European Journal of Social Psychology, Eur. J. Soc. Psychol. **41**, 688–694 (2011)
Published online 31 July 2011 in Wiley Online Library (wileyonlinelibrary.com) **DOI**: 10.1002/ejsp.839

Fast track report

Facial reactions reveal that slim is good but fat is *not* bad: Implicit and explicit measures of body-size bias

SARAH RODDY[1], IAN STEWART[1]* AND DERMOT BARNES-HOLMES[2]
[1]National University of Ireland, Galway, Ireland; [2]National University of Ireland, Maynooth, Ireland

Abstract

Facial electromyography (EMG) was used to gauge emotional responding towards images of slim and overweight individuals, and findings were compared with data from a series of alternative measures including two implicit attitudinal procedures, the Implicit Relational Assessment Procedure (IRAP) and the Implicit Association Test (IAT), and explicit measures of anti-fat prejudice and discriminatory behavior. Images of slim individuals elicited EMG responses consistent with more positive affect. Data from both the IRAP and IAT indicated higher levels of bias than were revealed on the explicit measures, and the IRAP also corroborated the EMG pattern by indicating responses consistent with pro-slim rather than anti-fat bias. The IRAP was moderately correlated with both EMG and the IAT and was the only measure to predict behavioral intentions. Copyright © 2011 John Wiley & Sons, Ltd.

Weight-related attitudes, including pro-slim attitudes on the one hand and anti-fat on the other, have been linked with significant problems such as eating disorders (Pepper & Ruiz, 2007; Thompson & Stice, 2001) and discrimination, respectively (Gapinski, Schwartz, & Brownell, 2006; Puhl & Brownell, 2001) and as such constitute important domains of psychosocial research. Accurate measurement of these attitudes is key to assessment and potential intervention. However, social desirability effects have become a concern in relation to the explicit self-report measures employed in traditional research (e.g., Dittmar, Halliwell, & Stirling, 2009; Mills, Polivy, Herman, & Tiggemann, 2002). Hence, a recent trend in measurement is the use of alternative procedures, which circumvent sources of bias characterizing self-reports.

Perhaps the most prominent of such measures is the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). The IAT has been employed as a measure of weight-related implicit attitudes in several previous studies (see Morrison, Roddy, & Ryan, 2009 for a review). In the critical phase of a typical IAT study of this phenomenon, participants are required to respond as rapidly as possible in accordance with two separate patterns: (i) categorize “Slim” with “Good” and “Fat” with “Bad” and (ii) categorize “Slim” with “Bad” and “Fat” with “Good”. Several studies have found that participants are faster on average to demonstrate the first pattern than the second, which is taken as evidence of “anti-fat” bias (e.g., Brochu & Morrison, 2007; Roddy, Stewart and Barnes-Holmes, 2010). Furthermore, participants tend to produce higher levels of bias on the IAT than with self-report suggesting that the IAT is revealing levels of prejudice that might not otherwise become apparent.

Despite its popularity as an implicit measure, several limitations of the IAT have been noted. Perhaps the most cited of these is that the associations found for any particular concept are always relative (De Houwer, 2002). For example, in the context of “anti-fat” bias, the standard IAT does not provide a measure of separate attitudes to “fat” and “slim”, and thus the meaning of an IAT effect with respect to attitudes towards the overweight is ambiguous; for example, it could indicate a neutral attitude towards slim and a negative attitude towards fat, or a positive attitude towards slim and a neutral attitude towards fat.

One key advantage of the Implicit Relational Assessment Procedure (IRAP; Barnes-Holmes, Barnes-Holmes, Stewart & Boles, 2010), a more recent measure of implicit cognition, is that in contrast with the IAT, it permits independent evaluation of concepts. Thus, in the context of weight-related attitudes it provides information on separate attitudes towards “slim” and “fat”. To illustrate, on a typical IRAP trial the participant responds by categorizing the relationship between a label (e.g., “Good” or “Bad”) and a target stimulus (e.g., “Slim” or “Fat”) as quickly as possible by pressing one of two keys (e.g., “Same” and “Opposite”). Four different trial types can be created by presenting different combinations of label and target stimuli. For example, in the case of an IRAP examining anti-fat bias, the four combinations would be *Good-Slim*, *Good-Fat*, *Bad-Slim*, and *Bad-Fat*. For each of these combinations, the participant can be required to respond in either a “pro-slim/anti-fat”, or a “pro-fat/anti-slim” manner, and the difference in mean response latency between the aggregate of the former and the latter trial types provides a measure of implicit bias. Importantly, however, in addition to an overall IRAP effect, a separate effect can be obtained for each of the four trial types, thus providing information regarding

