Psychophysiology, 51 (2014), 168–177. Wiley Periodicals, Inc. Printed in the USA.

DOI: 10.1111/psyp.12160

"Glass fairies" and "bone children": Adolescents and young adults with anorexia nervosa show positive reactions towards extremely emaciated body pictures measured by the startle reflex paradigm

VALESKA A. REICHEL,[a,b] NORA SCHNEIDER,[a,c] BARBARA GRÜNEWALD,[c] THORSTEN KIENAST,[e] ERNST PFEIFFER,[a] ULRIKE LEHMKUHL,[a] AND ALEXANDER KORTE[a,d]

[a]Department of Child and Adolescent Psychiatry and Psychotherapy, Charité Universitätsmedizin Berlin, Berlin, Germany
[b]Department of Psychiatry and Psychotherapy, Universitätsklinikum Halle (Saale), Halle, Germany
[c]Cognitive Science Nutrition & Health Department, Nestec Ltd., Nestlé Research Center, Lausanne, Switzerland
[d]Department of Child and Adolescent Psychiatry and Psychotherapy, Klinikum der Universität München, Munich, Germany
[e]Department of Psychiatry and Psychotherapy, Charité Universitätsmedizin Berlin, Berlin, Germany

Abstract

In this study, we investigated the emotional processing of extremely emaciated body cues in adolescents and young adults with ($n = 36$) and without ($n = 36$) anorexia nervosa (AN), introducing a new picture type, which was taken from websites that promote extreme thinness and is targeted specifically at adolescents interested in extreme thinness. A startle reflex paradigm was used for implicit reactions, while a self-assessment instrument was used for subjective responses. We found a significant group difference with a startle inhibition (appetitive response) among the patients and a startle potentiation (aversive response) among the controls, whereas no such difference for subjective measures was found. The results are in contrast to previous studies, which proposed a general failure to activate the appetitive motivational system in AN, but in keeping with findings from other addictions, where the same response pattern has been found. Implications for prevention and therapy are discussed.

Descriptors: Emotion, Psychopathological, Startle blink, Anorexia nervosa, Pro Ana

Anorexia nervosa (AN) can most easily be described as a pattern of self-starvation resulting in extreme weight loss. As key motivation, two motivational states are discussed (Levitt, 2003): an exaggerated drive to meet the mass media-propagated, general thin ideal (Thompson & Stice, 2001) and an obsessive fear of gaining weight (Vartanian, Herman, & Polivy, 2005). Each of them is mentioned in the ICD-10 (WHO International Classification of Diseases) in the context of distorted self-perception (Cash & Deagle, 1997), which is an obligatory diagnosis criterion of AN (American Psychiatric Association, 2000). Questionnaire data reveal that the patients show both an exaggerated fear of weight gain and an exaggerated drive for thinness (Thiel, Jacobi, Horstmann, Paul, Nutzinger, & Schüssler, 1997). Accordingly, an aversive response to pictures of fat bodies was found (Cserjesi et al., 2010; Uher et al., 2005). An appetitive response to slim body cues, however, could not yet be confirmed either for self-report or for implicit measures such as startle reflex paradigms (Friederich et al., 2006), priming paradigms (Cserjesi et al., 2010), or paradigms based on repertory grids (Ryle & Evans, 1991). Because of these findings, most authors assume that the predominant motivational factor in AN is to avoid the fear of becoming fat, and that the drive to approach a specific thin ideal plays an inferior role (Cserjesi et al., 2010). In fact, an overall downregulation of the appetitive motivational system is being discussed (Friederich et al., 2006). An alternative hypothesis might be that the body cues used so far were not extreme, exciting, and/or AN-specific enough to activate the appetitive motivational system of the patients.

A preliminary support for this hypothesis is given in Pro Ana forums. These websites are increasingly popular among anorexic adolescents and young adults (Overbeke, 2008, for review). "Thinspiration" galleries, that is, "inspirational photo galleries . . . that aim to serve as motivators for weight loss" (see Norris, Boydell, Pinhas, & Katzman, 2006, p. 443), are a common component of these websites, and the contents are strikingly deviant from what is the general understanding of a perfect body: Instead of typical magazine pictures, these galleries depict extremely emaciated, real anorexic girls or Photoshop-distorted waif-like models. Instead of classic beauty attributes, features like projecting ribs, hip- and cheekbones, sunken cheeks and abdomen, which are associated with extreme cachexia (life-threatening final state of weight loss, which cannot be reversed nutritionally) are highlighted (Bardone-Cone & Cass, 2006). In studies using the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008), healthy people reacted aversively and with (moderately) high arousal to pictures of starving people (see Ito & Lang, 1998, p. 860). Rand, Resnick, & Seldman (1997) showed that, when assessed by healthy females, extremely underweight shapes on a

Address correspondence to: Dipl. Psych. Valeska A. Reichel, Cansteinstrasse 1, 06110 Halle (Saale), Germany. E-mail: valeska.reichel@gmx.de or Dr. med. Alexander Korte, e-mail: Alexander.Korte@med.uni-muenchen.de

figure rating scale were rated as negative and socially undesirable as extremely overweight shapes. Yet, inside the Pro Ana logic, the glorification of cachexia and its reinterpretation as a "thin ideal" play a central role (Strife & Rickard, 2011), and community names such as "glass fairies," "feather girls," or "bone children" suggest that this positive reinterpretation is part of the forum identity and also serves as the ingroup versus outgroup differentiation in the forums (Haas, Irr, Jennings, & Wagner, 2011).

Objective and Hypotheses

The current study aimed to introduce extremely emaciated body pictures as a new stimulus type, and to reevaluate with this new stimulus whether adolescents and young adults with AN as compared to healthy controls (CN) show an appetitive reaction or not. In order to provide a relevant baseline for assessing the emotional reactions, emaciated body images were intermixed with images from a standardized affective image set. Accordant with Lang's bidimensional theory of emotions (Lang, 1995), two basic components of emotional reactions were considered: (1) a valence component, ranging from appetitive reactions (such as those we expected for AN patients while viewing emaciated body cues) to aversive reactions (such as those we expected for healthy adolescents); and (2) an arousal component, ranging from low emotional arousal to high arousal (since appetitive reactions and aversive reactions both go along with an increased arousal response, we expected a comparable arousal increase in both groups). To assess an objective, involuntary, physiological indicator of emotional valence, a startle eye blink reflex was recorded while viewing images. This paradigm is well known in addiction research: since the noise-elicited startle reflex increases for unpleasant pictures and decreases for pleasant pictures relative to neutral ones (Lang, Bradley, & Cuthbert, 1990), it is a reliable measure for emotional reactions that the individual is not conscious of or that the individual wants to hide or to suppress. Alcohol addicts, for example, who were confronted with drinking cues, classified them as subjectively aversive. However, they showed an appetitive reaction by their startle reflex (Mucha, Geier, Stuhlinger, & Mundle, 2000). Analogous observations were made in patients with illegal drug abuse (Rohsenow, Niaura, Childress, Abrams, & Monti, 1990) and bulimia nervosa (Friederich et al., 2006). To assess an objective indicator of emotional arousal, we recorded the overall heart rate (HR) change and skin conductance response (SCR). Increased SCR was found in nicotine and alcohol addicts after being confronted with substance specific cues (Childress, Ehrman, Rohsenow, Robbins, & O'Brien, 1992; Niaura et al., 1988). In smoking addicts, who were confronted with smoking cues, an increase of overall heart rate change was observed (Childress et al., 1992).

