Journal of Experimental Psychology:
Human Perception and Performance

ISSN: 0096-1523

2026, Vol. 52, No. 3, 237–250
https://doi.org/10.1037/xhp0001381

Adaptation Aftereffects to Adiposity Across Bodies and Faces

Klaudia B. Ambroziak[1], Sophie Field[1], Matthew R. Longo[1], and Elena Azañón[2, 3, 4, 5]
[1] Department of Psychological Sciences, Birkbeck, University of London
[2] Institute of Psychology, Otto von Guericke University Magdeburg
[3] Leibniz Institute for Neurobiology Magdeburg
[4] Center for Behavioral Brain Sciences (CBBS), Magdeburg, Germany
[5] Center for Intervention and Research on Adaptive and Maladaptive Brain Circuits Underlying Mental Health (C-I-R-C), Jena-Magdeburg-Halle, Germany

Recent research has highlighted the importance of information about adiposity in the visual perception of both bodies and faces. Behavioral and neuroimaging studies have demonstrated the existence of category-selective visual representations of faces and bodies, as well as integrated whole-person representations. It remains unknown whether visual perception of adiposity arises from category-selective or whole-person mechanisms. Here, we show that whole-person representations are involved by showing cross-category transfer of adaptation aftereffects to adiposity between faces and bodies. In Experiment 1, we demonstrate that adaptation to a gaunt face biases judgments of subsequently presented faces, complementing previous research demonstrating adiposity aftereffects in bodies. We then demonstrate cross-category transfer of such aftereffects from faces to bodies (Experiments 2 and 3) and from bodies to faces (Experiment 4). Cross-category transfer, however, was substantially weaker than within-category transfer and was not consistently observed across all individual conditions. A control study (Experiment 5) showed no adaptation when adapting face stimuli were inverted, suggesting that the effects are unlikely to result from nonspecific low-level features of the stimuli. These results demonstrate functional interactions between visual representations of faces and bodies in the perception of adiposity, suggesting the involvement of integrated whole-person representations.

Public Significance Statement

Adiposity aftereffects transfer between faces and bodies: adaptation to a gaunt (or fat) face biases perception of subsequently presented faces, or headless bodies in the opposite direction to the adaptor. The existence of cross-category adaptation between faces and bodies suggests the involvement of integrated whole-person representations in the perception of adiposity.

Keywords: adaptation aftereffects, adiposity perception, cross-adaptation, face representation, body representation

Faces and bodies are fundamental sources of information by which we learn about other people (Minnebusch & Daum, 2009). In the case of bodies, much research has focused on body adiposity (i.e., how fat or thin a body is) given its centrality to both perceived body attractiveness (Singh, 1993; Tovée et al., 1998) and to the distortions of body image seen in eating disorders such as anorexia nervosa (Bruch, 1978; Grogan, 2017). Less research has investigated the perception of facial adiposity, though it has also been found to be linked to perceived attractiveness (Coetzee et al., 2011; C. I. Fisher et al., 2014; Re & Perrett, 2014). Both faces and bodies have been

This article was published Online First January 8, 2026.
Isabel Gauthier served as action editor.
Elena Azañón https://orcid.org/0000-0001-9543-1222
Because this research was funded in whole, or in part, by the European Commission (EC; Grant 2013-StG-336050), for the purpose of open access, the author has applied a CC BY public copyright license to any author accepted manuscript version arising from this submission.
Matthew R. Longo and Elena Azañón contributed equally to this work.
This research was supported by European Research Council Grant ERC-2013-StG-336050 under the FP7. The data have been made publicly available via the Open Science Framework and can be accessed at https://osf.io/ern6w/. All “bodies” stimuli can be accessed at https://osf.io/fpr83/. This study was not preregistered.
Klaudia B. Ambroziak contributed equally to writing–original draft. Sophie Field served in a supporting role for conceptualization, investigation, and data collection. Matthew R. Longo served as lead for funding acquisition, project administration, resources, and supervision. Elena Azañón served as lead for supervision. Klaudia B. Ambroziak, Matthew R. Longo, and Elena Azañón contributed equally to conceptualization, formal analysis, investigation, methodology, software, validation, visualization, and data curation. Matthew R. Longo and Elena Azañón contributed equally to writing–review and editing.
Correspondence concerning this article should be addressed to Elena Azañón, Institute of Psychology, Otto von Guericke University Magdeburg (OVGU), Universitätsplatz 2, Building 24, 39106 Magdeburg, Germany, or Matthew R. Longo, Department of Psychological Sciences, Birkbeck, University of London, Malet Street, London WC1E 7HX, United Kingdom. Email: elena.azanon@ovgu.de or m.longo@bbk.ac.uk

found to contribute to overall attractiveness judgments (Currie & Little, 2009; Peters et al., 2007). Indeed, Thornhill and Grammer (1999) found that attractiveness judgments of the face and body of the same women were correlated and argued that faces and bodies are a single integrated signal of mate value. It remains unknown, however, whether the perception of adiposity in bodies and faces relies on distinct category-selective representations of faces and of bodies, or on an integrated representation of the whole person. We investigated this issue by testing whether adaptation aftereffects to adiposity transfer between faces and bodies.

A growing literature has investigated functional links between visual perception of faces and bodies. Behavioral studies have found that the presence of the body can affect facial perception of emotion (Aviezer et al., 2008, 2012; Meeren et al., 2005; Van den Stock et al., 2007), identity (Rice et al., 2013; Robbins & Coltheart, 2012), and face inversion effects (Brandman & Yovel, 2012). Some studies of patients with prosopagnosia have reported common deficits for both faces and bodies (Biotti et al., 2017; Moro et al., 2012; Righart & de Gelder, 2007), although others have reported selective impairment of faces (Duchaine et al., 2006; Susilo et al., 2013). Other studies have reported that adaptation aftereffects to gender (Ghuman et al., 2010; Palumbo et al., 2015) and orientation (Cooney et al., 2015) can transfer between face and body stimuli.

A number of recent studies have also investigated neural integration of faces and bodies using functional magnetic resonance imaging. Early studies using univariate analyses reported distinct areas of selectivity for faces and bodies (Pinsk et al., 2005, 2009), consistent with the idea that the ventral visual pathway maintains distinct modular regions for faces, such as the fusiform face area (Kanwisher et al., 1997) and occipital face area (Puce et al., 1996), and for bodies, such as extrastriate body area (Downing et al., 2001) and fusiform body area (Peelen & Downing, 2005). Some studies have, however, reported interactions between face and body stimuli in posterior visual areas (e.g., Bernstein et al., 2014; Cox et al., 2004; Schmalzl et al., 2012). Cox et al. (2004), for example, found that the fusiform face area can be activated by headless stimuli in the context of a body. Most recent studies, however, have failed to find evidence for integration of faces and bodies in posterior areas of the temporal lobe (C. Fisher & Freiwald, 2015; Harry et al., 2016; Kaiser et al., 2014; Song et al., 2013). In contrast, there is substantial evidence of integrated whole-person representations in more anterior regions of the temporal lobe (C. Fisher & Freiwald, 2015; Harry et al., 2016; Kaiser et al., 2014), suggesting a hierarchical organization with relatively early stages of visual processing operating separately for faces and bodies and later stages showing stronger integration.

Collectively, this work shows evidence for both modality-specific processing of information from faces and bodies and for more integrated whole-person representations (see Bratch et al., 2021; Brooks et al., 2019; Gould-Fensom et al., 2019, for examples of other category-selective aftereffects in relation to bodies). Little research, however, has investigated integration of facial and bodily perception of adiposity. Previous research showed that exposure to certain body types, that is, very thin or very fat, can affect preferences for facial adiposity. In a study by Re et al. (2011), participants indicated which face they found most attractive on a body mass index (BMI) continuum before and after exposure to heavy or thin headless bodies. Participants who viewed images of heavier bodies showed a significant preference for faces with higher adiposity, while those who viewed images of lighter bodies exhibited no significant change in their preferences. However, since participants in this study were asked to indicate their preferred face rather than perform a perceptual decision, it is not clear whether the shift after the exposure was due to changes in perception caused by adaptation aftereffects.

A growing body of literature reports that visual adaptation to extremely fat and thin bodies affects the perceived attractiveness and averageness of other bodies (Ambroziak et al., 2019; Glauert et al., 2009; Winkler & Rhodes, 2005), as well as judgments about participants' own bodies (Brooks et al., 2016; Hummel et al., 2012). Adaptation aftereffects have also been reported for faces, for a wide range of characteristics, including normality (i.e., for distorted facial test stimuli, Rhodes et al., 2003), identity (Leopold et al., 2001; Rhodes & Jeffery, 2006), emotion (Jaquet & Rhodes, 2008; Pell & Richards, 2011; Webster et al., 2004), gender (Afraz & Cavanagh, 2009; Webster et al., 2004), age (Schweinberger et al., 2010), ethnicity (Amihai et al., 2011; Webster et al., 2004), and gaze direction (Calder et al., 2008). To our knowledge, no studies have investigated whether facial adiposity is a feature susceptible to adaptation, analogous to the body adiposity aftereffects described above. There is evidence, however, that people are quite accurate in judging body mass from the face alone (Coetzee et al., 2009).

Several recent studies have shown that adaptation aftereffects can also transfer between faces and bodies for several attributes other than adiposity. Ghuman et al. (2010) showed that adaptation to bodies produced clear aftereffects on subsequently presented faces in the direction opposite to the adaptor for both gender and identity. After exposure to male bodies, neutral-looking faces were perceived as more female and vice versa. Notably, this cross-category transfer seemed to be specific to bodies and faces, with no evidence of cross-adaptation between faces and gender-specific objects. Palumbo et al. (2015) reported similar aftereffects from faces to bodies. In their study, exposure to female faces biased perception of the gender of bodies toward the gender of the adaptor. Cooney et al. (2015) showed that adaptation to images of heads turned to the right or left produced a perceptual bias in judging the turning direction of subsequently presented bodies, although no comparable effect of adaptation to bodies on face perception was apparent.

The present study investigated whether the visual perception of adiposity is coded by category-specific mechanisms or by more integrated whole-person mechanisms by testing whether adaptation to adiposity transfers between bodies and faces. In Experiment 1, we verified that adaptation to facial adiposity can actually induce aftereffects in perception of faces alone, as this had not been previously shown. Having established the existence of facial adiposity aftereffects, we then tested whether such adaptation transfers from faces to bodies (Experiments 2 and 3) and from bodies to faces (Experiment 4). By rotating the adaptor 180°, thereby inverting it, Experiment 5 confirmed that any transfer of aftereffects between faces and bodies did not result from nonspecific low-level features of the stimuli.