*Correspondence to: Ian Stewart, School of Psychology, National University of Ireland, Galway, Galway City, Ireland.
E-mail: ian.stewart@nuigalway.ie

 Received 26 April 2010, Accepted 15 June 2011

specific relationships (e.g., between "Slim" and "Good" and also "Fat" and "Good"). In a recent study (Roddy et al., 2010) comparing the IRAP and IAT as measures of body shape relevant prejudice, both measures revealed bias; however, the IRAP trial type analysis indicated that participants were showing strong pro-slim attitudes in the absence of negativity towards the overweight.

Both the IAT and IRAP are measures of implicit cognition and as such can provide useful information about underlying weight-related attitudes that explicit measures may fail to reveal. However, attitude theory suggests that cognition is only one facet of these phenomena and that another at least equally important component is emotion (Zajonc, 1980). Hence, exploration of implicit weight-related affective responding would constitute an important extension of research in this domain. In addition, immediate emotional responding may provide a particularly informative additional measure of implicit reaction. For example, evidence suggests affect is superior to cognition in the prediction of behavior (Vanman, Saltz, Nathan & Warren, 2004); thus affective reactions might yield better relationships with behavioral indices.

One possible methodology for measurement of implicit emotion is facial electromyography (EMG; Vanman, Paul, Ito & Miller, 1997; Vanman et al., 2004). Facial EMG records muscle activity involved in facial expressions and as such allows for the identification of muscle contractions based on speed and sensitivity (Stern, Ray & Quigley, 2001). It has been found to provide a sensitive and precise measure of muscle activity to weakly evocative emotional stimuli even in the absence of a detectable facial response by an observer (Cacioppo, Petty, Losch & Kim, 1986) and to yield reliable information regarding both the *valence* and the *intensity* of emotional reactions to stimuli more generally (Cacioppo et al., 1986). Several studies have demonstrated that attitude valence is reflected in facial EMG activity recorded at the zygomaticus major, and corrugator supercilii, muscles (e.g., see Tassinary & Cacioppo, 2000). The former are linked with smiling responses, whereas the latter are linked with frowning, although EMG activity at either location can vary as a function of both positive and negative valence (e.g., Cacioppo et al., 1986; Larsen, Norris & Cacioppo, 2003).

In the context of racial attitudes, facial EMG has revealed patterns of responding to target groups that contradict explicitly revealed attitudes. For example, Vanman et al. (1997) showed that Caucasian participants' facial EMG responses to images of White and Black faces revealed bias against Blacks even though explicit friendliness ratings suggested pro-Black bias. More recently, Vanman et al. (2004) demonstrated that EMG responses of Caucasian participants to photos of White and Black targets were related to a measure of discriminatory behavior, whereas responding on the IAT in the same study was not.

Based on its success as a measure of implicit prejudice in other domains such as race, the present study sought to use facial EMG as a measure of weight-related attitudes and to compare patterns found using this physiological measure with those revealed through more conventional implicit (IAT and IRAP) and explicit (Crandall's [1994] AFA and behavioral intentions) measures. In light of extant research documenting internalization of the thin ideal and of previous research from Roddy et al. (2010), it was hypothesized that a pattern of stronger pro-slim than anti-fat responding would be detected across a number of measures.

METHOD

Participants

Seventy-eight Irish university undergraduates (57 women) aged 17–38 years (M=20.25; SD=3.67) participated. Data from 14 individuals who failed to meet IRAP criteria (described subsequently) were removed, leaving a total of 64 (49 women).

Materials and Stimuli

Presentation of instructions and stimuli and recording of responses was computer-based for the EMG (Fujitsu Siemens desktop) and for the IAT and IRAP (Hewlett Packard Omnibook 4100 laptop). Weight-related images used for all three measures were selected from a pool of color pictures (32 images, 8 in each of the following categories: overweight men, overweight women, average weight men, average weight women) and were pilot tested for suitability with 18 postgraduates (8 women) using methods previously employed by Brochu and Morrison (2007) as follows. For each image, participants were asked to indicate gender, perceived body size (average or overweight), attractiveness and friendliness of the person depicted; how willing they would be to work with the person depicted on a group project; whether they recognized the person depicted; and the quality of the image. Images were removed if (i) anyone recognized the person; (ii) over 60% of participants did not appropriately identify gender or weight status; or (iii) mean rating of image quality was significantly worse than other images. This resulted in five images from each gender-weight category (20 in total) being retained. Explicit measures were paper and pencil tests.