Given these methodological preconditions, we can specify our hypotheses as follows (the scales of the Self-Assessment Manikin [SAM] were used as self-report measure):

Valence Hypotheses

Hypothesis 1. We expect a decrease of the startle reflex magnitude from unpleasant through neutral to pleasant cues in both groups (Lang et al., 1990).

Hypothesis 2. We expect a decrease of the SAM valence score (1: *pleasant*, 9: *unpleasant*) from unpleasant through neutral to pleasant cues in both groups (Lang et al., 1990).

Hypothesis 3. We expect a decrease of the startle reflex magnitude (relative to neutral cues) among the patients, but an increase among the controls while viewing emaciated body cues.

Hypothesis 4. No such group difference is expected for the SAM score, with both groups rating the emaciated body cues as negative relative to neutral cues.

Arousal Hypotheses

Hypothesis 5. We expect an increase of physiological arousal (SCR, overall HR change) for pleasant and unpleasant cues relative to neutral cues in both groups (Lang et al., 1990).

Hypothesis 6. We expect an increase of the SAM arousal score (1: *low arousal*; 9: *high arousal*) for pleasant and unpleasant relative to neutral cues in both groups (Lang et al., 1990).

Hypothesis 7. We expect a comparable increase of physiological arousal (SCR, overall HR change) (relative to neutral cues) during viewing of emaciated body cues in both groups.

Hypothesis 8. We expect a comparable increase of the SAM arousal score (1: *low arousal*; 9: *high arousal*) (relative to neutral cues) during viewing of emaciated body cues in both groups.

Method

Participants

A total of 72 female adolescents and young adults (36 AN, 36 CN) participated in the study. Both groups were matched for age (14 to 21 years) and education (high school). Hearing or visual impairments, neurological disease, or medication with influence on the startle reflex such as diazepam, morphine, and buspirone (Davis, Falls, Campeau, & Kim, 1993) were general exclusion criteria for the study.

Inclusion criteria for the patients were AN (ICD-10-Code F50.0, anorexia nervosa) as primary diagnosis (restrictive and purging type) and a body weight below the 10th percentile of BMI (body mass index)-for-age. Mean duration of eating disorder was 1.3 years (± 0.8 years). Mean duration of treatment was 7 months (± 3 months). All patients were recruited from inpatient and outpatient therapy programs of the Department of Child and Adolescent Psychiatry and the Department of Psychosomatic Medicine and Psychotherapy, Charité Universitätsmedizin Berlin.

Inclusion criteria for the controls were the absence of any psychiatric diagnosis described in the ICD-10 and a body weight within the normal range (i.e., above the 10th and below the 90th percentile of BMI-for-age). Recruitment methods included advertisements in newspapers, in local youth activity centres, and on the university campus.

All psychiatric diagnoses were based on ICD-10 criteria and established by experienced clinical raters using psychiatric routine measures (Structural Inventory for Anorexic and Bulimic Eating disorders, SIABS-EX; Composite International Diagnostic Interview—Diagnostic Inventory Psychiatric Disorders-Expert, CIDI-DIAX). All participants gave their written informed consent. With respect to minor age adolescents, we additionally obtained written informed consent of the legal guardians.

Table 1. *Block Design for the Four Stimulus Categories*

Stimulus category	With noise	Without noise	Overall number
Unpleasant pictures	9 (A: 4; B: 5)	3 (A: 2; B: 1)	12 (A: 6; B: 6)
Neutral pictures	9 (A: 5; B: 4)	3 (A: 1; B: 2)	12 (A: 6; B: 6)
Pleasant pictures	9 (A: 4; B: 5)	3 (A: 2; B: 1)	12 (A: 6; B: 6)
Emaciated body pictures	12 (A: 6; B: 6)	4 (A: 2; B: 2)	16 (A: 8; B: 8)
Overall number	39 (A: 19; B: 20)	13 (A: 7; B: 6)	52 (A: 26; B: 26)

Note. A = Block A; B = Block B.

Stimuli

The stimulus material consisted of 52 100 × 144 mm colored photographs, which we subdivided into four stimulus categories (12 unpleasant, 12 neutral, 12 pleasant, and 16 body pictures).

Affective standard pictures. Pictures from the IAPS (Lang et al., 2008) were used as reference material: 12 unpleasant pictures (IAPS numbers: 9571, 9300, 9301, 2800, 6550, 6540, 2811, 6230, 9140, 2095, 9800, 9810), 12 neutral pictures (2214, 2200, 2495, 2190, 7009, 7006, 7185, 7187, 2512, 2210, 2215, 7002), and 12 pleasant pictures (1710, 1463, 8179, 8180, 8041, 8185, 4643, 4650, 8496, 8490, 8187, 8040). Pictures with eating disorder-relevant (food) or x-rated content (eroticism, bloody violence, mutilation) were excluded.

Emaciated body pictures. The body pictures were preselected from a total of 8,000 body photographs from proanorexic internet galleries (key words: Pro Ana, thinspiration, girls, whole body). Pictures not showing any distinctive marks for cachexia (projecting ribs, hip-, cheek-, and collar bones, sunken cheeks and abdomen) were excluded, as well as images with a bad photographic quality or with a low identification potential for female adolescents and young adults. The resulting 36 pictures were presented to a pilot sample of 100 healthy female volunteers and rated for aversion, arousal, and perceived underweight, based on SAM-analogue 9-point scales. The 16 pictures that scored most points on these scales were selected for the study. To avoid nonweight-related influences, all pictures were standardized for background and emotional expression. To protect the displayed persons' anonymity, we did not show any faces and modified distinctive features digitally with Photoshop software.

Procedure

Pretest procedure. All participants were informed about the voluntary nature of the experiment. To control situational influences, we assessed current mood, arousal, hunger state, and body dissatisfaction using 100 mm visual analogue scales (VAS).

Psychophysiological measurement. Subjects were seated in front of a 1.5 × 1.7 m screen (1.5 m distance) and prepared for psychophysiological measurement. To reduce habituation effects, four landscape images with three startle-eliciting noises were used as introduction. Thereafter, the 52 stimuli were presented in two counterbalanced sets of 26 pictures each with a break (lasting 15 min) in between (Table 1). Within each set, the pictures of each stimulus type were presented in an intermingled design and alternated with black screens in random order. Each picture was shown for a period of 12 s. The same period was used as the intertrial interval (time between the offset of picture n to the onset of picture $n + 1$). Three quarters of the pictures of each stimulus category were accompanied by the presentation of a startle-eliciting noise, whereas the pictures without noise were used for the acquisition of the arousal data. To control learning effects, the noise occurred at variable times (3.5, 4.0, or 4.5 s after picture onset). Additional noises were presented during a quarter of the black screens.

Subjective rating and posttest procedure. After the removal of the electrodes, half of the pictures were shown again (intermingled with 9 new pictures) and rated subjectively for valence and arousal on the SAM scales. In a final step, questionnaires concerning body image, eating behavior (Eating Disorder Inventory, EDI-2), and general emotional functioning (Toronto Alexithymia Scale, TAS-26) were completed.

Data Recording

Psychophysiological measurement. A human startle reflex system (Coulbourn Instruments HMS 500) was used to generate the acoustic noises and to record the psychophysiological responses. The startle reflex was elicited by 50-ms pulse 95-dB white noise with instantaneous rise time through headphones (see Lang et al., 1990). To avoid confounding by the acoustic probes, SCR and HR were scored only for nonstartle trials.

