

The face size illusion is specific to whole faces

Perception
2026, Vol. 55(7) 651–662
© The Author(s) 2026
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/03010066261417184
journals.sagepub.com/home/pec



Anna Doherty¹, Eamonn Walsh^{2,3}, and Matthew R. Longo¹ 

Abstract

Faces are critical stimuli used for many social cognitive processes, believed to be served by specialised neural processes in the visual system. A recently described *face size illusion* shows that upright faces are perceived as physically smaller than inverted faces, and may provide insight into the neurocognitive mechanisms underlying human face perception. In this study, we investigated whether the face size illusion is specific to whole faces or whether it occurs as well for isolated face parts. The results provided a clear replication of the face size illusion for whole faces. In striking contrast, no comparable illusion was found for isolated noses, mouths, and eyes. For eyes, there was in fact an illusion in the opposite direction. These results provide further evidence for the specificity of the face size illusion and suggest that it may arise from the holistic processing of the face as an entire unit, rather than localised processing of individual face parts.

Keywords

face perception, face inversion, holistic processing, social cognition

Received: May 15, 2025; accepted: January 6, 2026

Introduction

Faces are among the most salient and important visual stimuli in our environments, which we use to recognise people and to understand their emotional, communicative, and mental states. Face perception is believed to differ from perception of other categories of visual stimuli in relying on a special form of perceptual processing distinct from those used for perception of other categories of stimuli, known as *configural* processing of the spatial relationships between facial features (Maurer et al., 2002; Piepers & Robbins, 2012). One widely used method for studying perceptual processing of faces is the face inversion effect. Face inversion has been shown to produce a variety of deficits in processing faces, including recognising identity (Diamond & Carey, 1986; Yin, 1969), emotional expressions (Bombari et al., 2013; McKelvie, 1995; Prkachin, 2003), and facial distortions (Searcy & Bartlett, 1996; Thompson, 1980).

¹School of Psychological Sciences, Birkbeck, University of London, London, UK

²Department of Basic & Clinical Neuroscience, Institute of Psychiatry, Psychology & Neuroscience, King's College London, London, UK

³Cultural and Social Neuroscience Research Group, Institute of Psychiatry, Psychology & Neuroscience, King's College London, London, UK

Corresponding Author:

Matthew Longo, School of Psychological Sciences, Birkbeck, University of London, Malet Street, London WC1E 7HX, UK.
Email: m.longo@bbk.ac.uk

Traditionally, face inversion effects have been quantified as performance impairments in recognition, identification, or classification tasks. More recently, another class of face inversion effect has been described in which rather than impair higher-level recognition processes, inversion produces systematic alterations in the perceived size and shape of a seen face. This distinction is theoretically significant because it suggests that inversion can influence basic perceptual encoding, not just higher-level recognition processes. Unlike traditional inversion effects, which are measured via accuracy or reaction time, these perceptual inversion effects reveal that orientation directly shapes what we see when we perceive a face. For example, Thompson and Wilson (2012) found that inverted faces are perceived as thinner than upright faces. Araragi and colleagues (2012) reported a different illusion in which inverted faces were perceived as physically larger than upright faces, an effect we call the *face size illusion*. Several recent studies have replicated the face size illusion (e.g., Walsh et al., 2018; Walsh, Whitby, et al., 2024; Zhang et al., 2021). These studies have also shown that the illusion has a high degree of specificity for faces, and does not occur for other categories such as bodies (Walsh et al., 2018), letters (Walsh, Moreira, et al., 2024), food items (Millbank et al., 2025), or everyday objects (Millbank et al., 2025; Walsh et al., 2018). Indeed, the effect appears specific to human faces and does not occur for faces of monkeys or cats (Monsen et al., in press). In the present study, we investigated a different form of specificity, namely whether the face size illusion is specific to whole faces or whether it also occurs for isolated face parts.