Procedure

The experiment consisted of three phases. Phase 1 involved IRAP and IAT testing; phase 2 involved measurement of facial EMG; and phase 3 involved completion of explicit measures. The order of completion of phases 1 and 2 was counterbalanced such that half the participants completed phase 1 followed by phases 2 and 3, whereas half completed phase 2 followed by phases 1 and 3. Also, within phase 1 the order of administration of the IAT and IRAP was counterbalanced across participants. Finally, for the IAT and IRAP, participants were exposed initially either to a pro-slim/anti-fat or to an anti-slim/pro-fat block of trials (the same block sequence being used for both implicit measures), and this too was counterbalanced across participants.

Facial Electromyography

As recommended by Tassinary, Cacioppo and Geen (1989), electrodes were placed on the left zygomaticus major (cheek) and left corrugator supercilii (brow) muscle regions, and a ground electrode was placed on the forehead. Similar to Vanman et al. (1997), dummy electrodes were placed on the back of the neck to divert attention from the face as the primary area of interest, and participants were informed that electrodes "record involuntary neural responses that emanate from the head".

After electrode placement, participants rested for 5 minutes with eyes closed. Following this, they viewed the 20 weight-related images along with 10 neutral images (nature scenes[1] from the International Affective System [IAPS; Lang, Bradley & Cuthbert, 1997]). Images were presented in random order and for 4 seconds each with a 1 second inter-presentation interval. EMG signals were relayed to amplifiers using Biopac 150 hardware (Biopac Systems, Inc., Goleta, CA, USA), whereas EMG activity was recorded and displayed using BSL Pro 3.7 software (Biopac Systems, Inc., Goleta, CA, USA). Data were sampled at a rate of 2000 Hz; digital filtering was performed to remove low (30 Hz) and high (50 Hz) frequencies; and the time constant for integration was 400 milliseconds. Waveform peaks were identified for each muscle on image presentation[2] (see Fridlund & Cacioppo, 1986) and peak activity for each image was averaged across image type (average weight, overweight, and neutral).

Implicit Association Test

Participants were exposed to images of average weight and overweight men and women and positive (*popular*, *active*, *cute*, *attractive*, *nice*, *quiet)* and negative (*loud*, *unhealthy*, *sloppy*, *ugly*, *mean*, *bad)* adjectives. They were required to use separate computer keys ("D" and "K") to indicate as quickly and accurately as possible whether each person was "Fat" or "Slim" and to use the same two keys to indicate whether each word was "Good" or "Bad". Incorrect responses resulted in the presentation of a red "X", which disappeared once the correct response was selected.

Seven blocks were presented with two critical test blocks (48 trials). One of these test blocks (pro-slim/anti-fat) required participants to categorize average weight images and "good" words using one response key and overweight images and "bad" words using the other. The other test block (anti-slim/pro-fat) required participants to categorize average weight images and "bad" words using one key and overweight images and "good" words using the other.

[1]Images 5551, 5750, 5760, 5764, 5779, 5780, 5781, 5870, 5800, 5881.
[2]The data were first analyzed by averaging the EMG signal over the 10-second interval during which each image was presented. The mean activity for the presentation of overweight, average weight and neutral images was subsequently averaged for the corrugator and the zygomaticus. These data were not normally distributed and no statistically significant effects were found for activation of either muscle on presentation of the three image types. Thus, it was decided to employ an alternative method of EMG data analysis. According to Fridlund and Cacioppo (1986) " [c]ounting or averaging the EMG signal's peaks... [is a] relatively easy method to implement" (p.579). These authors deem the method to be appropriate for gauging gross differences in EMG activity, when high sampling rates are utilized. Thus, given these guidelines and the high sampling rate employed in the current study (2000Hz) it was decided to employ this method of analysis with EMG data.

