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Altered exposure-related reshaping of body appreciation in adolescent patients with anorexia nervosa

Running Head: FAMILIARITY AND BODY APPRECIATION IN ANOREXIA

Altered Exposure-Related Reshaping of Body Appreciation in Adolescent Patients with Anorexia Nervosa.

Abstract

Several studies suggest a relation between repeated exposure to extremely thin bodies in media and the perceptual and emotional disturbances of body representation in anorexia nervosa (AN). In this study, we utilized an exposure paradigm to investigate how perceptual experience modulates body appreciation in adolescents with AN as compared to healthy adolescents. Twenty AN patients and 20 healthy controls were exposed to pictures of thin or round models and were then required to express liking judgments about bodies of variable weight. Brief exposure to round models increased the liking judgments of round bodies but not those of thin bodies in healthy adolescents. Furthermore, exposure to round models increased the liking judgments of both thin and round bodies in adolescents with AN. Patients did not show any change of liking judgments after exposure to thin models. These results point to weak norm-based reshaping of body appreciation in AN patients.

Keywords: body image; esthetic appreciation; perceptual adaptation; anorexia nervosa; configural processing

Introduction

Eating disorders (EDs) are a unique case in psychiatry because of the etiological role attributed to social and cultural factors. Since the overwhelming majority of individuals who develop an EDs are women (Stice, Marti, & Rohde, 2013), attention has been paid to cultural influences on the formation of woman identity and to the views of the social and family role of women in Western society. In particular, the ideal of thinness conveyed by mass media has been shown to negatively impact body image (Derenne & Beresin, 2006; Hausenblas, Campbell, Menzel, Doughty, Levine & Thompson 2013; Keel & Forney, 2013; Stice, 2002). The constant proposal of ultra-thin models in the media may lead to the internalization of lean body ideals of beauty, contributing to increase the degree of body dissatisfaction in adolescent and young women (Benowitz-Fredericks, Garcia, Massey, Vasagar, & Borzekowski, 2012; Calado, Lameiras, Sepulveda, Rodríguez, & Carrera, 2010; Groesz, Levine, & Murnen, 2002; Hoek, 2006; Rodgers, Salès, & Chabrol, 2010; Stice, Schupak-Neuberg, Shaw, & Stein, 1994; Sypeck, Gray, Etu, Ahrens, Mosimann & Wiseman, 2006; Voracek & Fisher, 2002). Internalizing ideals of ultra-thin beauty is more likely to affect adolescents than adult women, because adolescence is a dynamic phase of life, with many psychological and physical changes, which may make adolescents more sensitive to approval and recognition from others (Presnell, Bearman & Stice, 2004; Siervogel et al., 2003). Those who are dissatisfied with their bodies are also more likely to engage in potentially harmful weight-control behaviors and they are at risk of developing EDs (Moore, 1993). This urges the study of how media exposure affects body perception and its appreciation in adolescents.

Studies of face attractiveness have extensively demonstrated that familiarity is a crucial factor in driving our appreciation of others' faces (Langlois et al., 2000; Langlois & Roggman, 1990; Pollard, 1995) and that perceptual experience modulates attractiveness

judgments of faces (Rhodes, Jeffery, Watson, Clifford, & Nakayama, 2003) and also what we find normal or average in a face (Leopold, O'Toole, Vetter, & Blanz, 2001). More limited is research on the influence of perceptual experience on the ratings of normality and attractiveness of body figures. Winkler and Rhodes (2005) asked participants to make judgments of normality and attractiveness of bodies before and after exposure to a particular body weight. The results showed that exposure to both thin and round models modulated normality judgments, thus shifting perceived normality toward the adapted weight. Conversely, the judgment of body attractiveness was modulated only after exposure to thin models, but not after exposure to round models. Another study (Glauert, Rhodes, Byrne, Fink, & Grammer, 2009) showed that the degree of body dissatisfaction and internalization of Western ideals are negatively correlated with the effects of exposure to round models. Indeed, women with high body dissatisfaction did not change their body attractiveness judgments after exposure to round models, suggesting that body dissatisfaction may be associated with an asymmetric influence of perceptual experience on body appreciation. All in all, these studies showed that exposure to body models can change body appreciation either by changing the way in which bodies are perceived or by reshaping the aesthetic norms to which they are compared.

In line with this view, two non-mutually-exclusive mechanisms have been proposed to explain the experience-based reshaping of body appreciation, namely perceptual aftereffects and norm-based coding (Cazzato, Mian, Mele, Tognana, Todisco & Urgesi 2016; Mele, Cazzato, & Urgesi, 2013) Perceptual aftereffects occur when exposure to certain features of a stimulus modifies perception in the opposite direction to that of the adapted features (Thompson & Burr, 2009); for example, if an observer is exposed for a while to round body models, subsequently presented bodies appear thinner, while the opposite occurs

after exposure to thin models. These perceptual alterations may then influence body appreciation, explaining more positive ratings after exposure to round models and more negative ones after exposure to thin models. Crucially, these perceptually driven modulations of body appreciation are expected to be independent from the similarity between the weight of the model and the weight of the stimulus body (Glauert et al., 2009; Mohr et al., 2016; Thompson & Burr, 2009; Winkler & Rhodes, 2005). In other words, both round and thin bodies are expected to be perceived as thinner and, thus, probably liked more after exposure to round adapting bodies, while the opposite pattern is expected after exposure to thin adapting bodies.

