Received: 27 July 2020 | Revised: 17 September 2020 | Accepted: 1 November 2020

DOI: 10.1002/erv.2812

RESEARCH ARTICLE

WILEY

Weight bias and linguistic body representation in anorexia nervosa: Findings from the BodyTalk project

Simone Claire Behrens[1,2] | **Paolo Meneguzzo[3]** | **Angela Favaro[3,4]** | **Martin Teufel[5]** | **Eva-Maria Skoda[5]** | **Marion Lindner[5]** | **Lukas Walder[1]** | **Alejandra Quiros Ramirez[2,6]** | **Stephan Zipfel[1]** | **Betty Mohler[2]** | **Michael Black[2]** | **Katrin E. Giel[1]**

[1]Department of Psychosomatic Medicine and Psychotherapy, Medical University Hospital Tübingen, Tübingen, Germany

[2]Max Planck Institute for Intelligent Systems, Tübingen, Germany

[3]Department of Neuroscience, University of Padova, Padova, Italy

[4]Padova Neuroscience Center, University of Padova, Padova, Italy

[5]Clinic for Psychosomatic Medicine and Psychotherapy, University of Duisburg-Essen, LVR University-Hospital Essen, Essen, Germany

[6]Psychology Department, University of Konstanz, Konstanz, Germany

Correspondence
Simone Claire Behrens, Department of Psychosomatic Medicine and Psychotherapy, Medical University Hospital Tübingen, Tübingen 72076, Germany.
Email: simone.behrens@med.uni-tuebingen.de

Funding information
Medical Faculty Tübingen, Grant/Award Number: 2535-0-0

Open access funding enabled and organized by Projekt DEAL.

Abstract

Objective: This study provides a comprehensive assessment of own body representation and linguistic representation of bodies in general in women with typical and atypical anorexia nervosa (AN).

Methods: In a series of desktop experiments, participants rated a set of adjectives according to their match with a series of computer generated bodies varying in body mass index, and generated prototypic body shapes for the same set of adjectives. We analysed how body mass index of the bodies was associated with positive or negative valence of the adjectives in the different groups. Further, body image and own body perception were assessed.

Results: In a German-Italian sample comprising 39 women with AN, 20 women with atypical AN and 40 age matched control participants, we observed effects indicative of weight stigmatization, but no significant differences between the groups. Generally, positive adjectives were associated with lean bodies, whereas negative adjectives were associated with obese bodies.

Discussion: Our observations suggest that patients with both typical and atypical AN affectively and visually represent body descriptions not differently from healthy women. We conclude that overvaluation of low body weight and fear of weight gain cannot be explained by generally distorted perception or cognition, but require individual consideration.

KEYWORDS
anorexia nervosa, body image disturbance, body size estimation, double standards, weight bias

Abbreviations: AN, anorexia nervosa; ANOVA, analysis of variance; BIQ-20, Body Image Questionnaire; BMI, body mass index (kg/m2); BPI, Body Perception Index; EDE-Q, Eating Disorder Examination Questionnaire; EDI-2, Eating Disorder Inventory; PACS, Physical Appearance Comparison Scale; PHQ-9, Patient Health Questionnaire; R-SES, Rosenberg Self-Esteem Scale.

1 | INTRODUCTION

Body image disturbance is a key symptom of anorexia nervosa (AN) and a significant predictor for poor treatment outcome, potentially through increasing stress and depression (Junne et al., 2019). Although patients assign a crucial role to body image for their recovery (Kenny, Boyle, & Lewis, 2019; Richmond et al., 2020), body image disturbance is still insufficiently understood, and hence the scarce specific therapeutic interventions are largely atheoretical or focus on targeting fear of weight gain (Ziser et al., 2018). The current study investigates whether a shifted weight bias, reflected in language use on body shapes and weight might contribute to the tenaciousness of body image disturbance in AN.

To date, a significant proportion of clinical research on body image in AN was motivated by the question whether the patient's typical worries about being 'too fat' might be due to a perceptual deficit in judging body size and shape. Indeed, patients with AN frequently overestimate their body size in vision-based body size estimation tasks (for a review see Mölbert, Klein, et al., 2017) and, partly, also show altered performance in nonvisual tasks assessing body perception (Engel et al., 2020; Gaudio, Brooks, & Riva, 2014; Mergen, Keizer, Koelkebeck, van den Heuvel, & Waner, 2018). However, the effect pattern seen in a meta-analysis conducted by Mölbert, Klein, et al. (2017) as well as several well-controlled experimental studies (Cornelissen, Bester, Cairns, Tovee, & Cornelissen, 2015; Fernández Aranda, Dahme, & Meermann, 1999; Mölbert et al., 2018) suggest that the patients' idea of being 'too fat' is unlikely due to a deficit in representing the own body weight and dimensions accurately.

An alternative explanation for the apparently different concepts of 'thin' and 'fat' in people with anorexia nervosa may be a shift in language which patients use to describe bodies. It has been demonstrated for various psychological disorders that typical cognitive biases are reflected in characteristic changes in language use (Chojnicka & Wawer, 2020; Edwards & Holtzman, 2017; Hofmann, Moore, Gutner, & Weeks, 2012). Likewise, patients with AN could use emotional language to describe body shapes that would be considered normal by most people. Language is considered one of the main sources for the pervasive spread of weight bias (Rubino et al., 2020). Analyses of social media content suggest that weight-based stereotypes might also contribute to the maintenance of AN, claiming that the disorder might be a guard to attributes such as laziness, lack of will or minor intelligence (Branley & Covey, 2017; Cavazos-Rehg et al., 2019). Given the overestimation of weight and shape in AN, it is possible that patients with AN may associate a negative valence with body weights and shapes that are rated neutrally or even positive by healthy people.

Highlights

- Computerized tasks were used to assess the visual representation of linguistic body descriptions in patients with typical and atypical anorexia nervosa (AN) as compared with controls
- Performance suggested weight bias in all groups, but no differences between groups
- It is concluded that patients with AN apply double standards to their own and other bodies and that body image disturbance needs individual consideration

Interestingly, while some studies have been conducted on patients with AN as subject of stigmatization, little is known about the stereotypes they hold towards others (Puhl & Suh, 2015). In non-eating disordered participants, it has been shown that weight based valence ratings follow an inverse u-shape, that is, that slender healthy weight will be rated most positive whereas low and high weight are subject to weight-based stereotypes (Mölbert, Thaler, et al., 2017). If weight bias in patients with AN was indeed shifted on a general processing level, we would expect that only underweight should be associated with positive attributes, whereas normal and high weight should be subject to negative weight-based stereotypes. However, it has been suggested that in people with eating disorders, body representation might be characterized through double standards, that is that the own body is represented and evaluated differently from bodies in general (Voges et al., 2017, 2018, 2019; von Wietersheim et al., 2012). In this case, there should be no general bias, that is, no differences in weight bias between women with AN and healthy controls, but only distorted evaluations or representations of the own body.

