheint. Sie gehen mit einer Freundin im Park spazieren. Sie hören ein Rascheln im Gebüsch. Wie reagieren Sie?

Wie stark man sich bei einem plötzlich auftretenden Geräusch erschreckt, ist situationsabhängig, wie in den Beispielen. Auch das Betrachten von Bildern verändert die Schreckreaktion, je nachdem, wie positiv oder negativ diese bewertet werden. Umgekehrt erkennen wir an der Stärke Ihrer Schreckreaktion, **wie positiv oder negativ Sie ein Bild bewerten.**

Diese Bewertungsprozesse laufen so schnell ab, dass Sie nicht bewusst werden. Wir messen also Ihre **automatische Einstellung.**



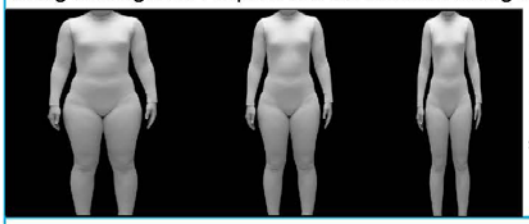


Inhalt

Was geschieht sonst noch?

Fragebögen und Interviews: Um die Forschungsfragen schlüssig beantworten zu können, müssen wir die Gruppe der Teilnehmenden Personen sehr genau beschreiben können. Deshalb werden wir Ihnen einige Fragen zu Ihrer Person und Ihren Lebensumständen stellen. Zudem ist es wichtig, dass wir Ihre persönliche Sicht der Dinge kennen, um die Ergebnisse aus den Messungen der Gehirnaktivität verstehen zu können. Aus diesem Grund werden wir Ihnen einige Fragebögen vorlegen, die sich auf Ihre Einstellungen, Gefühle und Gewohnheiten beziehen. Außerdem müssen wir sicher gehen, dass unsere Gruppe der Patientinnen mit Anorexie tatsächlich die Diagnosekriterien für Anorexie erfüllt und dass die Gruppe der Vergleichspersonen keine Diagnose aufweist. Deshalb werden wir Ihnen zusätzliche Fragen zu Ihren Einstellungen, Gefühlen und Gewohnheiten stellen, die es uns ermöglichen, eine Anorexie oder andere psychologische Diagnose zu stellen, wenn diese vorliegt.

Fotos: Während der Aufgaben betrachten Sie **Fotos Ihrer eigenen Person**. Diese werden wir im Rahmen der Studie anfertigen. Um Unterschiede in der Kleidung zu vermeiden und die Figur sichtbar zu machen, werden wir Sie bitten, für die Fotos einen Gymnastikanzug mit langen Armen und Beinen anzuziehen. Um die Wahrnehmung des eigenen Körpers von der Wahrnehmung eines fremden Körpers unterscheiden zu können, werden wir Ihnen zusätzlich Fotos einer anderen Person zeigen. Alle Fotos von Personen werden zudem in der Breite verzerrt, um Gewichtszu– und –abnahme zu simulieren. Sämtliche Fotos werden digital so bearbeitet, dass der Kopf nicht zu sehen ist, um Ihre Anonymität zu gewährleisten.



Zudem werden Sie **Fotos eines Haushaltsobjektes** (Tasse) sehen, wodurch wir Prozesse bei der Wahrnehmung von Körpern von Prozessen bei der Wahrnehmung von Objekten trennen können. Eine Tasse erhalten Sie von uns als Geschenk.

Zur Messung der automatischen Bewertung Ihres Körpers werden wir Ihnen außer Ihren eigenen Fotos einige Vergleichsfotos zeigen. Diese zeigen Szenen, die Ihnen im täglichen Leben oder in den Medien, z.B. in einer Nachrichtensendung, begegnen können. Diese Szenen wurden von einer großen Anzahl Menschen darauf hin bewertet, wie positiv oder negativ sie wirken. Indem wir Ihre Reaktion auf Ihre eigenen Fotos mit Ihrer Reaktion auf die Vergleichsfotos vergleichen, können wir herausfinden, wie positiv oder negativ Sie Ihren eigenen Körper bewerten. Einige der Vergleichsfotos können abstoßend wirken, wurden jedoch von mehreren Psychologen speziell so ausgewählt, dass sie sich nicht von dem unterscheiden, was einem im alltäglichen Fernsehprogramm begegnet.

Hier einige Beispielbilder:

Negativ bewertetes Bild: **Positiv bewertetes Bild:** **Neutral bewertetes Bild:**

Sonstiges: Wir messen Ihre Größe, Gewicht, Taillen– und Hüftumfang. Dies ist wichtig, um bei der Interpretation der Ergebnisse zur Körperwahrnehmung die tatsächlichen Körperdimensionen berücksichtigen zu können.

Praktische Informationen

Wie läuft die Teilnahme ab?

Die Teilnahme findet in **zwei Sitzungen** statt, die **einige Tage auseinander** liegen sollten. Während der ersten Sitzung findet die Beantwortung von Fragebögen, die Interviews, sowie die Fotoaufnahmen statt. In der zweiten Sitzung werden die Aufgaben durchgeführt, während der körperliche Signale registriert werden, wie zuvor beschrieben. Jede Sitzung dauert etwa **2-3 Stunden**. Die erste Sitzung kann in kürzere Teilsitzungen zerlegt werden und Sitzungen am Wochenende sind ebenfalls möglich. Dementsprechend werden wir die einzelnen Termine individuell und unter Berücksichtigung Ihres Therapieplans mit Ihnen abstimmen.

Wie wird mein Aufwand entschädigt?

Für Ihre Teilnahme an dieser Studie erhalten Sie als Aufwandsentschädigung einen Amazon-Gutschein im Wert von 40 €. Zusätzlich erhalten Sie die von Ihnen personalisierte Tasse und eine Teilnahmeurkunde. Nach Wunsch erhalten Sie ein Foto von Sich Selbst mit EEG-Kappe und wir informieren Sie nach Abschluss der Studie über die gewonnenen Ergebnisse und wissenschaftlichen Erkenntnisse.

Wo findet die Studie statt?

Für Patientinnen der Schön Klinik Roseneck findet die Studie direkt vor Ort an den Schön Klinik Standorten Prien am Chiemsee und Rosenheim statt. Genauere Informationen zu den Räumlichkeiten erhalten Sie bei Interesse von Frau Annika Lutz, Dipl.-Psych. Univ.

Wie werden Sie während der Teilnahme betreut?

Die zuvor beschriebenen Messungen, Interviews und Fotoaufnahmen werden von Frau Annika Lutz, Dipl.-Psych. Univ., durchgeführt. Frau Lutz besitzt bereits mehrere Jahre Erfahrung im Umgang mit den verwendeten Geräten und Messmethoden. Sie werden von ihr während Ihrer gesamten Studienteilnahme betreut und können Sich jederzeit mit Fragen und Anmerkungen an sie wenden.

Sie sind interessiert, an wen können Sie sich wenden?

Für weitere Informationen und bei Interesse an einer Teilnahme können Sie Sich jederzeit an Frau Annika Lutz, Dipl.-Psych. Univ. wenden. Gerne können Sie Frau Lutz direkt vor Ort ansprechen, oder per E-Mail (annika.lutz@uni.lu) oder Telefon (0179-3419997) kontaktieren. Ebenso können Sie Sich an die Therapeuten der Schön Klinik wenden, um den Kontakt herzustellen.
Als weiterer Ansprechpartner in der Schön Klinik Roseneck steht Ihnen Herr Dr. Stefan Koch zur Verfügung (Kontaktdaten siehe Rückseite).

Kontaktadressen

Bei Interesse an Studienteilnahme und für weitere Informationen:	Kontakt an der Schön Klinik Roseneck:	Kontakt an der Ludwig-Maximilians-Universität München:
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UNIVERSITY OF LUXEMBOURG
Integrative Research Unit on Social and Individual Development (INSIDE)

aides à la formation recherche

Fonds National de la Recherche Luxembourg

LMU KLINIKUM DER UNIVERSITÄT MÜNCHEN
CAMPUS INNENSTADT
KLINIKUM FÜR PSYCHIATRIE UND PSYCHOTHERAPIE

SCHÖN KLINIK

Code					CO
					CL

Soziodemographisches Standard-Interview
Version für NEUROBODY

Die Items werden durch eine fünfstellige Nummer gekennzeichnet:
1. Stelle = Kategorie
2. Stelle = Unterkategorie
3. und 4. Stelle = fortlaufende Nummer innerhalb einer Itemkategorie
5. Stelle = Identifikation von Alternativitems oder Identifikation von String-Variablen zur Kodierung der Angaben unter „Sonstige" (in diesem Fall entspricht die 5. Stelle der Nummer der Kategorie „Sonstige" (10 wird zu 1))
Z.B.: 21017 -> Kategorie 2 (Nationalität und Sprache), Unterkategorie 1 (Staatsangehörigkeit und Migrationshintergrund), Item 01, unter Antwortmöglichkeit 7 („Sonstige") angegebene Bezeichnung.
5. Stelle bei Schwangerschaftsitems: Kennzeichnung der einzelnen Schwangerschaften bei mehreren Schwangerschaften (1., 2. und 3. Schwangerschaft)

Kennzeichnung der Items in der SPSS-Maske:
Die Nummer ist identisch zur Nummer im Fragebogen, jedoch werden die Buchstaben *SD* für soziodemographisches Interview voran gestellt.
Nähere Angaben zur Kategorie „Sonstige" werden mit einer eigenen Stringvariablen kodiert, die mit Ausnahme der letzten Stelle der übergeordneten Itemnummer entspricht.

