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SHORT COMMUNICATION

What does weight stigma smell like? Cross-modal influence of visual weight cues on olfaction

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In a variety of personal and professional domains, heavy individuals face stigma associated with their body size. Here we investigate a new method for subtle detection of the negative perceptions consistent with that stigma. In two studies, participants were asked to view images of heavy and thin individuals while smelling substances that, unbeknownst to them, were odorless. Across both studies, the results showed that the substances were perceived to smell worse when they were paired with images of heavy individuals than when they were paired with images of thin individuals. These findings suggest that perceptions of stigmatized individuals can be assessed indirectly through olfactory responses. More generally, they suggest that the effects of weight stigma are broader than previously recognized.

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INTRODUCTION

A majority of adults in the United States are now overweight or obese,[1] but there is no majority privilege associated with being 'fat'. Negative bias toward obese individuals is actually increasing,[2,3] reflected in discriminatory practices across employment, healthcare and education.[4–8] Research shows that overweight individuals are perceived not just unfavorably but actually provoke more feelings of disgust than 12 historically stigmatized groups (homeless individuals, persons with mental illness, etc.).[9–11]

Might such feelings of disgust be strong enough to alter basic sensory perceptions? For example, could viewing someone who evokes the emotion of disgust translate into perceiving a scent as 'disgusting'? These questions motivated the present investigation.

Past research provides some intriguing clues. Foul odors have been shown to reliably elicit disgust,[12] and such disgust reactions to smells can extend to social judgments. For example, one study exposed participants to either a negative odor or control scent, and those in the negative odor condition rendered harsher judgments regarding several types of moral vignettes (for example, sex between first cousins[13]). At the same time, recent findings have highlighted the bidirectional nature of emotional states and olfactory responses. For example, one study found that socially induced suspicion fosters enhanced detection of fishy smells.[14] Finally, research has revealed neural mechanisms linking various sensory modalities. Along with its clear connection to taste, olfaction interacts with other senses, including vision,[15] and neuroscientists have highlighted the role of the hippocampus and orbitofrontal cortex in cross-modal connections between vision and olfaction.[16]

In light of this research and the strong, pervasive negative bias leading many to label obese individuals as 'disgusting',[9–11] we sought to test whether seeing overweight/obese individuals would provoke relatively negative olfactory evaluations of a neutral substance. In two studies, participants saw photos of heavy and thin individuals while sniffing odorless substances. We predicted that participants would rate scents worse when seeing images of heavy individuals.

STUDY 1

Method

Participants. Undergraduate students (43 females, 25 males) participated in this study for course credit. See Table 1 for sample characteristics.

Procedure. Participants were run individually. After obtaining informed consent, an experimenter informed participants that the study was investigating factors affecting appetite. The experimenter explained that participants would be 'randomly assigned' to rate images or scents or both but that 'for scientific purposes', everyone would be exposed to both stimuli. In reality, all participants rated scents. The experimenter explained that although images would be presented with each scent, participants were to rate only the scents.

Participants were next exposed to 12 sequentially presented computer-based images. As each image appeared, the experimenter placed a scent sample under the participant's nose. Participants were instructed to rate each scent using a scale on the computer screen. After all stimuli were presented, the experimenter assessed the participant's weight and then conducted a thorough debriefing, confirming that participants had rated only scents

Scent stimuli. The 12 scent samples consisted of 1 ounce of fragrance-free Eucerin lotion (Beiersdorf Global, Hamburg, Germany) mixed with 2 drops of food coloring, producing differently colored substances (with color counterbalanced across visual stimuli). The samples were stored in clear cylindrical containers.

Visual stimuli. Along with rating the scent samples, participants were randomly assigned to view one of two sets of visual stimuli. Both stimulus sets contained photographs of eight different individuals—four visibly overweight/obese and four normal weight/thin (hereafter 'heavy'/'thin'), along with four distractor objects (that is, a hammer, a window, a wooden desk and an

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Table 1. Characteristics of the study sample for Studies 1 and 2

	Study 1 (N = *68*)	*Study 2* (N = *177*)
Gender		
Male	36.8%	20.3%
Female	63.2%	79.7%
Age	*M* = 19.22 (s.d. = 1.05) (range 17–22)	*M* = 19.82 (s.d. = 3.09) (range 17-42)
Ethnicity		
White	17.6%	26.6%
Black	0%	1.7%
Asian	50.0%	41.8%
Latino/a	23.5%	22.0%
Other	4.4%	6.2%
Decline to state	2.0%	1.7%
Body mass index	*M* = 23.16 (s.d. = 5.62) (range 13.92–49.21)	*M* = 22.49 (s.d. = 2.12) (range 12.92–50.48)
Underweight	16.2%	12.4%
Normal weight	58.8%	65.5%
Overweight	14.7%	19.2%
Obese	10.3%	2.8%

Abbreviations: *M*, mean; s.d., standard deviation.