The current study seeks to provide a comprehensive assessment of own body representation and linguistic representation of bodies in general in women with AN and with atypical AN. To this end, we complement standard methods of body image assessment with novel methods to assess linguistic body shape perception and weight-based stereotypes. To obtain valid assessments of body shape visualization and prevent socially desired answer behaviour (Ruggs, King, Hebl, & Fitzsimmons, 2010), the current study adapts an experimental method developed by Streuber et al. (2016) and makes use of a 3D statistical body model for the biometrically plausible visualization of different body shapes (Loper, Mahmoud, Romero, Pons-Moll, & Black, 2015). Specifically, we investigated group differences between women with typical AN, atypical AN and control participants in body image, body representation and weight bias. Weight bias was assessed by (1) associations between body mass index (BMI, kg/m^2) and valence of attributed adjectives and (2) average BMI associated with negative, neutral, and positive attributes.

2 | METHODS

2.1 | Participants

Participants were recruited within the 'BodyTalk' project at three centres in Germany and Italy: Tübingen (GER), Essen (GER), and Padova (IT). In all study sites, adult patients (≥18 years) with AN and atypical AN were recruited from the outpatient department and inpatient services briefly after admission. Control participants were recruited from the local communities. About 39 women with AN, 20 women with atypical AN, and 40 age matched female control participants participated in the current study. AN was diagnosed by experienced clinicians according to ICD-10; a diagnosis of atypical AN (ICD-10 F50.1) was given when patients were partly weight restored or did not meet all AN criteria for other reasons (e.g., did not show fear of weight gain). Patients with acute and severe psychiatric or neuropsychiatric symptoms (e.g., severe attentional deficits, lack of orientation, or psychotic symptoms) were not considered eligible for the study. Control participants were screened in a brief interview and the EDE-Q (Hilbert, Tuschen-Caffier, Karwautz, Niederhofer, & Munsch, 2007) by the experimenter and excluded in case of a BMI <17.5 or >25 kg/m^2 as well as when the interview or EDE-Q indicated a potentially disturbed eating behaviour (e.g., binge or purging behaviour, scales values in the range of clinical groups). All participants provided written informed consent to participate in the study. The study was conducted in accordance with the ethical guidelines from the Declaration of Helsinki and was approved by the local ethics committees.

2.2 | Study materials

We used a set of self-report questionnaires as well as two computerized desktop tasks. Both computer tasks can be obtained from the authors upon request.

2.2.1 | Sample characteristics

To characterize the sample clinically, all participants completed the depression module of the Patient Health Questionnaire (PHQ-9, Kroenke & Spitzer, 2002) and the Rosenberg Self-Esteem Scale (R-SES, Ferring & Filipp, 1996; von Collani & Herzberg, 2003). Further, age, size, weight, lowest weight ever, age at first diagnosis, and duration of current symptoms were assessed using a self-developed questionnaire and, in case of patients, verified by the experimenter based on the clinical documentation.

2.2.2 | Body image and body representation

Eating disorder symptoms and body dissatisfaction were assessed using the Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994), the Body Image Questionnaire (BIQ-20, Clement & Löwe, 1996), and the Drive for Thinness and Body Dissatisfaction scales of the Eating Disorder Inventory 2 (EDI-2; Garner, Olmstead, & Polivy, 1983). Additionally, the Physical Appearance Comparison Scale (PACS; Thompson, Heinberg, & Tantleff, 1991) was administered.

2.2.3 | Weight bias

To assess explicit weight bias, we administered the short version of the Fat Phobia Scale (Bacon, Scheltema, & Robinson, 2001). For a more implicit assessment of weight bias, we used two computerized tasks: a rating task in which participants evaluated to what degree adjectives applied to bodies of different weight and an adjustment task in which participants generated prototypic bodies for different adjectives. Screenshots and schematic illustrations of the tasks are presented in Figures 1 and 2. To control for individual differences in valence of adjectives, we asked participants to rate each of the 15 adjectives on a 5-point scale ranging from 'clearly negative' to 'clearly positive'. The order of the adjectives was randomised.

For the rating task, we used a selection of 12 female bodies from the Streuber et al. (2016) dataset. The body shapes in this dataset were generated based on a statistical model of human body shape (SMPL; Loper et al., 2015) by sampling shape defining principal components following a normal distribution. To estimate BMI of the resulting bodies, height and weight of the body meshes were determined as follows: Height (in meters) was determined by subtracting its 'highest point' minus its 'lowest point'. Weight of the mesh in kilograms was obtained by first calculating the volume, in

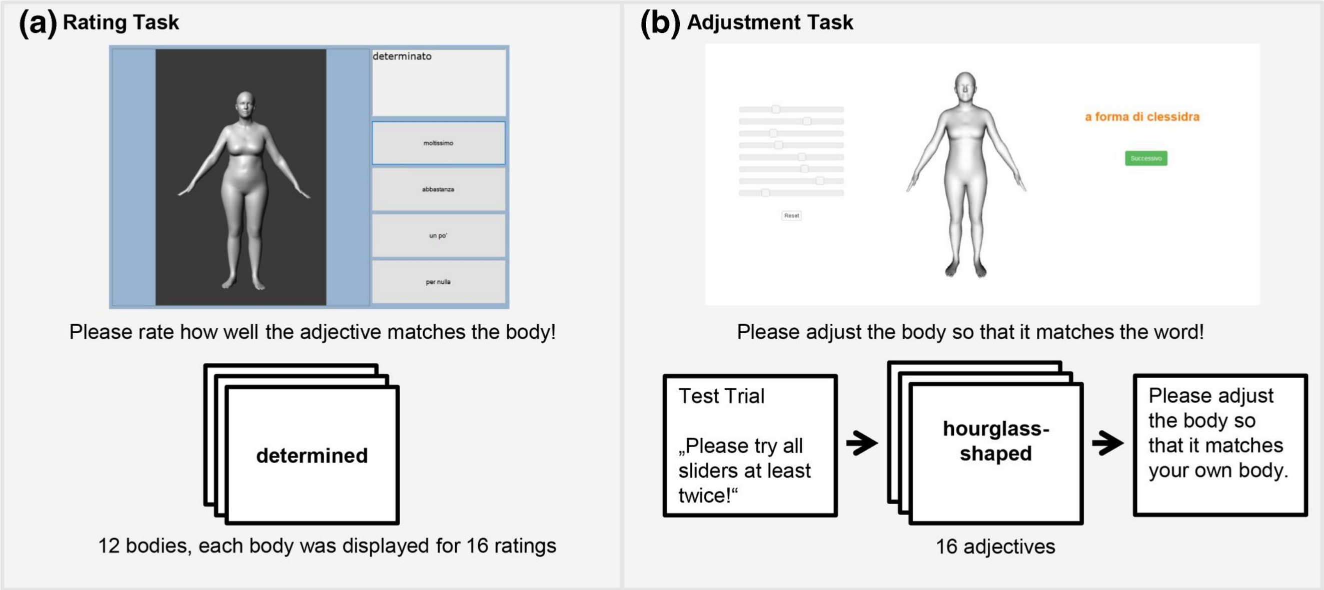

FIGURE 1 Illustration of the two computerized tasks that were used for the assessment of weight bias. (a) Rating task, (b) Adjustment task. The order of the bodies/adjectives was randomized. Both tasks are available from the authors upon request [Colour figure can be viewed at wileyonlinelibrary.com]

