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## Physiological and self-reported disgust reactions to obesity

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### ABSTRACT

There is accumulating evidence that disgust plays an important role in prejudice toward individuals with obesity, but that research is primarily based on self-reported emotions. In four studies, we examined whether participants displayed a physiological marker of disgust (i.e. levator labii activity recorded using facial electromyography) in response to images of obese individuals, and whether these responses corresponded with their self-reported disgust to those images. All four studies showed the predicted self-reported disgust response toward images of obese individuals. Study 1 further showed that participants exhibited more levator activity to images of obese individuals than to neutral images. However, Studies 2–4 failed to provide any evidence that the targets' body size affected levator responses. These findings suggest that disgust may operate at multiple levels, and that the disgust response to images of obese individuals may be more of a cognitive-conceptual one than a physiological one.

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### KEYWORDS

Obesity; weight stigma; disgust; facial EMG

Interactions between people from different groups can be fraught with emotions (see Iyer & Leach, 2009, for a review). Emotions that commonly arise in intergroup situations include anxiety (Paolini, Harris, & Griffin, 2016; Stephan, 2014), anger (Iyer, Schmader, & Lickel, 2007), and guilt (Lickel, Schmader, Curtis, Scarnier, & Ames, 2005). Another emotion that may be experienced in intergroup contexts, particularly those contexts involving stigmatised groups, is disgust (Giner-Sorolla, Bosson, Caswell, & Hettinger, 2012; Taylor, 2007). Disgust likely has its functional origins in distaste (i.e. the avoidance of toxins in food), and has evolved to help protect organisms from bacteria and viruses (Chapman & Anderson, 2012). For humans, disgust takes on the additional functions of avoiding compromised reproductive fitness (e.g. sexual contact with people who are too old or too young), and avoiding people who violate social and moral norms (Tybur, Lieberman, & Giskevicius, 2009).

One social group for whom it could be particularly important to look at emotional responses, including disgust, is people who are obese. Prejudice against

obese people is widespread and appears to be worsening over time (Andreyeva, Puhl, & Brownell, 2008; Latner & Stunkard, 2003). Importantly, efforts to reduce prejudice toward obese people have generally not been very effective (for a review, see Daniélsdóttir, O'Brien, & Ciao, 2010). Most attempts to reduce prejudice toward obese people involve changing beliefs about the controllability of body weight. Those studies show that, although the beliefs themselves can be modified, there is no impact on negative attitudes and stereotypes (e.g. Anesbury & Tiggemann, 2000; Teachman, Gapinski, Brownell, Rawlins, & Jeyaram, 2003). One explanation for the failure of previous stigma-reduction efforts is that obesity stigma is rooted in emotional reactions to obese people rather than in beliefs about personal control and responsibility. If that is the case, then targeting beliefs about obesity would be ineffective in changing the emotional components, and in turn would be ineffective in reducing prejudice.

There is growing evidence that intergroup emotions, and in particular disgust, are related to prejudice toward obese people. Disgust appears to

be particularly relevant in the context of obesity because disgust is elicited by impurity and moral violations (e.g. Hutcherson & Gross, 2011; Rozin, Lowery, Imada, & Haidt, 1999). Obesity itself may be seen as an impurity, or it may be that the behaviours presumed to make a person obese (e.g. overindulgence and laziness) are seen as immoral behaviours (Hoverd & Sibley, 2007), either of which could give rise to a disgust response toward individuals who are obese. Another possibility is that obesity activates a behavioural immune system that is overly responsive to cues that may signal infectious disease (Oaten, Stevenson, & Case, 2009; Schaller & Park, 2011). In an early study, Park, Schaller, and Crandall (2007) found that obesity was implicitly associated with disease-related concepts (such as “contagious”). Other research has shown that disgust predicts negative attitudes toward obese people (Vartanian, 2010), that disgust (but not anger or contempt) predicts negative stereotypes toward obese people (Vartanian, Thomas, & Vanman, 2013) as well as a desire for social distance from obese people (Vartanian, Trewartha, & Vanman, 2016). Building on recent work differentiating among the functional domains of disgust (i.e. pathogen, moral, and sexual disgust; Tybur et al. (2009), Lieberman, Tybur, and Latner (2012) found significant self-reported disgust toward obese people in each of the three functional domains, with sexual disgust being rated higher than pathogen and moral disgust. Overall, then, disgust appears to be an emotion that is highly relevant in the context of obesity stigma.

It is noteworthy that most of the research on the role of disgust in interpersonal and intergroup relations has relied on self-report measures. However, emotional responses can operate on a number of different levels (e.g. cognitive and physiological; Seth, 2013). Thus, although self-reports of emotion may capture subjective feelings and are an important component of the emotional response, they can also provide an incomplete representation of one’s internal emotional state. Self-reports may reflect concerns about social desirability and the motivation to comply with social norms. For example, society might regularly describe and depict obese people as “disgusting”, so one could feel compelled to agree with that assessment, even though the sight of an obese person does not actually elicit a disgust response. Physiological measures provide an alternative to self-report measures and can provide valuable insights into the nature of the disgust response

toward obesity. For example, some initial research has shown that fMRI blood-oxygen-level dependent activity in the amygdala and insula, two brain regions that can be activated when people experience disgust (as well as during other cognitive and emotional states), increased when participants viewed stigmatised (obese, pierced, unattractive, or transsexual) faces compared to when they viewed non-stigmatised faces (Krendl, Macrae, Kelley, Fugelsang, & Heatherton, 2006). Other physiological measures have been used to measure disgust, including electrogastrography, heart rate variability, and cardiac response (Harrison, Gray, Gianaros, & Critchley, 2010; Shenhav & Mendes, 2014), but none of these have been used to examine the link between obesity and disgust.