Conversely, according to norm-based coding mechanisms (Dennett, McKone, Edwards, & Susilo, 2012; Maurer, Grand, & Mondloch, 2002; Reed, Stone, Grubb, & McGoldrick, 2006; Trujillo, Jankowitsch, & Langlois, 2014; Valentine, 1991; Valentine, Darling, & Donnelly, 2004), body exposure may reshape a prototype-referenced template that is used to perceive and appreciate body stimuli. Thus, the appreciation of body stimuli that are similar to the model (e.g., round bodies after exposure to round models) increases, while the appreciation of body stimuli that deviate from the model (e.g., thin bodies after exposure to round models) decreases.

In sum, while perceptual aftereffects predict parallel changes of the perception and appreciation of thin and round bodies after body exposure, norm-based mechanisms would induce opposite modulation on the perception and appreciation of thin and round body stimuli. However, previous studies (Glauert et al., 2009; Winkler & Rhodes, 2005) have focused on estimating which body figure appears mostly attractive after body exposure, which prevented them to disentangle between the two mechanisms. Exploring the different effects exerted by body exposure on the appreciation of thin and round body stimuli, it has

been shown that both mechanisms are in action during body exposure in healthy adults (Cazzato et al., 2016; Mele et al., 2013). Conversely, only perceptual aftereffects may explain the consequences of body exposure in adult patients with AN, since a parallel increase of the liking of both thin and round body stimuli was observed after exposure to round bodies (Cazzato et al., 2016). This might point to weak norm-based reshaping of body ideals (Urgesi et al., 2014) and abnormally strong perceptual aftereffects after exposure to body models in AN patients.

In the present study, we aimed to test if similar alterations characterize body exposure effects in adolescence, which may be a critical age for the establishment of body ideals, and how they are associated with specific personality traits that have been previously shown to mediate body exposure effects. To this aim, we investigated how the liking judgments of body stimuli change after exposure to round and thin models in a group of adolescent patients with AN as compared to healthy adolescents. We utilized the same modified body exposure paradigm used in Mele and coworkers (2013), which allows testing the relative contribution of perceptual aftereffects and norm-based coding. We expected to replicate in healthy adolescents the same pattern of findings previously obtained in adults (Cazzato et al., 2016; Mele et al., 2013), with an asymmetric modulation of appreciation of round, but not of thin bodies; however, we could also expect greater sensitivity to exposure in adolescents as compared to adults, because their ideals of beauty may be in development. Conversely, we expected a different pattern of effects in AN patients, who have body image disturbances and may present a paradoxical increase of the appreciation of both round and thin bodies after exposure to round bodies (Cazzato et al., 2016). Additionally, we explored how the effects of body exposure on liking judgments were related to body dissatisfaction, interoceptive deficits and internalization of Western ideals. Finally, we also controlled that any difference between

patients and controls were not only due to difference in the observers' body mass index (BMI). Indeed, a recent study (George, Cornelissen, Hancock, Kiviniemi, & Tovée, 2011) in patients with AN and healthy controls has showed that the observers' body weight affects perception of others' body size and this, in turn, modulates attractiveness ratings. In particular, in both groups BMI was a strong predictor of attractiveness judgment, but observers with anorexia nervosa overestimated body size relative to controls. Thus, we also tested whether the different exposure effects in patients and controls were reliable after controlling for their variance in BMI.

Method

Participants

A total of 40 female adolescents were enrolled: 20 patients with a diagnosis of AN and 20 healthy volunteers. A further patient was also recruited and tested but not included in the study analyses since she missed a matched healthy control. Patients were recruited at a scientific institute and rehabilitation hospital. They were recruited over a 12-month period on the basis of a sequential recruitment procedure, according to which all the patients referred to as suffering from AN in the recruitment period were screened for inclusion and exclusion criteria. The main inclusion criteria were age between 12 and 18 years and diagnosis of AN restrictive (AN-R) or purge-binge (AN-PB) type, according to DSM-IV-TR. Exclusion criteria for patients included a history of a different type of EDs (bulimia nervosa or eating disorder not otherwise specified); any personality or psychotic disorder; a history of traumatic brain injury or any other neurological illness. Sixteen patients were diagnosed as AN-R, four patients as AN-PB (for binging behavior). No patient had a clinical history of a different ED. Patients with mood or anxiety disorders were not excluded to select a more representative sample of AN patients, considering the high comorbidity of ED disorder with mood and

anxiety disorders (Godart et al., 2007). Patients aged 12-18 years (M = 15.45, SD = 1.75) and their BMI at the time of testing was on average 16.57 Kg/m^2 (SD = 2.06). All patients were medication-free at the time of testing, while 13 received individual and/or group and/or family therapy.

Control participants were recruited from the local community by word of mouth and through advertisements. They were matched for age, gender, race, language, education, socio-economical status, and IQ as evaluated by means of the Raven Standard Progressive Matrices test. A difference of no more than 12 months was allowed between each patient's age and the matching control. Control participants aged 12-19 years (M = 15.23, SD = 1.92) and their BMI at the time of testing was on average 20.65 Kg/m^2 (SD = 2.61). Exclusion criteria for controls included history of any type of EDs, being under medication at the time of testing, presence of any psychiatric or neurological disorder, history of psychiatric disorders among first-degree relatives, history of alcohol or substance abuse or dependence, and any current major medical illness. All participants, except two controls, were right-handed according to a standard handedness inventory (Briggs & Nebes, 1975). All participants reported normal or corrected-to-normal visual acuity in both eyes. They were native Italian speakers of Caucasian race. The demographic and clinical characteristics of the patients and controls are reported in Table 1. In keeping with the diagnosis, the AN patients had a lower BMI with respect to the controls, while the two groups did not differ for educational level and IQ.

All participants were naïve as to the purposes of the experiment and were debriefed at the end of the experimental session. Informed consent was obtained from all patients and controls and their parents provided written informed consent. The procedures were approved by the local ethical committee. The study was carried out in accordance with the guidelines of the Declaration of Helsinki.