cubic meters, of the mesh as described by Zhang and Chen (2001) and dividing it by the human body density (in average 1010 kg/m^3; Satoh, 1992). For our task we selected 12 bodies ranging in BMI from 15.5 to 36.5 kg/m^2 such that the body shapes varied randomly in biometrically plausible shape and height, but systematically in their BMI. Three bodies were selected for each of the four weight categories defined by the world health organization: underweight, normal weight, overweight, and obesity. In a desktop experiment, we presented each of the 12 bodies 16 times in a row along with 16 different shape and character descriptive adjectives. The shape descriptive adjectives were selected from a range of shape descriptive words that were previously observed to be linked with specific shape representations in Streuber et al. (2016). The character descriptive adjectives were selected based on a review by Puhl and Suh (2015) that synthesizes findings on weight bias in different contexts. Adjectives were translated by a professional translator and double-checked for their connotations by two native speakers. The adjectives are listed in Table 2. In each of the 192 trials, participants had to judge on a 4-point scale from 'very much' to 'not at all' how well the adjective matched the displayed person. They were instructed to decide spontaneously or follow their first feeling, it was explicitly stated that there was no right or wrong answer. The order of the displayed bodies was randomised.

For the adjustment task, we adapted the body shape visualization tool by Streuber et al. (2016) such that we obtained a transformable female body shape. Transformation was implemented using eight sliders representing principal components of body shape. These principal components are statistical descriptors of body shape, not directly relatable to body shape dimensions, but appear to determine, for example, height, weight, leg length, or bust size. Start shape of the displayed body was set to the average SMPL body shape (for the female body 1.66 m, 69.5 kg), with all sliders starting in a neutral position. After a test trial in which participants could familiarize themselves with the sliders, we asked them to generate prototypic bodies for each of the 16 adjectives. In each trial, all sliders had to be moved before the participant could proceed to the next trial. The order of the adjectives was randomized. Lastly, participants were asked to generate a body that matches best their own body.

2.3 | Procedure

After providing written informed consent, participants completed the rating task, the adjustment task and the valence task. Questionnaires were completed after the computer tasks. The order of the tasks and materials was kept constant over the participants and chosen to minimize carry-over effects from one task to another. The whole experiment took about 30 min.

2.4 | Statistical analysis

Univariate ANOVAS and Bonferroni-corrected post-hoc tests were calculated to examine group differences in

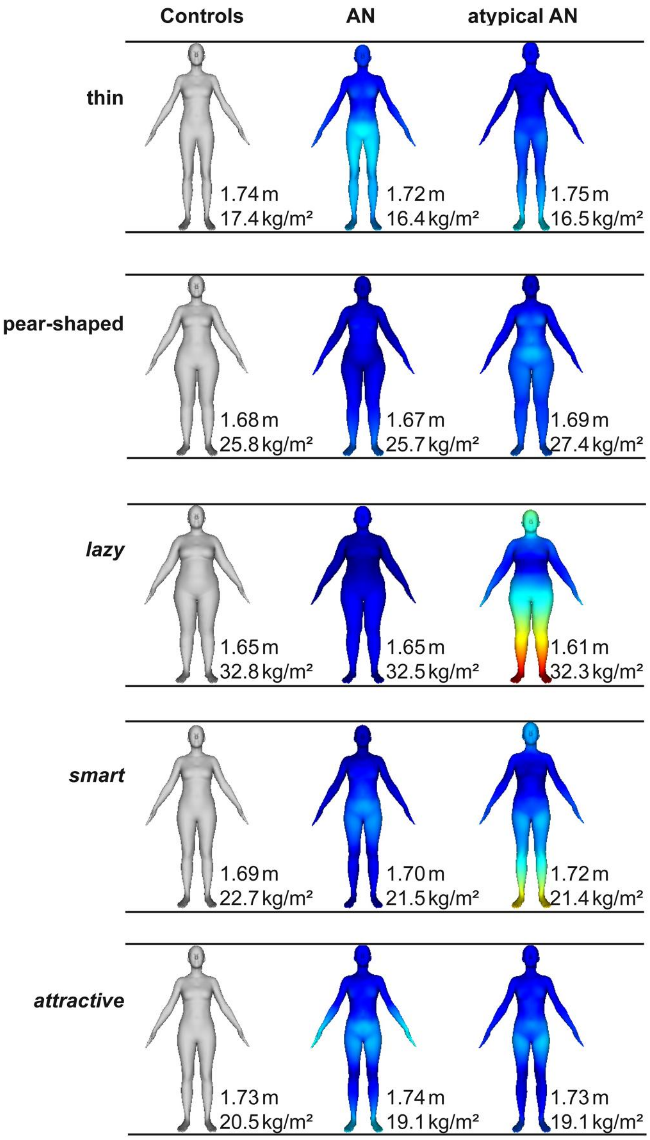

FIGURE 2 Average adjusted body shapes for selected adjectives in the adjustment task. The colour coding represents differences to the average adjusted body of the control group. Dark blue indicates no difference, dark red indicates the largest differences. Note that all observed shape differences were mainly due to height differences between the bodies. The statistical analysis uses body mass index (kg/m^2) of the body shapes and therefore ignores these height differences [Colour figure can be viewed at wileyonlinelibrary.com]

sample characteristics and body image. We also analysed the adjusted own bodies in terms of their BMI. To this end, we calculated Body Perception indices (BPI) according to the formula BPI = (estimated BMI/actual BMI) × 100 (Slade & Russell, 1973). We subsequently ran one-sample *t*-tests against the hypothetical accurate BPI of 100 for each subgroup and a one-way ANOVA to compare BPI over the groups.

As a preparatory step for the analysis of the rating task and adjustment task, we analysed the valence ratings of the adjectives. To account for the heterogeneity in valence evaluations (cf. Table 2), we used individual valence ratings of the adjectives (as opposed to average valences) in all further analyses.

To assess weight bias with the rating task, we combined valence ratings (−2 clearly negative to 2 clearly positive) and adjective match ratings (0 not at all to 4 very much) with the body mass index of the displayed bodies. To account for the individual variability in valence ratings of the adjectives, we computed a composite variable *Attitude* by multiplying the valence rating of the adjectives (−2 to 2) with the match ratings (1 to 4) of how well the adjectives matched the bodies. As a result, we obtained, for each participant and displayed body shape, 16 values for *Attitude*, indicating on a scale from −8 to 8 which valence was associated with the respective body and how strongly. Negative values indicate that a negatively valued adjective was considered to be matching, and positive values indicate that a positively valued adjective was associated. Neutral values indicate that a neutral valence was assigned to the respective adjective, that is, that it is irrelevant for a potential weight bias. *Attitude* had values ranging from −8 to 8, with $M = 0.56$ (SD = 3.44) and Md = 0, suggesting neutral attitudes on average but considerable variability in judgments. To check whether *Attitude* was systematically associated with the BMI of the displayed person, we computed Pearson correlations between *Attitude* and BMI of the displayed bodies for each group.