Several studies have compared face inversion effects for whole faces versus isolated face parts related to judgments of facial identity or emotional expression. As configural processing emphasises the relationships between different parts of the face, effects involving configural processing should be reduced or eliminated if individual face features are presented outside of the context of the full face. Rhodes and colleagues (1993) applied this logic to the face inversion effect using a recognition memory task. Inversion of face features such as the eyes and mouth produced clear decrements in performance, but critically only when they were presented in the context of the whole face. When inverted eyes and mouths were presented outside of context, no impairment of performance was found compared to upright stimuli. This pattern has been found in several subsequent studies (e.g., Pellicano et al., 2006; Pellicano & Rhodes, 2003; Tanaka & Farah, 1993; Tanaka & Sengco, 1997; for review see McKone & Yovel, 2009).

One study did report inversion effects for isolated parts (Rakover & Teucher, 1997), though as noted by McKone and Yovel (2009) these effects were small in magnitude and statistically weak. Some studies have found inversion effects for eyes specifically for both recognition memory (Rakover, 2012) and emotion recognition (Cassidy et al., 2022). It is also worth noting that the eyes were not really presented outside the face context, but rather were presented as if seen through a narrow aperture with the rest of the face occluded.

In the present study, we investigated whether the face size illusion is specific for whole faces or occurs as well for isolated face parts. We used a paradigm similar to that developed by Walsh and colleagues (2018) in which upright and inverted stimuli are shown and participants judge which appears larger. The stimuli are identical except for their orientation and size. We used the method of constant stimuli to quantify the difference in perceived size as a function of orientation. We compared the magnitude of this illusion for whole faces, eyes, noses, and mouths.

Method

Participants

Fifty-four individuals in the United Kingdom participated, 7 recruited through the personal network of the researchers, and 47 using the Prolific service (<https://www.prolific.co/>). The participants ranged from 19 to 71 years old (M : 36.7 years, SD : 12.4) and included 16 men and 38 women.

Participants had normal or corrected-to-normal vision. An additional 17 participants were tested, but were excluded from analyses due to poor model fit (see Analysis section below). The percentage of participants excluded (24%) is higher than in previous studies in our lab using this paradigm, although is not dramatically different from the 20% exclusion in Experiment 2 of Walsh, Moreira, and Longo (2024). The reasons for the high exclusion rate in this study are not fully clear. Seven of the participants clicked the upright stimulus on nearly all trials, suggesting they may not have paid full attention to the pre-experiment instructions. When offline data analysis showed poor model fit, additional data from new replacement participants was collected to reach our planned sample size and to ensure sufficient statistical power. The demographic information reported above describes the final sample of 54 participants included in analyses. Procedures were approved by the Birkbeck School of Psychological Sciences Research Ethics Committee.

We conducted an *a priori* power analysis using G*Power version 3.1.9.7 (Faul et al., 2007) to determine the minimum sample size required to test our hypotheses. In our previous studies using this paradigm (Walsh et al., 2018; Walsh, Moreira, et al., 2024; Walsh, Whitby, et al., 2024), the effect size for the size illusion for faces has been large. A weighted-average of the Cohen's d for t-tests comparing PSEs to 0 gave an overall average of $d = 0.907$. As we suspected that any potential effect for items of food might be smaller than this, we aimed to have 95% power to detect an effect of Cohen's $d = 0.50$, at a significance criterion of $\alpha = .05$, which produced an estimate of 54 participants. This power analysis is identical to one we used in another recent study using this paradigm (Millbank et al., 2025).

Stimuli

This study utilised eight images from the mixed race (CFD-MR) extension (Ma et al., 2021) of the Chicago Faces database (Ma et al., 2015). The CFD-MR was chosen to include a wider range of ethnic backgrounds than other databases, such as the Karolinska Directed Emotional Faces (Lundqvist et al., 1998), which we have used in previous studies using this paradigm (Millbank et al., 2025; Walsh, Moreira, et al., 2024; Walsh, Whitby, et al., 2024). The images included four men (model numbers: 316-156, 323-053, 304-002, 303-002) and four women (model numbers: 311-001, 335-002, 303-013, 330-001). Stimuli were digitally edited using the GNU Image Manipulation Program (GIMP). The face was isolated, excluding the neck and excess hair. This image was then sized down to fit within a 500×500 px square. From each face image, we also made stimuli isolating the left eye, the nose, and the mouth, as shown in Figure 1.