Clinical Evaluation

Standard clinical scales were administered in order to characterize the patients' disorder as compared to the controls. All participants were administered the Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime version (K-SADS-PL) (Kaufman et al., 1997) to confirm the diagnosis in AN patients and exclude any exclusion criteria in both groups. The Symptom Checklist-90-Revised (SCL-90R) was administrated to assess a wide range of psychological problems and both internalizing (depression, somatization, anxiety) and externalizing (aggression, hostility, impulsivity) symptoms of psychopathology. In addition to these clinical measures that were used to screen patients and controls, we also measured Body Dissatisfaction (reliability coefficients: .93 in adolescents with AN-R .93 and .96 in adolescents with AN-PB) and Interoceptive Awareness (reliability coefficients: .89 in adolescents with ED) using the Italian version of the Eating Disorder Inventory-3 (EDI-3) (Garner, 2004), and the degree of mass media internalization of models presented by mass media, using the Sociocultural Attitudes Toward Appearance Questionnaire-3 (SATAQ-3; Thompson, Van den Berg, Roehrig, Guarda, & Heinberg, 2004) in its Italian translation (Stefanile, Matera, Nerini, & Pisani, 2011; reliability coefficients in healthy adolescent girls: Information = .91, Pressures = .91, Internalization-General = .94, Internalization-Athlete = .84). The Body Shape Questionnaire (Cooper, Taylor, Cooper, & Fairburn, 1987), the Body Attitude Test and the Body Uneasiness Test (Cuzzolaro, Vetrone, Marano, & Garfinkel, 2006) were also administered to both patients and controls but data were non considered in the present study and are reported in supplementary material.

Experimental Stimuli and Tasks

Stimuli. The stimuli were taken from previous studies (Cazzato, Siega, & Urgesi, 2012; Mele et al., 2013) and depicted six 3-D human figure models (3 females) from the database of Poser Pro 2010 (e-frontier, Santa Cruz, CA). Each model was rendered in four different daily poses, either static (e.g., standing) or implying motion (e.g., walking, running), each taken from a frontal and a three-quarter view. For each posture and view, the models' body size was manipulated with the Poser software to have moderate to extreme levels of round and thin figures. Hence, a total of 16 images were created for each model: 4 postures x 2 views x 4 body sizes. The models were depicted with the face scrambled, wearing black underwear and on a grey background to reduce the influence of non-bodily cues. The 16 images of four models (2 females) were utilized during the pre- and post-exposure evaluation phases (64 evaluation stimuli), whereas the extreme round and thin figure images of the remaining 2 models (1 female) were utilized for the exposure phase (16 exposure stimuli). The body stimuli were used in a previous study in which we asked a large number of participants to judge the weight and other perceptual and affective dimensions of each stimulus (Cazzato et al., 2012); the results of this study showed a parametric correspondence between the intended manipulation of body weight and the perceptual judgments of participants who rated the stimuli as varying from extremely thin to extremely round. Furthermore, similar patterns of results were obtained for the ratings related to attractiveness and beauty dimensions as for those related to the subjective judgments of liking. We presented both male and female body stimuli in order to control for the effects of the emotional connotation that female bodies may have for patients with anorexia nervosa, thus telling apart the role of perceptual mechanisms, which should be comparable for male and female bodies, and emotional/motivational factors, which should be specific for female bodies. Nevertheless, previous studies (Cazzato et al., 2016; Mele et al., 2013) have shown comparable exposure effects for male and female bodies in women.

Procedure. The experiment was composed of three daily sessions, each one consisting of three phases: (1) initial evaluation of the stimuli (pre-exposure phase); (2) exposure phase; and (3) re-evaluation of the stimuli after exposure (post-exposure phase) (see Fig. 1). The three sessions were conducted in three separate days with a waiting period ranging from three to seven days. The session order was balanced between participants. In each session, the participants were administered the same pre- and post-evaluation procedures with different exposure conditions. In the two main exposure conditions, they received only the eight round body stimuli (round exposure) or the eight thin body stimuli (thin exposure). In a third control exposure condition, participants received both round and thin body stimuli, with a 1:1 matching of the number of round and thin figures (control exposure).

During the experimental sessions, participants sat 40 cm away from a 18-inch LCD monitor (resolution: 1,280 X 800 pixels; refresh frequency: 60 Hz) on which stimuli appeared on a grey background and subtended a 12° X 10° square region around the fovea. The stimulus-presentation timing and randomization were controlled with E-prime V2.0 (Psychology Software Tools Inc., Pittsburgh, PA) on a PC.

Pre- and post-exposure phase. The 64 evaluation stimuli were randomly presented in three blocks, for a total of 192 trials. Each trial started with the presentation of a central fixation point lasting 500 ms, followed by the body image stimulus presented for 150 ms at the center of the screen. A short stimulus presentation was used to avoid the confounding effects of stimulus exploration strategies that may differently affect the liking ratings across groups and sessions (George et al., 2011). The experimenter continuously inspected participant's gaze during presentation in order to monitor task compliance. The image persistence was limited by presentation of a random-dot mask (12° X 10° in size; duration: 500 ms) obtained by scrambling the corresponding body stimulus with a custom-made image

segmentation software. After the mask, the question "How much do you like it (Quanto ti piace in Italian)?" appeared on the screen with a vertical, 10-cm Visual Analogue Scale (VAS) ranging from "I like it very much (Mi piace molto)" (score=100) to "I do not like it at all (Non mi piace per niente)" (score=0). The top or bottom position of the two extremes was balanced between participants. The participants were asked to express a liking judgment on the body stimuli by moving the mouse cursor onto the point of the VAS corresponding to their opinion. The pre- and post-evaluation phases lasted approximately 10 min each.