Startle reflex response. The eye-blink component of the startle reflex was measured by recording the electromyographic activity (EMG) over the left orbicularis oculi muscle, using Ag/AgCl miniature electrodes. After sampling at 1000 Hz and filtering through a 30–500 Hz band-pass filter, raw EMG signal was rectified and integrated with a time constant of 20 ms. Digital sampling started 100 ms before and ended 400 ms after the probe noise onset. The EMG waveform was manually scored for magnitude and onset latency. Consistent with Blumenthal et al. (2005), EMG magnitude was defined as the difference between peak EMG (highest EMG level within the 200 ms after the noise) and baseline (EMG level just before response onset). Trials with no apparent reflex shape, a magnitude $< 0.1\ \mu V$, or an onset latency later than 150 ms were categorized as nonresponse and scored with zero magnitude. Responses with onset latency less than 20 ms, movement artifacts, or excessive baseline activity were defined as missing and rejected (1.04%). When the number of zero responses or "missings" exceeded one third of all recorded trials ($n = 2$), the respective participant was classified as a nonresponder and the whole data were rejected (i.e., the sample size was reduced from 74 to 72).

Skin conductance response. SCRs were recorded by a Coulbourn Isolated Skin Conductance Coupler V71-23 (time constant: 5 s; continual voltage over electrodes: 0.5 V), using Ag/AgCl standard electrodes on the hypothenar of the nondominant hand.

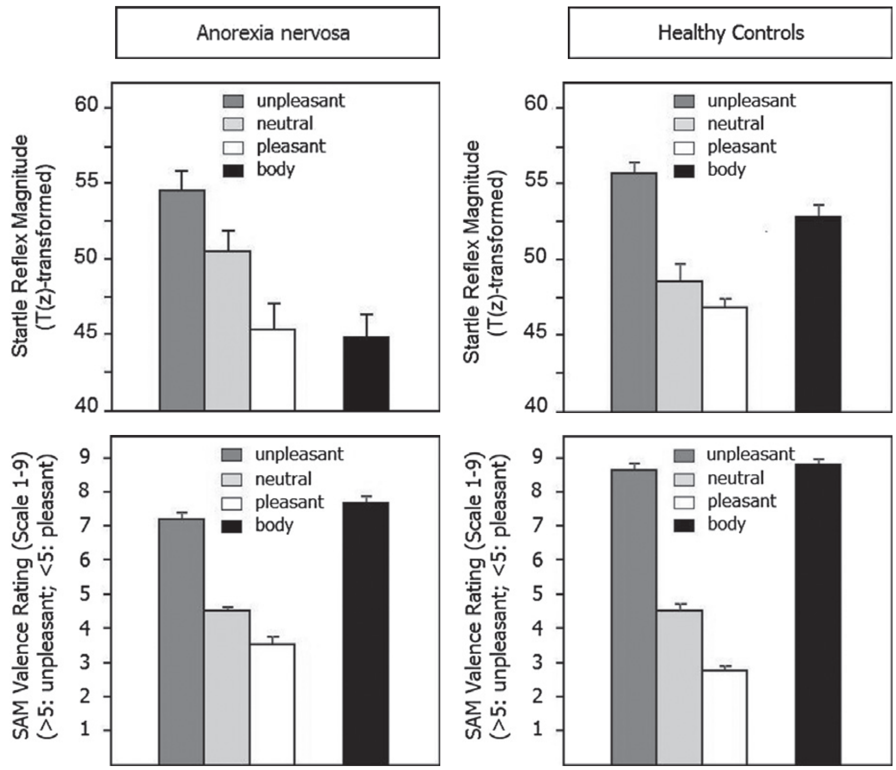

Figure 1. Emotional valence reactions of anorexia nervosa patients and healthy controls while being confronted with emaciated body pictures vs. affective standard pictures. The results are presented as means with standard error bars.

Digital sampling (at 10 Hz) started 1,000 ms before picture onset and ended 4,000 ms after picture offset. The SCR waveform was digitally scored for magnitude and latency to the peak. Magnitude was defined as the difference between peak SCR (highest SCR level within the 900-ms to 4,000-ms time interval after picture onset) and baseline (averaged SCR for the 1,000 ms before picture onset). Latency to the peak was defined as the time interval between picture onset and peak SCR. Responses with a magnitude less than 0.1 µS were defined as missing. As there were no participants with electrodermal nonresponding (i.e., maximum response = 0), the complete data set could be used for analysis.

Heart rate responses. Electrocardiographic activity (ECG) was measured according to Einthoven lead II, using Ag/AgCl standard electrodes. Raw analogue ECG signal was sampled at 1000 Hz and filtered through a 0.05–150 Hz band-pass filter. Thereafter, times of R peaks < 1 mV within the analogue signal were detected. According to the recommendations of Graham (1978), second-to-second HRs in beats per minute (bpm) for the 10 s after picture onset were computed. Three values were extracted: "overall HR change" was defined as the difference between mean HR (mean second-by-second HR for the 10-s window after picture onset) and baseline (mean HR for the 1 s before picture onset), "HR acceleration" was defined as the difference between HR max (maximal second-by-second HR for the 10 s after picture onset) and baseline, and "HR deceleration" was defined as the difference between baseline and HR min (minimal second-by-second HR for the 10 s after picture onset). On trials where HR never increased over baseline, the acceleration score was computed as zero. Deceleration scores were handled analogously. Because of incomplete data sets due to technical problems, the data files of 8 patients and 8 controls had to be excluded from analysis.

Subjective rating. As a self-report measure, we used the SAM scales of Bradley & Lang (1994): Scale "valence," ranging from 1 (*unpleasant*) to 9 (*pleasant*), and scale "arousal," ranging from 1 (*low arousal*) to 9 (*high arousal*). Data were acquired with the SAM original scales. In order to create a better comparability with the startle reflex data, the valence scale was reversed for analysis (i.e., now ranging from 1, *pleasant*, to 9, *unpleasant*; see Figure 1 and all related notes in the text); please note this when comparing our findings with other studies using the SAM.

Data Reduction and Statistical Preconditions

Data were processed by IBM SPSS Statistics 19 (2010) software. Raw data of each participant were averaged for stimulus category. Normal distribution was checked by Kolmogorov-Smirnov (K-S) tests. Except for the HR data, K-S Z = 1.075; $p = .198$, these tests were significant. Startle reflex and SCR magnitudes were T(z)-transformed to normalize the distribution ($T = 10 * z + 50$). Regarding the other measures, we solved this problem by examining the results by Kruskal-Wallis or Mann-Whitney U tests (analyzing these data exclusively by nonparametric methods seemed to be problematic because of the worse interpretability and the worse comparability with the startle reflex data). To reduce interindividual variability, the SCR values were additionally range-corrected by dividing each individual's score by the participant's maximum response (Lykken, Rose, Luther, & Maley, 1966). Following Jaccard & Wan (1996), VAS scores were treated like metric data.