Instruktion für die Interviewerin

Dieses Interview enthält Fragen zum soziodemographischen Hintergrund der Teilnehmerin. Fragen Sie alle Fragen ab, lassen Sie keine aus. Einige Fragen werden nur gestellt, wenn die vorherige Frage mit „ja" beantwortet wurde. Diese bedingten Fragen sind grau unterlegt. In der Kategorie 4 „Ausbildung und Beruf" gelten zusätzliche Regeln für bedingte Items, die an der entsprechenden Stelle beschrieben werden.
Fragen und Antworten sind jeweils normal gedruckt, während Instruktionen und Hinweise für die Interviewerin kursiv gesetzt sind. Die Formulierung der Fragen ist nicht zwingend vorgegeben und kann nach Bedarf umformuliert werden. Stellen Sie so viele zusätzliche Fragen wie nötig, um eine ausreichend ausführliche Antwort zu erhalten. Fragen und notieren Sie lieber zu viel, als zu wenig.
Versuchen Sie möglichst ausführliche und genaue Antworten von der Teilnehmerin zu erhalten. Wenn Sie sich bei geschlossenem Antwortformat nicht sicher sind, welche Antwort die zutreffende ist, notieren Sie möglichst genau die Aussagen der Teilnehmerin und besprechen Sie den Fall mit Ihrem/r Supervisor/in. Notieren Sie bei offenem Antwortformat möglichst ausführlich die Aussagen der Teilnehmerin.
Umkreisen Sie bei geschlossenem Antwortformat die zutreffende Zahl. Wenn Mehrfachnennungen möglich sind, ist dies angegeben. Notieren Sie offene Antworten auf den vorgegebenen Linien. Nutzen Sie, wenn nötig, die zusätzlichen Notizblätter am Ende des Interviews. Kennzeichnen Sie zusätzliche Notizen immer mit der zugehörigen Itemnummer.

Figure 37. Structured interview used for the assessment of socio-demographic characteristics in studies 2-4.

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Wenn Sie bemerken, dass einer Teilnehmerin eine Frage unangenehm ist, sprechen Sie sie empathisch darauf an. Versuchen Sie Zweifel aus der Welt zu schaffen, indem Sie z.B. nochmals die Anonymität der Daten betonen.
Achten Sie darauf, die Fragen an das Alter der Teilnehmerin anzupassen. Klären Sie z.B. ab, ob die Teilnehmerin gesiezt oder geduzt werden möchte. Wählen Sie ggf. bei jüngeren Teilnehmerinnen eine einfachere Sprache zur Formulierung der Fragen.

Besondere Kodierungen:
999 = nicht zutreffend
888 = weiß nicht/Antwort verweigert
Wenn eine Frage auf die Teilnehmerin nicht zutrifft, z.B. bedingte Fragen wenn zuvor mit „nein" geantwortet wurde, geben Sie als Antwort „999" an. Geben Sie auch in die SPSS-Datenmaske „999" ein. Wenn die Teilnehmerin eine Antwort nicht weiß oder nicht antworten möchte, kodieren Sie mit „888".

Einleitung für die Teilnehmerin
Erläutern Sie der Teilnehmerin sinngemäß folgende Informationen:

Lesen	Als nächstes machen wir jetzt ein Interview. Dabei werde ich die Fragen ablesen, so wie jetzt auch. Das machen wir deshalb so, damit wir auch sicher sein können, dass jeder Interviewer genau dieselben Fragen stellt und nichts vergisst. [*Wenn Teilnehmerin und Eltern zugestimmt haben, dass das Interview auf Tonband aufgezeichnet wird:* In der Einverständniserklärung hatten Sie ja zugestimmt, dass wir die Interviews aufzeichnen dürfen. Deshalb habe ich jetzt hier ein Diktiergerät aber das brauchen Sie nicht weiter zu beachten.] In diesem Interview werde ich Ihnen einige Fragen zu Ihrer Person und Ihren Lebensumständen stellen. Diese Informationen sind sehr wichtig für das Gelingen unserer Studie, damit wir die Gruppe der Teilnehmerinnen genau beschreiben können. Wichtig ist z.B. wie alt die Teilnehmerinnen waren, da das einen Einfluss auf die Gehirnprozesse haben kann, die uns interessieren. Wenn wir in unserer Studie etwas anderes herausfinden, als andere Forscher, kann das evtl. daran liegen, dass unsere Teilnehmerinnen z.B. jünger waren. D.h. nur, wenn wir das Alter und andere Informationen zu unseren Teilnehmerinnen haben, können wir unsere Ergebnisse mit denen aus anderen Studien vergleichen. Wenn Ihnen während des Interviews etwas unklar ist oder Sie eine Frage nicht richtig verstanden haben, fragen Sie bitte jederzeit nach. Ihre Antworten werde ich hier in diesem Interview-Bogen notieren und Sie dürfen auch gerne sehen, was ich aufschreibe. Selbstverständlich bleiben alle Ihre Antworten anonym, so wie alle anderen Daten auch, die wir im Rahmen dieser Studie aufzeichnen. Haben Sie momentan noch Fragen zum Interview? Sie können auch gerne später noch jederzeit Fragen stellen. Sind Sie bereit, um mit dem Interview anzufangen?

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Kategorie 1: Allgemeine Daten

Nr.	Frage	Antwort
10020	Was ist Ihr Geburtsdatum?	*Datum:* __ __ / __ __ / __ __ __ __ *(dd/mm/yyyy)*
10021	(Dann sind Sie heute ____ Jahre alt?) *Kann auch im Nachhinein berechnet werden.*	*-> Alter zum Zeitpunkt der Testung:* __ __ Jahre __ __ Monate
10030	*Legen Sie den Edinburgher Händigkeitsinventar vor und kreuzen Sie zusätzlich hier je nach Ergebnis an.*	1 Rechte Hand (LQ > 0) 2 Linke Hand (LQ < 0) 3 Beide Hände (LQ = 0)
10031	*Berechnen Sie das Ergebnis des Händigkeitsinventars mit folgender Formel:*	*Händigkeitsindex/Lateralitätsquotient:* LQ = (R - L) / (R + L) x 100 = _____

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Edinburgher Händigkeitsinventar

Bitte markieren Sie Ihren bevorzugten Handgebrauch bei den aufgelisteten Tätigkeiten durch ein Kreuz (+) in der entsprechenden Spalte. Wenn die Bevorzugung so stark ist, dass Sie nie versuchen würden, die andere Hand für diese Tätigkeit zu gebrauchen (ohne dazu gezwungen zu sein), dann markieren Sie diese durch zwei Kreuze (++). Wenn es wirklich egal ist, dann setzen Sie bitte in beide Spalten ein Kreuz.

Einige dieser Tätigkeiten erfordern den Einsatz beider Hände. In diesen Fällen ist der Teil der Aufgabe, bzw. das Objekt in Klammern angegeben, wofür die bevorzugte Hand erfragt wird.

Versuchen Sie bitte, alle Fragen zu beantworten, und lassen Sie nur dann einen Freiraum, wenn Sie überhaupt keine Erfahrung mit der Tätigkeit oder mit dem Objekt haben.

Tätigkeit	**links**	**rechts**
Schreiben		
Zeichnen		
Werfen		
Schere		
Zahnbürste		
Messer (ohne Gabel)		
Löffel		
Besen (obere Hand)		
Streichholz anzünden (Streichholz)		
Dose öffnen		
Welchen Fuß bevorzugen Sie beim Kicken?		
Welches Auge benutzen Sie, wenn Sie nur mit einem sehen?		

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Kategorie 2: Nationalität und Sprache

21	**Staatsangehörigkeit und Migrationshintergrund**	
21010 21017 21018	Welche Staatsangehörigkeit(en) haben Sie? *Kodieren Sie bei mehreren Staatsangehörigkeiten „8" und notieren Sie alle Staatsangehörigkeiten. Geben Sie diese unter der String-Variable 21018 in SPSS ein.*	1 Luxemburgische 2 Portugiesische 3 Französische 4 Italienische 5 Belgische 6 Deutsche 7 Sonstige: _____ 8 Multiple Staatsangehörigkeit: _____ _____
21020 21027 21028	Was war(en) Ihre Staatsangehörigkeit(en) bei Geburt? *Kodieren Sie bei mehreren Staatsangehörigkeiten „8" und notieren Sie alle Staatsangehörigkeiten. Geben Sie diese unter der String-Variable 21028 in SPSS ein.*	1 Luxemburgische 2 Portugiesische 3 Französische 4 Italienische 5 Belgische 6 Deutsche 7 Sonstige: _____ 8 Multiple Staatsangehörigkeit: _____ _____
21030 21037	In welchem Land wurden Sie geboren?	1 Luxemburg 2 Portugal 3 Frankreich 4 Italien 5 Belgien 6 Deutschland 7 Sonstige: _____

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21040 21045	In welchem Land leben Sie momentan? *Wenn nicht klar zu beantworten:* In welchem Land haben Sie Ihren (Haupt-)Wohnsitz angemeldet? In welchem Land verbringen Sie mehr als 50% Ihrer Zeit?	1 Luxemburg 2 Deutschland 3 Frankreich 4 Belgien 5 Sonstiges: _____
21050	Seit wann leben Sie (ununterbrochen) in diesem Land?	*Jahr:* __ __ __ __
21060 21067	Welches ist das Geburtsland Ihrer Mutter?	1 Luxemburg 2 Portugal 3 Frankreich 4 Italien 5 Belgien 6 Deutschland 7 Sonstiges: _____
21070 21077	Welches ist das Geburtsland Ihres Vaters?	1 Luxemburg 2 Portugal 3 Frankreich 4 Italien 5 Belgien 6 Deutschland 7 Sonstiges: _____