Another physiological measure that could provide insight into the obesity–disgust link is facial electromyography (EMG; see Hess, 2009, for an overview). Contractions of our facial muscles are important in social interactions because they can quickly display our positive or negative responses to another person, and perhaps even specific emotions such as anger or disgust. Thus, while interacting with others who are obese, people may smile or frown differently than they do with people who are not obese. Such facial activity is recorded non-invasively in EMG over the sites of muscles used in facial expressions, such as those used for smiling and frowning. EMG can index affective responses that participants are often unaware of or are possibly unwilling to report (e.g. Hazlett & Hazlett, 1999; Tassinary, Orr, Wolford, Napps, & Lanzetta, 1984; Vanman, Paul, Ito, & Miller, 1997). Thus, an advantage of using facial EMG over self-report measures is that it is difficult for participants to control their responses, particularly if they are not aware of what is being measured. It is therefore less susceptible to some of the biases and distortions to which self-report measures are vulnerable (Tassinary, Cacioppo, & Vanman, 2007), although facial EMG can still be moderated by social context (Fridlund, 1991; Hess, Banse, & Kappas, 1995). One of the emotion expressions that facial EMG can readily measure is disgust, which is characterised by pulling the upper lip in a way that creates wrinkles on both sides of the nose using the levator labii superior muscles (de Jong, Peters, & Vanderhallen, 2002; Vrana, 1993; Wolf et al., 2005). Overall, then, facial EMG can provide a useful tool for developing a more complete understanding of the obesity–disgust link.

## The present research

The first aim of the present research was to determine whether participants exhibit physiological signs of disgust (i.e. levator labii EMG activity) in response to images of obese individuals, and whether these responses correspond with their self-reported disgust to those images. The second aim of this research was to determine whether self-reported and levator labii responses are similarly affected by factors that have been shown to influence evaluations of obese individuals in past research (see below).

In all studies, participants passively viewed a series of images while their physiological responses were recorded using facial EMG. After completing the passive viewing task, participants indicated their self-reported emotion toward each image. Study 1 included images of obese people, as well as pathogen disgust stimuli, moral disgust stimuli, non-disgust negative stimuli, and neutral stimuli. Study 2 included images of obese people and non-obese people. Study 3 included images of obese people and non-obese people engaging in healthy or unhealthy behaviours. Finally, Study 4 included images of obese people and non-obese people, along with information indicating that they were or were not putting in effort to lead a healthy lifestyle. Collectively, these studies provide a clearer picture of the nature of the disgust response that people have toward obese individuals.

### Study 1

The aim of Study 1 was to determine whether obese individuals elicit activation of the levator labii muscles, in addition to self-reported disgust. Furthermore, this study compared responses for obese targets to responses for pathogen disgust and moral disgust images in order to determine how disgust associated with obesity aligns with other disgust-relevant stimuli.

## Method

### Participants

Previous research on self-reported disgust toward obese individuals has found medium to large effect sizes (e.g. Lieberman et al., 2012; Vartanian et al., 2016). Thus, we expected to observe at least a medium effect size for self-report measures. We expected to observe effects of at least the same magnitude for facial EMG activity given that facial EMG is

thought to be less subject to demand effects than are self-report measures, and given that previous research has shown that facial EMG indices of emotion are a better predictor of prejudice than are self-report measures (e.g. Vanman et al., 1997; Vanman, Saltz, Nathan, & Warren, 2004). Thus, for each study, the sample size was based on a power calculation anticipating a medium effect size ( $\eta_p^2 = .10$ ) with 80% power in a within-subjects design, resulting in an estimated minimum sample of 34 participants per study. However, because we also anticipated some data loss due to equipment malfunction, we aimed to recruit a total of 40–50 participants per study. In Study 1, participants were 50 first-year psychology students from the University of New South Wales, Australia, who received course credit for taking part in the study. One participant discontinued the study due to discomfort with the images presented, reducing the final sample size to 49 participants (30 women and 19 men). Their mean age was 18.65 years ( $SD = 1.47$ , range = 17–25) and their mean body mass index (BMI;  $kg/m^2$ ) was 22.05 ( $SD = 2.63$ , range = 16.02–28.41). Regarding ethnicity, 24 participants identified as Asian, 21 as Caucasian, and 4 participants identified with other ethnicities. All participants were fluent in English and had normal or corrected-to-normal vision.

### Materials

**Stimuli.** Participants viewed images from five different categories. Images of obese people (three men and three women) were sourced from various online websites, and were pilot tested to confirm that the individuals in the images were perceived as obese. Images intended to induce pathogen disgust and moral disgust were sourced from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) and from Google Images. The six pathogen disgust images were selected from IAPS images that were classified as having negative valence and high arousal (2730, 3000, 3150, 7361, 9008, 9300). The six moral disgust images were sourced from the Internet and depicted whaling, lynching, puppies in a cage, a child soldier, a person about to stomp on a baby, and a prisoner being held on a leash. Additional negative and neutral images were sourced from IAPS and from Google Images. All images were pilot tested to confirm that (a) pathogen disgust images elicited more physical disgust than did other image types, (b) moral disgust images elicited more moral disgust than did other image types, and (c) neutral images

were evaluated less negatively than were any other image type. Participants in Study 1 viewed 30 images in total, with 6 images presented from each category (obese people, pathogen disgust, moral disgust, non-disgust negative, and neutral). All stimuli were presented using Inquisit Millisecond software package (Inquisit 4, 2013) on a 24-inch LED Benq XL2420T monitor with the resolution set to 1920 × 1080 pixels. Stimuli were presented at 50% of the computer screen size, in the centre of a white background.