For the adjustment task, we derived BMI of the generated bodies following the procedure that was also used for determining the BMI of the rating task stimuli (for details see above). To check for general task adherence and data plausibility, we plotted the average adjusted bodies of the adjectives for each group and inspected shape differences visually. Figure 1 shows examples for average generated prototypic bodies for the given adjectives. Participants generated clearly different and plausible bodies, suggesting that the tool was adequate to assess a variety of different body shape visualizations and that participants were able to generate meaningful bodies using our body adjustment tool. The colour coding reflects differences in body shape relative to the average generated body of the control group. Shape differences occurred only in the context of height differences, which, however, were irrelevant for the study questions. To assess weight bias, we computed Pearson correlations between valence of the attributes (−2 to 2) and the average adjusted BMI for adjectives of this valence for each group. Univariate ANOVAS with post-hoc tests were used to compare the patterns between groups.

TABLE 1 Means and standard deviations for sample characteristics and body image/representation measures

	Controls ($n = 40$)			AN ($n = 39$)			Atypical An ($n = 20$)				
	M	SD		*M*	SD		*M*	SD		*Sig.*	*ES*
Sample characteristics											
Age	25.55	7.22	A	23.82	8.31	A	26.55	7.04	A	0.38	$Eta^2 = 0.02$
BMI (kg/m^2)	21.18	1.41	A	16.17	1.21	B	18.87	1.33	C	<0.001	$Eta^2 = 0.75$
Duration current episode of AN (months)	–	–		5.17	7.77	A	4.20	3.87	A	0.58	$d = 0.15$
Age first diagnosis	–	–		18.64	4.12	A	22.35	7.96	A	0.06	$d = 0.65$
Lowest BMI since puberty	18.91	1.44	A	14.36	1.72	B	16.15	2.54	C	<0.001	$Eta^2 = 0.56$
Highest BMI since puberty	22.59	1.99	A	20.96	3.00	A	24.46	7.64	B	<0.01	$Eta^2 = 0.09$
PHQ-9	3.95	3.27	A	11.10	4.83	B	12.23	6.85	B	<0.001	$Eta^2 = 0.39$
R-SES	20.81	5.28	A	15.51	4.44	B	12.26	6.02	B	<0.001	$Eta^2 = 0.31$
EDE-Q total score	0.77	0.85	A	2.58	1.22	B	2.99	1.82	B	<0.001	$Eta^2 = 0.39$
EDE-Q Restraint	0.79	1.06	A	2.08	1.54	B	2.75	2.07	B	<0.001	$Eta^2 = 0.22$
EDE-Q Eating Concern	0.26	0.51	A	2.17	1.17	B	2.19	1.64	B	<0.001	$Eta^2 = 0.44$
Body image/body representation											
EDE-Q weight concern	0.89	0.98	A	2.53	1.42	B	3.16	2.13	B	<0.001	$Eta^2 = 0.34$
EDE-Q shape concern	1.13	1.16	A	3.56	2.19	B	3.88	1.87	B	<0.001	$Eta^2 = 0.31$
BIQ-20 Perceived Body Dynamics	35.88	5.12	A	25.67	5.88	B	28.15	7.30	B	<0.001	$Eta^2 = 0.39$
BIQ-20 Negative Body Evaluation	21.65	7.56	A	33.41	5.98	B	37.45	9.33	B	<0.001	$Eta^2 = 0.45$
PACS	14.38	2.96	A	16.87	3.40	B	17.10	4.45	B	<0.01	$Eta^2 = 0.12$
EDI2 drive for thinness	8.18	8.34	A	14.81	8.80	B	21.77	13.34	C	<0.001	$Eta^2 = 0.22$
EDI2 body dissatisfaction	14.90	12.36	A	19.13	13.21	A	29.31	17.65	B	<0.01	$Eta^2 = 0.12$
BPI own body	104.41	11.82	A	113.18	19.18	B	114.58	21.24	B	<0.05	$Eta^2 = 0.07$

Note: Group differences were tested for significance with univariate ANOVAs (Duration of current Episode and Age at Diagnosis with *t*-Tests). Bonferroni-corrected post-hoc tests ($\alpha = 0.05$) are indicated with majuscules.

Abbreviations: BIQ-20, Body Image Questionnaire; BPI, Body Perception Index (estimated/actual size × 100) derived from adjustment task; EDE-Q, Eating Disorder Examination Questionnaire; EDI-2, Eating Disorder Examination 2; PACS, Physical Appearance Comparison Scale; PHQ-9, Patient Health Questionnaire Depression Module; R-SES, Rosenberg Self Esteem Scale.

3 | RESULTS

3.1 | Sample characteristics

Table 1 provides an overview on the sample characteristics. The groups did not differ in age, but in all other assessed variables, patient groups differed from control participants. In most of the variables assessing depression and eating disorder pathology, AN and atypical AN did not differ from each other, but both groups had more pathological scores than controls. In the PHQ-9, both patient groups had average scores >10, the cut-off that is indicative for a clinically relevant depression.

3.2 | Body image and representation of the own body

Body image data are presented in Table 1. As expected, women with (atypical) AN had significantly more pathological scores than Controls. Notably, women with AN and with atypical AN did not differ in body image but in the EDI scales. In these cases, women with atypical AN scored even higher than women with AN, indicating significantly higher levels of Drive for Thinness and Body Dissatisfaction (with medium effect sizes, $d = 0.37$ and $d = 0.31$).

In the assessment of body perception (adjustment task), data of 1 women with AN was lost, because she had

TABLE 2 Means and standard deviations of valence ratings of the provided *shape descriptive* and character descriptive adjectives

Adjective	Controls ($n = 40$) M	Controls SD	AN ($n = 39$) M	AN SD	Atypical AN ($n = 20$) M	Atypical AN SD	Sig.	Eta²
Smart	1.83	0.44	1.51	0.68	1.75	0.70	0.07	0.05
Attractive	1.76	0.43	1.38	0.63	1.55	0.81	<0.05	0.08
Open-minded	1.73	0.73	1.31	0.69	1.30	0.84	<0.05	0.07
Active	1.44	0.59	1.49	0.64	1.45	0.74	0.96	0.001
Determined	1.46	0.55	1.28	0.72	1.35	0.66	0.41	0.02
Feminine	1.32	0.75	1.10	0.78	1.05	0.81	0.40	0.02
Thin	0.56	0.77	0.79	0.99	1.20	0.98	0.06	0.06
Hourglass-shaped	0.20	0.89	0.00	1.09	−0.05	0.98	0.57	0.01
Impulsive	−0.32	0.87	−0.38	0.81	−0.65	0.85	0.27	0.03
Pear-shaped	−0.49	0.80	−0.85	0.92	−1.00	0.84	0.05	0.06
Apple-shaped	−0.73	0.59	−0.90	0.87	−1.00	0.84	0.46	0.02
Heavyset	−0.68	0.84	−0.95	0.68	−1.20	0.93	0.09	0.05
Clumsy	−0.68	0.75	−1.03	0.89	−1.20	0.60	<0.05	0.06
Insecure	−0.95	0.70	−1.18	0.68	−1.05	0.67	0.26	0.03
Lazy	−1.20	0.59	−1.31	0.69	−1.50	0.59	0.28	0.03
Unfriendly	−1.83	0.44	−1.51	0.78	−1.55	0.67	0.08	0.05