Table 2. *Between-Group Comparisons for the Raw Data*

	AN patients ($n = 36$)	CN ($n = 36$)	AN vs. CN p
Startle reflex magnitude (μV)	0.508 (0.028)	0.558 (0.027)	.189
SCR magnitude (μS)	0.212 (0.053)	0.218 (0.044)	.933
Mean HR (bpm)	73.53 (2.222)	74.78 (1.138)	.411
SAM valence score	4.832 (0.181)	4.875 (0.215)	.878
SAM arousal score	3.898 (0.199)	4.574 (0.218)	.023*

Note. AN = anorexia nervosa; CN = healthy controls; SCR = skin conductance response; HR = heart rate; SAM = Self-Assessment Manikin.
*$p < .05$.

Data Analysis

Data were analyzed by univariate variance analyses (ANOVAs), with group (AN vs. CN) as the between-groups factor and stimulus category (pleasant, neutral, unpleasant, body) as the within-group factor, and main effects for group and interaction effects were computed. As normalizing the data by T(z) transformation levels out any meaningful group differences in absolute startle magnitude, we did not compare T(z) scores between the groups. Instead, a table with between-groups comparisons for the raw data was included (Table 2). Effects that were significant for SAM ratings *and* physiological measures were additionally examined by multivariate tests (Wilk's lambda). A priori hypotheses about the single stimulus categories were tested by the pairwise comparisons option in ANOVA. Following Schmidt (1988), Bonferroni corrections were used only for post hoc tests. In order to ensure a better orientation, we marked the corrected p values as p_c. For all analyses, a p level < .05 (two-tailed) was defined as statistically significant.

Results

Group Characteristics

Compared to healthy participants, AN patients obtained a significantly lower BMI and scored higher on the Eating Disorder Inventory (EDI-2) and the Toronto Alexithymia Scale (TAS-26), but did not differ in age. All demographic and clinical characteristics of the samples are displayed in Table 3.

Valence Hypotheses

Affective standard pictures. In a first step, hypotheses regarding the affective standard pictures were tested by (3 × 2) ANOVAs with startle reflex (or SAM valence score) as the dependent variable and stimulus category (unpleasant, neutral, pleasant) and group (AN, CN) as the independent variables. The results are summarized in Figure 1.

Hypothesis 1: We expect a decrease of the startle reflex magnitude from unpleasant over neutral to pleasant cues in both groups. As predicted by Hypothesis 1, we found a significant main effect for the stimulus category, $F(2,210) = 17.7$; $p < .001$: The startle reflex magnitude was significantly higher for unpleasant pictures than for neutral pictures, $F(1,284) = 13.2$; $p < .001$, and it was also significantly higher for neutral pictures than for pleasant pictures, $F(1,284) = 4.1$; $p = .045$, in both groups; consequently, the unpleasant versus pleasant comparison was significant as well, $F(1,284) = 31.9$; $p < .001$. No Stimulus Category × Group interaction effect was observed, $F(2,210) = 1$; $p = .360$.

Hypothesis 2: We expect a decrease of the SAM valence score (1: pleasant*, 9:* unpleasant*) from unpleasant over neutral to pleasant in both groups.* Analysis of the SAM data revealed a significant main effect for the stimulus category, $F(2,210) = 347.3$; $p < .001$: the SAM score was significantly higher for unpleasant pictures than for neutral pictures, $F(1,284) = 298.8$; $p < .001$, and also for neutral pictures compared with pleasant ones in both groups, $F(1,284) = 67.5$; $p < .001$ (for the sake of completeness, the values for the pleasant vs. unpleasant comparison were $F(1,284) = 650.3$; $p < .001$). Comparable results were found by Kruskal-Wallis test ($\varphi^2 = 160.2$; $p < .001$, asymp.) and after correcting for multivariate testing (MANOVA; y: SAM score, startle magnitude; x: group, stimulus category) $F(4;418) = 118.3$; $p < .001$; exact test. An unexpected interaction effect, $F(2,210) = 7.5$; $p = .001$, was found; that is, the patients showed a significantly smaller increase of the SAM score for the unpleasant pictures, $F(1,70) = 4.5$; $p_c = .038$, and a significantly less decrease for the pleasant pictures (compared to neutral pictures), $F(1,70) = 7.4$ $p_c = .008$, than the controls did. However, as the examination by Mann-Whitney U tests replicated this group difference only for the unpleasant pictures, U = 416.5; $p_c = .024$, but not for the pleasant pictures. U = 448.0; $p_c = .069$, this side result should be taken with care.

Table 3. *Demographic and Clinical Characteristics of the Samples*

	AN patients ($n = 36$)	CN ($n = 36$)	AN vs. CN p
Age (years)	15.9 (2.0)	16.1 (1.7)	.660
BMI (kg/m^2)	15.8 (1.4)	20.5 (2.0)	< .001***
TAS-26 score	43.9 (8.3)	38.1 (8.3)	.026*
EDI-2 overall score	172.3 (37.5)	120.4 (25.5)	.043*
Scale body dissatisfaction	30.7 (10.3)	22.5 (7.9)	.013*
Scale drive for thinness	20.7 (11.0)	13.21 (3.4)	.033*

AN = anorexia nervosa; CN = healthy controls; BMI = body mass index; TAS-26 = Toronto Alexithymia Scale; EDI-2 = Eating Disorder Inventory.
*$p < .05$. ***$p < .001$.

Emaciated body pictures. In a second step, the main hypotheses regarding the body pictures were tested, using (2 × 2) ANOVAs with stimulus category (body vs. neutral) and group (AN, CN) as the independent variables. For overview, see Figure 1.

Hypothesis 3: We expect a decrease of the startle reflex magnitude (compared to neutral cues) among the patients, but an increase among the controls while viewing emaciated body cues. The overall analysis of body versus neutral pictures resulted in a significant stimulus Category × Group interaction effect, $F(1,140) = 9.5$; $p < .01$, which was in line with Hypothesis 3. Among the patients, the startle reflex response elicited during the viewing of emaciated bodies was significantly smaller than that elicited during the viewing of the neutral, $F(1,140) = 4.6$; $p = .030$, and unpleasant pictures, $F(1,140) = 13.0$; $p < .001$, but not different from that elicited during the viewing of the pleasant cues, $F(1,140) < 1$. The controls' response, in contrast, was significantly larger than that for the neutral, $F(1,140) = 5.4$; $p = .021$, and pleasant pictures, $F(1,140) = 9.6$; $p = .002$, but not as large as that for the unpleasant cues, $F(1,140) = 4.4$; $p = .038$. No main effect for stimulus category was found, $F(1,140) < 1$.

Hypothesis 4: No such group difference is expected for the SAM valence score (1: pleasant*, 9:* unpleasant*), with both groups rating the emaciated body cues as negative relative to neutral cues.* In contrast to the startle reflex data, self-report answers did not reveal any stimulus Category × Group interaction effect, $F(1,140) = 1.75$; $p = .187$. Yet, a significant main effect for stimulus category (body vs. neutral) was observed, $F(1,140) = 593.1$; $p < .001$. This effect was significant also by Kruskal-Wallis tests ($\varphi^2 = 105.9$; $p < .001$, asymp.). Thus, the body pictures scored significantly higher and were rated significantly more negatively than neutral pictures in both groups, AN: $F(1,140) = 150.5$; $p < .001$; CN: $F(1,140) = 291.0$; $p < .001$. The body versus pleasant comparison, $F(1,140) = 746.539$; $p < .001$, and the body versus unpleasant comparison, $F(1,140) = 7.791$; $p = .005$, were significant, too. This was also true for nonparametric methods (Mann-Whitney U tests: body vs. pleasant: U = 36.0; $p < .001$; body vs. unpleasant: U = 1922.5; $p = .007$; all tests exact).