**Self-reported disgust.** Participants were asked to rate their emotional response to each image. Each stimulus was presented individually above the instruction “Please indicate the extent to which you agree that [emotion] reflects the way you felt when you FIRST saw this image”. Responses were made on a 7-point Likert scale (1 = *Strongly Disagree* and 7 = *Strongly Agree*). In addition to disgust, four other emotion terms (anger, contempt, happiness, and fear) were included as filler items to mask our focus on disgust. Because anger and contempt (along with disgust) are considered to be moral emotions (Hutcherson & Gross, 2011; Rozin et al., 1999), we also examined ratings for those two emotions to determine whether any of the differences across image types are unique to disgust.<sup>1</sup>

**Facial EMG.** Facial EMG activity was recorded from the left levator, along with the zygomaticus major (the muscle associated with smiling) and corrugator supercilii (the muscle associated with frowning) muscle sites, and followed published guidelines for both placement and recording parameters (Fridlund & Cacioppo, 1986; Tassinari et al., 2007). Two Ag/AgCl electrodes with contact areas of 4-mm diameter were attached to the abraded skin on each site. Electrode contact impedance was tested using a UFI Checktrode model 1089 MkIII. If the impedance was higher than 10 k $\Omega$ , the skin was abraded further and the impedance was checked again. If the impedance remained higher than 10 k $\Omega$ , data for that muscle site were excluded. A ground electrode was attached on the right of the forehead. All electrodes were filled with highly conductive electrode gel. Signals from the electrodes were amplified by a factor of 5000 using a BIOPAC EMG100C amplifier (Biopac Systems, Inc., Santa Barbara, CA) and sampled at 1000 Hz. After data collection, a 20 Hz low pass and a 500 Hz high pass filter were applied

to the signal, which was then digitally rectified and integrated with a constant of 50 samples. The average EMG activity on each muscle site during passive viewing was calculated separately for the five stimulus categories (obese people, pathogen disgust, moral disgust, non-disgust negative, and neutral). Within each category, EMG activity was averaged across the six images.

### **Procedure**

This research was approved by the University of New South Wales Human Research Ethics Committee (HC13238), and all participants provided written informed consent. Participants came to the laboratory individually and were seated in front of a computer screen. The study was briefly described to participants as a study measuring “neural processing of visual stimuli”. Following recommended guidelines to reduce feelings of being observed (Tassinari et al., 2007), participants were told that the EMG electrodes were biosensors that measure physiological signals from the head, but were not informed that the electrodes measured their facial muscle activity until the end of the study. After participants provided informed consent, the electrodes were attached to their face. Participants then took part in the passive viewing phase of the experiment. Participants were asked to not look away from the computer screen for the duration of the task, but were told that they could discontinue the task at any point if they were uncomfortable with the images. The experimenter left the testing room and sat in the adjacent room during this portion of the study. Each stimulus was presented for 10 s, followed by a blank screen that was presented for 6 s between each stimulus. The order of stimulus presentation during this passive viewing task was randomised for each participant. EMG activity was recorded while participants passively viewed the images. After passively viewing all 30 images, participants were again shown all 30 images, one at a time in random order, and provided self-reports of their emotional response to each image. The emotion ratings were obtained after the passive viewing task to reduce the likelihood that participants would have guessed that we were interested in their emotional responses to the images during that task. Finally, to verify that the electrodes were recording muscle activity from the appropriate muscle sites, participants were asked to mimic a smiling face, a frowning face, and to wrinkle their nose upward.

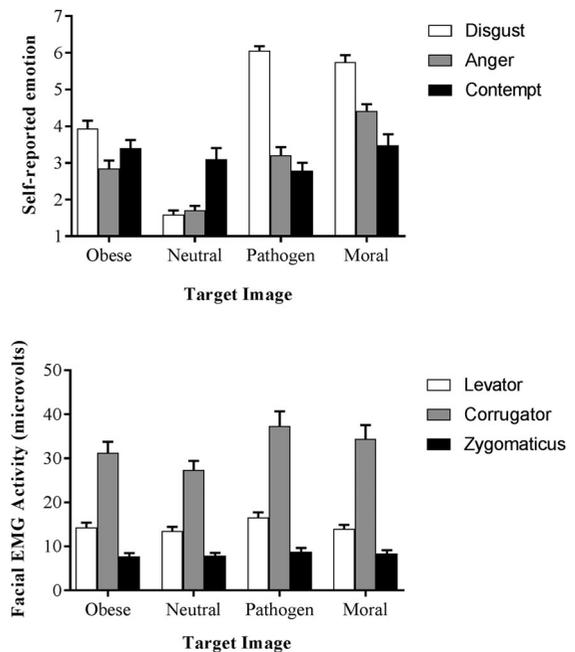
### Statistical analyses

All analyses (for all studies) were conducted using SPSS v24. Data were screened for outliers and for normality. Outlying scores were replaced with a value that was 3.29 SD above/below the mean. All variables were normally distributed. For self-reported disgust, anger, and contempt, mean ratings were calculated separately for each category of target images (obese targets, pathogen disgust, moral disgust, and neutral; non-disgust negative images were not included because they were not relevant to our hypotheses). Planned contrasts were then used to compare obese targets to each of the other target types. Prior to analysing facial EMG data, participants were removed from the analyses if there was any equipment malfunction (levator:  $n = 3$ ; corrugator:  $n = 1$ ; zygomaticus:  $n = 6$ ) or if their mean level of activity at a particular muscle site was more than three standard deviations above or below the sample mean (levator:  $n = 1$ ). Mean facial EMG activity toward each target category was calculated by computing the average activity toward all six images within each category across all 10 s of presentation. We then conducted two sets of planned contrasts. First, we compared the pathogen disgust, moral disgust, and negative images to neutral images to verify that the levator response was specific to disgust and did not apply to all negative images. Next, we compared facial EMG responses for images of obese targets to responses for neutral images, pathogen disgust images, and moral disgust images (non-disgust negative images were not included in this analysis because they were not relevant to our hypotheses). Because these were planned comparisons, no adjustments were made for multiple contrasts. Including participants' BMI as a covariate in the analyses did not change the pattern of results.

## Results

### Self-reported emotions

Mean ratings for self-reported emotions are shown in the top portion of Figure 1, and contrasts are shown in Table 1. Self-reported disgust ratings for images of obese people were significantly higher than disgust ratings for neutral images, and were significantly lower than disgust ratings for pathogen disgust and moral disgust images. The same pattern of results emerged for self-reported anger, although the effects were weaker overall. For contempt, the only significant



**Figure 1.** Mean self-reported emotions (top portion) and facial EMG activity (bottom portion) by target image type. Error bars represent the standard error of the mean.

contrast was that images of obese people elicited more contempt than did pathogen disgust images.