Experiment 1

Adaptation aftereffects have been reported for a range of different facial characteristics, as described above. To our knowledge, however, no previous research has demonstrated that facial adiposity is a characteristic susceptible to adaptation. Experiment 1 therefore investigated whether adaptation to a thin face produces aftereffects on the perception of subsequently presented faces. Participants were shown faces of different adiposity levels (Figure 1A) and had to decide whether the face they were looking at was thinner or fatter than that of an average woman in the United Kingdom. Participants performed the task before and after adaptation to a very thin face. We predicted that, as with bodies, after adaptation to a thin face, test stimuli would appear fatter compared to preadaptation and thus the judgment about the most average stimuli would be shifted toward the thin adaptor (see Ambroziak et al., 2019, for a similar procedure using faces presented with bodies).

Method

Transparency and Openness

We report the way we determined our sample size, as well as all data exclusion and inclusion criteria. We also report all manipulations and all measures in the study. The data that support the findings of this study are available as the additional online materials at https://osf.io/ern6w/. This study was not preregistered.

Participants

We restricted our sample to female participants, due to the nature of the stimuli depicting female bodies and faces (e.g., Glauert et al., 2009; Hummel et al., 2012; Brooks et al., 2016). This choice is further supported by evidence showing that aftereffect magnitude on body mass and fat perception is significantly greater when observers view same-gender, as opposed to other-gender, stimuli (Brooks et al., 2020). Twenty participants ($M_{age} = 26.4$, range = 20–53) took part in this experiment in 2017. All participants gave informed consent and were paid for their participation. The procedures were approved by the ethics board of the Department of Psychological Sciences, Birkbeck, University of London.

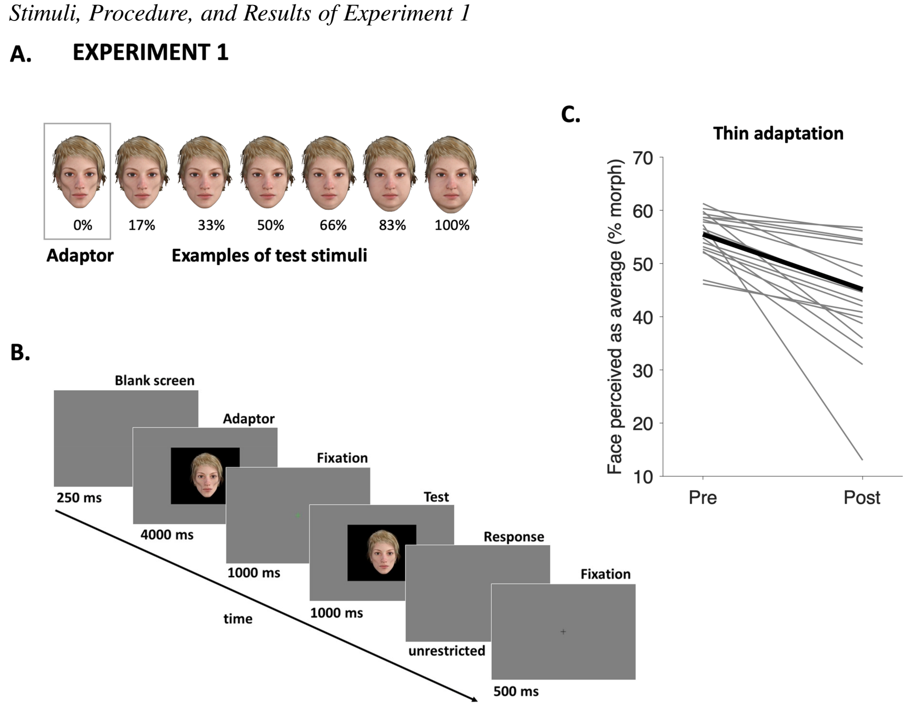
Our sample size was chosen to be in line with our previous study using a similar paradigm with body stimuli (Ambroziak et al., 2019). A weighted average of the effect sizes in the three experiments of that study gave a mean of $d_z = 2.225$, a very large effect size. A power analysis using G*Power 3.1 software (Faul et al., 2007) using this effect size and α of .05 showed that only four participants were needed for power of .95. Indeed, our sample size would give power of more than .95 even if the effect size for face adaptation was only half that we found for bodies in our earlier study.

Stimuli

Stimuli were a continuum of 100 images of the same identity face that differed in adiposity level. First, three base images: thin, neutral, and fat, were created in Digital Art Zone (Daz) Studio 4.8 (DAZ Productions, https://www.daz3d.com/). The neutral face (Figure 1A,

Figure 1

Stimuli, Procedure, and Results of Experiment 1



Note. (A) Examples of stimuli used in Experiment 1. The same identity face was adjusted to differ in adiposity level. The percentages indicate the degree of morph between the thin (0%) and the fat face (100%). The 0% morph was also used as the adaptor. (B) Trial in adaptation phase in Experiment 1. (C) Results of facial adiposity adaptation: the gray lines indicate individual subjects and the mean is shown in black. There was a clear effect of adaptation to a thin face, indicated by the shift of the PSE toward the thin adaptor. The perceived averageness is expressed in the percentage of morph between very thin and very fat face, higher numbers represent higher adiposity levels. The results were not driven by the outlier. PSE = point of subjective equality. See the online article for the color version of this figure.

50%) was taken from a default avatar provided by the software: model "Genesis female 3," and adjusted to create the thin (Figure 1A, 0%) and the fat (Figure 1A, 100%) faces in Daz by adjusting the adiposity parameters to be maximally low and high, respectively. Then, these base images were morphed using FantaMorph 5 (Abrosoft, https://www.abrosoft.com/) to create a spectrum of 100 images ranging from thin (0%) to fat (100%; see Figure 1A for examples).

Procedure

Participants sat approximately 50 cm from the screen with head movements unrestricted. The task was presented using Psychtoolbox (Brainard, 1997), running on MATLAB (Mathworks, Natick, Massachusetts, United States). Individual images were shown in the center of a 24-in. screen, on a black background. The height of each image was approximately 18 cm (20.4° visual angle).

The experiment was divided into pre- and postadaptation phases, in that order, each consisting of 60 trials. On each trial, participants were shown a face and judged whether the face was "thinner or fatter than average?." Before the start of the task, the experimenter explained to participants that "average" in this context means the most common/typical face in the United Kingdom for their age and gender (according to their best estimate). Participants responded with their right hand using left (thinner) and right (fatter) arrow keys on the keyboard. Responses were unspeeded. The point of subjective equality (PSE, i.e., the stimulus for which the participant was equally likely to judge it as fatter or thinner than average, represented as the percentage of thin vs. fat face morphs in the composite test stimuli) was calculated for each condition twice (based on 30 trials each) using a Bayesian adaptive method Quick Estimation Series Test (QUEST; A. B. Watson & Pelli, 1983) implemented in Psychtoolbox, with two interleaved "staircases." One "staircase" started with the 75% morphed face and the other with the 25% morphed face. Trials belonging to separate QUEST "staircases" were interleaved in a randomized order. PSE was calculated as the mean of the posterior probability density function (PDF), using the QuestMean function provided in Psychtoolbox (algorithm by A. B. Watson & Pelli, 1983).

In the preadaptation phase, each trial began with a blank screen (250 ms) followed by the test face (1 s) selected by QUEST from a set of 100 possible stimuli, based on the responses on previous trials. The screen remained blank until the response was made. A fixation cross (500 ms) indicated the end of the trial. The Adaptation phase (see trial procedure in Figure 1B) started with an initial exposure where participants first passively viewed an image of a very thin face (Figure 1A, 0% morph), which was shown on the screen for 2.35 min (4.5 s presentation with a 200 ms break repeated 30 times). On each subsequent trial, the thin adaptor was again presented for 4 s, followed by a fixation cross (1 s) before each test image to ensure that adaptation was sustained during the entire experiment. The rest of the trial was the same as in the preadaptation phase.

Analyses

We compared conditions using the Wilcoxon signed-rank test because the Shapiro–Wilk test indicated a deviation from normality. To quantify evidence, we conducted a Bayesian Wilcoxon signed-rank test (van Doorn et al., 2020) in Jeffreys's Amazing Statistics Program (Version 0.16.2) with default parameters, which include Monte Carlo estimation with 1,000 samples. As the effect size was expected to be very large ($d_z = 2.225$, based on data from Ambroziak et al., 2019), we repeated the analyses with an informed prior, specifying a Cauchy distribution centered on $d_z = 2.225$. Results were highly consistent across Cauchy scales ranging from 0.5 to 2 and closely matched those obtained with the default zero-centered prior, all indicating extreme evidence for the presence of an aftereffect. Bayes factors were interpreted following Jeffreys' (1961) scheme with updated labels ("anecdotal," "moderate," "strong," "very strong," "extreme"; Kelter, 2020).

Results and Discussion

Results from Experiment 1 are shown in Figure 1C. The PSE (expressed in % morph between thin and fat face) representing the face perceived as most average decreased from 55.26 ($SD = 4.39$) preadaptation to 43.49 ($SD = 10.29$) postadaptation, $W = 210$, $z = 3.92$, $p < .0001$, $r = 1$, Bayes factor (BF_{10}) = 709.84, revealing extreme evidence for the existence of an aftereffect. Further analyses using a Cauchy distribution centered on $d_z = 2.225$, produce similar results, $BF_{10} = 1706{,}60$. As it is clear from Figure 1C, this effect was present in every participant. One participant appears to be an outlier with a very large change in PSE, but importantly, removing this participant from analyses had no effect on the conclusions (55.15, $SD = 4.48$, at preadaptation to 45.10, $SD = 7.59$, postadaptation, $W = 190$, $z = 3.82$, $p < .0001$, $r = 1$, $BF_{10} = 1{,}724.22$).

These results provide a clear demonstration that facial adiposity is a characteristic susceptible to sensory adaptation. The shift of the perceived averageness toward the thin adaptor was consistent with our predictions and indicated that after adaptation to a thin face, participants judged test faces (including the face previously perceived as most average) to be fatter than before adaptation. This result shows that face adaptation produces adiposity aftereffects that are similar to those observed in previous studies of body adaptation (e.g., Ambroziak et al., 2019; Glauert et al., 2009; Myga et al., 2024; Winkler & Rhodes, 2005).

