Research Article

Where Do You Look? Visual Attention to Human Bodies across the Weight Spectrum in Individuals with Normal Weight or with Obesity

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Keywords

Attention · BMI · Body · Eye tracking · Obesity

Abstract

Objective: We investigated how individuals with normal weight (NW) versus individuals with obesity (OB) visually explore human bodies varying in BMI. **Methods:** 16 OB (BMI 37.5 ± 7.7 kg/m²) and 35 NW (BMI 21.5 ± 1.6 kg/m²) visually explored 35 natural photographs and 25 avatars depicting male and female bodies ranging from normal weight to obesity. Gaze behaviour was assessed using eye tracking technology. Additionally, participants rated the attractiveness of all body stimuli. **Results:** A comparison of the displayed gaze behaviour shown by both participant weight classes indicates that regarding visual stimuli of obese natural bodies, all participants (OB + NW) looked at the waist longer, whereas regarding visual stimuli of normal-weight bodies, all participants viewed the head longer. Overall, OB spent less time looking at the bodies than NW. All participants rated normal-weight bodies as more attractive than obese bodies. However, the NW sample rated the depicted obese bodies as even less attractive than the OB sample did. **Conclusions:** The BMI of the explored body, but not the observer's BMI, produces differences in the visual exploration of human bodies. The displayed exploration pattern of obese bodies can cautiously be interpreted as a 'de-individualised' and 'obesity-focused' perception. This tendency may prove in close relationship with the negative cultural views on obesity.

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Published by S. Karger GmbH, Freiburg

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Introduction

In modern European societies, obesity is considered norm ‘deviant’, which causes individuals suffering from obesity to often experience a negative evaluation in public perception [1]. This negative evaluation can also be internalised by individuals with obesity themselves, causing a weight bias internalisation [2] that effects their self-worth concepts. This biased perception may be reflected in the manner with which visual exploration of obese bodies occurs, for example in a specifically selective visual attention to body stimuli [3]. Selective attention to body parts, as a form of the attentional processing of body-related information, might subsequently contribute to the perpetuation of obesity based on reoccurring experiences of body dissatisfaction [4] and perceived weight stigmatisation, which are known to influence weight-related behaviours [5].

Studies show that attention allocation usually focuses on body parts that communicate social information, especially the face (e.g. [6, 7]). However, research on eating disorders shows that a second attention focus on ‘index body parts’ [8] that communicate information about body shape and size (e.g. waist) occurs as well.

Recent studies have investigated the attentional processing of individuals with eating disorders [8, 9] and obesity [10] of their own bodies. Most of these studies investigated the allocated attention to body parts that participants had previously classified as ‘ugly’ versus ‘beautiful’. These studies have demonstrated that attitudes, such as dissatisfaction towards the body or specific body parts, shape control groups’ overall attention to the body. In contrast, individuals with eating disorders spend more time looking at their own ‘ugly’ body parts [9, 11] or performed upward social comparison patterns [12]. Overall, evidence for an attentional bias in individuals with overweight or obesity is heterogeneous [9, 10]. A recent review summarised the evidence for heightened body dissatisfaction in individuals with obesity [13].

To date there is little known about the general (excluding self-reference) visual exploration of bodies with varying BMIs ranging from normal weight to obesity. Further, it is not clear whether or not attention allocation to bodies depends on the person’s own BMI. Attentional biases in body processing might influence the observer’s self-esteem, either increasing or decreasing self-worth [12] and, therefore, influencing subsequent weight-related behaviour [5]. A focused investigation of body stimuli processing and the influence the observer’s BMI plays may reveal further attentional biases and further disentangle stigmatisation (attentional bias regarding body stimuli in the overweight/obese spectrum of observers with normal weight) and weight bias internalisation (attentional bias regarding body stimuli in the overweight/obese spectrum of observers with obesity).