### Facial EMG activity

#### Preliminary analyses

Levator activity was higher for pathogen disgust images than for neutral images ( $F = 24.05$ ,  $p < .001$ ,  $\eta_p^2 = .37$ ), but moral disgust and negative images did not differ from neutral images ( $F_s < 2.50$ ,  $p_s > .12$ ,  $\eta_p^2 < .06$ ). Corrugator activity was higher for pathogen disgust, moral disgust, and negative images than for neutral images ( $F_s > 11.80$ ,  $p_s \leq .001$ ,  $\eta_p^2 > .21$ ), but there were no significant contrasts for zygomaticus activity ( $F_s < 1.80$ ,  $p_s > .19$ ,  $\eta_p^2 < .05$ ).

#### Comparisons to obese targets

Mean ratings for facial EMG activity are shown in the bottom portion of Figure 1, and contrasts are shown in Table 2. Levator activity for images of obese people was higher than levator activity for neutral images, lower than levator activity for pathogen disgust images, and did not differ from levator activity for moral disgust images. The same pattern of results

**Table 1.** Contrasts for self-reported emotions in study 1.

	Disgust			Anger			Contempt		
	<i>F</i>	<i>p</i>	$\eta_p^2$	<i>F</i>	<i>p</i>	$\eta_p^2$	<i>F</i>	<i>p</i>	$\eta_p^2$
Obese vs. Neutral	123.99	<.001	.74	35.97	<.001	.46	0.85	.36	.02
Obese vs. Pathogen	91.90	<.001	.68	4.39	.04	.10	5.41	.03	.12
Obese vs. moral	46.97	<.001	.52	179.66	<.001	.81	0.05	.83	.001

**Table 2.** Contrasts for facial EMG activity in study 1.

	Levator			Corrugator			Zygomaticus		
	<i>F</i>	<i>p</i>	$\eta_p^2$	<i>F</i>	<i>p</i>	$\eta_p^2$	<i>F</i>	<i>p</i>	$\eta_p^2$
Obese vs. Neutral	4.14	.05	.09	11.35	.002	.21	0.11	.75	.003
Obese vs. Pathogen	18.59	<.001	.31	17.25	<.001	.28	1.78	.19	.04
Obese vs. moral	0.62	.44	.02	3.64	.06	.08	1.89	.18	.05

emerged for corrugator activity, but there were no differences across image type in zygomaticus activity.

### *Correlation between levator activity and self-reported disgust*

Levator activity and self-reported disgust were not significantly correlated for any of the images types: obese images,  $r = -.28$ ,  $p = .08$ ; pathogen disgust images,  $r = .20$ ,  $p = .20$ ; moral disgust images,  $r = -.10$ ,  $p = .53$ ; negative images,  $r = -.03$ ,  $p = .83$ ; and neutral images,  $r = -.09$ ,  $p = .56$ .

## **Discussion**

Participants reported more disgust toward images of obese individuals than they did toward neutral images, but they reported less disgust toward images of obese individuals than they did toward pathogen disgust and moral disgust images. Although the same pattern of results emerged for anger, the effects were weaker overall, and there was also no difference between obese targets and neutral images for self-reported contempt. These findings are consistent with previous research indicating that disgust is more central to obesity than are either anger or contempt (Vartanian et al., 2013, 2016). With respect to facial EMG responses, the obese targets elicited more levator activity than did the neutral images. These findings are consistent with the growing body of evidence linking obesity with disgust (e.g. Krendl et al., 2006; Vartanian, 2010). In comparison to the other disgust stimuli, images of obese individuals elicited less levator activity than did pathogen disgust stimuli but did not differ from moral disgust stimuli. The same pattern emerged for corrugator activity, but there were no significant differences in zygomaticus activity. Interestingly,

there was no correspondence between self-reported disgust and facial EMG levator activity for any of the image types.

Although Study 1 showed that images of obese individuals elicited more self-reported disgust and more levator activity compared to neutral images, we did not examine participants' responses to obese people compared to non-obese people. Because weight bias is, at its core, about how obese people are evaluated relative to non-obese people, the next three studies examined participants' self-reported and physiological disgust response to obese and non-obese target individuals.

## **Study 2**

Study 2 compared responses to obese targets and non-obese targets in a passive viewing paradigm similar to that used in Study 1. We predicted that obese targets would elicit more self-reported disgust and greater levator activity than would non-obese targets.

## **Method**

### *Participants*

Participants were 46 first-year psychology students and paid community members (25 women and 21 men). Students received course credit and community members were paid \$15 for their participation. Participants' mean age was 24.76 years ( $SD = 6.98$ , range = 18–44) and their mean BMI was 23.12 ( $SD = 5.09$ , range = 17.48–49.95). Regarding ethnicity, 38 participants identified as Asian, 6 as Caucasian, and 2 identified with other ethnicities. As in Study 1, all participants were fluent in English and had normal or corrected-to-normal vision.

### Materials and procedure

Study 2 was identical to Study 1 with the following exceptions:

- (1) Participants viewed eight images of obese individuals (four men and four women) and eight images of non-obese individuals (four men and four women). These images were taken from the same sources as in Study 1, and were pilot tested to confirm that the obese targets were perceived as obese and that the non-obese targets were not perceived as obese.
- (2) The additional self-reported emotions that were assessed along with disgust included contempt, happiness, and sadness (but not anger or fear). Of these additional emotions, only contempt was included in the analyses described below.
- (3) Electrode signals were amplified by a factor of 2000.