8-ball). Images of heavy and thin individuals came from websites depicting those individuals before and after significant weight loss. The sets were compiled such that the thin individuals in one set were the heavy individuals in the other set (and *vice versa*). All participants saw the same eight individuals, but no participant saw both thin and heavy versions of the same person.

The distractor images were identical across both stimuli sets and served as a buffer between images of people, masking the study's true purpose.

Visual stimuli were contained in four blocks presented in random order. Each block included a heavy and thin image separated by a distractor image.

Measures

Scent ratings. Scent ratings were obtained using a computer-generated rating scale of 11 stars. To avoid biasing responses, participants were simply informed that 'more stars indicate a better rating'.

Body mass index. Body mass index (BMI) was calculated using the formula weight(lb)/(height(in))^{2}x703. Weight was assessed using a precision scale. Height was obtained from a subject pool survey.

Results

Because one participant's data was incomplete, results represent data from 67 participants. Preliminary analyses revealed no significant interactions involving perceiver age, sex or BMI. Accordingly, data were collapsed across these variables. In addition, in both this study and in Study 2, those exposed to one set of stimuli did not differ significantly in age, sex, BMI or ethnicity from those exposed to the other set of stimuli (all Ps > 0.05).

Scent ratings were averaged for each participant and subjected to a 2(stimulus set)x2(image weight) mixed analysis of variance, with repeated measures on the second factor. A main effect of image set emerged, F(1, 65) = 9.05, $P = 0.004$, 95% confidence interval (−0.67, −0.14), $\eta_p^2 = 0.122$. Scents paired with a heavy image were rated lower than scents paired with a thin image (see Table 2). There was, however, a significant interaction, F(1, 64) = 15.16, $P < 0.001$, $\eta_p^2 = 0.189$. Those participants ($n = 31$) who saw one set of images rated the scents associated with the heavy images (*M* = 5.96, s.d. = 1.88) significantly lower than the images associated with thin images (*M* = 6.88, s.d. = 1.87), $t(30) = 3.65$, $P = 0.001$, whereas those participants who saw the other set did not significantly differentiate the scents associated with the heavy (*M* = 5.46, s.d. = 1.94) vs thin (*M* = 5.34, s.d. = 1.92) images, $t > 1$.

Table 2. Study 1 and 2 mean scent ratings (including by perceiver BMI category for Study 2)

			95% CI	
	M	*s.d.*	*LL*	*UL*
Study 1				
Heavy images	5.69	1.91	5.22	6.16
Thin images	6.05	2.04	5.56	6.55
Distractor images	5.68	1.96	5.20	6.15
Study 2				
Heavy images	4.30	1.69	4.05	4.56
Underweight	4.36	1.55	3.67	5.05
Normal weight	4.24	1.58	3.97	4.55
Overweight	4.44	1.63	3.87	5.01
Obese	4.60	3.04	0.82	8.38
Thin images	4.49	1.75	4.22	4.75
Underweight	3.86	1.91	3.02	4.71
Normal weight	4.45	1.69	4.14	4.76
Overweight	4.90	1.71	4.30	5.49
Obese	5.05	2.22	2.30	7.80
Distractor images	4.43	1.65	4.19	4.68
Underweight	4.18	1.64	3.45	4.91
Normal weight	4.42	1.69	4.10	4.73
Overweight	4.64	2.13	1.87	7.18
Obese	4.53	1.65	4.19	4.68

Abbreviations: BMI, body mass index; CI, confidence interval; LL, lower limit; M, mean; UL, upper limit.

There was no significant difference between the heavy-paired scent ratings and the distractor-paired scent ratings, F(1, 65) = 0.011, $P = 0.918$, though the latter were significantly lower than the thin-paired scent ratings, F(1, 66) = 8.98, $P = 0.004$ (see Table 2).

Discussion

As hypothesized, scents paired with images of heavy individuals were rated worse than scents paired with images of thin individuals, despite all samples being odorless. However, the significant interaction indicated the results were driven by one image set. This set, according to independent judges' ratings (see below), featured significantly greater heavy vs thin discrepancies. Accordingly, in Study 2 we attempted to equate the size discrepancy in both sets and replicate the basic finding.