Implicit Relational Assessment Procedure

Participants were presented on each trial with a label (either "Good" or "Bad") and a target stimulus (a photo of an average weight or overweight person) and had to press the "D" or "K" key to respond "Same" or "Opposite", respectively as quickly and accurately as possible. On pro-slim/anti-fat blocks, the following combinations were correct: Slim-Good-Same, Slim-Bad-Opposite, Fat-Good-Opposite, Fat-Bad-Same, whereas on pro-fat/anti-slim blocks, the following were correct: Slim-Bad-Same, Slim-Good-Opposite, Fat-Bad-Opposite, Fat-Good-Same. Incorrect responses resulted in the presentation of a red "X", which disappeared once the correct response was selected. Participants were presented with a minimum of two practice blocks in which they had to achieve 80% correct and a median response latency of under 2000 milliseconds across a pair of successive blocks within five attempts. Participants who failed to reach criterion were thanked and debriefed, and their data were discarded. Those who achieved criterion were presented with six test blocks of 24 trials each, alternating between blocks requiring exclusively pro-slim/anti-fat or anti-slim/pro-fat responding.

Feeling Thermometers

Participants were presented with two feeling thermometers, adapted from Greenwald and Farnham (2000), which assessed feelings towards overweight and slim people, respectively on five-point scales (1=*very warm; 5=very cold*).

Explicit Anti-Fat Attitudes

The Dislike subscale (seven items) of Crandall's (1994) AFA assessed explicit anti-fat attitudes. Participants responded on nine-point scales (0=*True;* 9=*False*); with higher scores indicating more extreme anti-fat attitudes. Cronbach's alpha was acceptable at .72 (95% *CI*=.6–.82).

Behavioral Intentions Questionnaire

Participants were presented with two photographs, showing an overweight woman and an average weight woman, respectively, and answered five questions assessing the extent to which they would interact with each of the two individuals. Participants responded on seven-point rating scales (1=*very unlikely* to 7=*very likely*); with higher scores indicating greater willingness to interact. Cronbach's alpha was .87 (overweight target[3]; 95% *CI*=.8–.91) and .87 (average weight target; 95% *CI*=.80–91).

RESULTS

A series of independent *t*-tests indicated that order of completion of EMG and the implicit cognitive tests did not influence outcomes on these measures ($ps > .16$). In addition, a two-way between-group MANOVA was conducted with order of

[3]One item was deleted ("How likely is it that you would want to become friends with her") from both scales because its inclusion resulted in a marked reduction in Cronbach's alpha.

implicit measures (IAT → IRAP or IRAP → IAT) and test sequence (pro-slim/anti-fat first or anti-slim/pro-fat first) as independent variables, and the measures obtained from the IRAP and IAT as dependent variables. Neither of the tested variables was significant (all $ps > .24$) and thus their influence could also be ruled out.

Facial Electromyography

Activation peaks at each muscle on presentation of average weight, overweight and neutral images were averaged, thus providing an indicator of corrugator and zygomatic activity for each image type. Initial exploration revealed that the data violated several assumptions of parametric testing including normal distribution and heterogeneity of variance and hence logarithmic transformations were applied. The transformed data were still highly kurtotic, and thus non-parametric analyses were used.

A Friedman test revealed a statistically significant difference in peak activation levels for the zygomaticus muscle, χ^2 (2, N=64)=85.83, $p < .005$. Post hoc analyses indicated significant differences in zygomatic activation between the average weight images (*Mdn*=.92 μV) and each of the other two image categories (overweight {*Mdn*=.21 μV}: $z = -6.02$, $p < .005$, $r = -.53$; neutral {*Mdn*=.24 μV}: $z = -.695$, $p < .005$, $r = -.61$). Thus, the average weight images elicited EMG responses consistent with more positive affect. Corrugator activity was not significantly different for these three types of images ($p = .301$).

Implicit Association Test

Response latency data for each participant were transformed into *D*-scores using the *D*-algorithm (see Greenwald, Nosek & Banaji, 2003). Latencies from pro-slim/anti-fat blocks were subtracted from those for anti-slim/pro-fat blocks; thus a positive *D*-score indicates a pro-slim/ anti-fat bias. The average *D*-IAT score across participants was 63 (*SD*=0.36) and was significantly different from zero (t [63]=14.01, $p < .01$, $r = .87$), thus showing a predicted pro-slim/anti-fat bias.