Exposure phase. The exposure stimuli were presented in three 48-trial blocks, with random presentation of male and female models, static and dynamic postures and front- and three-quarter-view body images, for a total of 144 trials. Each stimulus was presented for 1,000 ms and was followed by a response frame that remained on the screen until response. The participants were asked to look carefully at the stimulus and to respond immediately to one of the following questions presented, in random order, after the offset of the stimuli: "Male or female model (Modello maschile o femminile)?", "Dynamic or static posture (Postura statica o dinamica)?" and "Front or three-quarter view (Visione frontale o di mezzo profilo)?". The two alternative answers were displayed below the question. The participant's task was to press a button that spatially corresponded to the correct answer. The association between the answers and the buttons was balanced between participants. This procedure ensured that participants paid attention to the different morphological and postural aspects of the stimuli, limiting the cognitive load of task response after stimulus presentation. The exposure phase lasted about eight minutes.

Data Analysis

We calculated the individual mean VAS values for each condition in the evaluation phase (64 trials per cell). The data were entered into a four-way 2×2×3×2 mixed-model

Analysis of Variance (ANOVA) with group as between factor and with time (pre- and post-exposure), exposure (round, thin and control), and weight (round, thin) as within-subject variables. We ran a control ANCOVA analysis to be ensured that any difference between groups was not merely due to their BMI difference per se, but to the psychological dimensions that characterize AN vs. healthy adolescents independently from their weight loss or recovery. Thus, BMI was entered as covariate since the two groups differed in body weight ($t_{(38)} = 5.477$, $p<.001$) and one's own BMI is likely to influence how people judge others' body figures (George et al., 2011; Tovée, Emery, & Cohen-Tovée, 2000; Tovée & Cornelissen, 2001). All pair-wise comparisons were calculated with the Tukey post-hoc test. A significance threshold of $p < .05$ was set for all statistical analyses. Effect sizes were estimated using the partial eta square measure (η_p^2) for ANOVA effects and Cohen's d for pairwise comparisons of the exposure effects. The data are reported as the M ± SEM.

To estimate the liking judgment change (LJC) after exposure, we calculated the ratio between the post- and pre-exposure VAS values for each participant and exposure condition, thus allowing an estimate of the judgment change independently from the absolute scale used by the participants in rating the stimuli. Higher LJC values correspond to greater changes in liking judgment. The Pearson's r coefficient between the individual LJC values and scores at the Body Dissatisfaction, Interoceptive Awareness and Internalization of Western Ideals scales, which have been previously associated to the effects of perceptual experience on body appreciation (Glauert et al., 2009; Mele et al., 2013), were calculated separately for each group, using a Bonferroni correction procedure to control for multiple correlations (6 correlations).

Results

Clinical Scales

The clinical data of patients and controls are reported in Table 1. Patients had marginally higher scores than controls at the Interoceptive Awareness deficit scale of the EDI-3, while the difference did not reach significance at the Body Dissatisfaction scale. For the SATAQ scales, patients had higher scores with respect to controls at all subscales except at the Internalization Athlete subscale.

Body Exposure Effects

Figure 2 shows the liking VAS judgment values for round and thin model bodies before and after the three exposure conditions. The 4-way ANOVA revealed non-significant main effects of time and exposure (all $F < 3.4$ and $p > .07$). The main effects of group ($F_{1,38} = 8.79$, $p = .005$, $\eta_p^2 = 0.187$) and weight ($F_{1,38} = 184.81$, $p < .001$, $\eta_p^2 = 0.829$) were significant, indicating that the patients (38.79 ± 1.91) had lower VAS liking judgments of body stimuli compared to the controls (46.81 ± 1.91); and the thin models (57.26 ± 1.90) received higher VAS liking judgments compared to the round models (28.34 ± 1.51). The two-way interactions time × exposure ($F_{2,76} = 23.79$, $p < .001$, $\eta_p^2 = 0.38$) and weight × group ($F_{1,38} = 5.13$, $p = .029$, $\eta_p^2 = .11$), as well as the three-way interaction time × weight × group ($F_{1,38} = 11.03$, $p < .001$, $\eta_p^2 = 0.22$) were significant and were further qualified by a significant four-way interaction time × weight × exposure × group ($F_{2,76} = 3.32$, $p < .05$, $\eta_p^2 = 0.08$), indicating that patients and controls showed different effects of exposure on the liking judgments.

The post-hoc analysis indicated that only the liking judgments of round bodies were modulated in controls, whereas the liking judgments of both round and thin bodies were modulated in patients. In particular, for the round exposure condition, controls provided higher VAS liking judgments of round body stimuli after exposure (38 ± 2.22) compared to baseline (31.67 ± 2.26; $p < .001$; $d = 0.67$), while the VAS liking judgments of thin bodies

were not modulated (pre: 59.21 ± 2.54; post: 61.25 ± 3.06; p = .930; d = 0.17). Conversely, patients provided higher VAS liking judgments after exposure as compared to baseline for both round (pre: 20.59 ± 2.26; post: 25.11 ± 2.22; p = .005; d = 0.46) and thin (pre: 53.62 ± 2.54; post: 60.32 ± 3.06; p < .001; d = 0.55) body stimuli.

Regarding the thin exposure condition, controls provided marginally lower VAS liking judgments of round body stimuli after exposure (33.01 ± 2.57) compared to baseline (36.83 ± 2.74; p = .051; d = 0.33), while the VAS liking judgments of thin bodies were not modulated (pre: 59.78 ± 3.37; post: 57 ± 2.96; p = .492; d = 0.2). No changes were obtained in patients for either round (pre: 23.20 ± 2.74; post: 20.23 ± 2.57; p = .36; d = 0.26) or thin (pre: 55.05 ± 3.37; post: 53.30 ± 2.96; p = 98; d = 0.13) body stimuli.