Note: The shape descriptive adjectives were selected from a range of shape descriptive words that were observed to be linked with specific shape representations in Streuber et al. (2016). The character descriptive adjectives were selected based on a review by Puhl and Suh (2015) that synthesizes findings on weight bias in different contexts. Ratings were given on a 5-point scale from −2 (clearly negative) to +2 (clearly positive). Group differences were tested for significance with univariate ANOVAs, but none of the group differences would have survived correction for multiple testing.

not adjusted a body for the own body. All groups adjusted bodies as 'own body' that had a significantly higher BMI than their actual body ($T_{AN}(37) = 4.24$, $p < 0.001$, $d = 0.69$; $T_{atyp.AN}(19) = 3.07$, $p < 0.01$, $d = 0.69$; $T_{Controls}(39) = 2.36$, $p < 0.05$, $d = 0.37$), but were roughly in the correct weight category. The ANOVA revealed a significant group difference, suggesting that the two patient groups overestimated even more than the control group ($F(2,95) = 3.53$, $p < 0.05$, $Eta^2 = 0.07$).

3.3 | Valence ratings

On a 5-point-scale from −2 to 2, the average valence rating was $M = 0.11$ (SD = 1.38), with only 'hourglass-shaped' having an average neutral valence ($M = 0.07$, SD = 0.99). All valence categories were covered with at least 14% of the ratings. However, standard deviations were high, especially in the neutrally rated adjectives. A series of one-way ANOVAs on average valence ratings suggested significant group differences in some adjective valence ratings between participants with AN, atypical AN, and Controls (see Table 2). While average rating tendencies, (i.e., whether it is positive, negative or neutral) were consistent across the groups, patients with AN and atypical AN generally rated adjectives more neutral, that is, showed a valence rating pattern consistent with 'affective flattening'. Effect sizes of these group differences were weak.

3.4 | Weight bias

In the Fat Phobia Scale, average scores were in the known range of biased judgments of overweight (Hellbardt, Riedel-Heller, & Sikorski, 2014). The ANOVA revealed a significant group effect ($F(2,96) = 3.31$, $p < 0.05$, $Eta^2 = 0.07$) suggesting that patients might express less weight bias, however post-hoc tests yielded no significant differences between the groups ($M_{Controls} = 3.56$, SD = 0.33, $M_{AN} = 3.42$, SD = 0.32, $M_{atyp.AN} = 3.34$, SD = 0.40, all $p > 0.06$).

In the rating task, we observed a small weight bias that did not differ between groups. As depicted in Figure 3a, all correlations between BMI of the displayed bodies and *Attitude* were small and negative ($r_{AN} = -0.13$, $r_{atyp.AN} = -0.12$, $r_{Controls} = -0.09$), that is the higher the body mass index of the displayed bodies, the less positive the body was evaluated. Notably, in absolute values, all ratings averaged in the positive and neutral range. This suggests that the weight bias here consists of less positive ratings rather than explicitly negative ones. Patients with typical AN and atypical AN generally assigned more neutral ratings, reflecting the flattened valence ratings for adjectives that was included in the *Attitude* variable.

A more pronounced weight bias was observed in the adjustment task (see Figure 3b). Correlations between valence of the adjective and BMI of the adjusted body were negative and moderate to strong in all groups ($r_{AN} = -0.58$, $r_{atyp.AN} = -0.57$, $r_{Controls} = -0.45$), that is negative adjectives were associated with higher adjusted BMI. For 'rather negative' and 'clearly negative' attributes participants adjusted bodies in the obese range while neutral bodies were associated with healthy weight and 'rather positive' and 'positive' attributes were associated with lean healthy weight bodies. A series of univariate ANOVAS with post-hoc tests revealed that in their average adjusted body mass indices, patients with typical AN and atypical AN did not differ significantly from each other, but both differed from Controls for clearly negative and clearly positive valence in the sense that they adjusted slightly more extreme high and low weights; whereas the inverse was true for 'rather negative' attributes and no such effect observed for 'rather positive' attributes. Note that all adjusted positive bodies in average had healthy weight, so there was neither a quantitative nor a qualitative shift in which weights are associated with positive, neutral, or negative attributes.

4 | DISCUSSION

In this study, we provide a comprehensive assessment of own and other body representation in AN and for the first time also include an experimental measure of weight bias. In addition to established methods for the assessment of body image, we used novel computerized tasks that enabled us to present weight graded bodies of different shapes as well as visualizing and analysing participants' attitudes and stereotypes towards different body weights. In a multicentre study design, we assessed a sample of 39 women with AN as well as 20 women with atypical AN and an age matched control sample of healthy females. Overall, our observations suggest that despite of their critical attitudes towards the own body, patients with typical and atypical anorexia nervosa do not generally represent body weight and shape differently from healthy controls.

Consistent with previous observations, we observed patients with (atypical) AN to be largely dissatisfied with their own body, to experience little positive affect regarding their body and to report strong habits of comparing their appearance to other people. Further, we observed an overestimation of the own body size in our adjustment task, that was even more pronounced in the women with (atypical) AN. However, in the context of previous studies we interpret this small effect in the context of task characteristics (Mölbert, Klein, et al., 2017). Our task was not clearly specified to be a perceptual one, so that this overestimation most likely reflects the self-assessment as 'too fat' and not a visual perceptual deficit.

Notably, in our data we did not observe any tendency to a shifted weight bias in the sense that patients with (atypical) AN generally hold stigma against healthy weight. Rather, both experimental tasks revealed a favouritism of underweight and healthy weight compared with overweight and obesity in all groups. In line with previous studies (Voges et al., 2018; Voges et al., 2017, 2019; von Wietersheim et al., 2012), we interpret our observations in the context of double standards for the own and other person's bodies. Our observations line up with studies (Cornelissen et al., 2015; Mergen et al., 2018; Mölbert et al., 2018) arguing that patients with AN do not show altered body representation in general, but rather a top–down cognitive–affective distortion in evaluating their own body. In this sense, social media contents that pick up weight based stereotypes and eating disorder symptoms (Branley & Covey, 2017; Cavazos-Rehg et al., 2019) most likely reflect over-occupation with weight and shape rather than shifted stereotypes.