Arousal Hypotheses

The statistical tests were conducted analogously to Hypotheses 1–4, but with SCR (overall HR change, HR acceleration, HR deceleration, and SAM arousal score, respectively) as the dependent variable. The results are summarized in Figure 2.

Affective standard pictures. *Hypothesis 5: We expect an increase of physiological arousal (SCR, overall HR change) for pleasant and unpleasant cues relative to neutral cues in both groups.* In contrast to our expectations, analysis of the SCR data did not show any main effect for the stimulus category, $F(2,210) < 1$; that is, comparably low SCR scores for pleasant, unpleasant, and neutral pictures were observed. SCR data did not reveal any stimulus Category × Group interaction effect, $F(2,210) = 2.372$; $p = .096$, and no main effect for the group, $F(1,210) < 1$. Yet, a significant main effect for the stimulus category regarding the overall HR, $F(2,162) = 17.132$; $p < .001$, with a significantly stronger decrease (relative to baseline) for unpleasant pictures than for pleasant, $F(1,110) = 27.923$ $p_c = .002$, and neutral pictures, $F(1,110) = 12.067$; $p_c = .002$, was found (the pleasant vs. neutral comparison did not reach the level of significance, $F(1,110) = 3.319$; $p_c = .210$. This pattern was replicated by the component scores (i.e., we found a significant increase of the HR deceleration, $F(2,162) = 17.132$; $p < .001$, and significant decrease of the HR acceleration, $F(2,162) = 6.754$; $p = .002$, from pleasant over neutral to unpleasant). No Group × Stimulus category interaction effect was observed (overall HR: $F(2,162) = 2.904$; $p = .058$, component scores: $F(2,162) < 1$.) However, there was an unexpected main effect for group with a significantly lower HR deceleration, $F(1,162) = 27.745$; $p < .001$, in AN patients than in controls, and a significantly lower decrease of the overall HR score relative to baseline, $F(1,162) = 27,75$; $p < .001$ was found.

Hypothesis 6: We expect an increase of the SAM arousal score (1: low arousal*; 9:* high arousal*) for pleasant and unpleasant cues relative to neutral cues in both groups.* The analysis of the SAM arousal data revealed a significant main effect for the stimulus category, $F(2,210) = 108.541$; $p < .001$, with a significantly enlarged self-reported arousal for the pleasant and unpleasant pictures compared to the neutral cues. This effect was significant even after examining the results by Kruskal-Wallis tests ($\varphi^2 = 81.105$; $p < .001$; asymp). No stimulus Category × Group interaction effect, $F(2,210) = 1.063$ $p = .347$, was found. Analogous to the HR data, there was an unexpected main effect for group, $F(1,210) = 12.876$; $p < .001$, with a significantly lower self-reported arousal in the patients than in the controls. This was true even after examining the results by Mann-Whitney U tests (U = 3023.5; $p = .023$) and after correction for multivariate testing (y: overall HR change, SAM arousal score; x: group, stimulus category), $F(2,166) = 9.512$; $p < .001$; exact.

Emaciated Body Pictures

Hypothesis 7: We expect a comparable increase of physiological arousal (SCR, overall HR change) (relative to neutral cues) during viewing of emaciated body cues in both groups. As expected, analysis of the SCRs regarding the body versus neutral pictures did not reveal any main effect for group, $F(1,140) < 1$, and no stimulus Category × Group interaction effect, $F(1,140) < 1$, was found. A significant main effect for the stimulus category was observed, $F(1,140) = 13.975$; $p < .001$; that is, SCR elicited by emaciated body pictures was significantly larger than that elicited by neutral cues in both groups. This finding was replicated by nonparametric methods (Mann-Whitney U test, U = 1692.5; $p < .001$; exact). In line with the findings regarding the affective standard cues, HR data showed a significant main effect for group, $F(1,108) = 31.029$; $p < .001$; that is, a significantly lower HR deceleration, $F(1,108) = 21.399$; $p < .001$, and a significantly lower decrease of the overall HR (relative to baseline) in AN patients than in controls were found, $F(1,108) = 31.029$; $p < .001$. No main effects for the stimulus category (body vs. neutral) overall HR score: $F(1,108) = 1.896$; $p = .171$; component scores: $F(1,108) < 1$, and no Group × Stimulus category interaction effects were observed (for all HR scores: $F(1,108) < 1$). Yet, there was a significant interaction effect for the body versus pleasant comparison: in the controls, emaciated body cues (compared to pleasant cues) evoked a significantly stronger decrease of the overall HR relative to baseline, $F(1,54) = 11.165$; $p = .002$, and a marginally stronger deceleration response, $F(1,54) = 2.401$; $p = .127$; in the patients, comparable low overall HR and deceleration responses for body versus pleasant cues were found, $F(1,54) < 1$. For the sake of completeness, we did not find any significant interaction effect (body vs. pleasant) for the accelerative component, $F(1,108) < 1$.

Hypothesis 8: We expect a comparable increase of the SAM arousal score (1: low arousal*, 9:* high arousal*) (relative to neutral cues) during viewing of emaciated body cues in both groups.*