### Statistical analyses

Data were screened for outliers and for normality. Outlying scores were replaced with a value that was 3.29 SD above/below the mean. All variables were normally distributed. Separate repeated-measures ANOVAs were used to determine whether self-reported emotions and facial EMG activity were affected by the targets' body size. As in Study 1, participants were excluded from the EMG analyses if there was equipment malfunction (levator:  $n = 5$ ; zygomaticus:  $n = 1$ ) or if their mean muscle activity for a particular site was more than three standard deviations above or below the sample mean (levator:  $n = 1$ ; zygomaticus:  $n = 1$ ). Including participants' BMI as a covariate did not influence the pattern of results.

### Results and discussion

Consistent with previous research (Vartanian et al., 2016), obese targets elicited more self-reported disgust than did non-obese targets,  $F(1, 45) = 58.96$ ,  $p < .001$ ,  $\eta_p^2 = .57$  (Table 3). In contrast, there was no difference between obese targets and non-obese targets in the level of self-reported contempt,  $F(1, 45) = 0.22$ ,  $p = .64$ ,  $\eta_p^2 = .005$  (see supplementary Table S2). Thus, the difference between responses to obese and non-obese targets was specific to self-reported disgust.

There was no significant difference in levator activity (in microvolts) between obese targets and

**Table 3.** Mean and SD for self-reported disgust in studies 2–4.

	Obese		Non-obese	
	Mean	SD	Mean	SD
Study 2	4.12	1.65	1.99	0.90
Study 3				
Unhealthy	4.20	1.45	3.08	1.17
Healthy	2.41	0.81	1.96	0.82
Study 4				
No effort	29.95	30.24	9.36	14.03
Effort	14.89	21.00	1.99	6.11

non-obese targets,  $F(1, 38) = 0.55$ ,  $p = .46$ ,  $\eta_p^2 = .01$  (Table 4). This latter finding is in contrast to the finding of Study 1, and suggests that the levator response to obese images observed in Study 1 may have been exaggerated by the comparison to neutral images that did not contain people. As in Study 1, levator activity was not significantly correlated with self-reported disgust either toward obese targets ( $r = -.19$ ,  $p = .23$ ) or toward non-obese targets ( $r = -.13$ ,  $p = .42$ ).

With respect to the other muscle sites, there was no significant difference in corrugator activity when viewing obese versus non-obese targets,  $F(1, 44) = 3.29$ ,  $p = .08$ ,  $\eta_p^2 = .07$  (supplementary Table S3), nor was there a difference in zygomaticus activity when viewing obese versus non-obese targets,  $F(1, 42) = 0.39$ ,  $p = .54$ ,  $\eta_p^2 = .01$  (supplementary Table S4).

### Study 3

To further explore disgust reactions to obese targets, participants in Study 3 were shown images of obese and non-obese target individuals who were engaging in healthy behaviours (e.g. exercising) or unhealthy behaviours (e.g. eating fast food). Previous research has found that portraying obese individuals in a counter-stereotypical manner (i.e. engaging in healthy behaviours) leads to lower anti-fat attitudes on both explicit and implicit measures (Hinman, Burmeister, Kiefner, Borushok, & Carels, 2015; Pearl, Puhl, & Brownell, 2012). Based on these prior findings, we hypothesised that counter-stereotypical images of obese people would similarly result in lower disgust ratings, and perhaps less levator activity, compared to stereotypical images of obese people.

### Method

#### Participants

Participants were 48 first-year psychology students and community members (30 women and 18 men).

**Table 4.** Mean (SD) levator activity for studies 2–4.

	Obese		Non-obese	
	Image only	Image + Text	Image only	Image + text
Study 2	18.34 (7.81)	–	18.73 (8.28)	–
Study 3				
Unhealthy	21.47 (13.74)	–	20.00 (11.91)	–
Healthy	20.59 (11.68)	–	21.53 (13.70)	–
Study 4				
No effort	12.94 (8.17)	12.31 (5.47)	12.52 (6.78)	13.17 (7.19)
Effort	12.10 (6.18)	13.98 (7.89)	11.72 (5.75)	11.71 (5.14)

Their mean age was 19.64 years (SD = 2.45, range = 18–32) and their mean BMI was 22.31 (SD = 2.79, range = 15.94–28.34). Regarding ethnicity, 23 participants identified as Asian, 18 as Caucasian, and 7 identified with other ethnicities. All participants were fluent in English and had normal or corrected-to-normal vision.

### Materials and procedure

Participants viewed a total of 32 images of obese or non-obese targets individuals engaging in healthy or unhealthy behaviours. There were 16 obese targets and 16 non-obese targets. Healthy behaviours included exercising, preparing healthy food, and shopping for fruit and vegetables; unhealthy behaviours included eating unhealthy food while watching television or sitting on a couch. Within the set of obese and non-obese images, there were an equal number of women and men represented, and an equal number depicting healthy and unhealthy behaviours. These images have previously been used in research examining anti-fat attitudes (Hinman et al., 2015). All other aspects of the procedure were identical to Study 1.

### Statistical analyses

Data were screened for outliers and for normality. Outlying scores were replaced with a value that was 3.29 SD above/below the mean. All variables were normally distributed. Self-reported emotions and facial EMG activity were analysed using separate 2 (target body size)  $\times$  2 (behaviour type) repeated-measures ANOVAs. Participants' data were excluded from the EMG analyses for a particular muscle site if there was equipment malfunction (levator:  $n = 4$ ; corrugator:  $n = 3$ ; zygomaticus:  $n = 6$ ). Controlling for participants' BMI did not change the pattern of results.