In the current sample, patients with atypical AN showed the same or even a more pronounced psychopathology and body image disturbance than patients with AN. This is insofar plausible, as in our sample, atypical AN was typically diagnosed in only recently weight restored patients with AN or in patients that did not verbalize anybody or weight concern. In both cases, core criteria of AN such as fear of weight gain and overvaluation of weight and shape are typically present (Wildes, Forbush, & Markon, 2013). The psychometric data support the notion that patients with AN might establish and maintain a low bodyweight in order to cope with these symptoms, as well as previous findings that body image disturbance is often treated insufficiently (Junne et al., 2019). Moreover, they support the validity of the frequent practice of investigating mixed groups of patients with typical and atypical AN under the label of 'broad AN' or 'anorexia nervosa spectrum disorders'

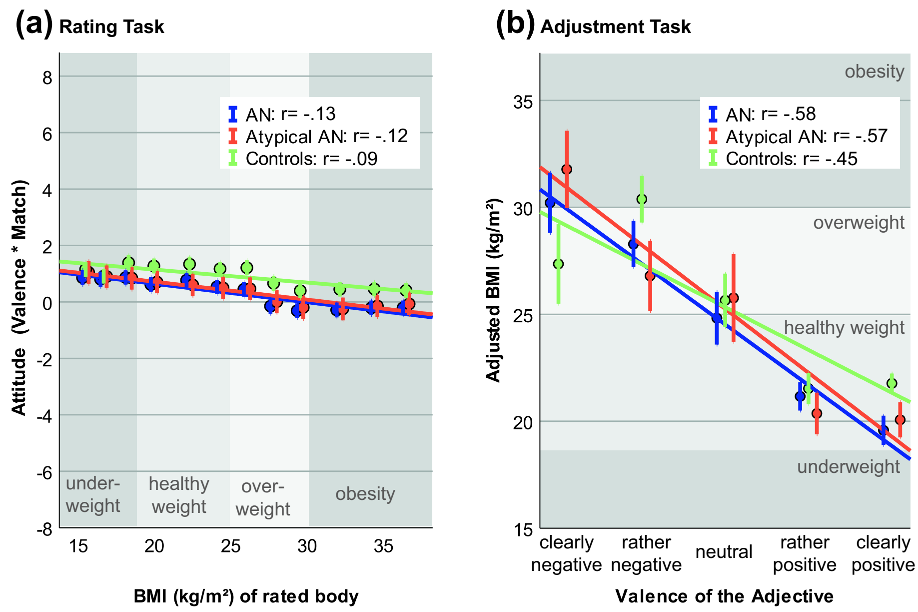

FIGURE 3 Weight bias as assessed through rating task and adjustment task. (a) Rating task: Association between attitude (adjective valence × match rating) and body mass index (BMI; kg/m^2) of the displayed body. Dots represent mean Attitudes for the respective body mass index. Error bars indicate 95% confidence intervals. (b) Adjustment task: Association between Valence of the adjective and BMI of the adjusted bodies. Dots represent mean BMI of the adjusted bodies; error bars indicate 95% confidence intervals. All values are jittered on the *x*-axis to improve readability of the figure [Colour figure can be viewed at wileyonlinelibrary.com]

(Cornelissen, McCarty, Cornelissen, & Tovee, 2017; Schmidt et al., 2013). For our analyses, we controlled for affective flattening in the patient groups, as reflected in the valence ratings of the adjectives and suggested by their increased depression scores in the PHQ-9.

Replicating previous studies on weight bias (Ruggs et al., 2010), we observed differently sized weight bias effects depending on the exact task instruction and setup. In our rating task, that asked participants to explicitly match attributes to specific bodies of different shape and weight, participants typically rated the body with a neutral or positive attribute. Although we observed small depreciating effects (r about -0.10) for higher weight, these bodies were only rated less positive, but not specifically assigned with negative attributes. By contrast, in our adjustment task, the weight of the generated prototypic bodies was strongly associated with valence of the attributes. Our tasks included aspects of both implicit and explicit association tests. However, in its design, our rating task assessed the tendency to apply stereotypes to evaluate *a specific* displayed person, whereas our adjustment task rather *generally* captured the strength of *held stereotypes* by instructing participants to generate a typical representative of the adjective. In this sense, the observed lack of group differences indicates that patients with (atypical) AN neither have more weight-based stereotypes nor apply them more willingly to individual persons.

Limitations of this study arise from the narrow focus of the used tasks as well as from technical and study design details. In this study, we presented average body shapes with grey shaded textures, that is, with no specific identity. Based on previous studies (Mölbert et al., 2018; Thaler et al., 2018), we assume that both shape characteristics and textures modulate how much participants identify with the stimulus and which mindset they activate to complete tasks. In the present study, we assessed only how participants evaluate bodies in general, but not how this might change when the evaluated bodies share features with their own body. Further, it is possible that the 4-point rating scale in the rating task artificially magnified the already small effect, and that the adjustment task results may be biased due to the limited options to deform the bodies. Specifically, the body model (Loper et al., 2015) that was used for the stimuli is created based on data from normal weight and overweight bodies, thus it does not generalize well to underweight body shapes. Consequently, it is possible that underweight body were perceived as more unnatural and that this produced a bias towards normal weight.

Overall, our study adds an important aspect to the clinical understanding of body image disturbance in (atypical) AN: it is neither defined by a fundamentally distorted body perception nor by distorted cognitions about bodies in general, but most likely limited to cognitive-affective biases about the own body and the relevance and consequences of potential weight gain. While this conclusion matches the upcoming changes of the body image criterion in ICD-11 and DSM 5, it also adds a perspective for more mechanism-oriented AN treatments (Brockmeyer, Friederich, & Schmidt, 2018; Glashouwer et al., 2020). Unlike prevention programs (Ciao, Loth, & Neumark-Sztainer, 2014), established treatment concepts for AN target body image only marginally (Alleva, Sheeran, Webb, Martijn, & Miles, 2015; Hay, 2020; Resmark et al., 2018). Conceptualizing overvaluation of body weight and shape as a phenomenon that needs to be understood and treated on an individual level may significantly improve patients motivation for treatment and their treatment outcomes.

ACKNOWLEDGEMENTS

Simone Claire Behrens was partially funded by the Fortüne program of the Medical Faculty Tübingen, Grant/Award Number 2535-0-0.

Open access funding enabled and organized by Projekt DEAL.

CONFLICT OF INTERESTS

In the last 5 years, MJB has received research gift funds from Intel, Nvidia, Facebook, and Amazon. He is a co-founder and investor in Meshcapade GmbH, which commercializes 3D body shape technology. While MJB is a part-time employee of Amazon, his research was performed solely at, and funded solely by, Max Planck Institute for Intelligent Systems.

DATA AVAILABILITY STATEMENT

Study data and materials can be provided by the authors upon reasonable request.