In order to investigate the allocation of visual attention to human bodies across the weight spectrum, including individuals with normal weight and individuals with obesity, we developed an eye tracking paradigm. In order to address internal and ecological validity, we compared body stimuli based on natural photographs versus avatars. Avatars are highly standardised computer-generated body stimuli and therefore have the advantage that they are less associated with confounders such as facial expression. Thus, avatars represent body stimuli with high internal validity; however, their high standardisation might also represent a disadvantage in the sense that they are perceived as ‘less than real’ humans. Therefore, we included a set of natural body photographs. Natural photographs are characterised by high ecological validity and show real human individuals with varying BMI; however, their main disadvantage is that other variables cannot be standardised (e.g. surrounding).

We had the following hypotheses: i) All participants will focus their attention on the face of the depicted persons longer than on other body parts. ii) As obesity and eating disorders share some characteristics [1, 14], participants with obesity, when compared to normal-

Table 1. Count or means ($\pm$ standard deviation) of sociodemographic and clinical data of the study sample

Variable	NW (n = 35)	OB (n = 16)	Test statistics (Chi, t or U)	p value
Males	6	2	0.2	>0.05
Age, years	23.5 (2.7)	25.3 (3.9)	194.0	>0.05
BMI, kg/m ²	21.5 (1.6)	37.5 (7.7)	0	<0.001
Lowest self-reported BMI, kg/m ²	19.4 (1.3)	26.4 (2.7)	-8.3	<0.001
Highest self-reported BMI, kg/m ²	22.3 (1.7)	39.3 (10.0)	0	<0.001
ASTS	45.0 (9.5)	47.1 (8.9)	-0.7	>0.05
EDE-Q: restraint eating	0.3 (0.6)	1.9 (1.3)	38.0	<0.001
EDE-Q: eating concern	0.2 (0.4)	0.8 (0.7)	90.5	<0.001
EDE-Q: shape concern	0.6 (0.6)	2.5 (1.1)	28.0	<0.001
EDE-Q: weight concern	0.4 (0.6)	2.3 (0.8)	18.0	<0.001
EDE-Q overall	0.4 (0.4)	1.8 (0.8)	18.5	<0.001
EDI-2: drive for thinness	14.2 (5.1)	20.1 (5.5)	105.0	<0.001

NW = Controls with normal weight; OB = sample with obesity; ASTS = Mood Scale, higher values indicating negative mood; EDE-Q = Eating Disorder Examination Questionnaire, higher values indicating higher occurrence of the symptom; EDI-2 = Eating Disorder Inventory, higher values indicating higher drive for thinness.

weight participants, will focus longer on the index parts of obese bodies, which can prove as an indicator for weight bias internalisation. iii) Participants with obesity, when compared to normal-weight participants, will evaluate obese bodies as less attractive.

Material and Methods

Participants

16 individuals with a BMI between 30 kg/m² and 53 kg/m² (OB, 14 females) and 35 individuals with normal weight (NW, 29 females) with a BMI between 19 kg/m² and 25 kg/m², all between 20 and 35 years, were recruited. Exclusion criteria were non-corrected vision, pregnancy or nursing and an eating disorder assessed via the Eating Disorder Examination Questionnaire (EDE-Q [15], German version [16, 17]). As additional control variables, we assessed mood (ASTS [18]) and the Eating Disorder Inventory subscale 'Drive for thinness' (EDI-2 [19], German Version [20]). Sample characteristics are displayed in table 1.

Stimuli

We used two sets of stimuli that included female and male bodies depicting normal weight and obesity: to achieve high ecological validity, 35 natural photographs (5 women and 5 men with BMI range 19–24 kg/m² and 11 women and 14 men with BMI range 30–49 kg/m²) were included and 25 avatars (2 female and 2 male avatars with different BMI, BMI range 19–25 kg/m² and 31–36 kg/m²) as highly standardised stimulus material. All stimuli were pre-tested with regard to attractiveness and BMI by experts working in the field of weight-related diseases and eating disorders (table 2). In regard to the rating of attractiveness, the inter-rater correlation was between $r = 0.37$ and $r = 0.93$ (all $p < 0.05$) for natural photographs. In comparison inter-rater correlation was between $r = 0.40$ and $r = 0.95$ (all $p < 0.05$) for the avatars. In regard to the BMI rating the inter-rater correlation was between $r = 0.69$ and $r = 0.95$ (all $p < 0.01$) for the natural photographs and between $r = 0.97$ and $r = 0.99$ (all $p < 0.01$) for the avatars.