No changes were observed after the control exposure for either round or thin bodies in both controls and patients (all ps > .38).

The ANCOVA analysis controlling for participants' BMI revealed no main effects or two- and three-way interactions (all F < 1.76 and p > .19); however, the four-way interaction time × weight × exposure × group ($F_{2,74}$= 6.06, p = .003, η_p^2 = 0.14) was significant even after controlling for the effects of BMI differences between the two groups. Thus, in keeping with the ANOVA results, the ANCOVA confirmed that the different exposure-related modulation on the liking judgments of the two groups was not merely due to their BMI difference per se. Only the main effects of group and model's weight were heavily influenced by the participant's BMI.

Correlation analysis

There were no significant correlations between the LJC and Body Dissatisfaction, Internalization of Western ideals, and Interoceptive Awareness in both control ($-.21 < r < .23$; $p > .149$) and patient ($-.21 < r < .29$; $p > .209$) groups.

Discussion

The present study wanted to investigate the effects of perceptual experience on body appreciation in adolescents with AN, with the ultimate aim of testing how and if it is possible to change their appreciation of bodies. The results showed that exposures to round or thin figures exerted a different modulation of the liking judgments of bodies in AN and healthy adolescents.

In keeping with previous studies on healthy adults (Cazzato et al., 2016; Mele et al., 2013), the healthy adolescents of this study showed an asymmetric exposure-related modulation of body appreciation: only round bodies were affected by exposure, with an medium-sized increase in their appreciation after exposure to round models and a small-sized decrease after exposure to thin models. Conversely, the liking judgments of thin bodies were not changed after any type of exposure. This asymmetric modulation may be explained by the interaction between perceptual aftereffects and norm-based reshaping processes (Mele et al., 2013). Indeed, the two mechanisms might have mutually reinforcing effects for round bodies, which are thought to appear thinner (for perceptual aftereffects) and more similar to the template (for norm-based coding) and are, thus, likely to be appreciated more after round exposure. Conversely, round bodies are thought to appear rounder (for perceptual aftereffects) and more distant from the template (for norm-based coding) after thin exposure, thus receiving lower liking ratings. Perceptual aftereffects and norm-based coding may have opposite and mutually deleting effects for thin bodies, which are thought to appear thinner (for perceptual aftereffects), but more distant from the template (for norm-based coding) after

round exposure. In a similar vein, thin bodies are thought to appear rounder (for perceptual aftereffects), but more similar to the template (for norm-based coding) after thin exposure. The ultimate outcome of the interaction between perceptual aftereffects and norm-based coding for the appreciation of thin bodies is that both round and thin exposures do not modify their appreciation, thus explaining the asymmetric modulation of the judgments of round but not of thin bodies in both healthy adolescents (this study) and healthy adults (Mele et al., 2013).

In patients, the liking ratings changed only after round exposure, whereas both thin and control exposure conditions did not affect body appreciation. The absence of any effect of thin exposure might be ascribed to the fact that AN patients were already adapted to thinness and the experimental thin models used in our study corresponded to or were even rounder than the ideal of thinness incorporated by patients, thus failing to induce any exposure-related modulation of body appreciation. This result is in line with a recent study (Mohr, Rickmeyer, Hummel, Ernst & Grabhorn, 2006) that has shown that only round body adaptation, but not thin body adaptation, influenced the judgment of own body weight in EDs patients, supporting the notion of a long-lasting visual adaptation to thinness in EDs patients. Crucially, the level of internalization, information and pressure of media messages was higher in our patients than in controls, revealing how the ultra-thin ideal of beauty offered by the media may be rooted in the patients. Indeed, a recent study has shown that AN patients tend to associate more easily emaciated than thin bodies to beauty-related words, suggesting that they have a beauty ideal of an emaciated body, rather than of a thin body (Smith, Joiner, & Dodd, 2014). In contrast, round bodies were distant from such emaciated body ideal, yet their presentation did not change the prototype-referenced template.

The increase of the liking ratings of both thin and round bodies after exposure to round models is in line with the modification expected according to perceptual aftereffects mechanisms devoid of any counteracting effect of norm-based reshaping. In other words, the increase of liking ratings of both round and thin bodies may be explained by the fact that body stimuli appeared thinner after round exposure for perceptual aftereffects. Thus, these results suggest that, in keeping with adult patients (Cazzato et al., 2016), adolescents with AN have an alteration of the mechanisms involved in the effects of perceptual experience on body appreciation, with weak norm-based reshaping of esthetic body ideals. This alteration of AN patients seems to be independent from illness duration and age at onset, being present on both adults and adolescents, and may stem from their deficits of configural processing and preference for detail-based processing of the human body (Urgesi et al., 2012, 2014). This deficit may prevent patients from updating the norms that are used to recognize and judge new bodies and faces (Rhodes, Jeffery, Boeing, & Calder, 2013), leaving them anchored to ideals of extreme thinness.

The rigidity of norm-based templates observed in the effects of perceptual experience on body appreciation in AN patients is in keeping with a recent model (Gaudio & Riva, 2013; Riva & Gaudio, 2012) claiming that AN patients have difficulties in updating their body representation on the basis of perceptual input, thus being anchored to the memory of a 'virtual body'. The patients would show deficits in shifting between egocentric and allocentric bodily information, preventing them from updating the self-image stored in long-term memory on the basis of direct perceptual experience. In other words, the egocentric representation of body image based on the perceptions and sensations that depart from the body does not integrate with the allocentric body representation that is conveyed by others (Cazzato et al., 2016). Although this model has been developed to explain self-body

misperception in AN patients, the template that AN patients use to judge what is familiar or beautiful in others may be anchored to long-term memory representations that are hard to change following perceptual experience.