Previous studies have shown that people can accurately judge the body size of a person from the face alone (Coetzee et al., 2009, 2010). Our results show, for the first time, that the adiposity level of faces is a visual characteristic susceptible to sensory adaptation. This finding extends the list of facial characteristics that are known to be subject to adaptation, including gender (Webster et al., 2004), identity (Leopold et al., 2001), ethnicity (Webster et al., 2004), emotional expression (Webster et al., 2004), age (Schweinberger et al., 2010), and gaze direction (Calder et al., 2008), and complements other research showing adiposity aftereffects for bodies (Ambroziak et al., 2019; Brooks et al., 2016; Glauert et al., 2009; Hummel et al., 2012; Winkler & Rhodes, 2005). This finding seems particularly important when we consider how many faces we encounter each day, not only in our environment but also in the media. Especially through social media, an average person is exposed to a great number of face images each day. In the next experiment, we investigated whether adiposity aftereffects induced by face adaptation affect perception of headless bodies.

Experiment 2

In Experiment 2, we investigated whether adiposity aftereffects transfer between faces and headless bodies. Participants were adapted to a thin/fat face but then asked to make judgments about adiposity of subsequently presented test bodies. If adiposity is coded by integrated whole-person representations, then adaptation to extremely thin or fat faces should produce aftereffects on judgments about bodies, analogous to the transfer reported for gender and identity (e.g., Ghuman et al., 2010; Palumbo et al., 2015). In contrast, if adiposity is coded by separate category-selective mechanisms, then no such transfer of adaptation should occur.

Method

Participants

Twenty female participants ($M_{age} = 25.4$, range = 20–46) took part in Experiment 2 in 2017. All participants gave informed consent and were paid for their participation. The procedures were approved by the ethics board of the Department of Psychological Sciences, Birkbeck, University of London. Although a power analysis based on our previous study on body-to-body adaptation aftereffects (Ambroziak et al., 2019) indicated that only four participants would be sufficient to achieve 95% power, we recruited a larger sample. This decision was motivated by the expectation that the magnitude of cross-adaptation would be smaller than the effect sizes previously observed.

Stimuli

Test Bodies. We used a set of 89 images of female bodies rendered from the avatars generated in DAZ Studio 4.8 from the default Genesis 3 avatar. Avatars' BMI ranged from 13 (*emaciated*) to 35 (*obese*) with an increment of 0.25 (see Figure 2A, left, for examples). We simplified the stimuli into a one-dimensional continuum of body shapes, approximating the avatars' BMI, using Cornelissen et al.'s (2009) formula for calculating the waist-to-hip ratio (WHR) in white U.K. women of reproductive age: WHR = (2.057 × BMI + 29.67)/(1.842 × BMI + 56.004), based on data from the Health Survey for England (2003). Following this formula, waist and hip circumferences were estimated for each required BMI from the range of 13–35. This approach allowed us to model realistic body shape changes along the fat continuum while maintaining experimental control, which would not be possible with the use of real human photographs. Avatars' waist and hip circumferences were adjusted using the Universal Sizing Apparatus tool (Rocketship Technologies Inc., https://rocketship3d.com/). The relative height of the avatars was kept constant at 170 cm. The avatars were rotated approximately 45° around the vertical axis (in the transverse plane) to provide an optimal view of the dimensions of the avatar. A recent study by Cornelissen et al. (2018) confirmed that this three-quarter view, which combines visual cues observed in front and profile, results in the most accurate estimations of body size. Finally, two-dimensional images were rendered from the avatars, as shown in Figure 2A, left. The stimuli were displayed on the screen with a head cropped out, so the face was not visible and could not affect adaptation. Note that the BMIs given to the avatars are approximations and may not align exactly with real BMIs in the physical world. Indeed, these virtual BMIs are overestimated when compared to real bodies. This is however irrelevant in the present study as we do not compare the BMI values of our participants with those of the avatars, and hence, the BMI values are simply a given nomenclature. The bodies used as stimuli can be accessed at https://osf.io/fpr83/.

Adapting Faces. The adapting images were a thin and a fat face created using Daz Studio 4.8 (DAZ Productions). We used the same face from a Genesis 3 avatar as in Experiment 1, altered to appear very thin and very fat, but this time, both faces were rotated at approximately 45° to match the orientation of the test bodies (Figure 2A, left). The height of the face and body images was matched and equaled approximately 18 cm (20° visual angle).

Procedure

The procedures were similar to those of Experiment 1, with a few changes. The experiment consisted of four rather than two parts, the preadaptation and postadaptation phase in that order, each repeated twice, once with a thin and once with a fat adaptor. We increased the number of trials in each part to 72 (288 in total), and two PSEs were calculated based on 36 trials each using QUEST (Watson & Pelli, 1983). We also increased the "top-up" adaptation time on each trial to 6 s. The procedure was repeated for the adaptor from the opposite side of the thin-fat spectrum with a 10-min break in between to allow the effect of adaptation to wear off. The order of thin/fat adaptation was counterbalanced across participants. Across the experiment, participants judged test images of bodies from the BMI spectrum 13–35, on each trial judging whether the body was "thinner or fatter than average."

Analyses

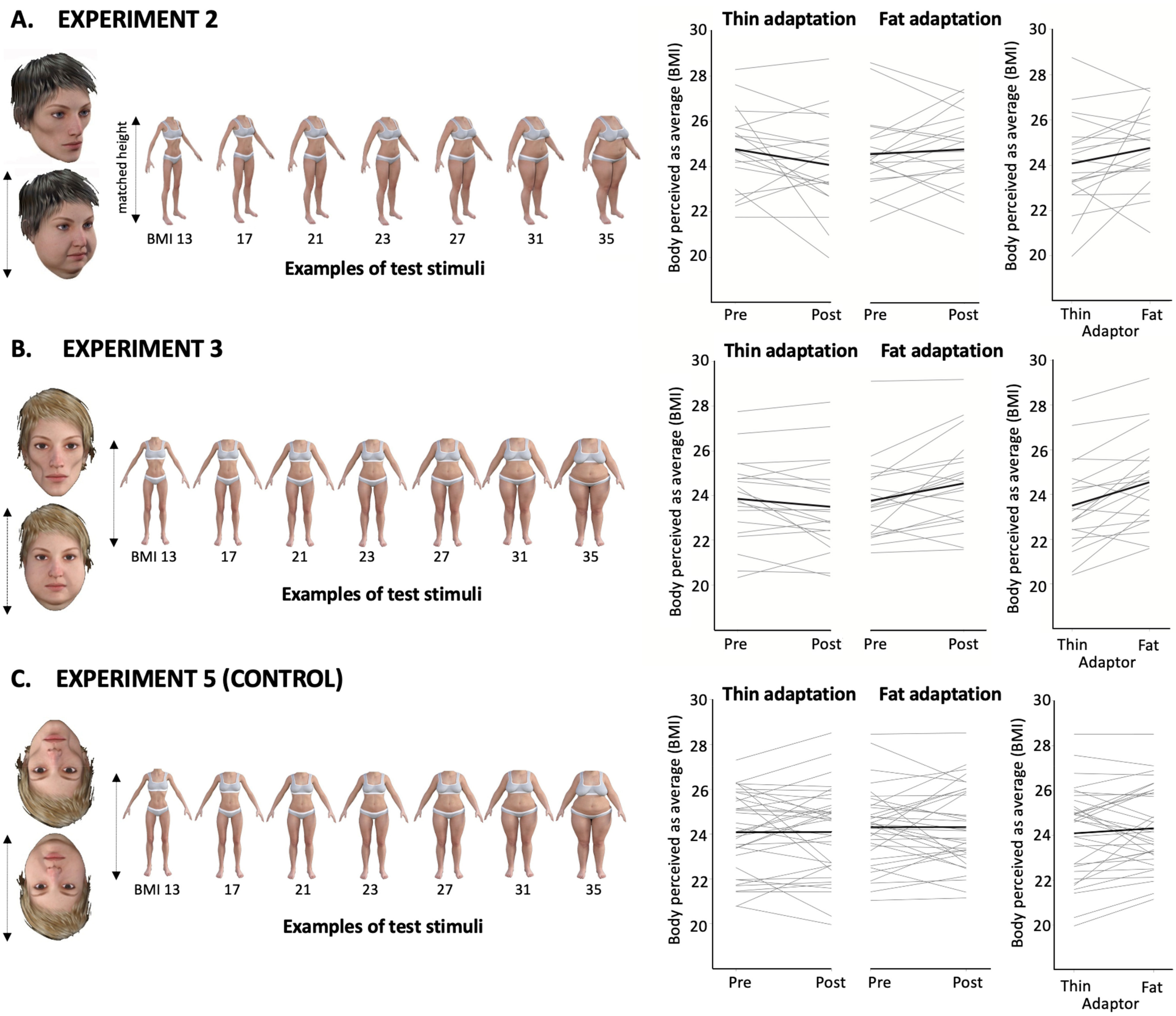
Repeated-measures analyses of variance (ANOVAs) with the factors adaptation (pre/post) and adaptor type (thin/fat) were conducted. Pairwise comparisons between two conditions were performed using two-tailed paired-sample *t* tests, employing both frequentist and Bayesian approaches. For this and the subsequent experiments, we adopted the default prior rather than an informed prior, as no prior evidence was available regarding the magnitude of cross-adaptation aftereffects.

Results and Discussion

In each adaptor type condition (thin/fat), two 50% thresholds (PSEs) per adaptation phase (pre/post) were calculated using QUEST to estimate the BMI at which participants were equally likely to respond thinner or fatter. These two thresholds were then averaged, resulting in one PSE for each condition (thin/fat) and adaptation phase (pre and post). The results are shown in Figure 2A, right. A 2 × 2 repeated measures ANOVA with factors adaptation (pre/post) and adaptor type (thin/fat) showed no main effect of adaptation, $F(1, 19) = 1.088$, $p = .310$, $\eta_p^2 = .054$, or adaptor type, $F(1, 19) = 0.823$, $p = .376$, $\eta_p^2 = .042$, and no interaction, $F(1, 19) = 2.53$, $p = .128$, $\eta_p^2 = .12$.