Procedure

The ethics committee of the Medical Faculty at the University Tübingen and the University Hospital Tübingen both approved the study (102/2011B02). All participants gave written informed consent.

Participants in the NW sample were screened via online questionnaires. During the experimental session, all participants filled out questionnaires, and weight and height were assessed in order to calculate

Table 2. Results of the stimulus pre-test: Means $\pm$ standard deviation regarding BMI and attractiveness expert rating^a

Stimulus type	Weight class	BMI	Attractiveness
Avatar	normal-weight bodies	21.6 $\pm$ 1.3	6.4 $\pm$ 0.7
	overweight/obese bodies	32.7 $\pm$ 3.5	3.5 $\pm$ 0.9
Natural photographs	normal-weight bodies	21.0.7 $\pm$ 0.8	6.9 $\pm$ 1.0
	overweight/ obese bodies	39.6 $\pm$ 4.3	3.4 $\pm$ 1.1

^aWeight was rated using the BMI; attractiveness was rated on a 1 to 10 scale, 1 indicating very unattractive, 10 indicating very attractive.

BMI. Participants sat in front of a screen and were instructed to freely explore the stimuli as though they were watching television, during this time eye movements were recorded. Each of the 60 trials started with a fixation cross (1,000 ms) followed by the body picture presented for 4,000 ms. Natural photographs and avatars were presented block-wise in a randomised order. Subsequently, participants rated the stimuli with regard to BMI and attractiveness on a computerised rating scale, ranging from 1 (very unattractive) to 10 (very attractive).

Apparatus

Eye movements were recorded using the IViewX Hi-Speed eye tracking system (SMI, Berlin, Germany) with a 500 Hz sampling rate and 0.25–0.5° gaze position accuracy. Distance between the subject's head and the 19-inch computer screen with a resolution of 1,280 $\times$ 1,024 pixels was 60 cm.

Gaze Data

Gaze data were analysed using BeGaze 3.0 (SMI). Trials were excluded if the fixation cross was not fixated (number of excluded trials over all participants $n = 2$) or technical problems occurred during data acquisition, e.g. delayed start or early stop of the eye tracking system (number of participants with reduced trial number $n = 2$) or bad recording of the eye movement in one condition (number of participants for which data from the avatar condition was excluded $n = 3$). Corresponding to Hewig et al. [7], we defined seven areas of interest (AOI): head, shoulder, arms, chest, waist, hips, legs. We calculated total dwell time per AOI for normal-weight versus obese body stimuli. Further, the percentage of total dwell time per AOI was used for comparisons.

Statistical Analyses

Statistical analyses were conducted using SPSS 21 (IBM, Armonk, NY, USA). Only lowest self-reported BMI and mood scales fulfilled normal distribution criteria and were analysed with t-tests, whereas all other self-report measures were analysed with non-parametric tests (Mann-Whitney Test), since the assumption of normality was violated (age, BMI, highest self-reported BMI, EDE-Q scales, EDI-2 scale). Possible group differences regarding gender were tested with a chi-squared test. Gaze data was analysed separately for natural photographs and avatars using an analysis of variance (ANOVA) with group (NW versus OB) as a between-subject factor and weight class (normal-weight versus obese bodies) and AOI (head, shoulder, arms, chest, waist, hips, legs) as a within-subject factor. Greenhouse-Geisser-corrected values will be reported in the case of sphericity violation. As there was only a small number of men included in the sample, but gender differences are documented regarding body image [21] and the processing of body stimuli [22, 23], we conducted each analyses with and without male participants. The conduction of comparative analyses between genders was not possible because of the small number of male participants. Nevertheless, the inclusion of male participants in our samples did not change results. To investigate the influence of body dissatisfaction on the gaze data we conducted group-wise Pearson correlation analyses between the EDE-Q subscales weight and shape concern and the difference value of dwell time for body stimuli showing obese versus normal weight for each stimulus category. Attractiveness and BMI ratings were analysed using an ANOVA with group as the between-subject factor and weight class as the within-subject factor. For all significant interactions, we conducted post-hoc tests with a Bonferroni-corrected alpha.