For the eye, included area featured the eyelid — cut off just at the shadow at the top of the eyelid, as well as a small area around the lower eyelid, including most of the lower eyelashes. This was done because the white of the eye with the tear ducts looked incomplete. For the nose, the clear outline around the nostrils was selected, and the top was cut off just above the bridge of the nose, where the reflection of the light is brightest. The sides have no clear outline, so a triangular shape was prioritised, again following the contours of the shading. For the mouth, the colour of the lips was used as a guide, however selecting only this made the lips look incomplete. Therefore, a small outline around the lips, capturing the highlight on the upper lip and the slight shadow below the lower lip was included to make the lips look complete.

The individual facial features were then enlarged to fit the 500×500 px canvas, and then all images were placed in the centre of a 550×550 px canvas. This was to ensure that, once resized, the +3/6/9% inverted images would still fit on the same canvas.

Procedure

This study uses a similar procedure to previous studies examining the face-size illusion in our lab. We used a two-alternative forced-choice task in which participants judge which of two images (one

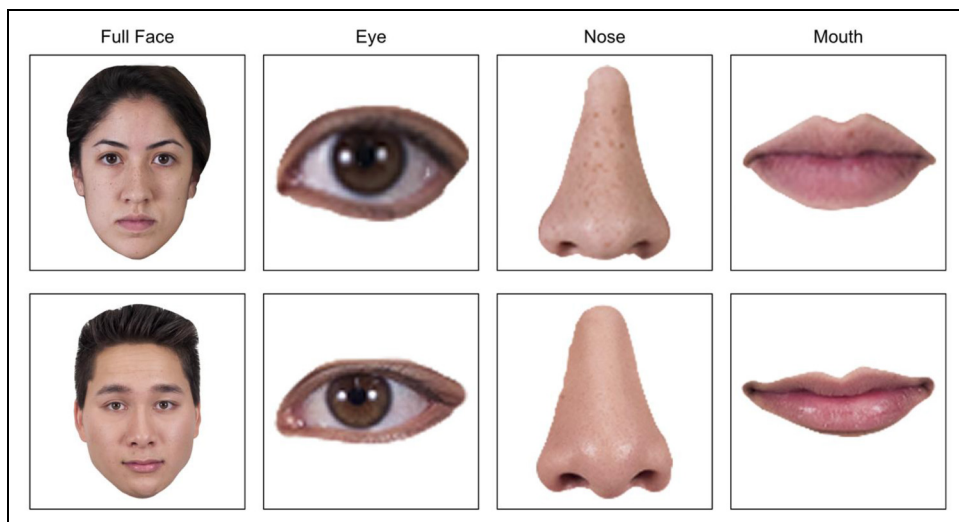


Figure 1. Schematic showing a sample female (top row) and male (bottom row) face and their isolated facial parts, as used in the experiment. Faces were cut off from the chin down, with excess hair removed. The eye included the upper eyelid and lower eyelashes. The nose extended from the nostrils to the bridge and prioritised a triangular shape on the sides. The mouth included a minimal amount of skin around the pink of the lips, so that the lips were clearly defined.

upright and one inverted) appears larger. Consistent with recent studies, we used the upright stimulus as a standard stimulus which remained constant in size across trials. The inverted stimulus was the comparison stimulus, and its size was manipulated across trials according to the method of constant stimuli.

Figure 2 shows the experimental procedure. The experiment was conducted through the online platform Gorilla (Anwyl-Irvine et al., 2020). Participants could access the experiment on a desktop, laptop or tablet, but not using a mobile phone. Because the size of participants' screens and their viewing distance varied, the visual angle size of stimuli was not controlled. This is potentially a source of between-participants variance, and may have effects on the results obtained. Critically, however, the relative size of the upright and inverted stimuli was matched, whatever the screen size and viewing distance of each participant. It is also worth noting in this context that online studies of the face size illusion (e.g., Millbank et al., 2025; Monsen et al., in press; Walsh, Moreira, et al., 2024; Walsh, Whitby, et al., 2024) have found very similar results as obtain in the lab where visual angular size was exactly matched across participants (Walsh et al., 2018).