Limitations

A limitation of our study is the comparatively low number of patients tested and further studies in larger sample populations are needed to evaluate the clinical significance of the findings. Furthermore, participants were not diagnosed using a well-established ED-specific standardized instrument (e.g., Eating Disorder Examination interview), thus limiting the assessment of the full range of the specific psychopathology of EDs. Furthermore, although both AN and healthy adolescents were tested in three separate sessions conducted at approximately the same time, we did not control for the time elapsed from the last meal and could not standardise levels of fullness/satiation across participants and sessions. It is also worth noting that our AN patient group had recovered weight (16.59 kg/m^2), thus urging caution in generalizing the results to the overall population of AN patients. However, a relatively high BMI in our patient sample may attenuate the impact of possible spurious effects of emaciation on cognitive functions. In a similar vein, it can be excluded that the remaining BMI differences between AN patients and controls may have contributed to their performance in body appreciation, because we controlled for such differences using BMI as covariate in a control analysis. Thus, the different effects of round body exposure on the AN patients' vs. healthy controls' appreciation of body stimuli must stem from their specific strategies in processing body stimuli. However, since we did not compare the effects of body exposure effects with those of exposure to nonbodily stimuli, the specificity of patients' alterations for the human body remains unclear.

Another limitation to the generalization of the results is due to the fact that AN patients and controls had comparable body dissatisfaction at the EDI-3, even if the greater body image concerns of the patients' groups were apparent at the BSQ and BUT (see Supplementary Material). However both AN and control groups were in the adolescent age, a period characterized by many changes in body shape due to ripening process that can affect body image and degree of body dissatisfaction (Presnell et al., 2004; Siervogel et al., 2003).

A critical question is related to the personality dimensions associated to the rigidity of norm-based templates of body processing in AN patients. The correlation analysis revealed no relation between the amount of exposure-related change of liking judgments and individual scores at the Body Dissatisfaction, Internalization of Western Ideals and Interoceptive Awareness scales in either controls or AN patients. This is in keeping with previous studies using the same paradigm in adult individuals (Cazzato et al., 2016; Mele et al., 2013) and may suggest that more sensitive measures are required to detect the subtle interindividual differences within each group that may be associated with abnormal susceptibility to the ideals of body beauty conveyed by media.

Conclusions

We investigated the psychological mechanisms that may explain the influence of media exposure on the establishment of the beauty ideals of extreme body thinness in adolescents with AN. As compared to control adolescents, AN adolescents showed an abnormal pattern of experience-dependent reshaping of body appreciation, which seems to be based on low-level perceptual mechanisms, affecting how bodies appear after repeated exposure to extreme body models, rather than on the dynamic reshaping of body norms. In conclusion, the present study provided evidence of weak norm-based reshaping of body appreciation in AN patients. The rigidity of norm-based coding processes may be associated

with deficits of configural body processing and contribute to patients' susceptibility to the influence of extreme body thinness ideals conveyed by media. Future studies will have to identify the multiple factors that may mediate the rigidity of norm-based templates of extreme body thinness in AN patients and to plan appropriate interventions to facilitate configural processing of body figures and the update of norm-based templates.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the local ethical committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

References

Benowitz-Fredericks, C. A., Garcia, K., Massey, M., Vasagar, B., & Borzekowski, D. L. G. (2012). Body image, eating disorders, and the relationship to adolescent media use. Pediatric Clinics of North America, 59, 693–704. doi:10.1016/j.pcl.2012.03.017

Briggs, G. G., & Nebes, R. D. (1975). Patterns of hand preference in a student population. Cortex, 11, 230–238.

Calado, M., Lameiras, M., Sepulveda, A. R., Rodríguez, Y., & Carrera, M. V. (2010). The mass media exposure and disordered eating behaviours in Spanish secondary students. European Eating Disorders Review: The Journal of the Eating Disorders Association, 18, 417–427. doi:10.1002/erv.1024

Cazzato, V., Siega, S., & Urgesi, C. (2012). "What women like": influence of motion and form on esthetic body perception. Frontiers in Psychology, 3, 235. doi:10.3389/fpsyg.2012.00235

Cazzato, V., Mian, E., Mele, S., Tognana, G., Todisco, P., Urgesi, C. (2016). The effects of body exposure on self-body image and esthetic appreciation in anorexia nervosa. Experimental Brain Research, 234, 695-709. doi:10.1007/s00221-015-4498-z

Cooper, P., Taylor, M., Cooper, Z., & Fairburn, C. G. (1987). The development and validation of the Body Shape Questionnaire, 6, 485–494.

Cuzzolaro, M., Vetrone, G., Marano, G., & Garfinkel, P. E. (2006). The Body Uneasiness Test (BUT): development and validation of a new body image assessment scale. Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity, 11, 1-13.

488 Dennett, H. W., McKone, E., Edwards, M., & Susilo, T. (2012). Face aftereffects predict
489 individual differences in face recognition ability. Psychological Science, 23, 1279-
490 1287. doi:10.1177/0956797612446350

491 Derenne, J. L., & Beresin, E. V. (2006). Body image, media, and eating disorders.
492 Academic Psychiatry, 30, 257-261. doi:10.1176/appi.ap.30.3.257

493 Garner, D. M. (2004). The eating disorder inventory-3 professional manual. Lutz, FL:
494 Psychological Assessment Resources (Italian Version; Giannini, M., Pannocchia,
495 L., Dalle Grave, R., Muratori, F., & Viglione, V., 2008. Eating Disorder Inventory-
496 3. Manuale. Firenze, Italy: Giunti OS - Organizzazioni Speciali).