Table 3. Mean dwell time in % (standard error) for each AOI of normal weight and obese stimuli

AOI	Normal-weight bodies	Overweight/obese bodies
Avatars		
Head	21.9 (1.4)	20.1 (1.6)
Shoulder	7.5 (0.7)	5.6 (0.7)
Arms	1.6 (0.2)	1.9 (0.4)
Breast	9.9 (0.7)	8.9 (0.6)
Waist	5.9 (0.5)	7.4 (0.5)
Hips	9.4 (0.7)	15.1 (1.1)
Legs	17.7 (1.1)	18.4 (1.2)
Natural photographs		
Head	28.7 (1.6)	24.3 (1.3)
Shoulder	5.5 (0.6)	5.8 (0.5)
Arms	4.2 (0.3)	5.8 (0.2)
Breast	7.0 (0.4)	8.1 (0.3)
Waist	5.8 (0.4)	10.7 (0.7)
Hips	11.0 (0.5)	5.6 (0.4)
Legs	7.7 (0.5)	7.6 (0.4)

AOI = Area of interest.

Results

Gaze Data

Avatars

Main effects were found for weight class, $F(1, 45) = 10.5$, $p < 0.001$, $\eta_p^2 = 0.3$, and AOI, $F(2.7, 120) = 49.4$, $p < 0.001$, $\eta_p^2 = 0.5$, as well as a significant interaction between these two factors, $F(3.9, 1.74) = 13.5$, $p < 0.001$, $\eta_p^2 = 0.2$. Post-hoc tests revealed that participants focused on the shoulders of normal-weight bodies for a longer time than on the shoulders of obese bodies, $t(46) = 3.7$, $p = 0.001$, $d = -0.4$. Dwell time for the index body parts waist, $t(46) = -3.8$, $p = 0.001$, $d = 0.5$, and hips, $t(46) = -8.7$, $p = 0.001$, $d = 1.2$, was longer for obese bodies than for normal-weight bodies. Mean percentages of dwell times are displayed in table 3. Correlation analyses revealed no significant correlation between body dissatisfaction scales (EDE-Q-shape and weight concern) and attention allocation (all $p > 0.05$).

Natural Photographs

There was a significant group effect, $F(1, 48) = 10.2$, $p = 0.003$, $\eta_p^2 = 0.2$, showing that the NW sample (mean = 71.6%, SE = 1.5%) took a longer look at the bodies in general than did the OB sample (mean = 63.0%, SE = 2.4%). Analysis revealed a significant main effect of AOI, $F(1.7, 80.6) = 97.5$, $p < 0.001$, $\eta_p^2 = 0.7$, as well as a significant interaction between AOI and weight class, $F(3.9, 188) = 31.3$, $p < 0.001$, $\eta_p^2 = 0.4$. Post-hoc tests displayed that participants looked longer at the head, $t(49) = 5.1$, $p < 0.001$, $d = -0.4$, and the hips, $t(49) = 10.5$, $p < 0.001$, $d = -1.4$, of normal-weight bodies than on head and hips of obese bodies. Conversely, all participants examined the arms, $t(49) = -5.0$, $p < 0.000$, $d = 0.9$, breast, $t(49) = -3.2$, $p = 0.002$, $d = 0.4$, and waist, $t(49) = -7.8$, $p < 0.001$, $d = 1.7$, of obese bodies longer than of normal-weight bodies. Mean percentages of dwell times are displayed in table 3. Correlation analyses revealed no significant correlation between body dissatisfaction scales (EDE-Q-shape and weight concern) and attention allocation (all $p > 0.05$), except for a significant positive correlation between the EDE-Q-shape concern and the difference value for the AOI head in the OB

Fig. 1. Mean attractiveness (range from 1 to 10, 1 indicating very unattractive, 10 indicating very attractive) and standard error. **A** Mean attractiveness rating for avatar stimuli. **B** Mean attractiveness rating for natural stimuli. NW = individuals with normal weight; OB = individuals with obesity.

sample, $r = 0.7$, $p < 0.01$. High scores regarding shape concern were associated with a higher dwell time for the head of obese bodies when compared to normal-weight bodies.