Participants were instructed that they would see two images on the screen, one upright and one inverted, and to click the image that seemed larger to them. Participants were shown a fixation cross for 500 ms in between trials. Trials were not time-constrained and progressed based on participant response. The upright stimulus was always embedded in a 500px square. The inverted variants ranged in size relative to the original 500px image: -9%, -6%, -3%, +0%, +3%, +6%, +9% (455, 470, 485, 500, 515, 530, 545px). Participants were not informed that the images could be the same size and were always forced to choose one image as appearing larger.

There were 8 blocks of 28 trials, resulting in 224 total trials. Each block consisted exclusively of stimuli from a single category (face, eye, nose, mouth) and contained 4 repetitions of each of the seven sizes of the inverted stimulus in random order. Within each block, the upright stimulus was on the left side half of the time, and on the right the other half. Blocks 1-4 consisted of one

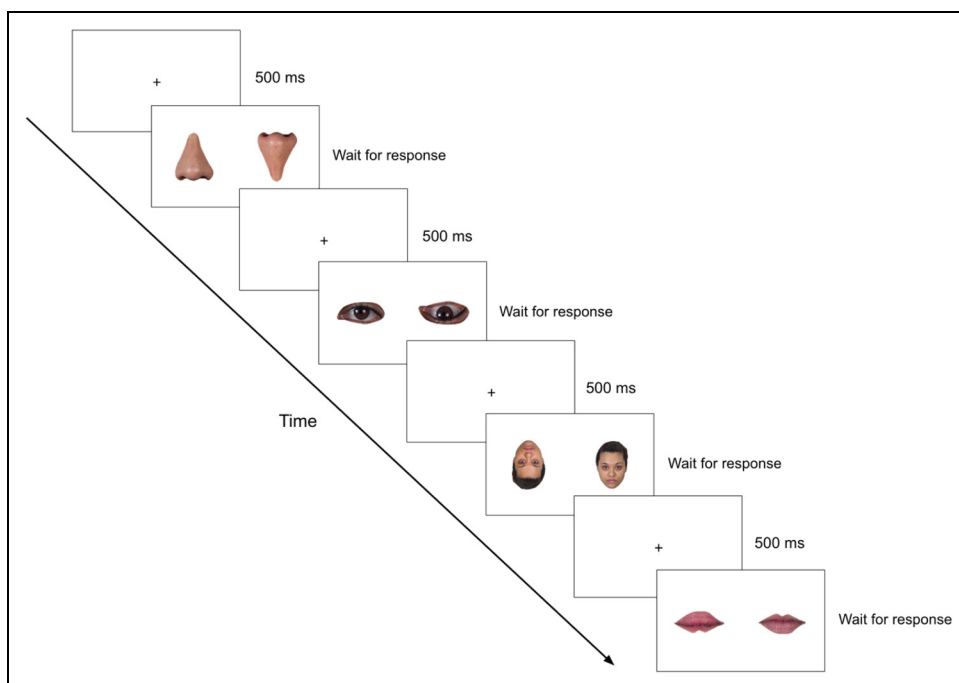


Figure 2. Schematic showing an example trial from each condition. Participants were shown a fixation cross for 500 ms, followed by two images of the same stimulus. One image was always upright, the other inverted. The upright stimulus had a fixed size, while the inverted stimulus could range in size (see text for details). The participant indicated which image they judged larger by clicking the image, which triggered the next trial.

repetition of each of the four conditions, counterbalanced across participants according to a Latin square. Blocks 5-8 were the identical, except in reverse order from the first four blocks.

Two sets of stimuli were created, so that the faces used for the isolated features were not the same as the faces used for the full-face stimuli. This was done so that participants could not mentally reconstruct a face from the given facial part. Set A consisted of male and female faces 1 and 2 for the full face, and males/females 3 and 4 for the individual face parts. Set B used Male and Female faces 3 and 4 for the full face, and males/females 1 and 2 for the individual face parts. The stimuli sets were counterbalanced across participants.