### Results and discussion

There was a significant main effect of target body size for self-reported disgust,  $F(1, 47) = 47.56$ ,  $p < .001$ ,  $\eta_p^2 = .50$ , such that obese targets elicited more disgust than did non-obese targets. There was also a main effect of target behaviour,  $F(1, 47) = 79.91$ ,  $p < .001$ ,  $\eta_p^2 = .63$ , such that targets engaging in unhealthy behaviours elicited more self-reported disgust than did targets engaging in healthy behaviours. These main effects were qualified by a significant interaction between target body size and behaviour,  $F(1, 47) = 23.03$ ,  $p < .001$ ,  $\eta_p^2 = .33$  (Table 3). Follow up simple-effects analyses showed that participants reported less disgust toward obese targets engaging in healthy behaviours than toward obese targets engaging in unhealthy behaviours,  $F = 98.04$ ,  $p < .001$ ,  $\eta_p^2 = .68$ . A similar pattern of results was observed for non-obese targets, with those engaging in healthy behaviours eliciting less self-reported disgust than those engaging in unhealthy behaviours, but the magnitude of this difference was slightly smaller than it was for obese targets,  $F = 41.87$ ,  $p < .001$ ,  $\eta_p^2 = .47$ .

Self-reported anger showed the same pattern as disgust, although the magnitude of the effects were weaker (see supplementary Table S1 for descriptive statistics): There was a significant main effect of target body size,  $F(1, 45) = 5.63$ ,  $p = .02$ ,  $\eta_p^2 = .11$ , such that obese targets elicited more anger than did non-obese targets, and there was also a main effect of target behaviour,  $F(1, 45) = 28.57$ ,  $p < .001$ ,  $\eta_p^2 = .39$ , such that targets engaging in unhealthy behaviours elicited more anger than did targets engaging in healthy behaviours. These main effects were qualified by a significant interaction between target body size and behaviour,  $F(1, 45) = 9.62$ ,  $p = .003$ ,  $\eta_p^2 = .18$ , showing that the magnitude of the healthy–unhealthy difference was greater for obese than for non-obese targets. There were no significant

effects for contempt ( $ps > .55$ ; see supplementary Table S2 for descriptive statistics).

For levator activity, there was no significant main effect of target body size,  $F(1, 38) = 0.42$ ,  $p = .52$ ,  $\eta_p^2 = .01$ , no main effect of target behaviour,  $F(1, 38) = 0.54$ ,  $p = .47$ ,  $\eta_p^2 = .01$ , and no significant interaction between target body size and behaviour,  $F(1, 38) = 3.27$ ,  $p = .08$ ,  $\eta_p^2 = .08$  (Table 4). Furthermore, as in Studies 1 and 2, levator activity and self-reported disgust were not correlated for any of the target groups: obese/unhealthy,  $r = .15$ ,  $p = .36$ ; obese/healthy,  $r = .17$ ,  $p = .27$ ; non-obese/unhealthy,  $r = -.02$ ,  $p = .89$ ; and non-obese/healthy,  $r = -.04$ ,  $p = .80$ . Finally, there were no significant effects for either corrugator activity or zygomaticus activity ( $ps > .06$ ; see supplementary Tables S3 and S4 for descriptive statistics).

Consistent with previous studies (Hinman et al., 2015; Pearl et al., 2012), ratings of disgust toward obese targets were attenuated when those targets were engaging in counter-stereotypical healthy behaviours compared to when they were engaging in stereotypical unhealthy behaviours. The same pattern was evident for self-reported anger (but not contempt), although the effects for anger were much weaker than they were for disgust. These findings again indicate that self-reported disgust is more strongly associated with obesity than are other moral emotions (Vartanian et al., 2013, 2016). Replicating Study 2, there was no evidence of any differential levator response to any of the target groups. Overall, then, obese targets appear to elicit self-reported disgust but not increased levator activity.

## Study 4

In a final study, we tested a factor that has been shown in previous research to influence evaluations of obese individuals. Specifically, recent research on weight bias has shown that, when obese individuals are perceived as investing effort to lead a healthy lifestyle and lose weight, they are evaluated more positively and elicit less self-reported disgust (Beames, Black, & Vartanian, 2016; Black, Sokol, & Vartanian, 2014; Fardouly & Vartanian, 2012; Vartanian & Fardouly, 2014). Following from this past research, participants in Study 4 were provided with information about the amount of effort the targets were investing in leading a healthy lifestyle. We predicted that obese individuals who were investing effort to lead a healthy lifestyle would elicit less self-reported

disgust and less levator activity compared to obese individuals who were not investing effort to lead a healthy lifestyle.

## Method

### Participants

Participants were 40 first-year psychology students (26 women and 14 men) who completed the study in exchange for course credit. Their mean age was 21.17 (SD = 5.94, range = 17–49) and their mean BMI was 22.42 (SD = 3.35, range = 17.58–35.50). Regarding ethnicity, 17 participants were Asian, 16 were Caucasian, and 7 identified with other ethnicities. All participants were fluent in English and had normal or corrected-to-normal vision.

### Materials and procedure

Participants viewed images of obese and non-obese women (the same stimuli used in Study 2). A fixation cross was presented on the left of the screen for 2 s prior to each stimulus presentation, after which an image of an obese or non-obese target was presented on the left of the screen for 4 s. The image remained on the screen for another 4 s while information describing the individual's efforts to lead a healthy lifestyle was also presented on the right side of the screen. Eight descriptions were used in this study: four described the target as investing no effort in trying to lead a healthy lifestyle (e.g. "I have never really tried to improve my diet or physical activity levels"), and the other four described the target as putting in long-term effort in trying to lead a healthy lifestyle (e.g. "Over the last few years, I have tried to have relatively small meals and eat plenty of fruits and vegetables each day"). Half of the images within each target body-size group were paired with no-effort information, and half were paired with long-term-effort information. The rest of the procedure was identical to that used in Study 1, with two exceptions: participants self-reported their level of disgust, anger, and contempt (as well as sympathy and pity; data not analysed) on a visual analogue scale anchored by "Not at all" (0) and "Extremely" (100); and self-reports were made after each image presentation rather than at the end of the passive viewing task.<sup>2</sup>

### Statistical analyses

Data were screened for outliers and for normality. Outlying scores were replaced with a value that was 3.29

SD above/below the mean. For self-reported disgust, data for the non-obese/high-effort group were not normally distributed (Kurtosis = 22.29, Skew = 4.74), primarily because most participants indicated no disgust toward that group. Consequently, data for self-reported disgust were transformed using a log10 transformation. The transformed variable more closely approximated a normal distribution (Kurtosis = 3.97; Skew = 2.15), and was used in the analyses below (for ease of interpretation, raw means are provided in Table 3). Self-reported emotions were analysed using separate 2 (target body size)  $\times$  2 (level of effort) repeated-measures ANOVAs.