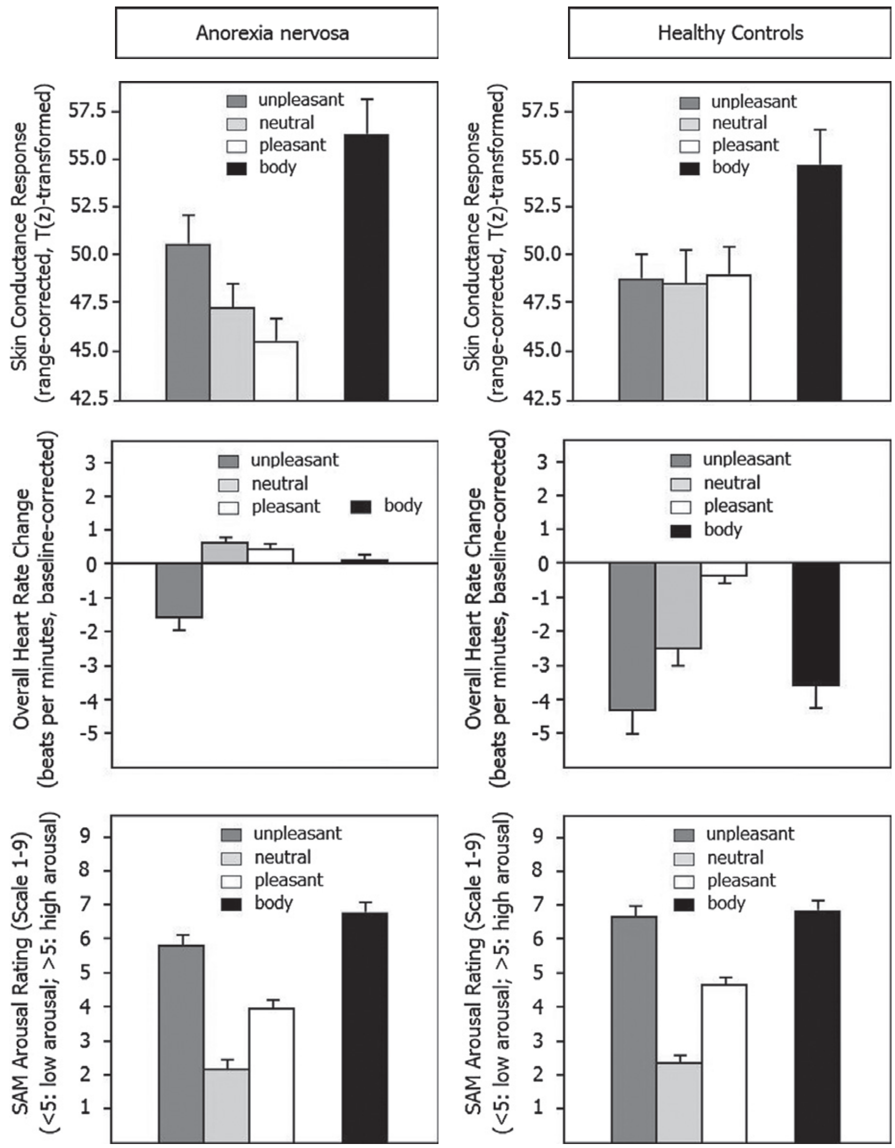

Figure 2. Emotional arousal reactions of anorexia nervosa patients and healthy controls while being confronted with emaciated body pictures in comparison to the three standard categories. The results are presented as means with standard error bars.

Analogous to the SCR data, SAM arousal scores showed a significant main effect for the stimulus category, $F(1,140) < 287.162$; $p < .001$: In both groups, a significant increase of self-reported arousal for emaciated body cues compared to neutral pictures was found. This main effect was significant even after correction by Mann-Whitney U tests, $U = 2858$; $p < .001$, and after correction for multivariate testing (y: SCR, SAM arousal score; x: group, stimulus category) $F(2,139) = 139.401$; $p < .001$ (all tests exact). No main effect for group, $F(1,140) = 1.638$; $p = .203$, and no Stimulus category × Group interaction effect, $F(1,140) < 1$, were observed.

Potential Confounders

AN patients self-reported a significantly worse mood, $F(1,70) = 10.9$; $p_c = .002$, a higher arousal, $F(1,70) = 5.9$; $p_c = .017$, and a significantly higher body dissatisfaction, $F(1,70) = 36.1$; $p_c < .001$, before the testing than healthy participants, but did not differ in hunger, $F(1,70) = 1.3$; $p_c = .268$. To determine, whether one of these factors might have biased the main results, we calculated (2 × 2) ANCOVAs analogous to step 2, that is, with body versus neutral as main contrast for stimulus category. As expected, including these covariates did not make any difference to the results: Main effects for stimulus category, SCR: $F_{anc}(1,136) = 13.975$; $p < .001$; SAM valence score: $F_{anc}(1,136) = 577.5$; $p < .001$; SAM arousal score: $F_{anc}(1,136) = 287.005$; $p < .001$, stayed significant, even if these covariates were included. The same was true for the main effect for group regarding the HR scores (overall HR score: $F_{anc}(1,102) = 11{,}595$, $p = .001$; HR deceleration: $F_{anc}(1,102) = 11{,}629$, $p = .001$) and for the Group × Stimulus category interaction effect regarding the startle reflex, $F_{anc}(1,136) = 9.6$; $p < .01$ (only significant effects were reported).

Within the patient group, we controlled for the influence of therapy duration and duration of the eating disorder: for this, several one-way analyses of covariance (ANCOVAs) with stimulus category (body vs. neutral) as independent variables were calculated. Also here, the main effect for stimulus category was significant, independently of whether the covariates were included or not (startle reflex: $F_{anc}(1,68) = 4.4$; $p = .040$; SCR: $F_{anc}(1,68) = 8.277$; $p = .005$; SAM valence score: $F_{anc}(1,68) = 226.1$, $p < .001$; SAM arousal score: $F_{anc}(1,68) = 145.268$; $p < .001$).

Discussion

As opposed to previous investigations, which deal with the issue of thin ideal internalization, this study uses a body cue that is aversive for healthy people (Ito & Lang 1998; Rand et al., 1997): bodies with projecting ribs, hips, and cheekbones, sunken cheeks and abdomen, which are indicative of cachexia. As expected, the results revealed a strikingly different physiological processing of this stimulus type in both groups.

Valence Hypotheses

Healthy participants showed a significant startle potentiation while being exposed to emaciated bodies. In contrast, a significant startle inhibition was found among AN patients, and the extent of this response was as strong as the one while viewing of pleasant cues, denoting that the pictures were substantially appealing to anorexic viewers. This is consistent with findings regarding other addictions (Rohsenow, Niaura, Childress, Abrams, & Monti, 1990, for review) and with observations in Pro Ana forums (Overbeke, 2008). However, it is contrary to findings of previous studies in AN (Cserjesi et al., 2010; Friederich et al., 2006) as well as the first evidence for automatic appetitive reactions on addiction-specific stimuli in AN at all. No group differences in general emotional functioning or situational factors, which might have biased the body cue results, were found. Therapy duration and duration of the eating disorder did not have any influence on the body cue results either.

No appetitive response, but an aversive one, was found on self-report level, with both groups rating emaciated body pictures as negative. This discrepancy might be explained as follows: the patients might have been "unaware" of their automatically activated appetitive reactions, or, "if aware," not have been "willing to express them but [have been] . . . rather motivated to hide or suppress them in fear of amplified social stigmatization" (Degner & Wentura, 2009, p. 215). Berridge (1996) spoke of a discrepancy between "wanting" (motivation to starve) and "liking" (knowledge of the negative consequences of starving and of the fact that emaciation is not generally considered beautiful). This conflict is characteristic for substance dependencies as well, such as for alcoholics, who also want to drink, although they do not really like the taste or smell and despite knowing the health-damaging effects of drinking (Mucha et al., 2000). Nevertheless, explaining the phenomenon by social desirability effects seems to be the more obvious choice, if we regard the setting (inpatient) and the fact, that denial of illness, noncompliance, and socially desirable answering tendencies are often observed in patients with AN (Vandereycken, 2006).

Arousal Hypotheses

In line with Lang (1995), whereupon appetitive reactions (as observed in AN) and aversive reactions (as observed in CN) necessitate an at-least-moderately high arousal degree, a significant increase of physiological (SCR) and self-reported arousal while viewing emaciated bodies was found. This might explain why emaciated body cues evoked an appetitive reaction among the patients, while idealized slim body cues did not: magazine pictures might have been simply not exciting enough for the patients to activate their appetitive motivational system. Addictive cues for substance dependencies are usually highly arousal-provoking, too (Childress et al, 1992; Niaura et al, 1988). An unexpected differential effect regarding the HR data was observed. Healthy controls showed a significant HR deceleration during viewing of the body cues, which was as strong as the one while viewing of unpleasant cues (in line with Lang, 1995, whereupon a sustained deceleratory response is indicative for this picture type). In the patients, in contrast, no HR deceleration but a comparable response as observed during viewing of the pleasant cues was found. Even if this finding seems to support the startle reflex results, it should be taken with care. Eighteen percent of the HR data was defective due to technical problems. The number of pictures that was used for the arousal analysis was very low (see Table 1). Most important, this effect was not specific for the body cues, but an overall reduced deceleratory response for AN versus CN was found. This suggests that differences in general arousal (possibly influenced by somatic characteristics such as bradycardia, which is a well-known side effect of continuous starving (Casiero & Frishman, 2006; Portilla, 2011), might have been an influencing factor.