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22	**Sprache**	
22014 22024 22034	Was ist Ihre Muttersprache oder Muttersprachen? *Tragen Sie bei mehreren Muttersprachen in beliebiger Reihenfolge ein.*	*Muttersprache 1:* _____ *Muttersprache 2:* _____ *Muttersprache 3:* _____
22044 22054	*Wenn die Interviewsprache nicht die Muttersprache ist:* Nun geht es darum, wie Sie Ihre Sprachkenntnisse in _____ *(Interviewsprache)* einschätzen. Bitte lesen Sie sich dazu den europäischen Referenzrahmen durch und sagen Sie mir dann, wie Sie sich einschätzen würden.	*Sprache:* _____ *Niveau:* A1 A2 B1 B2 C1 C2 *Sollte ein Niveau unter C1 angegeben werden, klären Sie mit der Teilnehmerin ab, ob der Wechsel zu einer anderen Sprache sinnvoll sein könnte.*
	Europäischer Referenzrahmen: A1 – einfachste Verständigung möglich, z.B. sich selbst vorstellen A2 – einfache Verständigung in gewohnten Situationen möglich, z.B. beim Einkaufen B1 – Verständigung bei vertrauten Themen möglich, z.B. persönliche Interessen B2 – Verständigung bei fast allen Themen möglich C1 – Verständigung auch bei komplexen Themen fließend möglich C2 – Sprachkompetenz wie Muttersprachler, Kenntnis feiner Bedeutungsnuancen	

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Kategorie 3: Aktuelle Lebenssituation

30010	Welchen Familienstand haben Sie? Leben Sie momentan in einer Partnerschaft? *Passen Sie die Fragen bei Minderjährigen Teilnehmerinnen entsprechend an! Mehrfachnennungen möglich, z.B. geschieden und neu verheiratet. In diesem Fall aktuelle Lebenssituation mit „A" kennzeichnen. Diese wird*	1 Ledig 2 Partnerschaft 21 Nicht eingetragene Partnerschaft 22 Eingetragene Lebenspartnerschaft (Deutschland) 23 PACS (Luxemburg, Frankreich) 24 Verheiratet
30012	*dann in die SPSS-Maske eingetragen, die vergangene Lebenssituation wird ignoriert.*	25 Sonstige: _____ 3 Partnerschaft aufgelöst 31 Geschieden 32 Gesetzlich aufgelöst
30013		33 Sonstige: _____ 4 Tod des Partners 41 Verwitwet 42 Partnerschaft durch Tod des Partners beendet
30014		43 Sonstige: _____
30015		5 Sonstige: _____

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30050	Mit wem leben Sie momentan zusammen? *Wenn Teilnehmerin momentan vollstationär in Klinik:* Mit wem haben Sie vor Ihrem Klinikaufenthalt zusammengelebt?	0 Lebt alleine 1 Eltern oder Elternteil 2 Großeltern oder Großelternteil 3 Stiefeltern oder Stiefelternteil *(hier auch ankreuzen, wenn Kind bei leiblichem Elternteil und dessen Partner/in lebt, ohne dass eine Ehe besteht)* 4 Geschwister 5 Ehegatte/in, Partner/in 6 Eigene Kinder
30058		7 Mitbewohner/in
		8 Sonstige Verwandte: _____
30059		_____
		9 Sonstige nicht Verwandte: _____
		_____

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Kategorie 4: Ausbildung und Beruf

41	**Derzeitige Tätigkeit**	
41010 41020 41014	Welche Tätigkeit üben Sie derzeit aus? Führen Sie daneben noch eine andere Tätigkeit aus, z.B. einen Nebenjob? *Mehrfachnennungen möglich, z.B. Student, der nebenher jobbt -> Haupttätigkeit = Student, Nebentätigkeit = berufstätig.* *Haupttätigkeit unter 41010 kodieren.* *Nebentätigkeit unter 41020 kodieren.* *Bei Mehrfachnennungen im Folgenden alles abfragen und notieren!*	1 Schüler/in an einer Primar- oder Sekundarschule 2 Student/in an einer Hochschule 3 Auszubildende/r *(in der Berufsausbildung, ohne 1 und 2)* 4 berufstätig *(wenn Auszubildende/r: 3 ankreuzen)* 41 Vollzeit 42 Teilzeit 43 vorübergehend nicht arbeitend, wegen: ______________________ __________________________ *(z.B. Mutterschutz/Elternzeit, Krankschreibung, ...)* 5 arbeitslos, arbeitssuchend 6 Hausfrau/-mann *(ausschließlich im eigenen Haushalt tätig, nicht berufstätig)* 7 Rentner/in, Frührentner/in (Pensions- oder Rentenempfänger/in), auch Witwenrente, etc. 8 Eigentümer/in, vom Vermögen lebend 9 Dauerhaft erwerbsunfähig
41011		10 Sonstiges: _________________________

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<u>Hinweise zum sozioökonomischen Status und dem Abfragen der Abschlüsse:</u>
Fragen Sie Haupt- und Nebentätigkeit ab! Z.B. Studium und Berufstätigkeit.
Wichtig ist, dass Sie ALLE Abschlüsse, Ausbildungen, etc. abfragen und notieren. Für den sozioökonomischen Status (SÖS) zählt später die höchste Schulausbildung und der höchste berufliche oder Hochschulabschluss.
Fragen Sie immer zuerst das Land ab, in dem ein Abschluss erworben wurde. Sehen Sie nach, ob eine entsprechende ISCED-Liste vorhanden ist. Wenn nicht, fragen Sie die Teilnehmerin nach einem luxemburgischen Äquivalent des Abschlusses. Notieren Sie auf jeden Fall die landesspezifische, originale Bezeichnung des Abschlusses und das entsprechende Land. Wenn für ein Land eine ISCED-Liste vorliegt und Sie mit dem Bildungssystem dieses Landes nicht vertraut sind, prüfen Sie, ggf. gemeinsam mit der Teilnehmerin, ob der Abschluss in der Liste aufgeführt ist. Wenn nicht, versuchen Sie einen gleichwertigen Abschluss auf der Liste zu finden.*

Manche Fragen werden nur gestellt, wenn beim ersten Item der Kategorie 4 (#41010) eine bestimmte Antwort gegeben wurde. Z.B. 1=1 bedeutet, diese Frage wird nur gestellt, wenn das Item #41010 mit 1 „Schüler/in" beantwortet wurde. Alle anderen Fragen werden immer gestellt!
<u>Fragen, die immer gestellt werden, ohne dass eine Bedingung gegeben sein muss, sind durch eine unterstrichene Item-Nummer gekennzeichnet!</u>
**ISCED= International Standard Classification of Education*

Lesen Sie vor:

lesen	Nun geht es um Ihre Ausbildung, also Ihre Schul- und Berufsabschlüsse. Da diese sich sehr stark zwischen Ländern unterscheiden können, werde ich Sie im Folgenden immer zuerst nach dem Land fragen, in dem Sie einen Abschluss erworben haben. Für jedes Land haben wir dann eine Liste, in der wir den Abschluss nachschlagen können. Auf dieser Liste sind die Abschlüsse dann in Kategorien eingeteilt, die es uns ermöglichen, die Abschlüsse über die Länder hinweg zu vergleichen.

42	**Aktuelle Beschulung**	
42020	*1=1* In welchem Land besuchen Sie die Schule?	*Land:* _____
42030	*1=1* Welche Schule/ welchen Schulzweig besuchen Sie?	*Notieren Sie die landesspezifische Bezeichnung und sehen Sie in der ISCED-Liste nach.* *Schule/Schulart/Schulzweig:* _____ _____ _____
42040	In welche Klasse gehen Sie?	*Klassenstufe:* _____ _____

Code					CO
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	1=1 Hilfsfrage: Haben Sie bereits einen oder mehrere Schulabschlüsse? *Wenn ja -> weiter mit nächster Frage (42050)* *Wenn nein -> Springe zu Unterkategorie 3 Berufsausbildung*

42	**Höchster Schulabschluss**	
42050	In welchem Land haben Sie Ihren höchsten (allgemeinbildenden) Schulabschluss erworben?	*Land:* _____
42060 42070	Welchen höchsten allgemeinbildenden Schulabschluss haben Sie? *Ohne Hochschulstudium* *Wenn unklar:* Auf welcher Schule haben Sie den Abschluss gemacht? *Sammeln Sie ausreichend Informationen, um den Abschluss in der ISCED-Liste finden zu können! Gehen Sie ggf. gemeinsam mit der Teilnehmerin die Liste durch!*	*Notieren Sie die landesspezifischen Bezeichnungen! Schlagen Sie diese in der ISCED-Liste nach.* *Abschluss (genaue Bezeichnung!):* _____ _____ *Schulart:* _____ _____
42080	*Wenn Schulabschluss unklar:* Wie viele Jahre sind Sie insgesamt zur Schule gegangen? *Ohne Hochschulstudium*	*Jahre:* __ __

43	**Aktuelle Berufsausbildung**	
43010	*1=3* In welchem Land machen Sie Ihre Ausbildung?	*Land:* _____
43020 43030	*1=3* Welche Ausbildung machen Sie momentan? *Evtl. Schule/Schulart abfragen*	*Ausbildung:* _____ *Schulart:* _____

43	**Abgeschlossene Berufsausbildung**	
43040	Haben Sie eine oder mehrere Berufsausbildung(en) abgeschlossen? *Hochschulstudium -> Unterkategorie 44*	0 nein 1 ja

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43050	In welchem Land haben Sie diese abgeschlossen?	*Land:* _____
43060	Welche Ausbildung haben Sie abgeschlossen?	*Ausbildungsbezeichnung(en):* _____
	Evtl. Schulart abfragen	_____
43070	*Sehen sie in der ISCED-Liste nach!*	*Schulart:* _____

44	**Aktuelles Hochschulstudium**	
44010	*1=2* In welchem Land besuchen Sie die Hochschule?	*Land:* _____
44020	*1=2* An welcher Art von Hochschule studieren Sie? Z.B. Universität, Fachhochschule, …	*Hochschule:* _____
44030	*1=2* Für welchen Studiengang sind Sie eingeschrieben?	*Studiengang:* _____
44040	*1=2* Im wievielten Semester studieren Sie dieses Fach?	*Semesterzahl:* _____
44050 44052 44054	*1=2* Auf welchem Niveau? *Geben Sie die Bezeichnung für einen dem Master äquivalenten Abschluss unter Item 44052 ein.*	1 Bachelor 2 Master (oder Äquivalent: _____) 3 Doktorat 4 Sonstige: *ggf. länderspezifisch* _____ _____