497 Gaudio, S., & Riva, G. (2013). Body image in anorexia nervosa: The link between
498 functional connectivity alterations and spatial reference frames. Biological
499 Psychiatry, 73, e25-e26. doi:10.1016/j.biopsych.2012.08.028

500 George, H. R., Cornelissen, P. L., Hancock, P. J. B., Kiviniemi, V. V, & Tovée, M. J.
501 (2011). Differences in eye-movement patterns between anorexic and control
502 observers when judging body size and attractiveness. British Journal of
503 Psychology, 102, 340–354. doi:10.1348/000712610X524291

504 Glauert, R., Rhodes, G., Byrne, S., Fink, B., & Grammer, K. (2009). Body dissatisfaction
505 and the effects of perceptual exposure on body norms and ideals. The International
506 Journal of Eating Disorders, 42, 443–452. doi:10.1002/eat.20640

507 Godart, N. T., Perdereau, F., Rein, Z., Berthoz, S., Wallier, J., Jeammet, P., & Flament, M.
508 F. (2007). Comorbidity studies of eating disorders and mood disorders. Critical

review of the literature. Journal of Affective Disorders, 97, 37–49. doi:10.1016/j.jad.2006.06.023

Groesz, L. M., Levine, M. P., & Murnen, S. K. (2002). The effect of experimental presentation of thin media images on body satisfaction : a meta-analytic review. The International Journal of Eating Disorders, 31, 1–16. doi:10.1002/eat.10005

Hausenblas HA, Campbell A, Menzel JE, Doughty J, Levine M, Thompson JK (2013) Media effects of experimental presentation of the ideal physique on eating disorder symptoms: a meta-analysis of laboratory studies. Clinical Psychology Review, 33, 168-181. doi: 10.1016/j.cpr.2012.10.011

Hoek, H. W. (2006). Incidence, prevalence and mortality of anorexia nervosa and other eating disorders. Current Opinion in Psychiatry, 19, 389–394. doi:10.1097/01.yco.0000228759.95237.78

Kaufman, J., Birmaher, B., Brent, D., Rao, U., Flynn, C., Moreci, P., Williamson, D. & Ryan N. (1997). Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime Version (K-SADS-PL): initial reliability and validity data. Journal of the American Academy of Child and Adolescent Psychiatry, 36, 980-988.

Langlois, J. H., Kalakanis, L., Rubenstein, A. J., Larson, A., Hallam, M., & Smoot, M. (2000). Maxims or myths of beauty? A meta-analytic and theoretical review. Psychological Bulletin, 126, 390–423.

Langlois, J. H., & Roggman, L. A. (1990). Attractive faces are only average. Psychological Science, 1, 115–121. doi: 10.1111/j.1467-9280.1990.tb00079.x

Leopold, D. a, O'Toole, a J., Vetter, T., & Blanz, V. (2001). Prototype-referenced shape encoding revealed by high-level aftereffects. Nature Neuroscience, 4, 89–94. doi:10.1038/82947

Maurer, D., Grand, R. Le, & Mondloch, C. J. (2002). The many faces of configural processing. Trends in Cognitive Sciences, 6, 255–260. doi: 10.1016/S1364-6613(02)01903-4

Mele, S., Cazzato, V., & Urgesi, C. (2013). The importance of perceptual experience in the esthetic appreciation of the body. PloS One, 8, e81378. doi:10.1371/journal.pone.0081378

Mohr H. M., Rickmeyer C., Hummel D., Ernst M. & Grabhorn R. (2006). Altered Visual Adaptation to Body Shape in Eating Disorders: Implications for Body Image Distortion. Perception, Feb 25. pii: 0301006616633385

Moore, D. C. (1993). Body image and eating behavior in adolescents. Journal of the American College of Nutrition, 12, 505–510. doi:10.1080/07315724.1993.10718343

Pollard, J. S. (1995). Attractiveness of composite faces: a comparative study. International Journal of Comparative Psychology, 8, 77–83.

Presnell K., Bearman S. K. & Stice E. (2004). Risk factors for body dissatisfaction in adolescent boys and girls: a prospective study. The International Journal of Eating Disorders, Dec;36(4):389-401. doi: 10.1002/eat.20045

Reed, C. L., Stone, V. E., Grubb, J. D., & McGoldrick, J. E. (2006). Turning configural processing upside down: part and whole body postures. Journal of Experimental Psychology. Human Perception and Performance, 32, 73–87. doi:10.1037/0096-1523.32.1.73

Rhodes, G., Jeffery, L., Boeing, A., & Calder, A. J. (2013). Visual coding of human bodies: perceptual aftereffects reveal norm-based, opponent coding of body identity. Journal of Experimental Psychology. Human Perception and Performance, 39, 313–317. doi:10.1037/a0031568

Rhodes, G., Jeffery, L., Watson, T. L., Clifford, C. W. G., & Nakayama, K. (2003). Fitting the mind to the world: face adaptation and attractiveness aftereffects. Psychological Science, 14, 558–566. doi:10.1046/j.0956-7976.2003.psci_1465.x

Riva, G., & Gaudio, S. (2012). Allocentric lock in anorexia nervosa: new evidences from neuroimaging studies. Medical Hypotheses, 79, 113–117. doi:10.1016/j.mehy.2012.03.036

Rodgers, R. F., Salès, P., & Chabrol, H. (2010). Psychological functioning, media pressure and body dissatisfaction among college women. Revue Européenne de Psychologie Appliquée/European Review of Applied Psychology, 60, 89–95. doi:10.1016/j.erap.2009.10.001