Analysis

Our analyses were similar to those used in previous experiments in our lab using this paradigm. We used the Palamedes toolbox (Prins & Kingdom, 2009) for MATLAB (MathWorks, Natick, MA) to fit a psychometric function to data from each of the four conditions for each participant. The proportion of responses for which the inverted stimulus was deemed larger was modelled as a function of the relative size difference between the upright and inverted stimuli using a cumulative Gaussian curve with maximum-likelihood estimation. The point of subjective equality (PSE, mean of the best fitting curve), the slope (inverse of the standard deviation), and the goodness of fit (R^2) were calculated for the four conditions. Consistent with other studies in our lab using this paradigm, we excluded participants who had poor model fit (i.e., $R^2 < 0.5$) in any of the four conditions. As mentioned above, 17 participants were excluded from analyses on this basis.

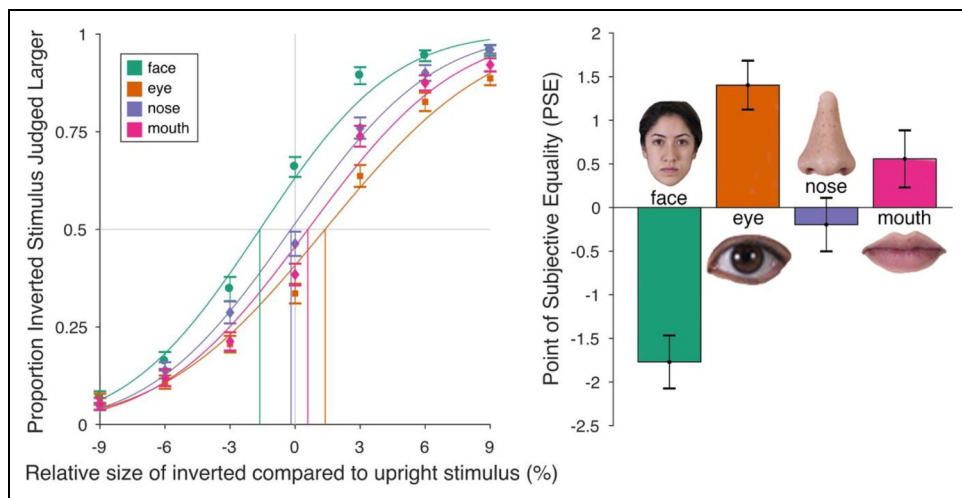


Figure 3. Left: Mean probability of trials where the inverted stimulus (face, eye, nose, mouth) was judged larger than the upright stimulus. 0% on x-axis indicates the two stimuli were objectively equal size, and 0.5 on y-axis indicates the perceived point of equality for their respective conditions. Right: Bar plot of mean PSEs for each condition (face, eye, nose, mouth). Positive PSE indicates that the upright stimulus was judged larger than the same-size inverted stimulus, while negative PSE indicates the opposite. Error bars give the standard error of the mean.

The PSE is the primary focus of this study, which estimates the actual size discrepancy between stimuli at the point at which the stimuli are perceived to be the same size. A positive PSE indicates a bias to judge upright stimuli as larger than inverted stimuli, while a negative PSE indicates the opposite. An unbiased assessment of both images should result in a PSE of 0.

Stimuli, raw data, and analysis scripts for the study are available on the Open Science Framework website: <https://osf.io/c96db/>

Results

The results are shown in Figure 3. There was good overall fit of psychometric functions to the data. Mean R^2 values were .925, .880, .917, and .907, in the full face, eye, nose, and mouth conditions, respectively.

To assess the basic size illusion, we used one-sample t-tests to compare the PSE of each of the four conditions to 0. The right panel of Figure 3 shows these results. PSEs for the full-faces ($M: -1.77\%$, $SD: 2.23$) were significantly less than 0, $t(53) = -5.83$, $p < .0001$, Cohen's $d = 0.794$, providing a clear replication of the original illusion.

Critically, however, this underestimation of the size of upright stimuli was not seen for individual face parts. The PSE for the eyes ($M: 1.40\%$, $SD: 2.06$) was significantly greater than 0, $t(53) = 5.00$, $p < .0001$, Cohen's $d = 0.680$, indicating a bias opposite to that seen for full faces. This reversed bias is consistent with that found in recent studies for human bodies (Walsh et al., 2018), letters and words (Walsh, Moreira, et al., 2024), and food items (Millbank et al., 2025). Neither noses ($M: -.20\%$, $SD: 2.25$), $t(53) = -.64$, $p = .525$, Cohen's $d = 0.087$, nor mouths ($M: .56\%$, $SD: 2.41$), $t(53) = 1.70$, $p = .095$, Cohen's $d = 0.232$, differed significantly from 0.