44	**Abgeschlossenes Hochschulstudium**	
44060	Haben Sie ein oder mehrere Hochschulstudien abgeschlossen?	0 nein 1 ja
44070	In welchem Land war das?	*Land:* _____
44080	Welches Studium war das/welche Studien waren das?	*Studiengang/-gänge:* _____ _____
44090	Auf welcher Art von Hochschule? Z.B. Universität, Fachhochschule, …	*Hochschule:* _____

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44100 44102 44104	Mit welchem Abschluss? Was ist insgesamt Ihr höchster akademischer Grad? *Mehrfachnennungen möglich. Markieren Sie alle Abschlüsse für alle Studiengänge. Für die Bestimmung des SÖS wichtig ist der insgesamt höchste Abschluss. Nur dieser wird in SPSS eingegeben. Sehen Sie in der ISCED-Liste nach!*	1 Bachelor 2 Master (oder Äquivalent: _____) 3 Doktor 4 Sonstige: *ggf. länderspezifisch* _____ _____

45	**Aktuelle <u>berufliche</u> Tätigkeit**	
45010	*1=4* Welche berufliche Tätigkeit führen Sie momentan aus? *Fragen Sie nach der genauen Bezeichnung des Berufs (z.B. nicht „Lehrer" sondern „Grundschullehrer")*	*Berufsbezeichnung:* _____ _____ _____
45020	*1=4* In welchem Land arbeiten Sie?	*Land:* _____

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Kategorie 5: Sozio-ökonomischer Status (Eltern/Partner)

Fragen Sie bei Minderjährigen und Volljährigen in der Ausbildung (Berufsausbildung, Studium), also allen, die noch im Haushalt der Eltern leben bzw. von diesem abhängig sind, die Unterkategorien 51-Mutter und 52-Vater ab. Wenn Minderjährige bei anderen Verwandten oder Pflegeeltern leben, fragen Sie diese ab und notieren Sie, um wen es sich handelt (z.B. Großmutter, Großvater). Es geht um die Personen, mit denen das Kind in einem Haushalt lebt bzw. von denen das Kind materiell abhängig ist. Fragen Sie ggf. mehr als 2 Personen ab, wenn die Familiensituation kompliziert ist, z.B.: Ein Kind lebt mit einem leiblichen Elternteil und einem Stiefelternteil zusammen und der zweite leibliche Elternteil ist weiterhin sorgeberechtigt/unterhaltspflichtig. Fragen Sie in solchen Fällen alle beteiligten Personen ab und beschreiben Sie die Rollen der einzelnen Personen genau. Klären Sie später mit Ihrem/r Supervidierenden, welche Person zur Bestimmung des SÖS herangezogen wird. Fragen Sie bei Volljährigen (mit eigenem Haushalt) die Unterkategorie 53-Partner ab (wenn Partner vorhanden). Klären Sie ggf. ab, ob der Partner/ die Partnerin im selben Haushalt wie der/die Teilnehmende lebt und ob eine finanzielle Abhängigkeit besteht und notieren Sie dies.
→Der Elternteil oder Partner mit dem höchsten sozialen Status bestimmt den Status des Haushalts und dieser ist somit der Status aller im Haushalt lebenden Personen, incl. der Teilnehmerin.

Wichtig ist, dass Sie ALLE Abschlüsse, Ausbildungen, etc. abfragen und notieren. Für den SÖS zählt später die höchste Schulausbildung und der höchste berufliche oder Hochschulabschluss.
Fragen Sie immer zuerst das Land ab, in dem ein Abschluss erworben wurde. Sehen Sie nach, ob eine entsprechende ISCED-Liste vorhanden ist. Wenn nicht, fragen Sie die Teilnehmerin nach einem luxemburgischen Äquivalent des Abschlusses. Notieren Sie auf jeden Fall die landesspezifische, originale Bezeichnung des Abschlusses und das entsprechende Land. Wenn für ein Land eine ISCED-Liste vorliegt und sie mit dem Bildungssystem dieses Landes nicht vertraut sind, prüfen Sie, ggf. gemeinsam mit der Teilnehmerin, ob der Abschluss in der Liste aufgeführt ist. Wenn nicht, versuchen Sie einen gleichwertigen Abschluss auf der Liste zu finden.*
**ISCED= International Standard Classification of Education*

Lesen Sie vor:

lesen	Nun geht es um die Ausbildung Ihrer Eltern/ Ihres Partners/ Ihrer Partnerin. Diese Informationen sind wichtig für diese Studie, damit wir nicht nur die teilnehmenden Personen selbst, sondern auch ihr Lebensumfeld beschreiben können. Auch dies sind wichtige Faktoren, die die Ergebnisse unserer Studie beeinflussen können. Wie gerade eben, werde ich Sie wieder zuerst nach dem Land fragen, in dem ein Abschluss erworben wurde, und diesen dann in der Liste nachschlagen.

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51	**Mutter**	
51010	In welchem Land hat Ihre Mutter ihren höchsten Schulabschluss gemacht? *Je nach Land wird die entsprechende Liste gewählt und nach ISCED kodiert.*	*Land:* _____
51020 51030	Welchen höchsten allgemeinbildenden Schulabschluss hat Ihre Mutter? *Evtl. noch Schule/Schulart abfragen.*	*Abschluss:* _____ _____ *Schulart:* _____
51040	Hat Ihre Mutter eine Berufsausbildung abgeschlossen?	0 nein 1 ja
51050	In welchem Land?	*Land:* _____
51060 51070	Welche Ausbildung? *Evtl. Schule/Schulart abfragen.* *Wiederum je nach Land die entsprechende ISCED-Liste wählen.*	*Ausbildung:* _____ _____ *Schulart:* _____
51080	Hat Ihre Mutter ein Hochschulstudium abgeschlossen?	0 nein 1 ja
51090	In welchem Land?	*Land:* _____
51100	An welcher Art von Hochschule?	*Hochschule:* _____
51110	Welches Studium?	*Studienfach:* _____
51120	Mit welchem Abschluss? Z.B. Bachelor, Master,… *Wiederum je nach Land die entsprechende ISCED-Liste wählen (Hochschulabschluss ist gewöhnlich ISCED 5).*	*Abschluss:* _____ _____
51130	Hat Ihre Mutter einen Doktortitel?	0 nein 1 ja
51140	In welchem Land wurde dieser erworben?	*Land:* _____

Code | | | | | CO / CL

51150	In welchem Fach? *Wiederum je nach Land die entsprechende ISCED-Liste wählen (Doktortitel ist gewöhnlich ISCED 6).*	*Studienfach:* ______________________ ______________________
51160 51170 51164 51161	Welche Tätigkeit übt Ihre Mutter momentan aus? *Mehrfachnennungen möglich, z.B. Student, der nebenher jobbt -> Haupttätigkeit = Student, Nebentätigkeit = berufstätig.* *Haupttätigkeit unter 51160 kodieren.* *Nebentätigkeit unter 51170 kodieren.* *Wenn berufstätig: unten (51190) genauere Beschreibung der beruflichen Tätigkeit abfragen und notieren.*	1 Schüler/in an einer Primar- oder Sekundarschule 2 Student/in an einer Hochschule 3 Auszubildende/r *(in der Berufsausbildung, ohne 1 und 2)* 4 berufstätig *(wenn Auszubildende/r: 3 ankreuzen)* 41 Vollzeit 42 Teilzeit 43 vorübergehend nicht arbeitend, wegen: ______________ ______________ *(z.B. Mutterschutz/Elternzeit, Krankschreibung, ...)* 5 arbeitslos, arbeitssuchend 6 Hausfrau/-mann (ausschließlich im eigenen Haushalt tätig) 7 Rentner/in, Frührentner/in (Pensions- oder Rentenempfänger/in), auch Witwenrente, etc. 8 Eigentümer/in, vom Vermögen lebend 9 Dauerhaft erwerbsunfähig 10 Sonstiges: ______________
51180	In welchem Land?	*Land:* ______________________
51190	Welchen Beruf übt Ihre Mutter aus?	*Beruf:* ______________________

Code					CO
					CL

52	**Vater**	
52010	In welchem Land hat Ihr Vater seinen höchsten Schulabschluss gemacht? *Je nach Land wird die entsprechende Liste gewählt und nach ISCED kodiert.*	*Land:* _____
52020 52030	Welchen höchsten allgemeinbildenden Schulabschluss hat Ihr Vater? *Evtl. noch Schule/Schulart abfragen.*	*Abschluss:* _____ _____ *Schulart:* _____
52040	Hat Ihr Vater eine Berufsausbildung abgeschlossen?	0 nein 1 ja
52050	In welchem Land?	*Land:* _____
52060 52070	Welche Ausbildung? *Evtl. Schule/Schulart abfragen.* *Wiederum je nach Land die entsprechende ISCED-Liste wählen.*	*Ausbildung:* _____ _____ *Schulart:* _____
52080	Hat Ihr Vater ein Hochschulstudium abgeschlossen?	0 nein 1 ja
52090	In welchem Land?	*Land:* _____
52100	An welcher Art von Hochschule?	*Hochschule:* _____
52110	Welches Studium?	*Studienfach:* _____
52120	Mit welchem Abschluss? Z.B. Bachelor, Master,… *Wiederum je nach Land die entsprechende ISCED-Liste wählen (Hochschulabschluss ist gewöhnlich ISCED 5).*	*Abschluss:* _____ _____
52130	Hat Ihr Vater einen Doktortitel?	0 nein 1 ja
52140	In welchem Land wurde dieser erworben?	*Land:* _____