We conducted further post hoc analysis of the individual effects despite the nonsignificant ANOVA to examine effect sizes and trends for each condition. This provides a clearer understanding of the numerical direction of the effects and allows a meaningful comparison across experiments. In particular, none of the adaptors produced a reliable aftereffect, although numerically both showed the expected pattern. In the thin adaptation condition, the body perceived as most average preadaptation had BMI = 24.77 ($SD = 1.77$) and after adaptation a BMI of 24.08 ($SD = 2.07$), $t(19) = 1.72$, $p = .102$, $d_z = 0.38$, $BF_{10} = 0.805$. In the fat condition, the BMI preadaptation was 24.55 ($SD = 1.72$), and 24.76 ($SD = 1.69$) after adaptation, $t(19) = -0.65$, $p = .52$, $d_z = -0.15$, $BF_{10} = 0.281$. A direct comparison taking only the adaptation phase into consideration in thin and fat conditions (Figure 2A, rightmost panel) showed

Figure 2
Stimuli and Results of Experiments 2, 3, and 5



Note. Left panels: The thin and fat faces used as the adapting stimuli and examples of test stimuli used in Experiment 2 (A), Experiment 3 (B), and Experiment 5. (C) Test stimuli were taken from a continuum of 89 bodies varying continuously in adiposity. The height of the face and body images was matched and equalled approximately 18 cm (20° visual angle). Note that the BMIs given to the avatars are an approximation and they do not reflect real BMIs in the physical world. Right panels: Results for thin and fat adaptation. The gray lines indicate individual subjects and the mean is shown in black. (A) In Experiment 2, there was no effect of adaptation as compared to preadaptation neither for thin nor fat condition. Direct comparison between adaptation phase for thin and fat adaptor showed a trend in the predicted direction. (B) In Experiment 3, with straight faces, there was an effect of adaption for the fat condition only. Direct comparison between adaptation phase for thin and fat adaptor showed a significant effect of adaptation. The control Experiment 5 with inverted faces did not show an effect of adaptation as compared to preadaptation neither for thin nor fat condition and neither when performing a direct comparison of the adaptation phases. BMI = body mass index. See the online article for the color version of this figure.

a trend in the predicted direction that was not significant: $t(19) = -1.73$, $p = .099$, $d_z = -0.39$, $BF_{10} = 0.825$. The results of Experiment 2 provide anecdotal to moderate evidence, supporting the null hypothesis that adiposity aftereffects do not transfer between faces and bodies.

One possible explanation for the lack of aftereffects was that the adapting face stimuli, which we chose for Experiment 2, did not induce strong adiposity adaptation. In Experiment 1, we used a different face as an adaptor, that is, a face looking straight ahead and therefore engaging with the observer. The faces used as adaptors in this experiment were looking away from the observer. It has been shown that people have a robust preference for direct rather than averted gaze (Lawson, 2015). This raises the possibility that the adaptors in this experiment did not attract enough attention to induce adaptation. Attention has been known to enhance adaptation to low-level features (Pestilli et al., 2007; Rezec et al., 2004), and previous research suggests that attention may also amplify the higher level aftereffects in face adaptation (Rhodes et al., 2011), body adaptation (Stephen et al., 2018), and in cross-category adaptation between faces and objects (Javadi & Wee, 2012). It can also be the case that a three-quarter view produces accurate estimations of size for bodies (Cornelissen et al., 2018) but not for faces, making the distinction between the perceived average and the fat and thin adaptors less salient. We decided to run the next experiment using the same adaptors as in Experiment 1, as they proved to work in face adaptation.

Experiment 3

In Experiment 3, we used both face adaptors and test bodies with straight orientation. The face stimuli were used in Experiment 1, and the results showed that these stimuli can induce facial adiposity aftereffects.

Method

Participants

Twenty female participants ($M_{\text{age}} = 22.6$, range = 17–36) took part in Experiment 3 in 2017. The sample size was chosen to be consistent with Experiments 1 and 2.

Stimuli

The same face stimuli as in Experiment 1 served as adaptors (Figure 1A), taking the thinnest and fattest stimuli. As test stimuli, we used images created from the same set of three-dimensional avatars as in Experiment 2, but positioned facing straight ahead. Two-dimensional images were rendered from the avatars. The stimuli were displayed on the screen with a head cropped out, as shown in Figure 2B, left. The height of the face and body images was matched and equaled approximately 18 cm (20° visual angle).

Procedure

The procedures and the analysis in Experiment 3 were identical to Experiment 2, except that we increased the number of trials in each part to 80 (320 in total), and two PSEs were calculated based on 40 trials each using QUEST (Watson, 1983).

Results and Discussion

The results from Experiment 3 are shown in Figure 2B, right. A 2 × 2 repeated measures ANOVA with factors adaptation (pre/post) and adaptor type (thin/fat) showed no main effect of adaptation, $F(1, 19) = 1.64$, $p = .216$, $\eta_p^2 = .08$, which is predicted if each adaptor produces the opposite aftereffect. There was a significant effect of the adaptor type $F(1, 19) = 4.91$, $p = .039$, $\eta_p^2 = .21$ and, most critically, a significant interaction between adaptation and adaptor type $F(1, 19) = 10.94$, $p = .004$, $\eta_p^2 = .37$, indicating a large effect size.

In the thin condition, the body perceived as most average preadaptation had BMI = 23.85 ($SD = 1.90$), and decreased numerically to 23.50 ($SD = 2.03$) after adaptation. However, this decrease was not significant: $t(19) = 1.71$, $p = .104$, $d_z = 0.38$, $BF_{10} = 0.80$. In the fat condition, the body perceived as most average preadaptation had BMI = 23.77 (1.77), and increased to BMI = 24.55 ($SD = 2.01$) after adaptation. This difference was significant: $t(19) = -2.92$, $p = .009$, $d_z = -0.65$, $BF_{10} = 5.676$, with moderate evidence for the aftereffect.

Notably, in many studies, the effects of adaptation are calculated through direct comparison between the adaptation phase in the two adaptation conditions (thin and fat, e.g., Hummel et al., 2012; Little et al., 2011; Palumbo et al., 2015) given the lack of preadaptation conditions. A comparison between the thin and fat postadaptation conditions provided very strong evidence for a difference in the predicted direction: $t(19) = -4.14$, $p < .001$, $d_z = -0.92$, $BF_{10} = 60.565$. Note that no significant differences were observed between both preadaptation conditions, $t(19) = 0.29$, $p = .78$, $d_z = 0.06$, $BF_{10} = 0.241$, with the Bayes factor moderately supporting the null hypothesis. Since the only difference between the conditions was the presence of the thin or fat adaptor in the adaptation phase, the results strongly suggest the effect was due to the cross-category transfer of the adaptation aftereffects. In the next experiment, we investigated the transfer of body size aftereffects in the opposite direction, that is, from bodies to faces.

Experiment 4

The results of Experiment 3 showed that adaptation to an extreme face presented straight produces aftereffects that transfer to judgments of body adiposity. In Experiment 4, we reversed this logic, testing whether adiposity aftereffects transfer from bodies to faces. Participants were adapted to a thin/fat body and made judgments about the adiposity of test faces.

Method

Participants

Twenty female volunteers ($M_{\text{age}} = 28.8$, range = 22–45) took part in this experiment in 2017. The sample size was chosen to be consistent with Experiments 1–3.

Stimuli and Procedure

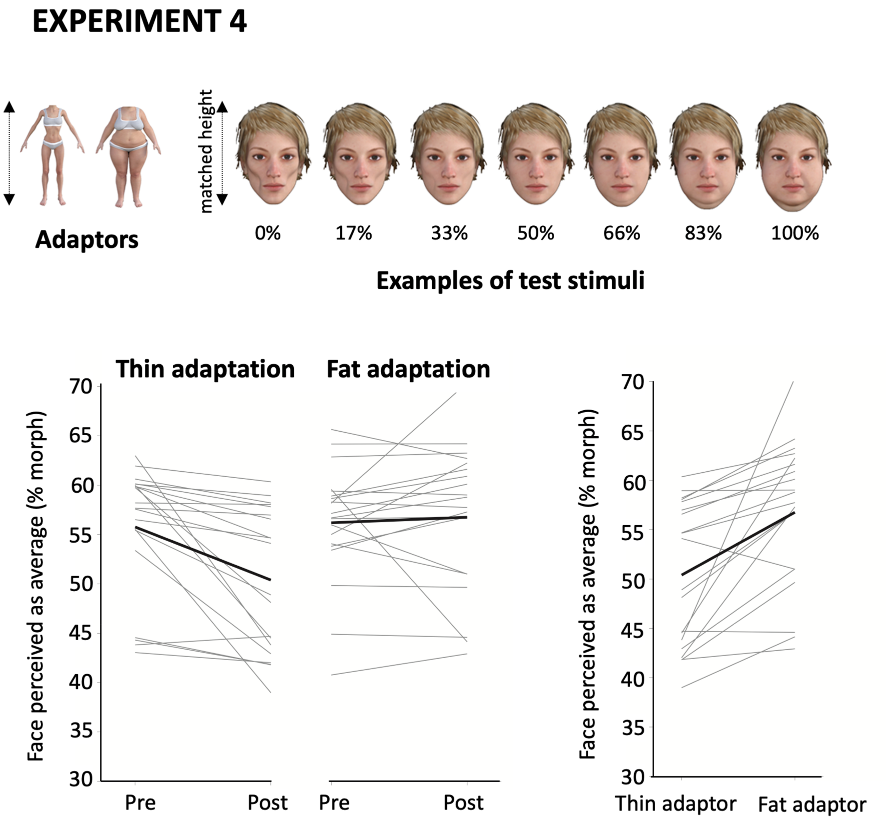
The stimuli and the procedures were similar to Experiment 3, but this time, the bodies were used as adaptors (BMI 35 in the fat condition and BMI 13 in the thin condition), and faces as test stimuli (Figure 3, top).

Results and Discussion

The results from Experiment 4 are shown in Figure 3, bottom. A 2 × 2 repeated measures ANOVA with factors adaptation (pre/post) and adaptor type (thin/fat) showed a main effect of adaptation $F(1, 19) = 7.79$, $p = .012$, $\eta_p^2 = .29$, and adaptor type, $F(1, 19) = 15.86$, $p < .001$, $\eta_p^2 = .45$. Most importantly, there was significant interaction between adaptation and adaptor type $F(1, 19) = 10.41$, $p = .004$, $\eta_p^2 = .35$, indicating a large effect size. These results provide further evidence for cross-category transfer.

In the thin condition, the face perceived as most average was $M = 55.76$ ($SD = 6.49$) preadaptation, which significantly decreased to $M = 50.39$ ($SD = 7.25$) after adaptation, $t(19) = 4.03$, $p < .001$, $d_z = 0.90$, $BF_{10} = 48.67$, providing very strong evidence of an

Figure 3
Stimuli and Results of Experiment 4



Note. Top: The thin and fat bodies as the adapting stimuli. Right: Examples of the test stimuli from the continuum of morphed faces (from thin 0% to fat 100%) varying continuously in adiposity. Bottom: Results of Experiment 4. The gray lines indicate individual participants and the mean is shown in black. There was a clear effect of adaptation as compared to preadaptation in the thin condition but not in the fat condition. The direct comparison between adaptation phase for thin and fat adaptor showed a clear effect of adaptation. See the online article for the color version of this figure.