Affective Standard Pictures

Although valence scores (startle reflex, SAM valence score) and arousal scores (overall HR change, SAM arousal score) separated significantly between the neutral and unpleasant cues, no significant neutral versus pleasant comparison was found (an exception was only the SAM valence score). This might have been due to the stimulus choice, as pictures that usually provoke high physiological arousal had to be excluded to adhere to the criteria of youth protection. The choice of the method might have played a role as well: Even if there is much evidence that the startle reflex magnitude is significantly larger for unpleasant pictures than for pleasant pictures, many studies failed to find a startle attenuation for pleasant pictures relative to neutral ones. Regarding the SCR results (no significant pleasant vs. neutral and no significant neutral vs. unpleasant comparison), the method of data acquisition might have contributed to the problem, too: SCR response peaks were scored in the time window between 0.9 s and 4 s after picture onset. Prior research, however, showed that the peak of an SCR response can occur within a window of 0.5–5 s following response onset. It seems possible that this shortened scoring window could have artificially lowered the SCR values observed. Hence, our results should be examined by other measures that do not exhibit these problems.

Implications

In this study, we have confirmed for the first time that extremely emaciated body pictures, in analogy to addictive cues from addiction disorders, evoke automatic appetitive reactions in adolescents and young adults with AN, but aversive reactions in healthy controls. No index on an overall downregulation of the appetitive motivational system in AN (Friederich et al., 2006) was found. The assumed special role of AN within addiction research and especially the presumption that AN would have more similarities (on the motivational level) with anxiety and obsessive disorders than with addiction disorders (Friederich et al., 2006) appears, therefore, at least doubtful. Possibilities for a practical application of the startle reflex paradigm in AN later on are given: the startle reflex inhibition towards addictive cues is a worthwhile prognostic parameter (Childress et al., 1992; Loeber et al., 2007), a measure for treatment effects, and a measure for the effects of exposure therapy beyond the level of self-report (Mauler, Hamm, Weike, & Tuschen-Caffier, 2006, p. 577).

Our results take a new glance at the fear of weight gain versus drive for thinness debate: the fear of weight gain theory (Vartanian et al., 2005) proposes that starving primarily serves as a "tool" to reduce the fear of being or becoming fat (Cserjesi et al., 2010). The drive for thinness theory (Thompson & Stice, 2001) also involves a strong motivation to approximate to a specific body ideal. Our study raises doubts for the exclusive validity of the fear of weight gain theory. Moreover, it also casts doubts on the common interpretation of the drive for thinness theory. Since pictures of extremely emaciated bodies provoked an appetitive reaction among the patients, while pictures of idealized slim bodies did not (Friederich et al., 2006), one might assume that the role-model function of the often criticized mass media pictures for anorexic adolescents is not as wide as expected, and that AN patients rather pursue a specific, extremely cachectic body ideal. As a consequence, AN therapy should abstain from unilaterally focusing on the aspect of weight phobia: in addition to negative learning experiences and negative role models (Vartanian et al., 2005), therapists should focus on the rewards or hedonic values that the patient might draw from starving, as well as the positive learning experiences and positive role models that might have reinforced the drive to reach an extremely emaciated body. Unfortunately, Pro Ana forums provide, in this respect, an almost optimal learning environment. This not only includes the way emaciation is portrayed or how far weight loss is linked to positive consequences (social support and positive weight-related comments by others, "rewarding points" for weight loss in "weight contests"), but also the community-specific obligation to post daily messages in the forums (Overbeke, 2008, for review)—in this context, a good precondition for successful learning.

Limitations

The results are limited as follows. Firstly, we investigated adolescents and young adults and cannot generalize for older patients. Secondly, we did not have a comparison group of noneating disordered underweight females. Thus, we cannot exclude that the results reflect a weight-related ingroup effect (first described by Degner & Wentura, 2009, in a study regarding overweight females). Thirdly, all patients were in contact with their anorexic fellow patients, which might have led to a certain habituation to cachectic bodies. The unbalanced number of pictures should be addressed (12 body, but 9 in each standard category). In general, averaging over a higher number of presentations could artificially produce a lower startle response because of habituation. This effect, however, is only relevant if the picture type is blocked, but not if the pictures of the different stimulus categories are intermingled, as was done in our study. Finally, we must mention the cross-sectional design (no valid information about the temporary stability of the observed effects) and the limited ecologic validity of the setting.

Summary and Directions for Future Studies

This study is, to the best of our knowledge, the first to examine emotional reactions to extremely emaciated body pictures in AN measured by the startle reflex paradigm, and the first to do so with picture material from Pro Ana forums. Our data show that extremely emaciated body pictures, similar to addictive cues from addiction disorders, evoke automatic appetitive reactions in patients with AN, but aversive reactions in healthy individuals. No group difference but comparably high aversion ratings were found in self-reports. These findings suggest that a distorted positive view of extreme emaciation is a relevant motivational factor for self-initiated starving, and that exposure to accordant body cues (thinspiration galleries) evokes the drive to reach this extremely emaciated body ideal. Future studies should aim to find out how this positive view on emaciation might have developed, and whether it is rather a precondition or a consequence of the disorder. Additionally, research should address the possibility of influencing these response patterns and the (therapeutic) conditions needed thereby. Further approaches for studies are the context dependency (such as antirecovery vs. preventive context), the behavioral relevance, and the potential prognostic value of the findings.

References

American Psychiatric Association, (2000). *Diagnostic and statistical manual for mental disorders* (4th ed.). Washington, DC: American Psychiatric Press. doi: 10.1176/appi.books.9780890423349

Bardone-Cone, A. M., & Cass, K. M. (2006). Investigating the impact of pro-anorexia websites: A pilot study. *European Eating Disorders Review*, *14*, 256–262. doi: 10.1002/erv.714

Berridge, K. C. (1996). Food reward: Brain substrates of wanting and liking. *Neuroscience & Biobehavioral Reviews*, *20*, 1–25. doi: 10.1016/0149-7634(95)00033-B

Blumenthal, T. D., Cuthbert, B. N., Filion, D. L., Hackley, S., Lipp, O. V., & van Boxtel, A. (2005). Committee report: Guidelines for human startle eyeblink electromyographic studies. *Psychophysiology*, *42*, 1–15. doi: 10.1111/j.1469-8986.2005.00271.x

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The Self-Assessment Manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, *25*, 49–59.

Cash, T. F., & Deagle, E. A. (1997). The nature and extent of body-image disturbances in anorexia nervosa and bulimia nervosa: A meta-analysis. *International Journal of Eating Disorders*, *22*, 107–125. doi: 10.1002/(SICI)1098-108X(199709)22:2<107:: AID-EAT1>3.0.CO;2-J

Casiero, D., & Frishman, W. H. (2006). Cardiovascular complications of eating disorders. *Cardiology in Review*, *14*, 227–231. doi: 10.1097/01.crd.0000216745.96062.7c

Childress, A. R., Ehrman, R., Rohsenow, D. J., Robbins, S. J., & O'Brien, C. P. (1992). Classically conditioned factors in drug dependence. In J. H. Lowinson, P. Ruiz, R. B. Millman, & J. G. Langrod (Eds.), *Substance abuse: A comprehensive textbook*, (2nd ed., pp. 56–69). Baltimore, MD: Williams & Wilkins.