STUDY 2

Method

Participants. Undergraduate students (141 female and 36 male participants) participated for course credit. See Table 1 for sample characteristics.

Procedure. Study 2 procedures replicated Study 1 except that participants rated 16 scent samples, rather than 12, and saw 16 images. We added four distractor images such that all images of people were separated by distractor images.

Stimuli. To obtain stimuli equated for size discrepancies, 19 independent raters evaluated the body weight and facial expressions in several pre- and post-weight loss photographs using 9-point Likert scales. The final heavy and thin image pairs were chosen from photographs showing the greatest difference in body weight (mean difference = 3.25, range: 3.14–4.92) but the smallest difference in facial expression between pre- and post-weight-loss images (mean difference = 0.42, range: 0.14–0.71). For the distractor objects, we selected eight images with the smallest s.d. ($s.d._{avg}$ = 0.89) in favorability ratings (that is, a doorknob, a sheet of paper, a paper towel roll, a tape dispenser, a manila folder, a screwdriver, a tissue box and a wooden plank).

The final two image sets each included four heavy individuals, four thin individuals and eight distractor images. As in Study 1, heavy and thin versions of the same individual were divided between the two sets. Images were presented in four randomized blocks (each containing a heavy, a thin and two distractor images). The distractor images were identical across sets.

The scent samples again differed in color but not scent; four samples were added to the array to match the four additional distractor images. The scent ratings and participant BMI were obtained the same way as in Study 1.

Results

Because three participants' data were incomplete, results reflect analyses on 175 participants. Preliminary analyses revealed no significant interactions involving participant age or sex, and therefore data were collapsed across these variables. Interestingly, a significant interaction emerged between scent ratings and BMI, $F(1, 173) = 7.31$, $P < 0.001$, with higher BMI participants manifesting the primary effect (see below and Table 2) more than lower BMI participants. BMI was therefore included as a covariate, though results remained significant without its inclusion.

Results of the 2(stimulus set)x2(image weight) mixed analysis of covariance revealed only a significant main effect of image weight on scent ratings, $F(1, 172) = 9.32$, $P = 0.003$, 95% confidence interval (−0.35, −0.02), $\eta^2_p = .051$ (without covarying BMI, $F(1, 173) = 4.49$, $P = 0.036$). Despite using different images from those in Study 1, scents paired with heavy images were again rated significantly lower than scents paired with thin images (see Table 2).

There was no significant difference between the average ratings of obese-paired and distractor-paired scents, $F(1, 174) = 2.88$, $P = 0.091$. There was also no significant difference between the average ratings of thin-paired and distractor-paired scents, $F(1, 174) = 0.563$, $P = 0.454$ (see Table 2).

Discussion

Consistent with Study 1, scents paired with images of heavy individuals were rated worse than those paired with thin individuals. The effect was most strongly manifested by participants with higher BMIs (paralleling a nonsignificant trend obtained in Study 1). This in-group derogation has emerged in other weight stigma studies[17,18] and in this investigation was driven primarily by higher BMI participants elevating their ratings of thin-paired scents relative to heavy-paired scents. Unlike Study 1, the distractor object scent ratings did not differ from that of either weight image group. Given this differing pattern of distractor image results between the two studies, and as these images (intended purely as distractors) purposely depicted objects rather than individuals, we attach no particular significance to these specific results.

GENERAL DISCUSSION

The findings reported here dovetail with research demonstrating that overweight individuals face widespread negative stigmatizing perceptions.[8] Nonetheless, this is the first investigation showing that cues associated with a stigmatized social category can influence olfactory perceptions. In terms of neural mechanisms underlying this process, when visual and odor cues are semantically related, vision–olfaction cross-modal facilitation has been shown to occur,[16] particularly in the hippocampus, which, anatomically, is as close as three synapses away from odor receptor neurons in the nasal mucosa.[19]

Our findings suggest that the extent of negative bias toward overweight individuals may be greater than previously assumed. Future research should examine the full range of this effect, for example, by testing images of obese type II and III individuals, for whom weight stigma might be even greater. Finally, although our results reflect a relative difference between social categories (see ref. 20), they nevertheless underscore that weight stigma can extend to unrelated olfactory evaluations. Before such stigma can be combatted, the myriad ways, both obvious and subtle, in which stigma can manifest itself should ideally be identified—a goal these findings advance.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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