Implicit Relational Assessment Procedure

Individual response latency data were transformed into *D*-IRAP scores (e.g., Roddy et al., 2010). Latencies from pro-slim/anti-fat blocks were subtracted from those for anti-slim/pro-fat blocks, thus yielding positive scores for pro-slim or anti-fat bias and negative scores for anti-slim or pro-fat bias. The overall mean *D*-IRAP score was .13 (*SD*=0.21), which was significantly different from zero (t [63]=4.81, $p < .001$, $r = .52$). A relatively strong pro-slim IRAP effect was observed for the *Good-Slim* ($M = 0.31$, $SD = 0.37$) and *Bad-Slim* ($M = 0.15$, $SD = 0.31$) trial types, with the former registering greater levels of pro-slim bias than the latter. In contrast, the *Bad-Fat* ($M = -0.01$, $SD = 0.27$) and the *Good-Fat* ($M = 0.06$, $SD = 0.31$) trial types showed negligible effects. One sample *t*-tests indicated that the *D*-IRAP scores for the two *Slim* trial types were significantly different from zero (*Good-Slim,* t [63]=6.94, $p < .001$, $r = .66$; *Slim-Bad,* t [63]=3.94, $p < .001$, $r = .44$), whereas those for the two *Fat* trial types were not. Overall, therefore, the IRAP indicated positive implicit bias towards the average weight, with the absence of any bias in relation to the overweight.

Explicit Attitudes and Inter-Measure Correlations

For explicit measures, no significant differences in attitudes towards average and overweight targets[4] emerged. Table 1 shows inter-measure correlations. The following statistically significant patterns are of note. The IRAP Bad-Slim *D*-score was correlated with zygomaticus activity on presentation of average weight targets, r_s (62) = .26, $p < .05$. The *D*-IRAP overall score was correlated with the *D*-IAT, r (62) = .26, $p = .038$ and also with behavioral intentions towards the overweight target, r (61) = .29, $p = .02$. Scores on the dislike subscale of the AFA were correlated with zygomaticus activity on presentation of overweight (r_s [57] = −.30, $p < .05$) and neutral stimuli (r_s [57] = −.34, $p < .001$), respectively.

Predictive Validity

Given that IRAP responses were correlated with behavioral intentions towards the overweight target, a simple linear regression analysis was conducted to determine if the overall *D*-IRAP scores would emerge as a statistically significant predictor of behavioral intentions towards this target. For both variables, data met the principal statistical assumptions required for multiple regression analysis. The *D*-IRAP score emerged as a significant predictor of behavioral intentions towards the overweight target, $F(1,61) = 5.67$, $p = .020$, $\beta = .29$, adjusted $R^2 = .07$, accounting for 7% of the variability in prediction of this variable.

DISCUSSION

This study was the first to use facial electromyography to investigate affective responding in relation to body shape. The main EMG pattern shown was that average weight images elicited EMG responses consistent with more positive affect. These findings were based on patterns of zygomatic activity, whereas the corrugator showed no differences between images. This pattern thus confirms previous work by (Larsen et al., 2003) that suggests the zygomaticus may be more sensitive than the corrugator.

The current study was also concerned with investigating the extent of agreement between the EMG and two alternative measures of implicit responding, the IAT and the IRAP. Consistent with previous research (e.g., Roddy et al., 2010), both the IAT and IRAP detected significant pro-slim/anti-fat bias, which was not observed on the explicit measure, Crandall's (1994) AFA. In addition, responding on the IRAP was correlated with EMG activity; specifically, positive affective responses to average weight images were associated with the *Bad-Slim* IRAP trial type. However, although scores for the

[4]Average scores on the explicit measures were as follows: 1.17 (*SD*=1.22) for dislike, 2.81 (*SD*=1.16) for feeling towards overweight people, 2.82 (*SD*=1.14) for feelings towards slim people, 19.08 (*SD*=4.36) for behavioral intentions towards the overweight target, and 17.67 (*SD*=5.14) for behavioral intentions towards the average weight target.