For the facial EMG data, mean activity at each muscle site was calculated separately for the epoch in which the images were presented alone and the epoch in which images were presented with effort information. Participants' data were excluded from analyses if there was equipment malfunction (levator:  $n = 2$ ; zygomaticus:  $n = 1$ ) or if their mean muscle activity was more than three standard deviations greater than the sample mean (levator:  $n = 1$ ; corrugator:  $n = 1$ ; zygomaticus:  $n = 1$ ). Mean activity for each muscle site was analysed using separate 2 (target body size)  $\times$  2 (level of effort)  $\times$  2 (epoch) repeated-measures ANOVAs. Including participants' BMI as a covariate did not change the pattern of results.

## Results and discussion

There was a significant main effect of target body size for self-reported disgust,  $F(1, 39) = 36.55$ ,  $p < .001$ ,  $\eta_p^2 = .48$ , such that obese targets elicited more disgust than did non-obese targets. There was also a significant main effect of effort information,  $F(1, 39) = 27.70$ ,  $p < .001$ ,  $\eta_p^2 = .42$ , such that targets who invested long-term effort elicited less self-reported disgust than did targets who invested no effort. There was no interaction between target body size and effort information,  $F(1, 39) = 0.01$ ,  $p = .93$ ,  $\eta_p^2 < .001$  (see Table 3 for raw means). As in Study 2, self-reported anger showed the same pattern of results as disgust, but the magnitude of the effects was weaker. Specifically, there was a significant main effect of target body size,  $F(1, 39) = 6.03$ ,  $p = .02$ ,  $\eta_p^2 = .13$ , and a significant main effect of effort,  $F(1, 39) = 16.06$ ,  $p < .001$ ,  $\eta_p^2 = .29$ , but no body size  $\times$  effort interaction,  $F(1, 39) = 0.05$ ,  $p = .82$ ,  $\eta_p^2 = .001$  (supplementary Table S1). For contempt, there was only a significant main effect of effort,  $F(1, 39) = 7.06$ ,

$p < .001$ ,  $\eta_p^2 = .17$ , such that those who invested long-term effort elicited less contempt than did those who invested no effort (supplementary Table S2).

For levator activity, there were no significant main effects of target body size,  $F(1, 36) = 0.99$ ,  $p = .33$ ,  $\eta_p^2 = .03$ , effort,  $F(1, 36) = 0.37$ ,  $p = .65$ ,  $\eta_p^2 = .01$ , or epoch,  $F(1, 36) = 1.84$ ,  $p = .18$ ,  $\eta_p^2 = .05$ . There were also no significant two-way or three-way interaction effects ( $ps \geq .07$ ) (see Table 4). As in the other studies, levator activity was not significantly correlated with self-reported disgust toward any target images ( $rs < |.25|$ ,  $ps > .14$ ). For the corrugator muscle site, the only significant effect was that participants showed less brow activity toward the images alone than toward the images + text ( $p = .002$ ; supplementary Table S3). For the zygomaticus muscle site, the only significant effect was an interaction between effort and epoch ( $p = .03$ ), such that the no-effort/image-only images elicited more zygomaticus activity than any other images (see supplementary Table S4 for descriptive statistics).

Consistent with previous research, investing effort to lead a healthy lifestyle was associated with lower self-reported disgust (Beames et al., 2016; Black et al., 2014). As in Studies 2 and 3, however, neither effort information nor the targets' body size influenced levator activity.

## General discussion

The purpose of the present research was to determine whether the self-reported disgust response that previous research has identified as being important to prejudice toward obese people was also manifest in a physiological index of disgust: levator labii activity, as measured with facial EMG. Across all four studies, there was strong evidence that obesity is associated with self-reported disgust. Self-reported anger was also associated with obesity, but the effects were much weaker than they were for disgust; there were no significant effects for self-reported contempt. These findings are consistent with previous research indicating that self-reported disgust is more central to perceptions of obesity than are anger and contempt (e.g. Vartanian et al., 2013, 2016). With respect to facial EMG responses, Study 1 showed that obese targets elicited more levator activity than did neutral images. However, Studies 2–4 failed to find any evidence that the targets' body size, or other factors known to influence evaluations of obese individuals

(i.e. their health behaviour, their effort to lead a healthy lifestyle), affected levator response (or corrugator or zygomaticus responses). Thus, overall, there is very little evidence suggesting that images of obese individuals elicit facial responses of disgust.

One possible explanation for the disconnect between levator activity and self-reported disgust is that obese targets prime disgust at a conceptual level rather than at a visceral level. Buckels and Trapnell (2013) proposed a similar explanation for the results of their research on disgust and outgroup dehumanisation in which they argued that some stimuli may activate concepts associated with disgust at a social-cognitive level without recruitment of the “emotional architecture”. This perspective also aligns with the notion that core (or pathogen) disgust and socio-moral disgust are different constructs (Simpson, Carter, Anthony, & Overton, 2006). Specifically, Simpson et al. argued that core disgust stimuli follow a direct associative route whereas socio-moral stimuli follow an interpretive appraisal route. These different routes are reflected in the nature of people’s emotional responses to particular stimuli, as well as the time-course of those responses. Extending those perspectives, it may be that pathogen disgust stimuli activate an immediate physiological response, whereas socio-moral stimuli elicit more of a cognitive disgust appraisal. In the context of the current work, then, obesity may be conceptually associated with disgust, rather than evoking a physiological disgust response.