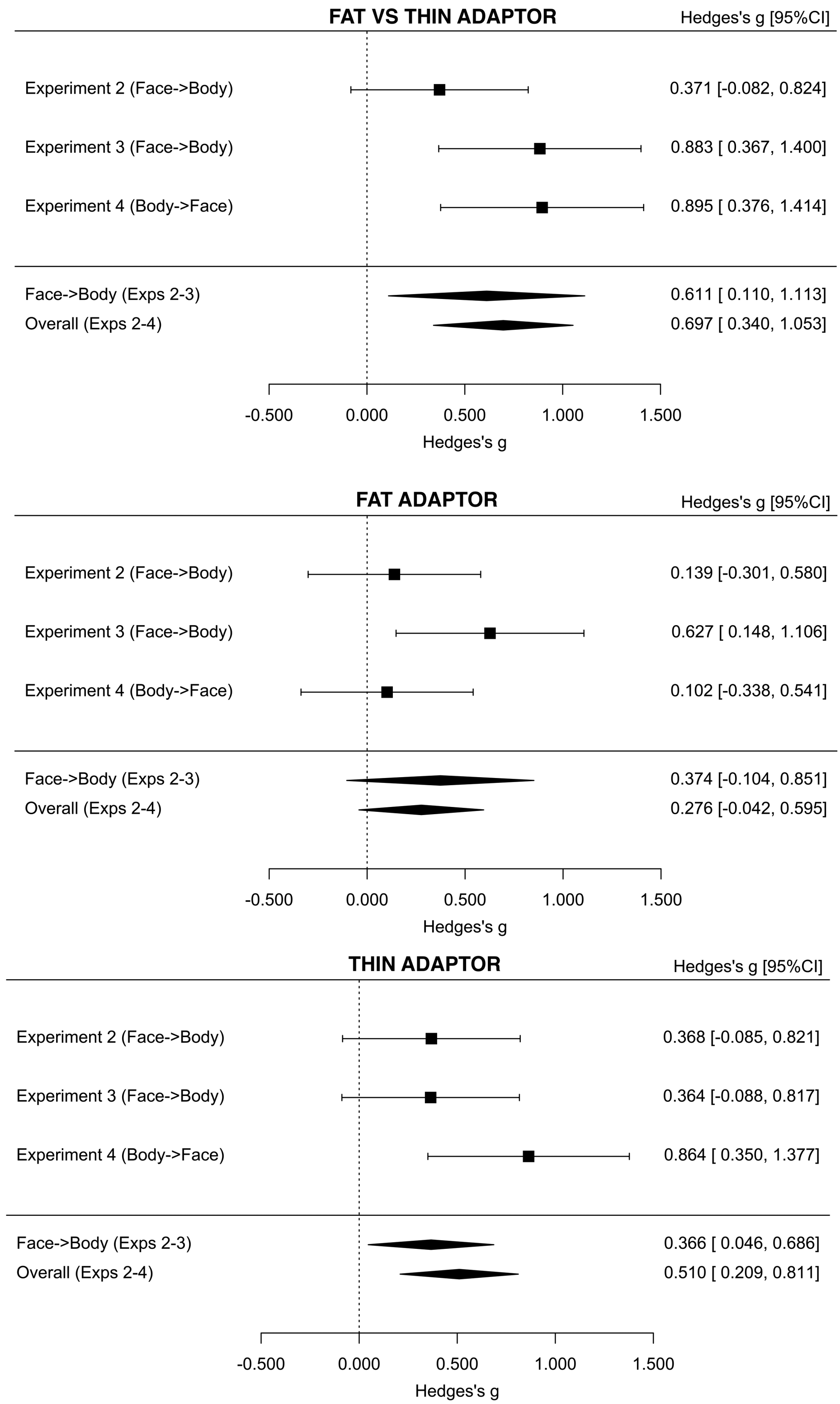
aftereffect. In the fat adaptation, the face perceived as most average was $M = 56.19$ ($SD = 5.92$) preadaptation, and increased numerically to $M = 56.75$ ($SD = 7.35$) after adaptation. The difference was not significant: $t(19) = -0.47$, $p = .64$, $d_z = -0.11$, $BF_{10} = 0.26$, with the Bayes factor providing moderate evidence for the null hypothesis, suggesting no substantial aftereffect. A direct comparison of the adaptation phases between the thin and fat conditions revealed a significant difference, $t(19) = -4.17$, $p < .001$, $d_z = -0.93$, $BF_{10} = 64.70$, with the Bayes factor very strongly supporting the presence of a difference between conditions. Note that no significant differences were observed in the preadaptation conditions, $t(19) = -0.47$, $p = .64$, $d_z = -0.11$, $BF_{10} = 0.26$, with the Bayes factor moderately supporting the null hypothesis.

Meta-Analysis of Cross-Category Adaptation Experiments

The results from Experiments 3 and 4 provided evidence of cross-category transfer of adaptation between faces and bodies, particularly when comparing the two adaptation conditions against each other, whereas the results of Experiment 2 were inconclusive. To determine the overall evidence these experiments provide for transfer of adaptation between categories, we conducted a random-effects meta-analysis (Borenstein et al., 2009) using the metafor package (Viechtbauer, 2010) for R 3.4.3 software. We used a random-effects rather than a fixed-effects model because the three experiments differed in several respects (as described above), for example, in whether the adapting or test stimulus varied by type. Consequently, it was not reasonable to assume that the true effect size was identical across studies, making the random-effects model more appropriate (Borenstein et al., 2009). For each experiment, we compared the effect size for the comparison between the posttest PSEs following adaptation to a thin versus a fat stimulus. Because Cohen's *d* shows a slight bias, we used corrected effect sizes (i.e., Hedges' *g*; Borenstein et al., 2009). A forest plot showing the results is shown in Figure 4 (top). Across the three experiments, there was clear evidence for cross-category transfer of adaptation, with a mean estimated effect size of $d_z = 0.697$, 95% confidence interval (CI) [0.340, 1.053], $z = 3.83$, $p < .0001$. There was no evidence for heterogeneity across experiments, $Q(2) = 3.04$, $p = .218$, indicating that the differences we observed between experiments were not larger than would be expected from chance variation alone. An analysis including only Experiments 2 and 3, which tested face-to-body transfer, also showed significant effects, with a mean

Figure 4

Meta-Analyses for Experiments 2, 3, and 4



Note. Forest plot showing a meta-analysis of the three cross-adaptation experiments for the fat versus thin adaptors (top panel), fat adaptor (middle panel), and thin adaptor (bottom panel). For the first contrast, we used the postadaptation values. For the latter two contrasts, the effect sizes were computed from pre- versus postadaptation values. Error bars are 95% confidence intervals around the Hedges's *g* effect size for each individual experiment. CI = confidence interval; Exps = experiments.

estimated effect size of $d_z = 0.611$, 95% CI [0.110, 1.113], $z = 2.39$, $p < .02$. Again, there was no evidence for heterogeneity, $Q(1) = 2.14$, $p = .144$. Thus, despite the lack of significant results in Experiment 2, the data from our full set of experiments provide evidence for bilateral transfer of adaptation between faces and bodies.

Given the asymmetry between the effects of fat versus thin adaptors across experiments, we next conducted separate meta-analyses comparing the pre- and posttest values for each type of adaptor. For thin adaptors, there was clear evidence for cross-adaptation between faces and bodies, with a mean estimated effect size of Hedges's $g = 0.510$, 95% CI [0.209, 0.811], $z = 3.32$, $p < .001$ as shown in Figure 4 (middle). There was no evidence for heterogeneity across experiments, $Q(2) = 2.60$, $p = .273$. In contrast, there was no overall evidence for cross-adaptation with fat adaptors across experiments (Figure 4, bottom), with a mean estimated effect size of Hedges's $g = 0.276$, 95% CI [−0.042, 0.595], $z = 1.70$, $p = .089$. There was again no evidence for heterogeneity, $Q(2) = 3.03$, $p = .220$.

Experiment 5

We provided evidence that adaptation to extreme faces produces aftereffects that transfer to judgments of adiposity in headless bodies, and vice versa. This bilateral transfer suggests that adaptation aftereffects for adiposity may influence integrated representations of whole persons. Nonetheless, a question remains of whether these transfer of aftereffects from faces to bodies, and vice versa, are driven by adaptation to low-level simple geometric features, such as shapes or dimensions. For instance, adaptation to the rounded shaped face of the fat adaptor might have driven size aftereffects at the rounded portion of the bodies across the belly, hip, and legs of the avatars, independently of face-body specific mechanisms. Similarly, the distance between the vertical lines shaping the cheeks of the thin adaptor could have driven distance aftereffects spanning the edges of the avatars' waist. To control adaptation to low-level properties of the stimuli, we tested transfer of aftereffects from faces to bodies using the same stimuli as in Experiment 3, but with inverted thin and fat faces as adaptors.

It is widely assumed that upright and inverted faces are processed qualitatively different, engaging distinct perceptual mechanisms, with upright faces relying on configural or holistic encoding, and inverted faces relying mostly on part-based encoding (Bartlett & Searcy, 1993; Rhodes et al., 1993). In this regard, if the aftereffects obtained so far in this study were based on low-level properties of the stimuli, we would expect a similar amount of transfer with inverted face adaptors.

Method

Participants

We doubled the number of participants to increase the study's power to detect a null effect. Forty female volunteers participated in the study. Three of them did not complete data collection, and two responded with the same response key in over 95% of the trials and were excluded from analyses ($n = 35$, $M = 27.8$ years of age; note that we lack the age of three participants). $N = 20$ participants were collected in Birkbeck, University of London, in 2020, and the other $N = 20$ participants were collected at the Otto-von-Guericke-University Magdeburg, Germany, in 2023. The procedures for the latter sample were approved by the ethics committee at Otto-von-Guericke-University Magdeburg, Germany.

Procedure

All procedures were identical to those of Experiment 3 except that the adapting face stimuli were rotated 180° (see Figure 2C, left). Additionally, due to an unintended error, each staircase contained 36 rather than 40 trials.

Results and Discussion

The results from Experiment 5 are shown in Figure 2C, right. A 2 × 2 repeated-measures ANOVA with factors adaptation (pre/post) and adaptor type (thin/fat) showed no significant main effects of adaptation, $F(1, 34) = 0.002$, $p = .963$, $\eta_p^2 < .0001$, or adaptor type, $F(1, 34) = 1.567$, $p = .219$, $\eta_p^2 = .044$, nor an interaction, $F(1, 34) < 0.001$, $p = .982$, $\eta_p^2 < .0001$, all providing small to extremely small effect sizes.