Code					CO
					CL

52150	In welchem Fach? *Wiederum je nach Land die entsprechende ISCED-Liste wählen (Doktortitel ist gewöhnlich ISCED 6).*	*Studienfach:* ______________________ ______________________
52160 52170 52164 52161	Welche Tätigkeit übt Ihr Vater momentan aus? *Mehrfachnennungen möglich, z.B. Student, der nebenher jobbt -> Haupttätigkeit = Student, Nebentätigkeit = berufstätig.* *Haupttätigkeit unter 52160 kodieren.* *Nebentätigkeit unter 52170 kodieren.* *Wenn berufstätig: unten (52190) genauere Beschreibung der beruflichen Tätigkeit abfragen und notieren.*	1 Schüler/in an einer Primar- oder Sekundarschule 2 Student/in an einer Hochschule 3 Auszubildende/r *(in der Berufsausbildung, ohne 1 und 2)* 4 berufstätig *(wenn Auszubildende/r: 3 ankreuzen)* 41 Vollzeit 42 Teilzeit 43 vorübergehend nicht arbeitend, wegen: ______________ ______________ *(z.B. Mutterschutz/Elternzeit, Krankschreibung, ...)* 5 arbeitslos, arbeitssuchend 6 Hausfrau/-mann (ausschließlich im eigenen Haushalt tätig) 7 Rentner/in, Frührentner/in (Pensions- oder Rentenempfänger/in), auch Witwenrente, etc. 8 Eigentümer/in, vom Vermögen lebend 9 Dauerhaft erwerbsunfähig 10 Sonstiges: ______________
52180	In welchem Land?	*Land:* ______________________
52190	Welchen Beruf übt Ihr Vater momentan aus?	*Beruf:* ______________________

Code					CO
					CL

53	**Partner/in**	
53010	In welchem Land hat Ihr/e Partner/in seinen/ihren höchsten Schulabschluss gemacht? *Je nach Land wird die entsprechende Liste gewählt und nach ISCED kodiert.*	*Land:* _____
53020 53030	Welchen höchsten allgemeinbildenden Schulabschluss hat Ihr/e Partner/in? *Evtl. noch Schule/Schulart abfragen.*	*Abschluss:* _____ _____ *Schulart:* _____
53040	Hat Ihr/e Partner/in eine Berufsausbildung abgeschlossen?	0 nein 1 ja
53050	In welchem Land?	*Land:* _____
53060 53070	Welche Ausbildung? *Evtl. Schule/Schulart abfragen.* *Wiederum je nach Land die entsprechende ISCED-Liste wählen.*	*Ausbildung:* _____ *Schulart:* _____
53080	Hat Ihr/e Partner/in ein Hochschulstudium abgeschlossen?	0 nein 1 ja
53090	In welchem Land?	*Land:* _____
53100	An welcher Art von Hochschule?	*Hochschule:* _____
53110	Welches Studium?	*Studienfach:* _____
53120	Mit welchem Abschluss? Z.B. Bachelor, Master,… *Wiederum je nach Land die entsprechende ISCED-Liste wählen (Hochschulabschluss ist gewöhnlich ISCED 5).*	*Abschluss:* _____ _____
53130	Hat Ihr/e Partner/in einen Doktortitel?	0 nein 1 ja
53140	In welchem Land wurde dieser erworben?	*Land:* _____

Code					CO
					CL

53150	In welchem Fach? *Wiederum je nach Land die entsprechende ISCED-Liste wählen (Doktortitel ist gewöhnlich ISCED 6).*	*Studienfach:* ___________________________
53160 53170 53164 53161	Welche Tätigkeit führt Ihr/e Partner/in momentan aus? *Mehrfachnennungen möglich, z.B. Student, der nebenher jobbt -> Haupttätigkeit = Student, Nebentätigkeit = berufstätig.* *Haupttätigkeit unter 53160 kodieren.* *Nebentätigkeit unter 52170 kodieren.* *Wenn berufstätig: unten (53190) genauere Beschreibung der beruflichen Tätigkeit abfragen und notieren.*	1 Schüler/in an einer Primar- oder Sekundarschule 2 Student/in an einer Hochschule 3 Auszubildende/r *(in der Berufsausbildung, ohne 1 und 2)* 4 berufstätig *(wenn Auszubildende/r: 3 ankreuzen)* 41 Vollzeit 42 Teilzeit 43 vorübergehend nicht arbeitend, wegen: ____________________ ____________________________ *(z.B. Mutterschutz/Elternzeit, Krankschreibung, ...)* 5 arbeitslos, arbeitssuchend 6 Hausfrau/-mann (ausschließlich im eigenen Haushalt tätig) 7 Rentner/in, Frührentner/in (Pensions- oder Rentenempfänger/in), auch Witwenrente, etc. 8 Eigentümer/in, vom Vermögen lebend 9 Dauerhaft erwerbsunfähig 10 Sonstiges: ______________________
53180	In welchem Land?	*Land:* ______________________________
53190	Welchen Beruf übt Ihr Partner/ Ihre Partnerin momentan aus?	*Beruf:* ______________________________

Code					CO
					CL

54	**Auswertung des SÖS nach ISCED**
	Tragen Sie hier die oben ermittelten ISCED-Werte ein!
	In Ausbildung/ohne eigenes Einkommen/bei den Eltern lebend:
54010	*ISCED Mutter:* __
54020	*ISCED Vater:* __
	Nicht mehr vom elterlichen Haushalt abhängig (eigener Haushalt):
54030	*ISCED Teilnehmer/in:* __
54040	*ISCED Partner/in:* __
54050	*Höchster ISCED im Haushalt = SÖS =* ___

Code					CO
					CL

Kategorie 6: Gesundheit

62	**Psychische Störungen und Psychopharmaka – Alternativversion für Patienten in stationärer Behandlung wegen Anorexia Nervosa**			
62010	Wurde bei Ihnen jemals eine psychische Störung diagnostiziert? *Einfach „ja" ankreuzen*	0 nein 1 ja		
62150	*Momentan in stationärer Behandlung aufgrund Anorexia nervosa?*	0 nein 1 ja		
62160	Was sind Ihre momentanen Diagnosen?	*Diagnosen:* _____ _____ _____		
62170 62171	Seit wann sind Sie in stationärer Behandlung? *Aufnahmedatum für momentanen Klinikaufenthalt*	*Datum:* __ __ . __ __ . __ __ __ __ (dd.mm.yyyy) *Tage von aktueller Aufnahme bis Studienteilnahme:* __ __ __		
62180	Wie oft waren Sie bereits in stationärer Behandlung (inkl. aktueller Klinikaufenthalt)?	*Anzahl:* __ __ mal		
6219_ 6220_	Bitte nennen Sie Jahr und Alter aller Klinikaufenthalte aufgrund von Anorexie. *Aufenthaltsnummer = letzte Ziffer der Itemnummer (0 beim 10. Aufenthalt)* *6219_ -> Jahr* *6220_ -> Alter*	*Aufenthalt Nr.*	*Jahr*	*Alter*
		1		
		2		
		3		
		4		
		5		
		6		
		7		
		8		
		9		
		10		

Code					CO
					CL

62210 62211	Wann hatten Sie zum ersten Mal Symptome einer Anorexie?	*Jahr:* __ __ __ __ *Alter:* __ __ Jahre
62220	Welche Therapieangebote haben Sie während Ihres aktuellen Aufenthalts bereits wahrgenommen? *V.a. Körperbildtherapie*	_____ _____ _____ _____ _____ _____
62110	Nehmen Sie gegenwärtig Medikamente aufgrund der Anorexie ein? *Gemeint sind Psychopharmaka.*	0 nein 1 ja
	Welche? *Möglichst genaue Angaben: Name des Produkts oder Wirkstoff (soweit bekannt)* In welcher Dosierung? Also, welche Menge nehmen Sie ein und wie oft? *Möglichst Angabe in ml oder mg. Bei Tabletten o. Ä. nachfragen, wie viel 1 Tablette in mg ist.* *Wenn nicht bekannt -> Zuhause nachschauen lassen und nachtragen*	*Tragen Sie die Antworten unter den nachfolgenden Items ein.* *Wenn mehr Medikamente eingenommen werden, als Items vorhanden sind, nummerieren Sie die zusätzlichen Items nach dem Muster der vorhandenen.*
62120	*Name Medikament 1*	
62121	*Dosierung Medikament 1*	
62130	*Name Medikament 2*	
62131	*Dosierung Medikament 2*	
62140	*Name Medikament 3*	
62141	*Dosierung Medikament 3*	
62230	Wurde bei Ihnen jemals eine andere psychische Störung diagnostiziert, als Sie gerade keine Symptome einer Anorexie hatten?	0 nein 1 ja
62020	Welche war das?	*Störung:* _____

Code					CO
					CL

62030	Wann war das?	*Jahr:* _____
62040	Waren Sie aufgrund dieser Störung in Behandlung?	0 nein 1 ja
62050	Wurde die Behandlung erfolgreich abgeschlossen?	0 nein 1 ja
62060	Nahmen Sie aufgrund der Erkrankung Medikamente ein? *Gemeint sind Psychopharmaka*	0 nein 1 ja
	Welche waren das? *Möglichst genaue Angaben: Name des Produkts oder Wirkstoff (soweit bekannt)* In welcher Dosierung? Also, welche Menge nahmen Sie ein und wie oft? *Falls bekannt. Möglichst Angabe in ml oder mg. Bei Tabletten o. Ä. nachfragen, wie viel 1 Tablette in mg ist. Wenn nicht bekannt -> Zuhause nachschauen lassen und nachtragen*	*Tragen Sie die Antworten unter den nachfolgenden Items ein. Wenn mehr Medikamente eingenommen wurden, als Items vorhanden sind, nummerieren Sie die zusätzlichen Items nach dem Muster der vorhandenen.*
62070	*Name Medikament 1*	
62071	*Dosierung Medikament 1*	
62080	*Name Medikament 2*	
62081	*Dosierung Medikament 2*	
62090	*Name Medikament 3*	
62091	*Dosierung Medikament 3*	
62100	Leiden Sie gegenwärtig unter dieser Erkrankung?	0 nein 1 ja
62110	Nehmen Sie gegenwärtig Medikamente aufgrund dieser Erkrankung ein? *Gemeint sind Psychopharmaka.*	0 nein 1 ja