If we accept the argument that disgust responses to obese individuals represent a conceptual association rather than an emotional reaction, does this also suggest that the term “disgust” is simply a proxy for a more general negative evaluation of obese individuals (cf. Nabi, 2002)? The available evidence (including the results of the current studies) suggests that there is in fact something unique about disgust in the context of obesity. For example, previous research has shown that participants reported more disgust toward an obese target person than toward a lean target person, but that there were no differences in reports of other negative emotions, such as anger or contempt (Vartanian et al., 2016). Furthermore, self-reported disgust (but not anger or contempt) has been shown to predict prejudice and discrimination toward individuals with obesity (Vartanian et al., 2013, 2016). These findings indicate that people can distinguish between disgust and other negative emotions in the context of

obesity. In addition, society (via mass media or literature) may consistently label people as disgusting because they are seen as unhealthy (reducing their reproductive fitness) and/or because they violate social and moral norms with their behaviour (as may be the case with obesity). Thus, one can acquire an association between obesity and the verbal label of disgust without the physiological experience that might be associated with, for example, eating something that is disgusting. The implication of this argument is that, even if the concept of disgust is divorced from its emotional architecture (as suggested by Buckels & Trapnell, 2013), there is still something unique about the concept of disgust that is relevant in the context of obesity, and disgust does not appear to be a mere proxy for negative evaluation.

Another possible explanation for the dissociation between the self-reported and physiological indicators of disgust is that people have become, in some sense, “desensitised” to obesity. Because of the increasing prevalence of obesity around the globe over the past 30 years (Finucane et al., 2011), along with frequent media discussions of obesity, people are regularly exposed to individuals with obesity. It is possible that, with repeated exposure, the physiological response to obesity may have become blunted over time, even though obesity continues to be associated with disgust at a cognitive-conceptual level. Indeed, disgust, like other emotions, is subject to the process of habituation, particularly when exposure to a disgust-eliciting stimulus occurs in multiple contexts (Viar-Paxton & Olatunji, 2012). Furthermore, recent work by Robinson and Kirkham (2014) suggests that repeated exposure to overweight bodies leads people to evaluate those bodies as more “normal”. Although this finding seems to be incompatible with the increasing prevalence of weight bias (Andreyeva et al., 2008; Latner & Stunkard, 2003), it may be that repeated exposure to obesity is dampening the physiological emotional response rather than changing attitudes or reducing discrimination (consistent with Simpson et al.’s (2006) finding that core disgust response weakens over time but that socio-moral disgust actually increases over time). Both of the proposed explanations for our findings (i.e. the conceptual/visceral distinction and the possibility of exposure leading to desensitisation) are merely speculations and should be tested in future research.

Of course, our laboratory-based studies contained features that limit our conclusions. For instance,

participants merely passively viewed images of obese and non-obese people across the four studies. A picture-viewing paradigm may be sufficient to affect self-reports of disgust but is perhaps not enough to arouse a more visceral emotional response. Video stimuli that illustrate aspects of obesity that people perhaps find particularly disgusting (e.g. fat wobbling) or interactions with actual obese people may indeed elicit the kind of responses we hypothesised for the levator labii muscle. Blascovich, Mendes, Hunter, Lickel, and Kowai-Bell (2001), for example, measured cardiovascular activity while participants interacted with a stranger who was either stigmatised or not (i.e. the presence/absence of a facial birthmark, low socioeconomic status, or a different race). Such approaches may be fruitful to study the physiological responses that underlie reactions to obese people, particularly in contexts where behavioural discrimination has been observed.

Another potential limitation is that the physiological measure we used here, levator EMG activity, was chosen because it is involved in *expressions* of disgust, whereas other physiological measures, such as fMRI activity at the insula, may better index the *activation* or *processing* of disgusting stimuli. That is, the levator might be a less sensitive measure of disgust when the emotion is at a low level of intensity. It is important to note, however, that both of these limitations – the relatively low emotional impact of picture viewing and the reliance on facial EMG as a measure of emotional expression – would also apply to other non-social disgust stimuli, but Study 1 did show that levator EMG was greatest when participants passively viewed pathogen-based disgust stimuli. Moreover, facial EMG recorded from other sites (i.e. the zygomaticus and corrugator, reflecting smiling and brow furrowing, respectively) has been reliably demonstrated to index affective states at similarly low levels of intensity – even when no overt facial expressions are observed (e.g. Cacioppo, Petty, Losch, & Kim, 1986; Vanman et al., 2004; Weyers, Mühlberger, Kund, Hess, & Pauli, 2009). Thus, research that uses other physiological measures (e.g. electrogastrography and heart rate variability) in a more socially impactful paradigm might not yield findings very much different from our own.

Finally, our self-report measure relied on a single item directly assessing disgust. However, disgust as an emotion can encompass different domains (e.g. moral disgust vs. physiological disgust), and can also include an experiential component (e.g. feeling sick). Thus, future research using self-report measures

of disgust could provide a more nuanced understanding of people's reactions to obesity by assessing the different domains of disgust, as well as a range of experiences or sensations related to the target (e.g. sickens me and grosses me out).

In conclusion, the research we reported here indicates that participants subjectively experience images of people who are obese as more disgusting than images of people who are not obese. Importantly, however, we found little evidence that participants' physiologically responses converge with their subjective ratings. Our findings highlight the importance of a multi-method approach in the study of reactions to obesity. They also raise interesting questions about the nature of disgust itself, suggesting that disgust may be represented at multiple levels (e.g. social-cognitive and physiological). It would be worthwhile for future research to determine which level of disgust best predicts behavioural responses (including discrimination) toward a particular stimulus or object (including obese people).

## Notes

1. An additional measure of participants' emotional response to the target stimuli was included in all studies. For each image, participants were asked to select from an array of facial expressions of emotion the one that most closely corresponded to the emotion they felt when they initially saw the image. Because that measure does not provide information about participants' disgust response to all targets, and therefore does not address the questions we pose in this paper, that measure was not analysed.
2. As part of a larger project, participants also provided self-reports of stereotypes and desire for social distance from the target individuals. However, those measures are unrelated to the questions addressed in the present study and are thus not reported here.

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