Table 1. Correlations between measures of weight-related bias

Measures	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. *D*-IAT	—	.26*	.16	.16	.14	.01	.00	−.01	.00	.06	.01	−.01	.04	.04	.18	.20	.12
2. *D*-IRAP		—	.36*	.58**	.62**	.57**	.10	.14	.20	.01	.01	.02	.09	.08	.05	.29**	.11
3. *D*-$IRAP_{Bad\text{-}Slim}$			—	.24	.04	−.07	−.26*	−.11	−.20	.00	−.14	−.13	.16	.15	.05	.21	-.07
4. *D*-$IRAP_{Bad\text{-}Fat}$				—	.20	.38**	.00	.09	.04	−.01	.01	−.10	.03	.01	.18	.12	.10
5. *D*-$IRAP_{Good\text{-}Slim}$					—	.36*	.04	.01	.01	.07	.04	.04	.17	.17	−.01	.23	.10
6. *D*-$IRAP_{Good\text{-}Fat}$						—	−.07	−.15	−.08	−.11	−.12	−.10	.13	.12	.10	.13	.12
7. Zygo. average weight							—	.55**	.67**	.78**	.83**	.79**	−.17	−.17	−.07	.00	−.23
8. Zygo. overweight								—	.80**	.27**	.32**	.24	−.12	−.12	.17	−.12	−.33**
9. Zygo. neutral									—	.24	.35**	.25**	−.14	−.14	.14	−.04	−.32**
10. Corr. average weight										—	.83**	.94**	−.23	−.23	−.12	.10	−.18
11. Corr. overweight											—	.94**	−.17	−.16	−.27	.01	−.18
12. Corr. neutral												—	−.16	−.15	−.24	.04	.20
13. Feeling average weight													—	.99**	−.10	−.00	−.1
14. Feeling overweight														—	.01	−.09	−.09
15. B.I average weight															—	.16	−.12
16. B.I. overweight																—	−.03
17. Dislike																	—

Note: $*p < .05$; $**p < .001$.

overall IRAP and IAT were also found to be correlated, IAT and EMG data were not.

This pattern indicates greater agreement between the EMG and the IRAP than between the EMG and the IAT. In addition, IRAP trial type output indicates further convergence of EMG and IRAP findings, because, consistent once more with Roddy et al. (2010), it shows positive responding towards average weight targets in the absence of negativity towards overweight targets; thus, similar to the EMG, the IRAP indicates that positive responses towards the average weight targets were driving the pattern of body-shape bias.

Previous research has indicated the prevalence of thin ideal internalization, documenting this phenomenon in children, adolescents, and adults (e.g., Thompson & Stice, 2001). The pattern of findings in the current study in which participants have shown strongly pro-slim implicit responding appears to be a further reflection of this phenomenon. What seems particularly novel, however, is that the pattern includes an absence of anti-fat responding. This seems to run counter to the patterns of weight-related attitudes apparently detected in previous research using implicit and explicit measures, which have been reported as anti-fat negativity. One possibility is that previous research actually detected pro-slim rather than anti-fat bias, but the measures used did not allow the disentangling of these phenomena.

A central trend indicated by the current study is a pro-slim bias. A possible limitation, however, was the use of images of “average weight” as opposed to “thin” individuals. All images were selected by pilot participants from an image pool employed by Brochu and Morrison (2007). Images were selected as representative of their target weight categories when more than 60% of participants in the pilot study agreed on that status (Ernst, Godfrey, Silva, Pouget & Welkowitz, 1994). However, the category that pilot participants were prompted to contrast with “overweight” was “average weight” and the pool of images provided contained typical weight individuals rather than “ultra-slim” or “thin” individuals. In light of the cultural premium on ultra-slim or thin individuals, it might be argued that understanding responses to this body-type is particularly important, both for its own sake as well as in contrast with the category “overweight”. Future research might address this issue.

A related issue concerns differences in weight-related bias towards men and women. The thinness ideal is particularly pronounced for women (Stice, Schupak-Neuberg, Shaw & Stein, 1994), and therefore it is possible that a strong negative attitude towards overweight women relative to overweight men might be detected. The current study did not parse attitudes, either explicit or implicit, based on the gender of the person pictured but future work of this kind might do so.

A classic pattern in implicit attitude research in socially sensitive domains is that there is a divergence between implicit and explicit attitudes, and this pattern was also observed in the current study. On the explicit affective feeling thermometers, for example, participants reported similar levels of warmth/positivity toward the overweight and average weight, but the EMG showed a bias towards the latter. This observed divergence between implicit affective responses and self-reported affective reactions is similar to the work of Vanman et al. (1997) discussed earlier.

Alongside divergence between the measures, research using both explicit and implicit measures, including in the domain of weight-related bias (e.g., Gapinski et al., 2006), also often shows correlations between the two and this was produced again in the present study. More specifically, the AFA dislike subscale was significantly correlated with zygomatic activity in response to both overweight and neutral images. The fact that the corrugator did not show any such correlations further supports the previous suggestion that the zygomaticus is a more sensitive measure of implicit emotion. Further research is needed, however, to explore the relationship between facial EMG and both implicit and explicit attitudinal measures in the context of weight-related bias.