In the thin condition, the body perceived as most average had a mean BMI = 24.08 ($SD = 1.81$) preadaptation and BMI = 24.09 ($SD = 1.98$), $t(34) = -0.05$, $p = .961$, $d_z = -0.008$, $BF_{10} = 0.182$, after adaptation. In both fat and thin conditions, the body perceived as most average had the same numerical BMI = 24.31 ($SD = 1.70$, $SD = 1.77$, respectively), $t(34) = -0.025$, $p = .98$, $d_z = -0.004$, $BF_{10} = 0.181$, providing moderate evidence for the null hypothesis. A direct comparison of the adaptation phase in the thin and fat conditions showed no significant difference, $t(34) = -1.180$, $p = .246$, $d_z = -0.199$, $BF_{10} = 0.343$. There was also no difference between the two preadaptation conditions, $t(34) = -0.914$, $p = .367$, $d_z = -0155$, $BF_{10} = 0.267$.

We also compared the results of Experiment 5 directly with Experiment 3, where participants were exposed to the same stimuli but in upward orientation. An ANOVA with factors adaptation (pre-/postadaptation), adaptor type (thin/fat) and Experiment (3 vs. 5) revealed a main effect of adaptor type, $F(1, 53) = 5.98$, $p = .02$, $\eta_p^2 = .101$, and Adaptor Type × Adaptation, $F(1, 53) = 6.981$, $p = .011$, $\eta_p^2 = 0.116$. More importantly, the three-way interaction Adaptor Type × Adaptation × Experiment was also significant, $F(1, 53) = 7.122$, $p = .01$, $\eta_p^2 = .118$. These results suggest that the transfer of aftereffects observed in Experiment 3 (and in principle also 4) does not simply reflect adaptation to visual forms of narrow and wide shapes. Thus, low-level adaptation does not seem to account for the transfer effects observed in the previous experiments.

General Discussion

Previous studies showed that adaptation aftereffects transfer between bodies and faces for features such as identity and gender (Ghuman et al., 2010; Palumbo et al., 2015). The present study is the first one investigating whether perception of human body size is sensitive to similar cross-category adaptation. Across a series of experiments, we demonstrated bilateral transfer of adiposity aftereffects between bodies and faces and vice versa, though this cross-category transfer was considerably smaller compared to the within-modality transfer effects observed in Experiment 1, and less consistent than expected, emerging only under specific conditions.

The results of Experiment 1 provide the first demonstration of within-category adiposity aftereffects in the perception of faces, with strong aftereffects observed consistently across all participants. While faces may not traditionally be associated with the concept of fatness or thinness, they are the body parts of other people to which we are most often exposed to. Our findings suggest that faces alone can provide enough adiposity cues to induce body size adaptation aligning with research that identifies facial adiposity as an important visual feature (e.g., Coetzee et al., 2009, 2011), and adds to the list of facial features known to be susceptible to adaptation, alongside features such as identity (Leopold et al., 2001), emotion (Webster et al., 2004), age (Schweinberger et al., 2010), gender (Afraz & Cavanagh, 2009), ethnicity (Amihai et al., 2011), and face distortion (T. L. Watson & Clifford, 2003).

Our findings that adaptation to adiposity transfers between faces and bodies complements previous reports of such transfer for other characteristics such as gender (Ghuman et al., 2010; Palumbo et al., 2015), identity (Ghuman et al., 2010), and orientation (Cooney et al., 2015). Notably, however, none of these previous studies demonstrated bilateral transfer of adaptation from faces to bodies and vice versa. Ghuman et al. (2010) only tested for transfer of gender and identity from bodies to faces, whereas Palumbo et al. (2015) only tested for transfer of gender from faces to bodies. Cooney et al. (2015) tested for transfer of orientation in both directions, but only found evidence for transfer from faces to bodies, but not in the opposite direction. Our results provide evidence for bilateral transfer from faces to bodies and vice versa, thus providing stronger evidence that adaptation likely affects integrated representations of whole persons than previous studies.

Nonetheless, the variability in our findings suggests at least some separation of the neural mechanisms processing adiposity for faces and bodies. Indeed, despite finding transfer of adiposity aftereffects from faces to bodies and vice versa, with all comparisons numerically aligning in the expected direction, only a few comparisons reached statistical significance in this study. Moreover, the reliability of the aftereffects across subjects was weaker compared to within-category transfer, which was present consistently across all participants, indicating a reduced and partial transfer of aftereffects across categories.

In addition, we observed an asymmetry between thin and fat adaptation, which was inconsistent across experiments. In Experiment 3, we found an aftereffect with the fat but not the thin face adaptor, whereas in Experiment 4, this pattern reversed with the thin body producing aftereffects. Furthermore, the absence of aftereffects in Experiment 2 contrasts with their presence in Experiment 3, where the only change was the avatar's orientation, shifting from a 45° view to straight-on views of both faces and bodies. This suggests that viewpoint may modulate the strength of adiposity aftereffects. One explanation is that changes in viewpoint alter visual features critical for adaptation, reducing the availability of diagnostic cues, consistent with feature-based accounts of viewpoint dependency (Demeyer et al., 2007). This, however, would be more relevant when adaptation and test stimuli would differ in the viewpoint, which was not the case here. Another possibility is that higher level processes are involved, such as differences in attention or in the extent to which faces and bodies are conceptually linked as representations of the same individual across viewpoints. In line with this, Little et al. (2011) found that the category-selectivity of face aftereffects was modulated by whether the participants were given socially meaningful labels to describe the different categories they were shown. This suggests that higher level cognitive factors, such as how participants conceptualize the categories they are presented with, can influence aftereffects. Overall, while our findings indicate that cross-category transfer of adiposity aftereffects is possible, the robustness and reliability of these effects under varying conditions require further investigation.

Our behavioral results complement recent neuroimaging studies providing evidence for integrated representations of faces and bodies in the ventral visual pathway (e.g., C. Fisher & Freiwald, 2015; Harry et al., 2016; Kaiser et al., 2014). Intriguingly, these studies have generally not found evidence of whole-person representations in relatively posterior regions of the temporal lobe, such as the fusiform face area or extrastriate body area, which appear to process information from faces and bodies separately. Rather, whole-person representations have been found in more anterior areas of the temporal lobe, such as the so-called anterior temporal face patch (Harry et al., 2016), suggesting that information from faces and from bodies is progressively integrated across subsequent stages of visual processing (C. Fisher & Freiwald, 2015). Our finding of transfer of adaptation between faces and bodies thus suggests that coding of adiposity is likely to occur at relatively late stages of processing, rather than in classical category-selective areas such as the fusiform face area.

One possible interpretation of body size adaptation could be that adiposity aftereffects result from adaptation to the low-level features of the stimuli: the overall size or a specific dimension such as width. To test this alternative hypothesis, we used inverted faces as adaptors and upright bodies as test stimuli. Contrary to Experiment 3, using the same stimuli in the upright configuration, we found no transfer of aftereffects from faces to bodies. This is in accordance with previous studies showing no body size aftereffects after adaptation to wide/narrow rectangles (Hummel et al., 2012). It seems therefore unlikely that aftereffects occurred simply due to low-level adaptation to the dimensions of the stimuli. It is worth mentioning that the lack of adaptation aftereffects for inverted faces is not likely driven by a general lack of adaptation for inverted as compared to upright faces. Indeed, it has been previously shown that when both adaptor and test faces have the same orientation, the magnitude of the aftereffect is equal for both inverted and upright faces (T. L. Watson & Clifford, 2003; Webster & MacLin, 1999), or even larger for the inverted ones (T. L. Watson & Clifford, 2006). In addition, several studies have found reduced, but not eliminated, aftereffects for gender (T. L. Watson & Clifford, 2006) and face distortions (T. L. Watson & Clifford, 2003; Webster & MacLin, 1999), from inverted to upright faces. Interestingly, and similar to the present study, face identity does not transfer from inverted to upright faces (Guo et al., 2009).

The results of this study may also be interpreted in terms of adaptation to a more general, abstract concept of adiposity rather than a higher level visual representation specific to bodies, an interpretative difficulty common to many high-level aftereffects (cf. Storrs, 2015). Previous studies on cross-category gender adaptation between bodies and gender-specific objects showed mixed results. Ghuman et al. (2010) found no transfer of gender aftereffects between faces and gender-specific objects, for example, shoes, while Javadi and Wee (2012) reported opposite results. Nevertheless, our findings are less likely to reflect abstract adiposity concepts, as inverted faces did not produce similar effects.

The generalizability of our findings to the broader population is limited. Although we imposed no restrictions on nationality or education level, our sample primarily consisted of female participants from Europe and Asia, most of whom were university students in central London (United Kingdom) or Magdeburg (Germany).

Additionally, we used a single computer-generated identity for both hand and face stimuli, representing a Caucasian female. While these stimuli provided a continuum from thin to fat, they may not fully capture the variability of real human bodies and may not simulate increases and decreases in fat in the same way, potentially limiting external validity. It is important to note, however, that while computer-generated stimuli might lead to less accurate body size judgments compared to real photographs (Alexi et al., 2019), this would likely affect sensitivity at specific stimulus levels but not the PSE, which was our primary measure of interest. Moreover, the differences between adaptation conditions should not be influenced by these factors. Additionally, it is possible that participants perceived the headless bodies as part of a coherent whole, even though the head appeared disproportionately large, because the height of the head and the bodies was matched. Future research could explore whether cross-adaptation effects on adiposity between faces and bodies persist when bodies and faces correspond to different racial identities (Gould-Fensom et al., 2019), genders (Brooks et al., 2019), and when different fat or thin adaptors are presented.

Overall, our findings highlight the complexity of cross-category adaptation. While adiposity aftereffects can transfer from faces to bodies and vice versa—suggesting functional interactions between the visual representations of faces and bodies in the perception of adiposity—these effects are generally weaker and less consistent compared to within-category adaptation. This suggests at least some separation in the neural mechanisms processing body size and shape for faces versus bodies. Additionally, high-level cognitive factors, such as conceptual associations between faces and bodies, may significantly influence the adaptation process.