Cserjési, R., Vermeulen, N., Luminet, O., Marechal, M., Nef, F., Simon, Y., & Lénárd, L. (2010). Explicit vs. implicit body image evaluation in restrictive anorexia nervosa. *Psychiatry Research*, *175*, 148–153. doi: 10.1016/j.psychres.2009.07.002

Davis, M., Falls, W. A., Campeau, S., & Kim, M. (1993). Fear-potentiated startle: A neural and pharmacological analysis. *Behavioral Brain Research*, *58*, 175–198. doi: 10.1016/0166-4328(93)90102-V

Degner, J., & Wentura, D. (2009). Not everybody likes the thin and dislikes the fat: One's weight matters in the automatic activation of weight-related social evaluations. *Social Cognition*, *27*, 202–21. doi: 10.1521/soco.2009.27.2.202

Friederich, H. C., Kumari, V., Uher, R., Riga, M., Schmidt, U., Campbell, I. C., . . . Treasure, J. (2006). Differential motivational responses to food and pleasurable cues in anorexia and bulimia nervosa: A startle reflex paradigm. *Psychological Medicine*, *36*, 1327–1335. doi: 10.1017/S0033291706008129

Graham, F. K. (1978). Constraints in measuring heart rate and period sequentially through real and cardiac time. *Psychophysiology*, *15*, 492–495. doi: 10.1111/j.1469-8986.1978. tb01422.x

Haas, S. M., Irr, M. E., Jennings, N. A., & Wagner, L. M. (2011). Communicating thin: A grounded model of online negative enabling support groups in the pro-anorexia movement. *New Media & Society*, *13*, 40–57. doi: 10.1177/1461444810363910

Ito, T. A., & Lang, P. J. (1998). Eliciting affect using the International Affective Picture System: Trajectories through evaluative space. *Personality and Social Psychology Bulletin*, *24*, 855–879. doi: 10.1177/0146167298248006

Jaccard, J., & Wan, C. K. (1996). *LISREL approaches to interaction effects in multiple regression*. Thousand Oaks, CA: Sage Publications.

Lang, P. J. (1995). The emotion probe. Studies of motivation and attention. *American Psychology*, *50*, 372–385. doi: 10.1037/0003-066X.50.5.372

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual*. Technical Report A-8. Gainsville, FL: University of Florida.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1990). Emotion, attention, and the startle reflex. *Psychological Review*, *97*, 377–398. doi: 10.1037/0033-295X.97.3

Levitt, D. H. (2003). Drive for thinness and fear of fat: Separate yet related constructs? *Eating Disorders: The Journal of Treatment and Prevention*, *11*, 221–234. doi: 10.1080/10640 260390218729

Loeber, S., Croissant, B., Nakovics, H., Zimmer, A., Georgi, A., Klein, S., . . . Flor, H. (2007). The startle reflex in alcohol-dependent patients: Changes after cognitive-behavioral therapy and predictive validity for drinking behavior. A pilot study. *Psychotherapy and Psychosomatics*, *76*, 385–390. doi: 10.1159/000107567

Lykken, D. T., Rose, R., Luther, B., & Maley, M. (1966). Correcting psychophysiological measures for individual differences in range. *Psychological Bulletin*, *66*, 481–484. doi: 10.1037/h0023922

Mauler, B. I., Hamm, A. O., Weike, A. I., & Tuschen-Caffier, B. (2006). Affect regulation and food intake in bulimia nervosa: Emotional responding to food cues after deprivation and subsequent eating. *Journal of Abnormal Psychology*, *115*, 567–579. doi: 10.1037/0021-843X.115.3.567

Mucha, R. F., Geier, A., Stuhlinger, M., & Mundle, G. (2000). Appetitive effects of drug cues modeled by pictures of the intake ritual: Generality of cue-modulated startle examined with inpatient alcoholics. *Psychopharmacology*, *151*, 428–432. doi: 10.1007/s0021300 00508

Niaura, R. S., Rohsenow, D. J., Binkoff, J. A., Monti, P. M., Pedraza, M., & Abrahams, D. B. (1988). Relevance of cue reactivity to understanding alcohol and smoking relapse. *Journal of Abnormal Psychiatry*, *97*, 133–152. doi: 10.1037/0021-843X.97.2.133

Norris, M. L., Boydell, K. M., Pinhas, L., & Katzman, D. K. (2006). Ana and the Internet: A review of pro-anorexia websites. *International Journal of Eating Disorders*, *39*, 443–447. doi: 10.1002/eat.20305

Overbeke, G. (2008). Pro-anorexia websites: Content, impact, and explanations of popularity. *Mind Matters: The Wesleyan Journal of Psychology*, *3*, 49–62. Retrieved from http://www.wesleyan.edu/psyc/mindmatters/volume03/article05.pdf

Portilla, M. G. (2011). Bradycardia: an important physical finding in anorexia nervosa. *The Journal of the Arkansas Medical Society*, *107*, 206–208.

Rand, C. S., Resnick, J. L., & Seldman, R. S. (1997). Assessment of socially acceptable body sizes by university students. *Obesity Research*, *5*, 425–429. doi: 10.1038/oby

Rohsenow, D. J., Niaura, R. S., Childress, A. R., Abrams, D. B., & Monti, P. M. (1990). Cue reactivity in addictive behaviors: Theoretical and treatment implications. *International Journal of Addictions*, *25*, 957–993. doi: 10.3109/10826089109071030

Ryle, A., & Evans, C. D. (1991). Some meanings of body and self in eating disordered and comparison subjects. *British Journal of Medical Psychology*, *64*, 273–283. doi: 10.1 111/j.2044-8341.1991.tb01666.x

Schmidt, D. R. (1988). *The use of a priori techniques with a MANOVA*. Paper presented at the Annual Meeting of the Mid-South Educational Research Association (17th), Louisville, KY.

Strife, S. R., & Rickard, K. (2011). The conceptualization of anorexia: The Pro-Ana perspective. *Affilia*, *26*, 213–217. doi: 10.1177/0886109911405592

Thiel, A., Jacobi, C., Horstmann, S., Paul, T., Nutzinger, D. O., & Schüssler, G. (1997). Eine deutschsprachige Version des Eating Disorder Inventory EDI-2 [A German version of the Eating Disorder Inventory EDI-2]. *Psychotherapie, Psychosomatik, Medizinische Psychologie*, *47*, 365–376.

Thompson, J. K., & Stice, E. (2001). Thin-ideal internalization: Mounting evidence for a new risk factor for body-image disturbance and eating pathology. *Current Directions in Psychological Science*, *10*, 181–183. doi: 10.1111/1467-8721.00144

Uher, R., Murphy, T., Friederich, H. C., Dalgleish, T., Brammer, M. J., Giampietro, V., & Phillips, M. L. (2005). Functional neuroanatomy of body shape perception in healthy and eating disordered women. *Biological Psychiatry*, *58*, 990–997. doi: 10.1016/j.biops ych.2005.06.001

Vandereycken, W. (2006). Denial of illness in anorexia nervosa—a conceptual review: Part 1 Diagnostic significance and assessment. *European Eating Disorders Review*, *14*, 341–351. doi: 10.1002/erv.721

Vartanian, L. R., Herman, P. C., & Polivy, J. (2005). Implicit and explicit attitudes toward fatness and thinness: The role of the internalization of societal standards. *Body Image*, *2*, 373–381. doi: 10.1016/j.bodyim.2005.08.002

(Received July 10, 2012; Accepted September 6, 2013)