One of the aims of the current study was to compare facial EMG with the IRAP and IAT as measures of implicit anti-fat attitudes with respect to their ability to predict explicit discriminatory behavior towards the overweight. In fact, the IRAP was the sole predictor of behavioral intentions in this respect. Specifically, pro-slim/anti-fat responding as shown by the D-IRAP was significantly correlated with reporting an increased likelihood of interacting with an overweight target. The direction of this correlation might seem unusual; however, it may well be the result of a social desirability effect in which participants over-compensated for bias via their responses on the explicit behavioral intentions measure. Use of a measure of motivation to conceal prejudice in future studies might shed further light on this issue.

Roddy et al. (2010) previously reported that the IRAP offered a greater contribution than the IAT to the predictive validity of explicit measures and the current findings repeat this pattern. Whereas the failure of the IAT in this respect is thus consistent with previous findings, the failure of the EMG in this respect is unprecedented. This latter finding was unexpected in light of previous research into implicit bias in domains other than body size (e.g., racial attitudes: Vanman et al., 2004) in which EMG did predict discriminatory behavior. The failure of the EMG to predict discriminatory behavior towards the overweight in this study suggests that its utility in this respect may be limited, but further research is needed before firm conclusions can be drawn.

It is important to note that the current study adopted a different approach to EMG analysis (i.e., examination of peak activation across integrated waveforms) than previous studies (i.e., mean integrated EMG activity over successive intervals). The use of an alternative procedure does make it more difficult to compare directly the findings of this study with past EMG results, and of course it is possible that the failure of the EMG to predict behavioral intentions may have been a result of the difference in analytic techniques. However, the current analysis is justifiable in accordance with recommendations of Fridlund and Cacioppo (1986) who suggest that summing peaks is a useful method of measuring EMG activity provided that sampling rates are sufficiently high. According to the authors, a sampling rate that is 2–4 times greater than the average frequency is recommended. Thus, in light of these guidelines and the use of a high sampling rate (2000 Hz) in the current work, it was decided to use this method of EMG data analysis. Furthermore, the patterns obtained using the EMG are corroborated by IRAP findings in this as well as previous research.

The measure of behavioral discrimination utilized by Vanman et al. (2004) also differed in an important respect from the measure employed in the current study. In the former, participants were required to evaluate three candidates for a teaching fellowship and were provided with candidate's CVs and photographs in order to make this decision. In the current research, participants were only provided with information about the target's weight. Thus, participants in the Vanman study were, ostensibly, provided with additional information on which to base their decision. In effect then, discrimination towards a particular candidate in that study could be the result of one of several variables that differed between the candidates. However, in the present research, discrimination towards a target was an obvious result of target weight status. Thus, this measure may have been more susceptible to social desirability effects.

In conclusion, the core finding of the current study was that two separate measures of implicit responding, the IRAP and the EMG, appeared to indicate that pro-slim and *not* anti-fat responding may be driving weight related bias. These data also constitute the first evidence for the efficacy of facial EMG as a tool for the assessment of implicit weight-related attitudes. In addition, they confirm advantages of the IRAP over the IAT as implicit cognitive measures and have allowed for useful comparisons between these methods and EMG.

REFERENCES

Barnes-Holmes, D., Barnes-Holmes, Y., Stewart, I., & Boles, S. (2010). A sketch of the Implicit Relational Assessment Procedure (IRAP) and the Relational Elaboration and Coherence (REC) model. *Psychological Record*, *60*, 527–542.

Brochu, P. M., & Morrison, M. A. (2007). Implicit and explicit prejudice toward overweight and average weight men and women: Testing their correspondence and relation to behavioral intentions. *Journal of Social Psychology*, *147*, 681–706.

Cacioppo, J. T., Petty, R. E., Losch, M. E., & Kim, H. S. (1986). Electromyography activity over facial muscle regions can differentiate the valence and intensity of affective reactions. *Journal of Personality and Social Psychology*, *50*, 260–268.

Crandall, C. S. (1994). Prejudice against fat people: Ideology and self-interest. *Journal of Personality and Social Psychology*, *66*, 882–894.

De Houwer, J. (2002). The Implicit Association Test as a tool for studying dysfunctional associations in psychopathology: Strengths and limitations. *Journal of Behavior Therapy and Experimental Psychiatry*, *33*, 115–133.