References

Afraz, A., & Cavanagh, P. (2009). The gender-specific face aftereffect is based in retinotopic not spatiotopic coordinates across several natural image transformations. *Journal of Vision*, *9*(10), Article 10. https://doi.org/10.1167/9.10.10

Alexi, J., Dommisse, K., Cleary, D., Palermo, R., Kloth, N., & Bell, J. (2019). An assessment of computer-generated stimuli for use in studies of body size estimation and bias. *Frontiers in Psychology*, *10*, Article 2390. https://doi.org/10.3389/fpsyg.2019.02390

Ambroziak, K. B., Azañón, E., & Longo, M. R. (2019). Body size adaptation alters perception of test stimuli, not internal body image. *Frontiers in Psychology*, *10*, Article 2598. https://doi.org/10.3389/fpsyg.2019.02598

Amihai, I., Deouell, L., & Bentin, S. (2011). Conscious awareness is necessary for processing race and gender information from faces. *Consciousness and Cognition*, *20*(2), 269–279. https://doi.org/10.1016/j.concog.2010.08.004

Aviezer, H., Hassin, R. R., Ryan, J., Grady, C., Susskind, J., Anderson, A., Moscovitch, M., & Bentin, S. (2008). Angry, disgusted, or afraid? Studies on the malleability of emotion perception. *Psychological Science*, *19*(7), 724–732. https://doi.org/10.1111/j.1467-9280.2008.02148.x

Aviezer, H., Trope, Y., & Todorov, A. (2012). Body cues, not facial expressions, discriminate between intense positive and negative emotions. *Science*, *338*(6111), 1225–1229. https://doi.org/10.1126/science.1224313

Bartlett, J., & Searcy, J. (1993). Inversion and configuration of faces. *Cognitive Psychology*, *25*(3), 281–316. https://doi.org/10.1006/cogp.1993.1007

Bernstein, M., Oron, J., Sadeh, B., & Yovel, G. (2014). An integrated face-body representation in the fusiform gyrus but not the lateral occipital cortex. *Journal of Cognitive Neuroscience*, *26*(11), 2469–2478. https://doi.org/10.1162/jocn_a_00639

Biotti, F., Gray, K. L. H., & Cook, R. (2017). Impaired body perception in developmental prosopagnosia. *Cortex*, *93*, 41–49. https://doi.org/10.1016/j.cortex.2017.05.006

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. Wiley.

Brainard, D. H. (1997). The psychophysics toolbox. *Spatial Vision*, *10*(4), 433–436. https://doi.org/10.1163/156856897X00357

Brandman, T., & Yovel, G. (2012). A face inversion effect without a face. *Cognition*, *125*(3), 365–372. https://doi.org/10.1016/j.cognition.2012.08.001

Bratch, A., Chen, Y., Engel, S. A., & Kersten, D. J. (2021). Visual adaptation selective for individual limbs reveals hierarchical human body representation. *Journal of Vision*, *21*(5), Article 18. https://doi.org/10.1167/jov.21.5.18

Brooks, K. R., Baldry, E., Mond, J., Stevenson, R. J., Mitchison, D., & Stephen, I. D. (2019). Gender and the body size aftereffect: Implications for neural processing. *Frontiers in Neuroscience*, *13*, Article 1100. https://doi.org/10.3389/fnins.2019.01100

Brooks, K. R., Keen, E., Sturman, D., Mond, J., Stevenson, R. J., & Stephen, I. D. (2020). Muscle and fat aftereffects and the role of gender: Implications for body image disturbance. *British Journal of Psychology*, *111*(4), 742–761. https://doi.org/10.1111/bjop.12439

Brooks, K. R., Mond, J. M., Stevenson, R. J., & Stephen, I. D. (2016). Body image distortion and exposure to extreme body types: Contingent adaptation and cross adaptation for self and other. *Frontiers in Neuroscience*, *10*, Article 334. https://doi.org/10.3389/fnins.2016.00334

Bruch, H. (1978). *The golden cage: The enigma of anorexia nervosa*. Harvard University Press.

Calder, A. J., Jenkins, R., Cassel, A., & Clifford, C. W. G. (2008). Visual representation of eye gaze is coded by a nonopponent multichannel system. *Journal of Experimental Psychology: General*, *137*(2), 244–261. https://doi.org/10.1037/0096-3445.137.2.244

Coetzee, V., Chen, J., Perrett, D. I., & Stephen, I. D. (2010). Deciphering faces: Quantifiable cues to weight. *Perception*, *39*(1), 51–61. https://doi.org/10.1068/p6560

Coetzee, V., Perrett, D. I., & Stephen, I. D. (2009). Facial adiposity: A cue to health? *Perception*, *38*(11), 1700–1711. https://doi.org/10.1068/p6423

Coetzee, V., Re, D., Perrett, D. I., Tiddeman, B. P., & Xiao, D. (2011). Judging the health and attractiveness of female faces: Is the most attractive level of facial adiposity also considered the healthiest? *Body Image*, *8*(2), 190–193. https://doi.org/10.1016/j.bodyim.2010.12.003

Cooney, S., Dignam, H., & Brady, N. (2015). Heads first: Visual aftereffects reveal hierarchical integration of cues to social attention. *PLOS ONE*, *10*(9), Article e0135742. https://doi.org/10.1371/journal.pone.0135742

Cornelissen, P. L., Cornelissen, K. K., Groves, V., McCarty, K., & Tovée, M. J. (2018). View-dependent accuracy in body mass judgements of female bodies. *Body Image*, *24*, 116–123. https://doi.org/10.1016/j.bodyim.2017.12.007

Cornelissen, P. L., Toveé, M. J., & Bateson, M. (2009). Patterns of subcutaneous fat deposition and the relationship between body mass index and waist-to-hip ratio: Implications for models of physical attractiveness. *Journal of Theoretical Biology*, *256*(3), 343–350. https://doi.org/10.1016/j.jtbi.2008.09.041

Cox, D., Meyers, E., & Sinha, P. (2004). Contextually evoked object-specific responses in human visual cortex. *Science*, *304*(5667), 115–117. https://doi.org/10.1126/science.1093110

Currie, T. E., & Little, A. C. (2009). The relative importance of the face and body in judgments of human physical attractiveness. *Evolution and Human Behavior*, *30*(6), 409–416. https://doi.org/10.1016/j.evolhumbehav.2009.06.005

Demeyer, M., Zaenen, P., & Wagemans, J. (2007). Low-level correlations between object properties and viewpoint can cause viewpoint-dependent object recognition. *Spatial Vision*, *20*(1-2), 79–106. https://doi.org/10.1163/156856807779369760

Downing, P. E., Jiang, Y., Shuman, M., & Kanwisher, N. (2001). A cortical area selective for visual processing of the human body. *Science*, *293*(5539), 2470–2473. https://doi.org/10.1126/science.1063414

Duchaine, B., Yovel, G., Butterworth, E., & Nakayama, K. (2006). Prosopagnosia as an impairment to face-specific mechanisms: Elimination of the alternative hypotheses in a developmental case. *Cognitive Neuropsychology*, *23*(5), 714–747. https://doi.org/10.1080/02643290500441296

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. https://doi.org/10.3758/BF03193146

Fisher, C., & Freiwald, W. A. (2015). Whole-agent selectivity within the macaque face-processing system. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(47), 14717–14722. https://doi.org/10.1073/pnas.1512378112

Fisher, C. I., Hahn, A. C., DeBruine, L. M., & Jones, B. C. (2014). Integrating shape cues of adiposity and colour information when judging facial health and attractiveness. *Perception*, *43*(6), 499–508. https://doi.org/10.1068/p7728

Ghuman, A. S., McDaniel, J. R., & Martin, A. (2010). Face perception without a face. *Current Biology*, *20*(1), 32–36. https://doi.org/10.1016/j.cub.2009.10.077

Glauert, R., Rhodes, G., Byrne, S., Fink, B., & Grammer, K. (2009). Body dissatisfaction and the effects of perceptual exposure on body norms and ideals. *International Journal of Eating Disorders*, *42*(5), 443–452. https://doi.org/10.1002/eat.20640

Gould-Fensom, L., Tan, C. B., Brooks, K. R., Mond, J., Stevenson, R. J., & Stephen, I. D. (2019). The thin white line: Adaptation suggests a common neural mechanism for judgments of Asian and Caucasian body size. *Frontiers in Psychology*, *10*, Article 2532. https://doi.org/10.3389/fpsyg.2019.02532

Grogan, S. (2017). *Body image: Understanding body dissatisfaction in men, women and children* (3rd ed.). Routledge.

Guo, X. M., Oruç, I., & Barton, J. J. S. (2009). Cross-orientation transfer of adaptation for facial identity is asymmetric: A study using contrast-based recognition thresholds. *Vision Research*, *49*(18), 2254–60. https://doi.org/10.1016/j.visres.2009.06.012

Harry, B. B., Umla-Runge, K., Lawrence, A. D., Graham, K. S., & Downing, P. E. (2016). Evidence for integrated visual face and body representations in the anterior temporal lobes. *Journal of Cognitive Neuroscience*, *28*(8), 1178–1193. https://doi.org/10.1162/jocn_a_00966

Hummel, D., Rudolf, A. K., Untch, K.-H., Grabhorn, R., & Mohr, H. M. (2012). Visual adaptation to thin and fat bodies transfers across identities. *PLOS ONE*, *7*(8), Article e43195. https://doi.org/10.1371/journal.pone.0043195

Jaquet, E., & Rhodes, G. (2008). Face aftereffects indicate dissociable, but not distinct, coding of male and female faces. *Journal of Experimental Psychology: Human Perception and Performance*, *34*, 101–112. https://doi.org/10.1037/0096-1523.34.1.101

Javadi, A. H., & Wee, N. (2012). Cross-category adaptation: Objects produce gender adaptation in the perception of faces. *PLOS ONE*, *7*(9), Article e46079. https://doi.org/10.1371/journal.pone.0046079

Jeffreys, H. (1961). *Theory of probability* (3rd ed.). Oxford University Press.