Siervogel, R. M., Demerath, E. W., Schubert, C., Remsberg, K. E., Chumlea, W. C., Sun, S., ... Towne, B. (2003). Puberty and body composition. Hormone Research, 60 (SUPPL. 1), 36-45. doi: 10.1159/000071224

572 Smith, A. R., Joiner, T. E., & Dodd, D. R. (2014). Examining implicit attitudes toward
573 emaciation and thinness in anorexia nervosa. The International Journal of Eating
574 Disorders, 47, 138–147. doi:10.1002/eat.22210

575 Stefanile, C., Matera, C., Nerini, A., & Pisani, E. (2011). Validation of an Italian version of
576 the sociocultural attitudes towards appearance questionnaire-3 (SATAQ-3) on
577 adolescent girls. Body Image, 8, 432–436. doi: 10.1016/j.bodyim.2011.06.001

578 Stice, E., Schupak-Neuberg, E., Shaw, H. E., & Stein, R. I. (1994). Relation of media
579 exposure to eating disorder symptomatology: an examination of mediating
580 mechanisms. Journal of Abnormal Psychology, 103, 836–840. doi: 10.1037/0021-
581 843X.103.4.836

582 Stice, E. (2002). Sociocultural influences on body image and eating disturbance. In C. G.
583 Fairburn & K. D. Browne (Eds.), Eating disorders and obesity: A comprehensive
584 handbook (pp. 103-107). New York, NY: The Guilford Press.

585 Stice, E., Marti, C. N., & Rohde, P. (2013). Prevalence, incidence, impairment, and course
586 of the proposed DSM-5 eating disorder diagnoses in an 8-year prospective
587 community study of young women. Journal of Abnormal Psychology, 122, 445–
588 457. doi:10.1037/a0030679

589 Sypeck, M. F., Gray, J. J., Etu, S. F., Ahrens, A. H., Mosimann, J. E., & Wiseman, C. V.
590 (2006). Cultural representations of thinness in women, redux: playboy magazine's
591 depiction of beauty from 1979 to 1999. Body Image, 3, 229–235.
592 doi:10.1016/j.bodyim.2006.07.001

593 Thompson, J. K., van den Berg, P., Roehrig, M., Guarda, A. S., & Heinberg, L. J. (2004).
594 The sociocultural attitudes towards appearance scale-3 (SATAQ-3): development
595 and validation. The International Journal of Eating Disorders, 35, 293–304.
596 doi:10.1002/eat.10257

597 Thompson, P., & Burr, D. (2009). Visual aftereffects. Current Biology, 19, R11-R14.
598 doi:10.1016/j.cub.2008.10.014

599 Tovée, M. J., Emery, J. L., & Cohen-Tovée, E. M. (2000). The estimation of body mass
600 index and physical attractiveness is dependent on the observer's own body mass
601 index. Proceedings of the Royal Society B: Biological Sciences, 267, 1987–1997.
602 doi:10.1098/rspb.2000.1240

603 Tovée, M. J., & Cornelissen, P. L. (2001). Female and male perceptions of female physical
604 attractiveness in front-view and profile. British Journal of Psychology, 92, 391–
605 402. doi: 10.1348/000712601162257

606 Trujillo, L. T., Jankowitsch, J. M., & Langlois, J. H. (2014). Beauty is in the ease of the
607 beholding: a neurophysiological test of the averageness theory of facial
608 attractiveness. Cognitive, Affective & Behavioral Neuroscience, 1061–1076.
609 doi:10.3758/s13415-013-0230-2

610 Urgesi, C., Fornasari, L., Perini, L., Canalaz, F., Cremaschi, S., Faleschini, L., …
611 Brambilla, P. (2012). Visual body perception in anorexia nervosa. The International
612 Journal of Eating Disorders, 45, 501–511. doi: 10.1002/eat.20982

613 Urgesi, C., Fornasari, L., Canalaz, F., Perini, L., Cremaschi, S., Faleschini, L., ... &
614 Brambilla, P. (2014). Impaired configural body processing in anorexia nervosa:

evidence from the body inversion effect. British Journal of Psychology, 105, 486-508. doi: 10.1111/bjop.12057

Valentine, T. (1991). A unified account of the effects of distinctiveness, inversion, and race in face recognition. Quarterly Journal of Experimental Psychology, 43, 161–204. doi: 10.1080/14640749108400966

Valentine, T., Darling, S., & Donnelly, M. (2004). Why are average faces attractive? The effect of view and averageness on the attractiveness of female faces. Psychonomic Bulletin & Review, 11, 482–487.

Voracek, M., & Fisher, M. L. (2002). Shapely centrefolds? Temporal change in body measures: trend analysis. British Medical Journal, 325, 1447-1448.

Winkler, C., & Rhodes, G. (2005). Perceptual adaptation affects attractiveness of female bodies. British Journal of Psychology, 96, 141–154. doi:10.1348/000712605X36343

Figure 1. Study procedure. The experiment was composed of three daily sessions, each one consisting of three phases: A) initial evaluation of the stimuli (pre-exposure phase); B) exposure phase; and C) re-evaluation of the stimuli after exposure (post-exposure phase). In each session, the participants were administered the same pre- and post-evaluation procedures (A and C) with different exposure conditions (B). In the two main exposure conditions, they received only the 8 round body stimuli (round exposure) or the 8 thin body stimuli (thin exposure). In a third control exposure condition, participants received both round and thin body stimuli, with a 1:1 matching of the number of round and thin figures (control exposure)

Figure 2. Study results. The graphs show the M (± SEM) scores on the visual analogue scale (VAS) before and after the three exposure conditions in both control and AN patient groups. Asterisks indicate significant pair-wise comparisons ($p < .05$).