Attractiveness Rating

Both groups rated avatars with normal weight as more attractive than avatars with obesity, $F(1, 48) = 94.2$, $p < 0.001$, $\eta_p^2 = 0.7$ (fig. 1). The NW sample rated the attractiveness of both avatars and obese natural bodies as significantly lower than the OB sample: for avatars $F(1, 48) = 5.4$, $p = 0.024$, $\eta_p^2 = 0.1$; $t(48) = -3.3$, $p = 0.002$, $d = 1.3$; and for natural bodies $F(1, 48) = 5.0$, $p = 0.03$, $\eta_p^2 = 0.1$; $t(48) = -2.5$, $p = 0.015$, $d = 0.5$ (fig. 1).

BMI Rating

The BMI rating of avatars revealed a significant main effect of weight class, $F(1, 48) = 498.1$, $p < 0.001$, $\eta_p^2 = 0.9$, and no significant main effect of group, $F(1, 48) = 0.3$, $p = 0.586$, $\eta_p^2 = 0.01$. We found a main effect for weight class, $F(1, 48) = 1301.7$, $p < 0.001$, $\eta_p^2 = 1.0$, a significant main effect for group, $F(1, 48) = 7.9$, $p = 0.007$, $\eta_p^2 = 0.1$, and a significant interaction between weight class and group, $F(1, 48) = 6.7$, $p = 0.012$, $\eta_p^2 = 0.1$, for the natural photographs. Post-hoc tests displayed significant rating differences between both groups, but only for the obese bodies, $t(48) = -2.9$, $p = 0.006$, $d = 0.9$, showing that on average the OB sample rated obese bodies with a higher BMI, mean = 32.7 kg/m^2 , SE = 0.5 kg/m^2 , than the NW sample, mean = 31.0 kg/m^2 , SE = 0.3 kg/m^2 .

Discussion

We investigated the allocation of visual attention to human bodies across the weight spectrum in individuals with normal weight and individuals with obesity. Our results suggest that the BMI of the explored body, but not the BMI of the observer, influences attention allocation during the processing of body stimuli. The BMI of the explored body produced differences in visual exploration of all participants. Participants observing photographs of individuals with obesity looked longer at an ‘index body part’ (waist) than in the face of the depicted bodies. Thus, when confronted with obesity, participants were more interested in regions that are indicative of BMI and represent negative body-related stereotypes than in areas that transport social and individual information. We cautiously interpret this finding as an indication of a ‘de-individualised’ and ‘obesity-focused’ approach of perceiving individuals with obesity. This discovered tendency may be in close relationship with the negative cultural viewpoint concerning obesity – as also expressed in the attractiveness ratings of stimuli – and even weight stigmatisation [24–26]. This de-individualisation effect corresponds to results of studies investigating deviant body appearance (e.g. [27, 28]). Both studies found that pictures of individuals with deviant body appearance, e.g. individuals with port-wine stain or strabismus [28] and children with cleft lip [27], were associated with an attentional bias towards viewing them: a physical deviant face appearance attracted more attention without increasing memory for these faces [28], and the mouth area of children with cleft lip was dwelt on longer than viewing children without cleft lip, whereas the eye area of children with cleft lip was fixated less [27].

In contrast to our hypothesis, the overall visual exploration of bodies did not differ between the OB and NW sample. The BMI of an observer (considering individuals with normal weight and obesity) therefore seems to have hardly any influence on attentional processing of body stimuli. This corresponds to one recent study investigating visual exploration of body stimuli in individuals with underweight and an eating disorder and individuals with normal weight [29]. In contrast, several studies in the field of eating disorders found differences regarding the exploration pattern of body stimuli in anorexia nervosa (e.g. [30–34]) and bulimia nervosa (e.g. [34–37]) compared to healthy controls. One explanation for these inconsistent results might be the fact that BMI-related differences in the exploration pattern of body stimuli are specific for clinically diagnosed groups which are characterised by body image disturbance symptoms. The only observer-BMI-related difference in the current study was that OB spent less time exploring natural body stimuli than normal-weight participants. This could be interpreted as a visual avoidance pattern in order to reduce discomfort [10]. The avoidance of natural stimuli might serve as self-value protection function [38]. Sonnevile et al. [39] found that overweight women who underestimated their body weight showed a less disordered eating pattern and a lower risk for depression, which might be an indicator for a self-serving function. Compared to the NW sample, the OB sample rated the attractiveness of obese bodies as less negative, which could also be interpreted as an attempt to regulate discomfort through a less negative appraisal of in-group members. Nevertheless, as already mentioned, all participants rated normal-weight body pictures as more attractive, indicating a similar beauty ideal in both weight groups. Only the OB sample showed a significant correlation between shape dissatisfaction and gaze pattern, indicating that in the case of ‘high shape concern’ individuals with obesity looked significantly longer at the head region of obese bodies when compared with normal-weight bodies. This contrasts our general effect of preferred attention allocation to index body parts of natural bodies with obesity. This result also contrasts a study in individuals with normal weight that found that participant’s body dissatisfaction increases their attentional bias for thinness [40]. Nevertheless, it might again be an attempt of individuals with obesity suffering from high body dissatisfaction to