Code					CO
					CL

	Welche? *Möglichst genaue Angaben: Name des Produkts oder Wirkstoff (soweit bekannt)* In welcher Dosierung? Also, welche Menge nehmen Sie ein und wie oft? *Möglichst Angabe in ml oder mg. Bei Tabletten o. Ä. nachfragen, wie viel 1 Tablette in mg ist.* *Wenn nicht bekannt -> Zuhause nachschauen lassen und nachtragen*	*Tragen Sie die Antworten unter den nachfolgenden Items ein.* *Wenn mehr Medikamente eingenommen werden, als Items vorhanden sind, nummerieren Sie die zusätzlichen Items nach dem Muster der vorhandenen.*
62120	*Name Medikament 1*	
62121	*Dosierung Medikament 1*	
62130	*Name Medikament 2*	
62131	*Dosierung Medikament 2*	
62140	*Name Medikament 3*	
62141	*Dosierung Medikament 3*	

Code					CO
					CL

64	**Weitere Medikamente**	
64010	Nehmen Sie momentan regelmäßig Medikamente ein? *Ohne Psychopharmaka ABER MIT hormoneller Empfängnisverhütung (Pille).*	0 nein 1 ja
	Welche? *Möglichst genaue Angaben: Name des Produkts oder Wirkstoff (soweit bekannt)* In welcher Dosierung? Also, welche Menge nehmen Sie ein und wie oft? *Möglichst Angabe in ml oder mg. Bei Tabletten o. Ä. nachfragen, wie viel 1 Tablette in mg ist. Wenn nicht bekannt -> Zuhause nachschauen lassen und nachtragen*	*Tragen Sie die Antworten unter den nachfolgenden Items ein.* *Wenn mehr Medikamente eingenommen werden, als Items vorhanden sind, nummerieren Sie die zusätzlichen Items nach dem Muster der vorhandenen.*
64020	*Name Medikament 1*	
64021	*Dosierung Medikament 1*	
64030	*Name Medikament 2*	
64031	*Dosierung Medikament 2*	
64040	*Name Medikament 3*	
64041	*Dosierung Medikament 3*	
64050	*Name Medikament 4*	
64051	*Dosierung Medikament 4*	

65	**Sport**	
65000 65001	*Fragen Sie den IPAQ ab. Notieren Sie evtl. Wichtiges hier.* *Halten Sie einen Taschenrechner bereit zur Umrechnung von Stunden in Minuten.*	*MET-Minuten/Woche:* _____ *Aktivitätskategorie:* 1 niedrig 2 mittel 3 hoch

Code					CO
					CL

IPAQ Kurzversion, Interview, letzte 7 Tage

VORLESEN: Ich werde Sie zu der Zeit befragen, die Sie während der letzten 7 Tage in körperlicher Aktivität verbracht haben. Bitte beantworten Sie alle Fragen, auch wenn Sie sich selbst nicht als aktive Person ansehen. Bitte berücksichtigen Sie die Aktivitäten im Rahmen Ihrer Arbeit/Schule/Studium, in Haus und Garten, um von einem Ort zum anderen zu gelangen und in Ihrer Freizeit für Erholung, Bewegung und Sport.

VORLESEN: Denken Sie nun an alle *anstrengenden* Aktivitäten, die Sie in den vergangenen 7 Tagen ausgeführt haben. Anstrengende Aktivitäten bezeichnen Aktivitäten, die *starke körperliche* Anstrengungen erfordern und bei denen Sie deutlich stärker atmen als normal. Dies beinhaltet z.B. Aktivitäten wie das Tragen schwerer Lasten, Erdarbeiten, Aerobic oder schnelles Fahrradfahren. Denken Sie nur an die körperlichen Aktivitäten, die Sie für mindestens 10 Minuten ohne Unterbrechung ausgeführt haben.

65010	1. Während der **letzten 7 Tage**, an wie vielen Tagen haben Sie **anstrengende** körperliche Aktivitäten ausgeführt?	__ Tage pro Woche [Range 0-7, 888, 999] 888 weiß nicht 999 keine Angabe

[**Interviewer Verdeutlichung:** Denken Sie nur an die körperlichen Aktivitäten, die Sie für mindestens 10 Minuten ohne Unterbrechung ausführen.]

[**Interviewer Anmerkung:** Wenn der/die Befragte mit null antwortet, sich weigert zu antworten oder die Antwort nicht weiß, springen Sie zu Frage 3.]

65020	2. Wie viel Zeit insgesamt haben Sie für gewöhnlich an einem dieser Tage mit **anstrengenden** körperlichen Aktivitäten verbracht?	__ __ Stunden pro Tag [Range 0-16] __ __ __ Minuten pro Tag [Range 0-960, 888, 999] 888 weiß nicht 999 keine Angabe *Nur die Minuten werden in SPSS eingegeben -> umrechnen!*

[**Interviewer Verdeutlichung:** Denken Sie nur an die körperlichen Aktivitäten, die Sie für mindestens 10 Minuten ohne Unterbrechung ausgeführt haben.]

Code					CO
					CL

65021	[**Interviewer Klarstellung:** Wir suchen eine durchschnittliche Zeit für einen der Tage, an denen Sie anstrengende körperliche Aktivitäten ausführen. Wenn der/die Befragte nicht antworten kann, da die Zeitverteilung sehr stark von Tag zu Tag variiert, fragen Sie: „Wie viel Zeit haben Sie insgesamt über **die letzten 7 Tage** mit anstrengenden körperlichen Aktivitäten verbracht?“	__ __ Stunden pro Woche [Range 0-112] __ __ __ __ Minuten pro Woche [Range 0-6720, 888, 999] 888 weiß nicht 999 keine Angabe *Nur die Minuten werden in SPSS eingegeben -> umrechnen!*

VORLESEN: Denken Sie nun an alle *moderaten* Aktivitäten, die Sie in den vergangenen 7 Tagen ausgeführt haben. Moderate Aktivitäten bezeichnen Aktivitäten mit *moderater* körperlicher Anstrengung, bei denen Sie ein wenig stärker atmen als normal. Dies beinhaltet z.B. Aktivitäten wie das Tragen leichter Lasten, Fahrradfahren bei gewöhnlicher Geschwindigkeit oder Doppel-Tennis. Schliessen Sie Gehen nicht mit ein. Denken Sie wiederum nur an die körperlichen Aktivitäten, die Sie für mindestens 10 Minuten ohne Unterbrechung ausgeführt haben.

65030	3. Während der **letzten 7 Tage**, an wie vielen Tagen haben Sie **moderate** körperliche Aktivitäten ausgeführt?	__ Tage pro Woche [Range 0-7, 888, 999] 888 weiß nicht 999 keine Angabe

[**Interviewer Verdeutlichung:** Denken Sie nur an die körperlichen Aktivitäten, die Sie für mindestens 10 Minuten ohne Unterbrechung ausführen.]

[**Interviewer Anmerkung:** Wenn der/die Befragte mit null antwortet, sich weigert zu antworten oder die Antwort nicht weiß, springen Sie zu Frage 5.]

65040	4. Wie viel Zeit insgesamt haben Sie für gewöhnlich an einem dieser Tage mit **moderaten** körperlichen Aktivitäten verbracht?	__ __ Stunden pro Tag [Range 0-16] __ __ __ Minuten pro Tag [Range 0-960, 888, 999] 888 weiß nicht 999 keine Angabe *Nur die Minuten werden in SPSS eingegeben -> umrechnen!*

[**Interviewer Verdeutlichung:** Denken Sie nur an die körperlichen Aktivitäten, die Sie für mindestens 10 Minuten ohne Unterbrechung ausführen.]

Code					CO
					CL

65041	[**Interviewer Klarstellung:** Wir suchen eine durchschnittliche Zeit für einen der Tage, an denen Sie moderate körperliche Aktivitäten ausführen. Wenn der/die Befragte nicht antworten kann, da die Zeitverteilung sehr stark von Tag zu Tag variiert, fragen Sie: „Wie viel Zeit haben Sie insgesamt über **die letzten 7 Tage** mit moderaten körperlichen Aktivitäten verbracht?“	__ __ Stunden pro Woche [Range 0-112] __ __ __ __ Minuten pro Woche [Range 0-6720, 888, 999] 888 weiß nicht 999 keine Angabe *Nur die Minuten werden in SPSS eingegeben -> umrechnen!*

VORLESEN: Denken Sie nun an die Zeit, die Sie in den letzten 7 Tagen mit zu Fuß gehen verbracht haben. Dies schliesst das zu Fuss gehen auf der Arbeit und zu Hause, das Gehen, um von einem Ort zum anderen zu gelangen, und alles andere Gehen, was Sie ausschliesslich als Entspannung, Sport, Bewegung und Freizeit ausgeführt haben, ein.

65050	5. Während der vergangenen 7 Tage, an wie vielen Tagen sind Sie mindestens 10 Minuten ohne Unterbrechung **zu Fuss gegangen**?	__ Tage pro Woche [Range 0-7, 888, 999] 888 weiß nicht 999 keine Angabe

[**Interviewer Verdeutlichung:** Denken Sie nur an das zu Fuß gehen, das Sie für mindestens 10 Minuten ohne Unterbrechung ausgeführt haben.]

[**Interviewer Anmerkung:** Wenn der/die Befragte mit null antwortet, sich weigert zu antworten oder die Antwort nicht weiß, springen Sie zu Frage 7.]

65060	6. Wie viel Zeit haben Sie für gewöhnlich an einem dieser Tage mit **zu Fuss gehen** verbracht?	__ __ Stunden pro Tag [Range 0-16] __ __ __ Minuten pro Tag [Range 0-960, 888, 999] 888 weiß nicht 999 keine Angabe *Nur die Minuten werden in SPSS eingegeben -> umrechnen!*

Code					CO
					CL

65061	[**Interviewer Klarstellung:** Wir suchen eine durchschnittliche Zeit für einen der Tage, an denen Sie zu Fuß gehen. Wenn der/die Befragte nicht antworten kann, da die Zeitverteilung sehr stark von Tag zu Tag variiert, fragen Sie: „Wie viel Zeit haben Sie insgesamt über **die letzten 7 Tage** mit zu Fuß gehen verbracht?“	__ __ Stunden pro Woche [Range 0-112] __ __ __ __ Minuten pro Woche [Range 0-6720, 888, 999] 888 weiß nicht 999 keine Angabe *Nur die Minuten werden in SPSS eingegeben -> umrechnen!*

VORLESEN: Denken Sie nun an die Zeit, die Sie während der letzten 7 Tage an Wochentagen sitzend verbracht haben, z.B. bei der Arbeit, zu Hause, beim Studieren und in der Freizeit. Dies schliesst ein das Sitzen am Schreibtisch, den Besuch bei Freunden, das Lesen oder das Sitzen oder Liegen vor dem Fernseher.

