

Adaptation Aftereffects to Adiposity Across Bodies and Faces

Klaudia B. Ambroziak¹, Sophie Field¹, Matthew R. Longo¹, and Elena Azañón^{2, 3, 4, 5}

¹Department of Psychological Sciences, Birkbeck, University of London

²Institute of Psychology, Otto von Guericke University Magdeburg

³Leibniz Institute for Neurobiology Magdeburg

⁴Center for Behavioral Brain Sciences (CBBS), Magdeburg, Germany

⁵Center 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.

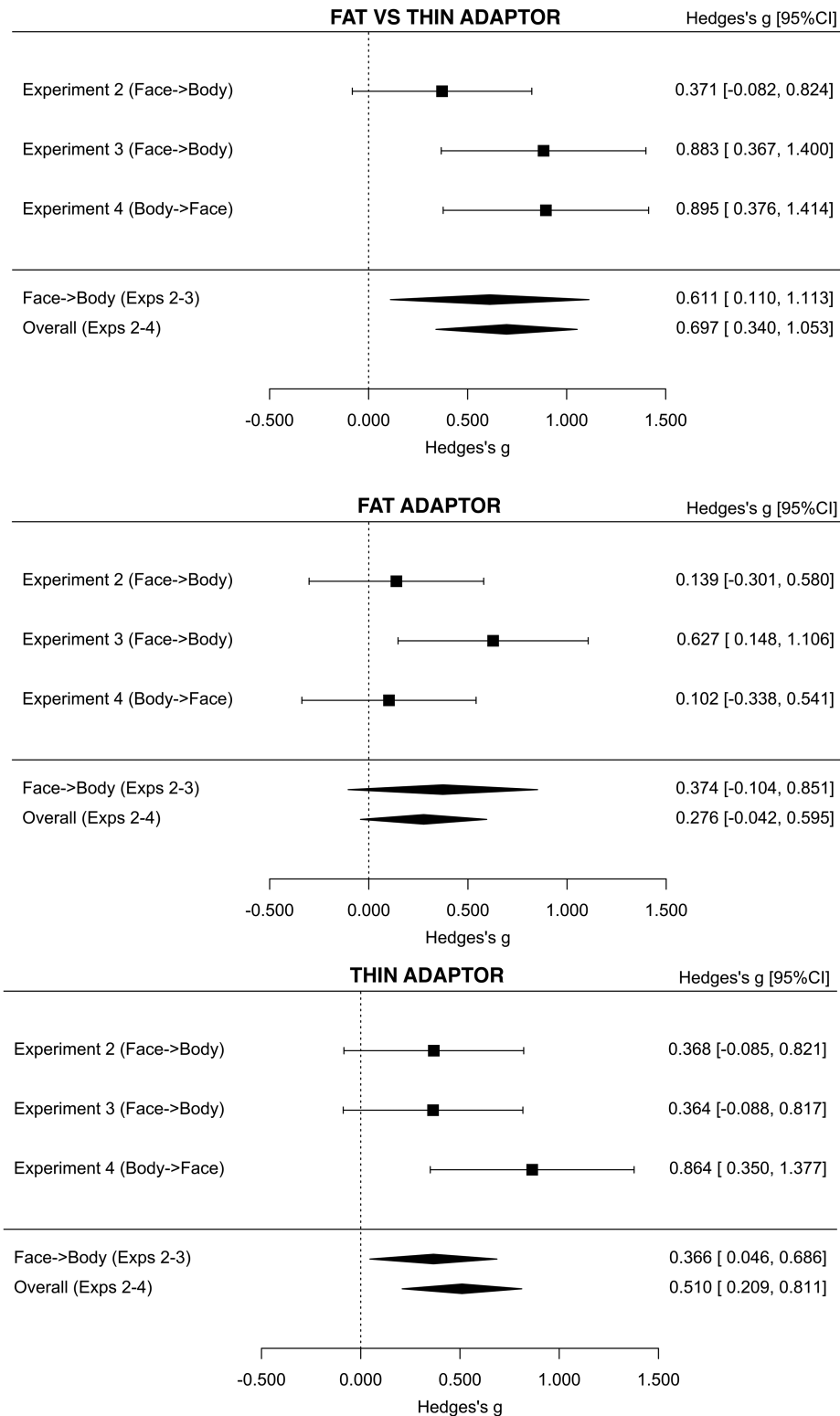
This research was supported by European Research Council Grant ERC-2013-StG-336050 under the FP7. The data have been made publicly available via the Open Science Framework and can be accessed at <https://osf.io/ern6w/>. All “bodies” stimuli can be accessed at <https://osf.io/fpr83/>. This study was not 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

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, $t(34) = -0.914$, $p = .367$, $d_z = -0.155$, $BF_{10} = 0.267$.

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 \times Adaptation, $F(1, 53) = 6.981$, $p = .011$, $\eta_p^2 = 0.116$. More importantly, the three-way interaction Adaptor Type \times Adaptation \times 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., Dommissie, 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>
- Coetsee, 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>
- Coetsee, 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>
- Coetsee, 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](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](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](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 ■