ORCID

Simone Claire Behrens https://orcid.org/0000-0002-0430-5245

Paolo Meneguzzo https://orcid.org/0000-0003-3323-6071

Angela Favaro https://orcid.org/0000-0002-6540-5194

REFERENCES

Alleva, J. M., Sheeran, P., Webb, T. L., Martijn, C., & Miles, E. (2015). A meta-analytic review of stand-alone interventions to improve body image. *PLoS One*, *10*(9), e0139177. https://doi.org/10.1371/journal.pone.0139177

Bacon, J. G., Scheltema, K. E., & Robinson, B. E. (2001). Fat phobia scale revisited: The short form. *International Journal of Obesity*, *25*, 252–257.

Branley, D. B., & Covey, J. (2017). Pro-ana versus pro-recovery: A content analytic comparison of social media users' communication about eating disorders on twitter and tumblr. *Frontiers in Psychology*, *8*, 1356. https://doi.org/10.3389/fpsyg.2017.01356

Brockmeyer, T., Friederich, H. C., & Schmidt, U. (2018). Advances in the treatment of anorexia nervosa: A review of established and emerging interventions. *Psychological Medicine*, *48*(8), 1228–1256. https://doi.org/10.1017/S0033291717002604

Cavazos-Rehg, P. A., Krauss, M. J., Costello, S. J., Kaiser, N., Cahn, E. S., Fitzsimmons-Craft, E. E., & Wilfley, D. E. (2019). I just want to be skinny: A content analysis of tweets expressing eating disorder symptoms. *PLoS One*, *14*(1), e0207506. https://doi.org/10.1371/journal.pone.0207506

Chojnicka, I., & Wawer, A. (2020). Social language in autism spectrum disorder: A computational analysis of sentiment and linguistic abstraction. *PLoS One*, *15*(3), e0229985. https://doi.org/10.1371/journal.pone.0229985

Ciao, A. C., Loth, K., & Neumark-Sztainer, D. (2014). Preventing eating disorder pathology: Common and unique features of sccessful eating disorders prevention programs. *Current Psychiatry Reports*, *16*(7), 453. https://doi.org/10.1007/s11920-014-0453-0

Clement, U., & Löwe, B. (1996). [Validation of the FKB-20 as scale for the detection of body image distortions in psychosomatic patients]. *Psychotherapie Psychosomatik Medizinische Psychologie*, *46*, 254–259.

Cornelissen, K. K., Bester, A., Cairns, P., Tovee, M. J., & Cornelissen, P. L. (2015). The influence of personal BMI on body size estimations and sensitivity to body size change in anorexia spectrum disorders. *Body Image*, *13*, 75–85. https://doi.org/10.1016/j.bodyim.2015.01.001

Cornelissen, K. K., McCarty, K., Cornelissen, P. L., & Tovee, M. J. (2017). Body size estimation in women with anorexia nervosa and healthy controls using 3D avatars. *Scientific Reports*, *7*(1), 15773. https://doi.org/10.1038/s41598-017-15339-z

Edwards, T. M., & Holtzman, N. S. (2017). A meta-analysis of correlations between depression and first person singular pronoun use. *Journal of Research in Personality*, *68*, 63–68. https://doi.org/10.1016/j.jrp.2017.02.005

Engel, M. M., van Denderen, K., Bakker, A. R., Corcoran, A. W., Keizer, A., & Dijkerman, H. C. (2020). Anorexia nervosa and the size-weight illusion: No evidence of impaired visual-haptic object integration. *PLoS One*, *15*(8), e0237421. https://doi.org/10.1371/journal.pone.0237421

Fairburn, C. G., & Beglin, S. J. (1994). The assessment of eating disorders: Interview or self-report questionnaire? *International Journal of Eating Disorders*, *16*, 363–370.

Fernández Aranda, F., Dahme, B., & Meermann, R. (1999). Body image in eating disorders and analysis of its relevance: A preliminary study. *Journal of Psychosomatic Research*, *47*(5), 419–427.

Ferring, D., & Filipp, S. (1996). Messung des Selbstwertgefühls: Befunde zu Reliabilität, Validität und Stabilität der Rosenberg-Skala. *Diagnostica*, *42*(3), 284–292.

Garner, D. M., Olmstead, M. A., & Polivy, J. (1983). Development and validation of a multidimensional eating disorder inventory for anorexia nervosa and bulimia. *International Journal of Eating Disorders*, *2*(2), 15–34.

Gaudio, S., Brooks, S. J., & Riva, G. (2014). Nonvisual multisensory impairment of body perception in anorexia nervosa: A systematic review of neuropsychological studies. *PLoS One*, *9*(10), e110087. https://doi.org/10.1371/journal.pone.0110087

Glashouwer, K. A., Brockmeyer, T., Cardi, V., Jansen, A., Murray, S. B., Blechert, J., … Werthmann, J. (2020). Time to make a change: A call for more experimental research on key mechanisms in anorexia nervosa. *European Eating Disorders Review*, *28*(4), 361–367. https://doi.org/10.1002/erv.2754

Hay, P. (2020). Current approach to eating disorders: A clinical update. *Internal Medicine Journal*, *50*(1), 24–29. https://doi.org/10.1111/imj.14691

Hellbardt, M., Riedel-Heller, S. G., & Sikorski, C. (2014). Dietitians' attitudes towards obese patients. *Ernährungs Umschau*, *61*(5), 78–81. https://doi.org/10.4455/eu.2014.015

Hilbert, A., Tuschen-Caffier, B., Karwautz, A., Niederhofer, H., & Munsch, S. (2007). Eating disorder examination-questionnaire. *Diagnostica*, *53*(3), 144–154. https://doi.org/10.1026/0012-1924.53.3.144

Hofmann, S. G., Moore, P. M., Gutner, C., & Weeks, J. W. (2012). Linguistic correlates of social anxiety disorder. *Cognition & Emotion*, *26*(4), 720–726. https://doi.org/10.1080/02699931.2011.602048

Junne, F., Wild, B., Resmark, G., Giel, K. E., Teufel, M., Martus, P., ... Zipfel, S. (2019). The importance of body image disturbances for the outcome of outpatient psychotherapy in patients with anorexia nervosa: Results of the ANTOP-study. *European Eating Disorders Review*, *27*(1), 49–58. https://doi.org/10.1002/erv.2623

Kenny, T. E., Boyle, S. L., & Lewis, S. P. (2019). #Recovery: Understanding recovery from the lens of recovery-focused blogs posted by individuals with lived experience. *International Journal of Eating Disorders*. https://doi.org/10.1002/eat.23221

Kroenke, K., & Spitzer, R. L. (2002). The PHQ-9: A new depression diagnostic and severity measure. *Psychiatric Annals*, *32*(9), 509.

Loper, M., Mahmoud, N., Romero, J., Pons-Moll, G., & Black, M. J. (2015). SMPL: A skinned multi-person linear model. *ACM Transactions on Graphics*, *34*(248), 1.

Mergen, J., Keizer, A., Koelkebeck, K., van den Heuvel, M. R. C., & Waner, H. (2018). Women with anorexia nervosa do not show altered tactile localization compared to healthy controls. *Psychiatry Research*, *267*, 446–454.