In order to compare the magnitude of the illusion across the four conditions, a repeated measures analysis of variance (ANOVA) was calculated. It provided clear evidence for a change in PSE as a

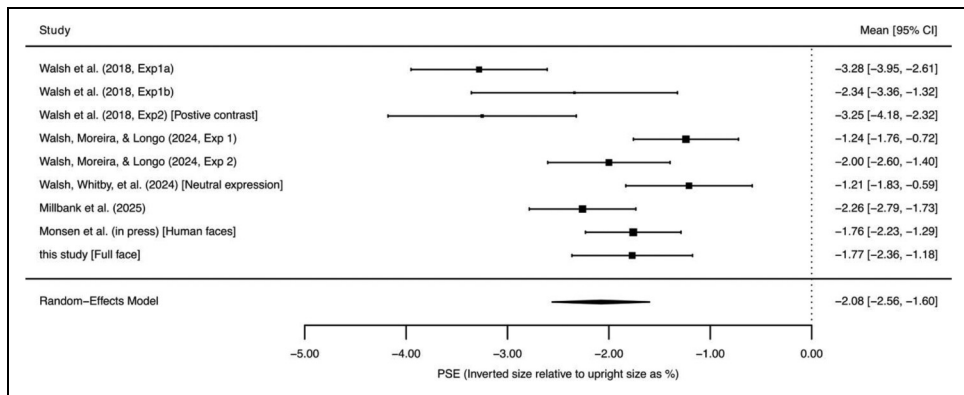


Figure 4. A forest plot showing a meta-analysis of studies of the face size illusion in our lab.

function of facial part, $F(3,51) = 21.23$, $p < .001$, $\eta_p^2 = .286$. Pairwise t-tests using Holm-Bonferroni correction for multiple comparisons showed that PSEs for full faces were significantly lower than for eyes, $t(53) = -7.98$, $p < .0001$, $d_z = 1.086$, noses, $t(53) = -3.44$, $p < .005$, $d_z = 0.486$, and mouths, $t(53) = -6.10$, $p < .0001$, $d_z = 0.830$. There was also a significant difference for PSEs between eyes and noses, $t(53) = 3.94$, $p < .0005$, $d_z = 0.537$, but no significant differences between mouths and either eyes, $t(53) = 2.04$, $p = .046$, $d_z = 0.278$, or noses, $t(53) = 1.79$, $p = .079$, $d_z = 0.243$. As there were significant effects for both full faces and eyes, we also looked to see if there was a correlation between them, but there was no evidence of any relation between them, $r(52) = .074$, $p = .595$. This lack of correlation suggests that the underlying perceptual mechanisms for the eye-size illusion and the whole-face-size illusion may be independent.

In a recent paper (Walsh, Whitby, et al., 2024), a reviewer, seeing the comparatively wide age range of our participants, asked us to look at whether the magnitude of the face size illusion changed with age. The correlation between PSEs and age was modestly positive in that study, $r(37) = .339$, $p < .05$. In the present study, in contrast, there was no significant correlation between PSEs for the face condition and age, $r(52) = .060$, $p = .667$.

Finally, as there have been several recent studies from our lab investigating the face size illusion, we conducted a meta-analysis of these studies using the *metafor* package in R (Viechtbauer, 2010) to aggregate the overall evidence for the effect (Goh et al., 2016). Figure 4 shows a forest plot of these results. The overall meta-analytic estimate of PSE was -2.08% , 95% CI: $[-2.56, -1.60]$, significantly less than 0, $z = -8.48$, $p < .0001$, providing strong evidence that the face size illusion for whole faces is indeed a robust perceptual phenomenon. There was significant evidence for heterogeneity, $Q(8) = 38.13$, $p < .0001$, with the I^2 statistic indicating that 81.3% of the between-study variance was due to heterogeneity.