Kaiser, D., Strnad, L., Seidl, K. N., Kastner, S., & Peelen, M. V. (2014). Whole person-evoked fMRI activity patterns in human fusiform gyrus are accurately modelled by a linear combination of face- and body-evoked activity patterns. *Journal of Neurophysiology*, *111*(1), 82–90. https://doi.org/10.1152/jn.00371.2013

Kanwisher, N., McDermott, J., & Chun, M. M. (1997). The fusiform face area: A module in human extrastriate cortex specialized for face perception. *The Journal of Neuroscience*, *17*(11), 4302–4311. https://doi.org/10.1523/JNEUROSCI.17-11-04302.1997

Kelter, R. (2020). Bayesian alternatives to null hypothesis significance testing in biomedical research: A non-technical introduction to Bayesian inference with JASP. *BMC Medical Research Methodology*, *20*(1), Article 142. https://doi.org/10.1186/s12874-020-00980-6

Lawson, R. (2015). I just love the attention: Implicit preference for direct eye contact. *Visual Cognition*, *23*(4), 450–488. https://doi.org/10.1080/13506285.2015.1039101

Leopold, D. A., O'Toole, A. J., Vetter, T., & Blanz, V. (2001). Prototype-references shape encoding revealed by high-level aftereffects. *Nature Neuroscience*, *4*(1), 89–94. https://doi.org/10.1038/82947

Little, A. C., DeBruine, L. M., & Jones, B. C. (2011). Category-contingent face adaptation for novel colour categories: Contingent effects are seen only after social or meaningful labelling. *Cognition*, *118*(1), 116–122. https://doi.org/10.1016/j.cognition.2010.09.011

Meeren, H. K. M., van Heijnsbergen, C. C. R. J., & de Gelder, B. (2005). Rapid perceptual integration of facial expression and emotional body language. *Proceedings of the National Academy of Sciences of the United States of America*, *102*(45), 16518–16523. https://doi.org/10.1073/pnas.0507650102

Minnebusch, D. A., & Daum, I. (2009). Neuropsychological mechanisms of visual face and body perception. *Neuroscience & Biobehavioral Reviews*, *33*(7), 1133–1144. https://doi.org/10.1016/j.neubiorev.2009.05.008

Moro, V., Pernigo, S., Avesani, R., Bulgarelli, C., Urgesi, C., Candidi, M., & Aglioti, S. M. (2012). Visual body recognition in a prosopagnosic patient. *Neuropsychologia*, *50*(1), 104–117. https://doi.org/10.1016/j.neuropsychologia.2011.11.004

Myga, K. A., Azañón, E., Ambroziak, K. B., Ferrè, E. R., & Longo, M. R. (2024). Haptic experience of bodies alters body perception. *Perception*, *53*(10), 716–729. https://doi.org/10.1177/03010066241270627

Palumbo, R., D'Ascenzo, S., & Tommasi, L. (2015). Cross-category adaptation: Exposure to faces produces gender aftereffects in body perception. *Psychological Research*, *79*(3), 380–388. https://doi.org/10.1007/s00426-014-0576-2

Peelen, M. V., & Downing, P. E. (2005). Selectivity for the human body in the fusiform gyrus. *Journal of Neurophysiology*, *93*(1), 603–608. https://doi.org/10.1152/jn.00513.2004

Pell, P. J., & Richards, A. (2011). Cross-emotion facial expression aftereffects. *Vision Research*, *51*(17), 1889–1896. https://doi.org/10.1016/j.visres.2011.06.017

Pestilli, F., Viera, G., & Carrasco, M. (2007). How do attention and adaptation affect contrast sensitivity? *Journal of Vision*, *7*(7), Article 9. https://doi.org/10.1167/7.7.9

Peters, M., Rhodes, G., & Simmons, L. W. (2007). Contributions of the face and body to overall attractiveness. *Animal Behaviour*, *73*(6), 937–942. https://doi.org/10.1016/j.anbehav.2006.07.012

Pinsk, M. A., Arcaro, M., Weiner, K. S., Kalkus, J. F., Inati, S. J., Gross, C. G., & Kastner, S. (2009). Neural representations of faces and body parts in macaque and human cortex: A comparative fMRI study. *Journal of Neurophysiology*, *101*(5), 2581–2600. https://doi.org/10.1152/jn.91198.2008

Pinsk, M. A., DeSimone, K., Moore, T., Gross, C. G., & Kastner, S. (2005). Representations of faces and body parts in macaque temporal cortex: A functional fMRI study. *Proceedings of the National Academy of Sciences of the United States of America*, *102*(19), 6996–7001. https://doi.org/10.1073/pnas.0502605102

Puce, A., Allison, T., Asgari, M., Gore, J. C., & McCarthy, G. (1996). Differential sensitivity of human visual cortex to faces, letterstrings, and textures: A functional magnetic resonance imaging study. *The Journal of Neuroscience*, *16*(16), 5205–5215. https://doi.org/10.1523/JNEUROSCI.16-16-05205.1996

Re, D. E., Coetzee, V., Xiao, D., Buls, D., Tiddeman, B. P., Boothroyd, L. G., & Perrett, D. I. (2011). Viewing heavy bodies enhances preferences for facial adiposity. *Journal of Evolutionary Psychology*, *9*(4), 295–308. https://doi.org/10.1556/JEP.9.2011.4.2

Re, D. E., & Perrett, D. I. (2014). The effects of facial adiposity on attractiveness and perceived leadership ability. *Quarterly Journal of Experimental Psychology*, *67*(4), 676–686. https://doi.org/10.1080/17470218.2013.825635

Rezec, A. A., Krekelberg, B., & Dobkins, K. R. (2004). Attention enhances adaptability: Evidence from motion adaptation experiments. *Vision Research*, *44*(26), 3035–3044. https://doi.org/10.1016/j.visres.2004.07.020

Rhodes, G., Brake, S., & Atkinson, A. (1993). What's lost in inverted faces? *Cognition*, *47*(1), 25–57. https://doi.org/10.1016/0010-0277(93)90061-Y

Rhodes, G., & Jeffery, L. (2006). Adaptive norm-based coding of facial identity. *Vision Research*, *46*(18), 2977–2987. https://doi.org/10.1016/j.visres.2006.03.002

Rhodes, G., Jeffery, L., Evangelista, E., Ewing, L., Peters, M., & Taylor, L. (2011). Enhanced attention amplifies face adaptation. *Vision Research*, *51*(16), 1811–1819. https://doi.org/10.1016/j.visres.2011.06.008

Rhodes, G., Jeffery, L., Watson, T. L., Clifford, C. W., & Nakayama, K. (2003). Fitting the mind to the world: Face adaptation and attractiveness aftereffects. *Psychological Science*, *14*(6), 558–566. https://doi.org/10.1046/j.0956-7976.2003.psci_1465.x

Rice, A., Phillips, P. J., Natu, V., An, X. B., & O'Toole, A. J. (2013). Unaware person recognition from the body when face identification fails. *Psychological Science*, *24*(11), 2235–2243. https://doi.org/10.1177/0956797613492986

Righart, R., & de Gelder, B. (2007). Impaired face and body perception in developmental prosopagnosia. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(43), 17234–17238. https://doi.org/10.1073/pnas.0707753104

Robbins, R. A., & Coltheart, M. (2012). The effects of inversion and familiarity on face versus body cues to person recognition. *Journal of Experimental Psychology: Human Perception and Performance*, *38*(5), 1098–1104. https://doi.org/10.1037/a0028584

Schmalzl, L., Zopf, R., & Williams, M. A. (2012). From head to toe: Evidence for selective brain activation reflecting visual perception of whole individuals. *Frontiers in Human Neuroscience*, *6*, Article 108. https://doi.org/10.3389/fnhum.2012.00108

Schweinberger, S. R., Zäske, R., Walther, C., Golle, J., Kovács, G., & Wiese, H. (2010). Young without plastic surgery: Perceptual adaptation to the age of female and male faces. *Vision Research*, *50*(23), 2570–2576. https://doi.org/10.1016/j.visres.2010.08.017

Singh, D. (1993). Adaptive significance of female attractiveness: Role of waist-to-hip ratio. *Journal of Personality and Social Psychology*, *65*(2), 293–307. https://doi.org/10.1037/0022-3514.65.2.293

Song, Y., Luo, Y. L., Li, X., Xu, M., & Liu, J. (2013). Representation of contextually related multiple objects in the human ventral visual pathway. *Journal of Cognitive Neuroscience*, *25*(8), 1261–1269. https://doi.org/10.1162/jocn_a_00406

Stephen, I. D., Sturman, D., Stevenson, R. J., Mond, J., & Brooks, K. R. (2018). Visual attention mediates the relationship between body satisfaction and susceptibility to the body size adaptation effect. *PLOS ONE*, *13*(1), Article e0189855. https://doi.org/10.1371/journal.pone.0189855

Storrs, K. R. (2015). Are high-level aftereffects perceptual? *Frontiers in Psychology*, *6*, Article 157. https://doi.org/10.3389/fpsyg.2015.00157

Susilo, T., Yovel, G., Barton, J. J. S., & Duchaine, B. (2013). Face perception is category-specific: Evidence from normal body perception in acquired prosopagnosia. *Cognition*, *129*(1), 88–94. https://doi.org/10.1016/j.cognition.2013.06.004

Thornhill, R., & Grammer, K. (1999). The body and face of woman: One ornament that signals quality? *Evolution and Human Behavior*, *20*(2), 105–120. https://doi.org/10.1016/S1090-5138(98)00044-0

Tovée, M. J., Reinhardt, S., Emery, J. L., & Cornelissen, P. L. (1998). Optimum body-mass index and maximum sexual attractiveness. *The Lancet*, *352*(9127), Article 548. https://doi.org/10.1016/S0140-6736(05)79257-6

Van den Stock, J., Righart, R., & de Gelder, B. (2007). Body expressions influence recognition of emotions in the face and voice. *Emotion*, *7*(3), 487–494. https://doi.org/10.1037/1528-3542.7.3.487

van Doorn, J., Ly, A., Marsman, M., & Wagenmakers, E. J. (2020). Bayesian rank-based hypothesis testing for the rank sum test, the signed rank test, and Spearman's ρ. *Journal of Applied Statistics*, *47*(16), 2984–3006. https://doi.org/10.1080/02664763.2019.1709053

Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software*, *36*(3), 1–48. https://doi.org/10.18637/jss.v036.i03

Watson, A. B., & Pelli, D. G. (1983). QUEST: A Bayesian adaptive psychometric method. *Perception & Psychophysics*, *33*(2), 113–120. https://doi.org/10.3758/BF03202828

Watson, T. L., & Clifford, C. W. (2003). Pulling faces: An investigation of the face-distortion aftereffect. *Perception*, *32*(9), 1109–1116. https://doi.org/10.1068/p5082

Watson, T. L., & Clifford, C. W. (2006). Orientation dependence of the orientation-contingent face aftereffect. *Vision Research*, *46*(20), 3422–3429. https://doi.org/10.1016/j.visres.2006.03.026

Webster, M. A., Kaping, D., Mizokami, Y., & Duhamel, P. (2004). Adaptation to natural facial categories. *Nature*, *428*(6982), 557–561. https://doi.org/10.1038/nature02420

Webster, M. A., & MacLin, O. H. (1999). Figural aftereffects in the perception of faces. *Psychonomic Bulletin & Review*, *6*(4), 647–653. https://doi.org/10.3758/BF03212974

Winkler, C., & Rhodes, G. (2005). Perceptual adaptation affects attractiveness of female bodies. *British Journal of Psychology*, *96*(2), 141–154. https://doi.org/10.1348/000712605X36343

Received December 7, 2022
Revision received September 3, 2025
Accepted September 5, 2025 ■