avoid the confrontation, especially with body parts indicative of weight. Durso and Latner [41] promoted the term weight bias internalisation, e.g. the internalisation of negative social stereotypes regarding overweight and obesity by individuals suffering from overweight or obesity. Assuming an internalisation of weight bias, the confrontation with obese bodies, but especially with body parts indicative of weight, might be especially threatening for individuals suffering from obesity and high body dissatisfaction.

Taking a clinical perspective, our results highlight the importance of attentional biases for body-related information processing in the treatment of individuals with overweight and obesity. Since attentional biases might be changeable [3], it would be interesting to further investigate the possibility of interventions focusing on the modulation of attentional biases and its possible influence on health behaviour.

In regard to the different stimulus types (avatars vs. natural photographs) results are largely comparable. The most prominent difference is that there was no difference in dwell time for the head of obese bodies compared to normal-weight bodies in the avatar condition. The assumption may be made that the face of avatars is in general not that important since participants might not expect to receive valid social information from avatars in the same way they do from natural faces. Nevertheless, avatar heads were also looked at the most frequently when compared to the other AOIs. Furthermore, whereas in the avatar condition the hips and waist of obese bodies were viewed longer when compared to the hips and waist of normal-weight bodies, in the natural photograph condition an attentional bias was found for the waist but not the hips of obese bodies. We interpret this as an artefact since the individuals on the natural photographs were ‘in action’ and not clothed in a standardised manner. Therefore, the differentiation between hips and waist might not have been very exact. This is one of the first studies to investigate the attentional processing patterns of human bodies by individuals with obesity as compared to individuals with normal weight. We have presented standardised and natural stimulus material to heighten the generalisability of our findings. Limitations of the study are: i) weight bias internalisations which may have an influence on attention allocation toward human bodies was not assessed through questionnaires; ii) the stimulus material did not include the participants’ own body; iii) we cannot provide information on mechanisms (e.g. strategies or beliefs, social desirability) underlying the exploration patterns of our study samples; and iv) the number of male participants was too small to detect potential gender differences, although gender differences in body image have been shown in other research (e.g. [42]).

In conclusion, the BMI of the explored body, but not the observer’s BMI, produced differences in the visual exploration pattern of human bodies. The exploration pattern of obese bodies might cautiously be interpreted as a ‘de-individualised’ and ‘obesity-focused’ perception. Obese bodies are seen as less attractive than normal-weight bodies in general. Individuals with normal weight seem to evaluate obese bodies more negatively than do individuals suffering from obesity. A selective attention pattern to index body parts might be an important contributing factor to various maintenance factors within obesity and states of increased overweight, as it promotes stigmatisation (even though indirect through gaze behaviour) and may be interpreted as a sign for weight bias internalisation. Since perceived weight stigmatisation is known to influence weight-related behaviours [5], it may contribute to the maintenance of states of overweight and obesity.

Future research should focus on the underlying mechanisms of attentional biases, e.g. the attentional processing of simultaneously presented bodies (obese vs. normal-weight) and address the possible contribution of external and internal weight biases in the maintenance of states of overweight and obesity.

Acknowledgements

We thank Viola Renner for linguistic revision of the manuscript.

Disclosure Statement

None of the authors declares a conflict of interest.

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