65070	7. Während der vergangenen 7 Tage, wie viel Zeit haben Sie für gewöhnlich an einem **Wochentag** im **Sitzen** verbracht?	__ __ Stunden pro Tag [Range 0-16] __ __ __ Minuten pro Tag [Range 0-960, 888, 999] 888 weiß nicht 999 keine Angabe *Nur die Minuten werden in SPSS eingegeben -> umrechnen!*

[**Interviewer Verdeutlichung:** Schließen Sie Zeit, in der Sie gelegen haben (und dabei wach waren), ebenso ein wie Sitzen.]

65071	[**Interviewer Klarstellung:** Wir suchen eine durchschnittliche Zeit, die Sie pro Tag sitzend verbringen. Wenn der/die Befragte nicht antworten kann, da die Zeitverteilung sehr stark von Tag zu Tag variiert, fragen Sie: „Wie viel Zeit haben Sie insgesamt letzten **Mittwoch** mit **Sitzen** verbracht?“	__ __ Stunden am Mittwoch [Range 0-16] __ __ __ Minuten am Mittwoch [Range 0-960, 888, 999] 888 weiß nicht 999 keine Angabe *Nur die Minuten werden in SPSS eingegeben -> umrechnen!*

Code					CO
					CL

IPAQ-Auswertung – Berechnung von MET-Minuten/Woche:

MET-Minuten/Woche Gehen = 3.3 * Minuten Gehen * Tage Gehen

MET-Minuten/Woche moderat = 4.0 * Minuten moderate Aktivität * Tage moderate Aktivität

MET-Minuten/Woche anstrengend = 8.0 * Minuten anstrengende Aktivität * Tage anstrengende Aktivität

Gesamtscore physische Aktivität in MET-Minuten/Woche = Summe von MET-Minuten/Woche Gehen + moderat + anstrengend

IPAQ-Auswertung – Kategorien:

Kategorie 1: niedrig

Niedrigstes Level physischer Aktivität. In diese Kategorie fallen Personen, die die Kriterien für die Kategorien 2 und 3 nicht erfüllen.

Kategorie 2: mittel

Ein moderates Aktivitätsmuster wird anhand der folgenden Kriterien definiert:
a) 3 oder mehr Tage mit anstrengender Aktivität von mindestens 20 Minuten am Tag
oder
b) 5 oder mehr Tage mit moderater Aktivität und/oder Gehen von mindestens 30 Minuten pro Tag
oder
c) 5 oder mehr Tage mit einer beliebigen Kombination aus Gehen, moderaten oder anstrengenden Aktivitäten von insgesamt mindestens 600 MET-Minuten/Woche
Bei Personen, bei denen mindestens eines dieser Kriterien zutrifft, geht man von einem Mindestmaß an Aktivität aus und klassifiziert sie deshalb als „moderat".

Kategorie 3: hoch

Diese Kategorie wird zur Beschreibung von hohen Aktivitätsniveaus verwendet.
Die beiden Kriterien zur Klassifikation sind:
a) anstrengende Aktivität an mindestens 3 Tagen mit einer Gesamtaktivität von mindestens 1500 MET-Minuten/Woche
oder
b) 7 oder mehr Tage mit einer beliebigen Kombination aus Gehen, moderaten oder anstrengenden Aktivitäten von insgesamt mindestens 3000 MET-Minuten/Woche

Code					CO
					CL

66	**Substanzkonsum**	
66010	Rauchen Sie?	0 nein 1 ja
66011	Wie viele Zigaretten rauchen Sie durchschnittlich am Tag?	*Zigaretten/Tag:* _____ *Ggf. umrechnen, z.B. 1 in der Woche -> 0,14 pro Tag*
66020	*Bei Minderjährigen:* Haben Sie schon einmal Alkohol getrunken? *Weitere Alkoholfragen nur bei „ja" stellen.*	0 nein 1 ja
66030	Wie oft trinken Sie gewöhnlich Alkohol?	_____ mal pro Woche *Ggf. umrechnen, z.B. 1 mal im Monat -> 0,25 mal pro Woche. Kodieren Sie nur mit 0, wenn die Person angibt, überhaupt nie Alkohol zu trinken (1 mal im Jahr = 0,0027)*
66080	Nehmen Sie andere Drogen, z.B. Cannabis?	0 nein 1 ja
66081	Welche Drogen?	*Droge(n):* _____
66082	Wie oft?	_____ mal pro Woche

Code					CO
					CL

Kategorie 7: weibliche Gesundheit

71	**Nur für Frauen: Menstruation und Verhütung**	
71100 71101 71103	Hatten Sie in den letzten 3 Monaten regelmäßig Ihre Periode, also 3 mal?	0 nein 01 Periode ist ausgeblieben und zwar ___ Mal 02 Momentan schwanger 03 Anderer Grund: _____ _____ 1 ja
71010	Wann begann Ihre letzte Periode? (Vor der Studienteilnahme)	*Datum:* __ __ / __ __ / __ __ __ __ *(dd/mm/yyyy)*
71030 71031	Verwenden Sie eine hormonelle Empfängnisverhütung (z.B. die Pille)?	0 nein 1 ja, und zwar: _____ _____

Code					CO
					CL

Vorbefragung 1. Termin

61	**Ausschlusskriterien**	
61030	Sind Sie in Ihrer Hörfähigkeit eingeschränkt? Haben Sie sonstige Hörprobleme, wie Ohrgeräusche oder einen Hörsturz?	0 nein 1 ja -> *kein Startle möglich*
61040	Haben Sie einen Tinnitus?	0 nein 1 ja -> *kein Startle möglich*
61050	Haben Sie Allergien oder Unverträglichkeiten, z.B. Erdnussallergie, Laktoseunverträglichkeit, Hautallergien?	0 nein 1 ja -> *abklären, ob Elektroden okay*
61051	Welche?	_____ _____ _____ _____
61070	Haben Sie jemals einen Ohnmachtsanfall erlebt?	0 nein 1 ja -> *Risiko abschätzen! Evtl. von einer Teilnahme am Startle-Experiment abraten!*
61071	Wann war das? Wie war das damals? Ist das öfter vorgekommen? Was müsste passieren, damit Sie heute in Ohnmacht fallen? *Fragen Sie möglichst genau nach! Wichtig ist, dass wir das Risiko abschätzen können, dass die Person während der Studienteilnahme (v.a. Präsentation affektiver Bilder) in Ohnmacht fallen könnte.*	*Beschreibung:* _____ _____ _____ _____ _____ _____ _____
61080	Leiden Sie momentan unter chronischen oder akuten körperlichen Erkrankungen?	0 nein 1 ja -> *Risiko abschätzen!*

1

Figure 38. Structured interview used at the beginning of the first session of studies 2-4 for the verification of entrance/exclusion criteria.

Code					CO
					CL

61081	An welchen? *Chronisch: dauert meist mehrere Jahre an, mind. 4 Wochen (z.B. Herz-Kreislauferkrankungen, Asthma, Epilepsie,...)* *Akut: dauert nur eine kurze Zeit an, meist bis 14 Tage (z.B. Erkältung)* *Achtung bei Hauterkrankungen, neurologischen Erkrankungen, Herz-Kreislauf-Erkrankungen*	*Erkrankung(en):* _____ _____ _____ _____ _____ _____ _____ _____
61090	Hatten Sie jemals einen epileptischen Anfall?	0 nein 1 ja -> *Teilnahme nicht möglich! Bildpräsentation kann bei Epileptikern Anfall auslösen!*
61100	Haben Sie eine schizophrene Erkrankung?	0 nein 1 ja -> *Teilnahme abklären*
61110	Haben Sie eine posttraumatische Belastungsstörung?	0 nein 1 ja -> *Teilnahme abklären*

Code					CO
					CL

Vorbefragung 2. Termin

61	**Ausschlusskriterien**	
61010	Brauchen Sie eine Brille oder Kontaktlinsen und tragen Sie diese heute?	0 nein 1 ja, eingeschränkt aber durch Brille korrigiert 2 ja, eingeschränkt und nicht korrigiert 3 trägt Kontaktlinsen -> *wenn möglich, sofort herausnehmen lassen; Startle mit Kontaktlinsen nicht möglich!*
61020	Sind Sie farbenblind?	0 nein 1 ja -> *keine Auswertung des Startle-Experiments möglich*
61030	Sind Sie in Ihrer Hörfähigkeit eingeschränkt? Haben Sie sonstige Hörprobleme, wie Ohrgeräusche, Tinnitus oder Hörsturz?	0 nein 1 ja, -> *keine Teilnahme am Startle-Experiment möglich*
61050	Haben Sie Hauterkrankungen oder Hautallergien, z.B. Pflasterallergie?	0 nein 1 ja -> *abklären, ob Elektroden okay*
61051	Welche?	*Allergie(n):* _____ _____ _____ _____
61080	Leiden Sie momentan unter chronischen oder akuten körperlichen Erkrankungen?	0 nein 1 ja -> *Risiko abschätzen!*

1

Figure 39. Structured interview used at the beginning of the second session of studies 2-4 for the verification of entrance/exclusion criteria and the assessment of state variables.