Mölbert, S. C., Klein, L., Thaler, A., Mohler, B. J., Brozzo, C., Martus, P., ... Giel, K. E. (2017). Depictive and metric body size estimation in anorexia nervosa and bulimia nervosa: A systematic review and meta-analysis. *Clinical Psychology Review*, *57*, 21–31. https://doi.org/10.1016/j.cpr.2017.08.005

Mölbert, S. C., Thaler, A., Mohler, B. J., Streuber, S., Romero, J., Black, M. J., ... Giel, K. E. (2018). Assessing body image in anorexia nervosa using biometric self-avatars in virtual reality: Attitudinal components rather than visual body size estimation are distorted. *Psychological Medicine*, *48*(4), 642–653. https://doi.org/10.1017/S0033291717002008

Mölbert, S. C., Thaler, A., Streuber, S., Black, M. J., Karnath, H. O., Zipfel, S., ... Giel, K. E. (2017). Investigating body image disturbance in anorexia nervosa using novel biometric figure rating scales: A Pilot study. *European Eating Disorders Review*, *25*(6), 607–612. https://doi.org/10.1002/erv.2559

Puhl, R. M., & Suh, Y. (2015). Stigma and eating and weight disorders. *Current Psychiatry Reports*, *17*(3), 552. https://doi.org/10.1007/s11920-015-0552-6

Resmark, G., Kennedy, B., Mayer, M., Giel, K., Junne, F., Teufel, M., ... Zipfel, S. (2018). Manualised cognitive behaviour therapy for anorexia nervosa: Use of treatment modules in the ANTOP study. *Journal of Clinical Medicine*, *7*(11), 398. https://doi.org/10.3390/jcm7110398

Richmond, T. K., Woolverton, G. A., Mammel, K., Ornstein, R. M., Spalding, A., Woods, E. R., & Forman, S. F. (2020). How do you define recovery? A qualitative study of patients with eating disorders, their parents, and clinicians. *International Journal of Eating Disorders*. https://doi.org/10.1002/eat.23294

Rubino, F., Puhl, R. M., Cummings, D. E., Eckel, R. H., Ryan, D. H., Mechanick, J. I., ... Dixon, J. B. (2020). Joint international consensus statement for ending stigma of obesity. *Nature Medicine*, *26*(4), 485–497. https://doi.org/10.1038/s41591-020-0803-x

Ruggs, E. N., King, E. B., Hebl, M., & Fitzsimmons, M. (2010). Assessment of weight stigma. *Obesity Facts*, *3*(1), 60–69. https://doi.org/10.1159/000273208

Satoh, H. (1992). *Collection of ergonomic data and equations*. Tokyo: Gihoudou.

Schmidt, U., Renwick, B., Lose, A., Kenyon, M., DeJong, H., Broadbent, H., ... Landau, S. (2013). The MOSAIC study - comparison of the Maudsley model of treatment for adults with anorexia nervosa (MANTRA) with specialist supportive clinical management (SSCM) in outpatients with anorexia nervosa or eating disorder not otherwise specified, anorexia nervosa type: Study protocol for a randomized controlled trial. *Trials*, *14*(160), 1–10.

Slade, P. D., & Russell, G. F. M. (1973). Awareness of body dimensions in anorexia nervosa: Cross-sectional and longitudinal studies. *Psychological Medicine*, *3*, 188–199.

Streuber, S., Quiros-Ramirez, M. A., Hill, M. Q., Hahn, C. A., Zuffi, S., O'Toole, A., & Black, M. J. (2016). Body talk: Crowdshaping Realistic 3D avatars with words. *ACM Transactions on Graphics*, *35*(4), 1–14. https://doi.org/10.1145/2897824.2925981

Thaler, A., Geuss, M. N., Mölbert, S. C., Giel, K. E., Streuber, S., Romero, J., ... Mohler, B. J. (2018). Body size estimation of self and others in females varying in BMI. *PLoS One*, *13*(2), e0192152. https://doi.org/10.1371/journal.pone.0192152

Thompson, J. K., Heinberg, L. J., & Tantleff, S. (1991). The Physical appearance comparison scale (PACS). *The Behavior Therapist*, *14*, 174.

Voges, M. M., Giabbiconi, C. M., Schone, B., Braks, K., Huber, T. J., Waldorf, M., ... Vocks, S. (2018). Double standards in body evaluation? How identifying with a body stimulus influences ratings in women with anorexia nervosa and bulimia nervosa. *International Journal of Eating Disorders*, *51*(11), 1223–1232. https://doi.org/10.1002/eat.22967

Voges, M. M., Giabbiconi, C. M., Schone, B., Waldorf, M., Hartmann, A. S., & Vocks, S. (2017). Double standards in body evaluation? The influence of identification with body stimuli on ratings of attractiveness, body fat, and muscle mass. *Eating and Weight Disorders*. *24*:1173-1180. https://doi.org/10.1007/s40519-017-0450-5

Voges, M. M., Giabbiconi, C. M., Schone, B., Waldorf, M., Hartmann, A. S., & Vocks, S. (2019). Gender differences in body evaluation: Do men show more self-serving double standards than women? *Frontiers in Psychology*, *10*, 544. https://doi.org/10.3389/fpsyg.2019.00544

von Collani, G., & Herzberg, P. Y. (2003). Eine revidierte Fassung der deutschsprachigen Skala zum Selbstwertgefühl von

Rosenberg. *Zeitschrift für Differentielle und Diagnostische Psychologie*, *24*(1), 3–7. https://doi.org/10.1024//0170-1789.24.1.3

von Wietersheim, J., Kunzl, F., Hoffmann, H., Glaub, J., Rottler, E., & Traue, H. C. (2012). Selective attention of patients with anorexia nervosa while looking at pictures of their own body and the bodies of others: An exploratory study. *Psychosomatic Medicine*, *74*(1), 107–113. https://doi.org/10.1097/PSY.0b013e31823ba787

Wildes, J. E., Forbush, K. T., & Markon, K. E. (2013). Characteristics and stability of empirically derived anorexia nervosa subtypes: Towards the identification of homogeneous low-weight eating disorder phenotypes. *Journal of Abnormal Psychology*, *122*(4), 1031–1041. https://doi.org/10.1037/a0034676

Zhang, C., & Chen, T. (2001). *Efficient feature extraction for 2D/3D objects in mesh representation*. Paper presented at the International Conference on Image Processing.

Ziser, K., Mölbert, S. C., Stuber, F., Giel, K. E., Zipfel, S., & Junne, F. (2018). Effectiveness of body image directed interventions in patients with anorexia nervosa: A systematic review. *International Journal of Eating Disorders*, *51*(10), 1121–1127. https://doi.org/10.1002/eat.22946

How to cite this article: Behrens SC, Meneguzzo P, Favaro A, et al. Weight bias and linguistic body representation in anorexia nervosa: Findings from the BodyTalk project. *Eur Eat Disorders Rev*. 2021;29:204–215. https://doi.org/10.1002/erv.2812