Dittmar, H., Halliwell, E., & Stirling, E. (2009). Understanding the impact of thin media models on women's body-focused affect: The roles of thin-ideal internalization and weight-related self-discrepancy activation in experimental exposure effects. *Journal of Social and Clinical Psychology*, *28*, 43–72.

Ernst, M., Godfrey, K. A., Silva, R. R., Pouget, E. R., & Welkowitz, J. (1994). A new pictorial instrument for child and adolescent psychiatry: A pilot study. *Psychiatry Research*, *51*, 87–104.

Fridlund, A. J., & Cacioppo, J. T. (1986). Guidelines for human electromyographic research. *Psychophysiology*, *23*, 567–589.

Gapinski, K. D., Schwartz, M. B., & Brownell, K. D. (2006). Can television change anti-fat attitudes and behaviour? *Journal of Applied BioBehavioural Research*, *11*, 1–28.

Greenwald, A. G., & Farnham, S. D. (2000). Using the implicit association test to measure self-esteem and self-concept. *Journal of Personality and Social Psychology*, *79*, 1022–1038.

Greenwald, A. G., McGhee, A. D., & Schwartz, J. L. (1998). Measuring individual differences in implicit cognition: The Implicit Association Test. *Journal of Personality and Social Psychology*, *74*, 1464–1480.

Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the Implicit Association Test: I. An improved scoring algorithm. *Journal of Personality and Social Psychology*, *85*, 198–216.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). International Affective Picture System (IAPS): Technical manual and affective ratings. NIMH Centre for the Study of Emotion and Attention.

Larsen, J. T., Norris, C. J., & Cacioppo, J. T. (2003). Effects of positive and negative affect on electromyographic activity over zygomaticus major and corrugator supercilli. *Psychophysiology*, *40*, 776–785.

Mills, J. S., Polivy, J., Herman, C. P., & Tiggemann, M. (2002). Effects of exposure to thin media images: Evidence of self-enhancement among restrained eaters. *Personality & Social Psychology Bulletin*, *28*, 1687–1699.

Morrison, T. G., Roddy, S., & Ryan, T. A. (2009). Methods for measuring attitudes about obese people. In D. B. Allison, & M. L. Baskin (Eds.), *Handbook of assessment methods for obesity and eating behaviors* (pp. 79–113.). Sage: CA.

Pepper, A. C., & Ruiz, S. Y. (2007). Acculturation's influence on antifat attitudes, body image and eating behaviors. *Eating Disorders*, *15*, 427–447.

Puhl, R., & Brownell, K. D. (2001). Bias, discrimination, and obesity. *Obesity Research*, *9*, 788–805.

Roddy, S., Stewart, I., & Barnes-Holmes, D. (2010). Anti-fat, pro-slim, or both? Using two reaction-time based measures to assess implicit attitudes to the slim and overweight. *Journal of Health Psychology*, *15*, 416–425.

Stern, R. M., Ray, W. J., & Quigley, K. S. (2001). *Psychophysiological Recording*. New York: Oxford University Press.

Stice, E., Schupak-Neuberg, E., Shaw, H. E., & Stein, R. I. (1994). Relation of media exposure to eating disorder symptomatology: An examination of mediating mechanisms. *Journal of Abnormal Psychology*, *103*, 836–840.

Tassinary, L. G., & Cacioppo, J. T. (2000). The skeletomotor system: Surface electromyography. In J. T. Cacioppo, L. G. Tassinary, & G. G. Bernston (Eds.), *Handbook of psychophysiology* (2nd edn, pp.163–199.). Cambridge England: Cambridge University Press.

Tassinary, L. G., Cacioppo, J. T., & Geen, T. R. (1989). A psychometric study of surface electrode placements for facial electromyography recording: I. The brow and cheek muscle regions. *Psychophysiology*, *26*, 1–16.

Thompson, J. K., & Stice, E. (2001). Thin-ideal internalization: Mounting evidence for a new risk-factor for body-image disturbance and eating pathology. *Current Directions in Psychological Science*, *10*, 181–183.

Vanman, E. J., Paul, B. Y., Ito, T. A., & Miller, N. (1997). The modern face of prejudice and structural features that moderate the effect of cooperation on affect. *Journal of Personality and Social Psychology*, *73*, 941–959.

Vanman, E. J., Saltz, J. L., Nathan, L. R., & Warren, J. (2004). Racial discrimination by low-prejudiced whites. *Psychological Science*, *15*, 711–714.

Zajonc, R. B. (1980). On the primacy of affect. *American Psychologist*, *39*, 117–123.