Code					CO
					CL

61081	An welchen? *Chronisch: dauert meist mehrere Jahre an, mind. 4 Wochen (z.B. Herz-Kreislauferkrankungen, Asthma, Epilepsie,...)* *Akut: dauert nur eine kurze Zeit an, meist bis 14 Tage (z.B. Erkältung)* *Achtung bei Hauterkrankungen, neurologischen Erkrankungen, Herz-Kreislauf-Erkrankungen*	*Erkrankung(en):* _____ _____ _____ _____ _____ _____ _____ _____ _____

Kategorie 8: Fragen zum heutigen Tag

	Diese Fragen beziehen sich, wenn nicht anders angegeben, auf die letzten 24 Stunden.	
80010	Wie lange haben Sie in der letzten Nacht geschlafen?	*Stunden:* __ __
80020	Wie lange schlafen Sie für gewöhnlich?	*Stunden:* __ __
80030	Wann haben Sie, bevor Sie hierher kamen, zum letzten Mal etwas gegessen?	*Uhrzeit:* __ __ : __ __ *(hh:mm, 24-Std.-Format)*
80040	*Zeitspanne vom Beginn der Testung bis zur letzten Mahlzeit davor berechnen.* (Das war also vor ____ Stunden/Minuten?)	__ __ : __ __ *(hh:mm)*
80050	Was haben Sie gegessen und wie viel?	*Gegessene Nahrungsmittel und Menge notieren* _____ _____ _____ _____
80060	*Wenn keine richtige Mahlzeit angegeben wird, sondern z.B. nur ein Apfel:* Wann haben Sie, bevor Sie hierher kamen, zum letzten Mal eine richtige Mahlzeit gegessen?	*Uhrzeit:* __ __ : __ __ *(hh:mm, 24-Std.-Format)*

Code					CO
					CL

80070	Was haben Sie gegessen und wie viel?	*Gegessene Nahrungsmittel und Menge notieren* _____ _____ _____ _____
80080	Haben Sie in den letzten 24 Stunden koffeinhaltige Getränke getrunken, z.B. Kaffee, schwarzer oder grüner Tee, Cola, Red Bull?	0 nein 1 ja
80090	Wann haben Sie, bevor Sie hierher kamen, zum letzten Mal ein koffeinhaltiges Getränk zu sich genommen?	*Uhrzeit:* __ __ : __ __ *(hh:mm, 24-Std.-Format)*
80100	*Zeitspanne vom Beginn der Testung bis zum letzten koffeinhaltigen Getränk davor berechnen.* (Das war also vor ____ Stunden/Minuten?)	__ __ : __ __ *(hh:mm)*
80110	Welches Getränk/ welche Getränke?	*Getränk(e):* _____
80120	Wie viel?	*Menge:* __ __ , __ __ l
80130	Haben Sie in den letzten 24 Stunden alkoholhaltige Getränke getrunken?	0 nein 1 ja
80140	Wann haben Sie, bevor Sie hierher kamen, zum letzten Mal ein alkoholhaltiges Getränk zu sich genommen?	*Uhrzeit:* __ __ : __ __ *(hh:mm, 24-Std.-Format)*
80150	*Zeitspanne vom Beginn der Testung bis zum letzten alkoholhaltigen Getränk davor berechnen.* (Das war also vor ____ Stunden/Minuten?)	__ __ : __ __ *(hh:mm)*
80160	Welches Getränk/ welche Getränke?	*Getränk(e):* _____
80170	Wie viel?	*Menge, möglichst in ml:* __ __ __ __
80180	Haben Sie in den letzten 24 Stunden Zigaretten geraucht oder in anderer Form Nikotin zu sich genommen?	0 nein 1 ja

Code					CO
					CL

80190	Wann haben Sie, bevor Sie hierher kamen, zum letzten Mal eine Zigarette geraucht oder in anderer Form Nikotin zu sich genommen?	*Uhrzeit:* __ __ : __ __ *(hh:mm, 24-Std.-Format)*
80200	*Zeitspanne vom Beginn der Testung bis zur letzten Zigarette davor berechnen.* (Das war also vor ____ Stunden/Minuten?)	__ __ : __ __ *(hh:mm)*
80210	Haben Sie innerhalb der letzten 24 Stunden Cannabis oder andere Drogen eingenommen?	0 nein 1 ja
80220	Welche?	*Bezeichnung:* _____
80230	Wann war das?	*Uhrzeit:* __ __ : __ __ *(hh:mm, 24-Std.-Format)*
80240	*Zeitspanne vom Beginn der Testung bis zur letzten Drogeneinnahme davor berechnen.* (Das war also vor ____ Stunden/Minuten?)	__ __ : __ __ *(hh:mm)*
80210	Haben Sie in den letzten 4 Tagen Medikamente eingenommen?	0 nein 1 ja
	Welche Medikamente waren das? In welcher Dosierung haben Sie diese eingenommen? Wann haben Sie diese zum letzten Mal eingenommen? *Wenn nicht bekannt -> Zuhause Nachschauen lassen und nachtragen!*	
80220	*Name/Präparat*	_____
80221	*Dosierung*	__ __ __ __ ml/mg *(angeben!)*
80222	*Letzte Einnahme Datum*	*Datum:* __ __ / __ __ / __ __ __ __ *(dd/mm/yyyy)*
80223	*Letzte Einnahme Uhrzeit*	*Uhrzeit:* __ __ : __ __ *(hh:mm, 24-Std.-Format)*
80230	*Name/Präparat*	_____
80231	*Dosierung*	__ __ __ __ ml/mg *(angeben!)*

Code					CO
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80232	*Letzte Einnahme Datum*	*Datum:* __ __ / __ __ / __ __ __ __ *(dd/mm/yyyy)*
80233	*Letzte Einnahme Uhrzeit*	*Uhrzeit:* __ __ : __ __ *(hh:mm, 24-Std.-Format)*
80240	*Name/Präparat*	_____
80241	*Dosierung*	__ __ __ __ ml/mg *(angeben!)*
80242	*Letzte Einnahme Datum*	*Datum:* __ __ / __ __ / __ __ __ __ *(dd/mm/yyyy)*
80243	*Letzte Einnahme Uhrzeit*	*Uhrzeit:* __ __ : __ __ *(hh:mm, 24-Std.-Format)*
80250	*Name/Präparat*	_____
80251	*Dosierung*	__ __ __ __ ml/mg *(angeben!)*
80252	*Letzte Einnahme Datum*	*Datum:* __ __ / __ __ / __ __ __ __ *(dd/mm/yyyy)*
80253	*Letzte Einnahme Uhrzeit*	*Uhrzeit:* __ __ : __ __ *(hh:mm, 24-Std.-Format)*
80260	*Name/Präparat*	_____
80261	*Dosierung*	__ __ __ __ ml/mg *(angeben!)*
80262	*Letzte Einnahme Datum*	*Datum:* __ __ / __ __ / __ __ __ __ *(dd/mm/yyyy)*
80263	*Letzte Einnahme Uhrzeit*	*Uhrzeit:* __ __ : __ __ *(hh:mm, 24-Std.-Format)*

Code					CO
					CL

Bitte kreuzen Sie im Folgenden die auf Sie zutreffende Zahl von 0% bis 100% an.

Wie hungrig sind Sie momentan?
0% = überhaupt nicht hungrig
100% = stärkster vorstellbarer Hunger

0	10	20	30	40	50	60	70	80	90	100

Wie satt sind Sie momentan?
0% = überhaupt nicht satt
100% = stärkste vorstellbare Sättigung

0	10	20	30	40	50	60	70	80	90	100

Denken Sie an ein Nahrungsmittel, auf das Sie gerade Lust haben.
Wie stark ist Ihr Verlangen nach diesem Nahrungsmittel?
0% = überhaupt kein Verlangen
100% = stärkstes vorstellbares Verlangen

0	10	20	30	40	50	60	70	80	90	100

Wie zufrieden sind Sie jetzt in diesem Moment mit Ihrer Figur?
0% = überhaupt nicht
100% = vollkommen

0	10	20	30	40	50	60	70	80	90	100

Wie zufrieden sind Sie jetzt in diesem Moment mit Ihrem Gewicht?
0% = überhaupt nicht
100% = vollkommen

0	10	20	30	40	50	60	70	80	90	100

Wie fühlt sich Ihr Körper jetzt in diesem Moment an?
0% = sehr dünn
100% = sehr dick

0	10	20	30	40	50	60	70	80	90	100

2

Figure 40. Questionnaire for the assessment of hunger and body image state variables during the second session of studies 2-4.

Abbreviations

ACC = anterior cingulate cortex
AN = anorexia nervosa
ANOVA = analysis of variance
BDI = Beck Depression Inventory
BED = binge eating disorder
BMI = body mass index
BN = bulimia nervosa
CBT = cognitive behavioural therapy
CNS = central nervous system
DSM = Diagnostic and Statistical Manual of Mental Disorders
EBA = extrastriate body area
EDI = Eating Disorder Inventory
ECG = electrocardiography
EEG = electroencephalography
EMG = electromyography
ERP = event-related potential
FBA = fusiform body area
HEOG = horizontal electrooculogram
HEP = heartbeat evoked brain potential
HF = high frequency (of heart rate variability)
HRV = heart rate variability
IAPS = International Affective Picture System
IPAQ = International Physical Activity Questionnaire
ISCED = International Standard Classification of Education
LF = low frequency (of heart rate variability)
LF n.u. = low frequency expressed in normalised units
ln LF = logarithmised low frequency
ln HF = logarithmised high frequency
MEG = magnetencephalography
MET = metabolic equivalent of task
OECD = Organisation for Economic Co-operation and Development
SAM = Self-Assessment Manikin scale
SCID = Structured Clinical Interview for DSM-IV
SDT = signal detection theory
SES = socio-economic status
SIAB-S = self-report screening version of the Structured Interview for Anorexic and Bulimic Syndromes
SSNRI = selective serotonin-norepinephrine reuptake inhibitor
SSRI = selective-serotonin reuptake inhibitor
STAI = State-Trait Anxiety Inventory
TMS = transcranial magnetic stimulation
VEOG = vertical electrooculogram

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