Discussion

The present results provide a clear replication of the face size illusion, showing that upright faces are perceived as physically smaller than inverted ones (Araragi et al., 2012; Walsh et al., 2018; Zhang et al., 2021). Critically, however, this illusion did not generalise to individual face parts. For noses and mouths there was no significant illusion, while for eyes there was a significant illusion in the opposite direction, such that upright eyes were perceived as larger than inverted eyes.

The specificity of the face size illusion to whole faces is consistent with previous research using recognition tasks which has also found that face inversion effects are specific to whole faces (e.g.,

Rhodes et al., 1993; Tanaka & Farah, 1993; Tanaka & Sengco, 1997). These results are consistent with the interpretation that face inversion effects result from configural processing which is present only in full faces, although the present study was not designed to test the role of configural processing directly. In that sense, the present approach differs in important ways from these earlier studies which focused on comparing the perception of individual facial features when presented in isolation versus in the context of an entire face. Our approach has the strength of providing a relatively pure test of whether the face size illusion occurs for single facial features outside of any context. This parallels the logic of other recent studies of the face size illusion which have investigated whether similar size illusions occur for inverted hands (Walsh et al., 2018), objects (Walsh et al., 2018), letters (Walsh, Moreira, et al., 2024), and food items (Millbank et al., 2025). It is possible that the results for individual face parts might differ if they were placed in the context of an entire face, and this is an interesting topic for future research.

The present results show an interesting contrast with recent studies that have investigated emotion recognition from whole bodies and isolated parts (Blythe et al., 2023, in press). In those studies, similar inversion effects were seen for full bodies as well as isolated parts, such as hands, arms, and torsos. It is worth noting that in a previous study, we also found no evidence for a size illusion for isolated hands (Walsh et al., 2018). The specific features driving this difference between studies are not fully clear. One possibility is that perception of emotion might utilise body part information from many isolated parts, whether on the body or the face, though it is worth noting that Blythe and colleagues (2023) found that emotion recognition was substantially higher for isolated hands than for other isolated body parts. Another possibility is that this reflects a difference between body parts and face parts, perhaps linked to the particularly critical role of configural processing for face recognition.

In the specific case of the eyes, there was an inversion effect on perceived size, but this was in the opposite direction as seen for whole faces. Upright eyes were perceived as larger than inverted eyes. This pattern is similar to that seen in previous studies for bodies (Walsh et al., 2018), letters and words (Walsh, Moreira, et al., 2024), everyday objects (Millbank et al., 2025), and food items (Millbank et al., 2025). As noted in the Introduction, there is some evidence for inversion effects for eyes for both recognition memory (Rakover, 2012) and emotion recognition (Cassidy et al., 2022). This may be linked to the critical role played by the eyes in social cognition (Itier & Batty, 2009). For example, studies of eye movements show that viewers start looking at a face by focusing on the eyes (Henderson et al., 2005; Janik et al., 1978; Walker-Smith et al., 1977), at least in Western cultures (Blais et al., 2008). Similarly, the perceived direction of the eyes automatically captures and orients attention (Driver et al., 1999; Friesen & Kingstone, 1998; Langton & Bruce, 1999), although this effect appears only to occur when eyes are presented in the context of the entire face (Breil et al., 2022).

The potentially unique effect for eyes, compared to other facial features, fits with existing research showing that eyes may be particularly important for interpreting other human faces (Diego-Mas et al., 2020). This has led to claims that the anatomy of the human eye, with large white sclera, evolved to facilitate the use of eye signals in social perception (e.g., Kano et al., 2022; Kobayashi & Kohshima, 1997, 2001; Tomasello et al., 2007). At the same time, other research has identified various illusions related to the eyes, related to their perceived size (Morikawa et al., 2015; Xiao et al., 2014) and location (Carbon & Wirth, 2014). In this study, we made the (essentially arbitrary) choice to present isolated left eyes specifically. While we do not know of any reasons to suspect that this decision influenced the results, it is possible that there could be lateralised effects such that perceptual effects resulting from presentation of right eyes might differ.

The present results add to the growing evidence that the specific pattern seen in the face size illusion (i.e., upright stimuli seen as smaller than inverted stimuli) is highly specific to faces. No similar bias is seen for other categories, such as hands (Walsh et al., 2018), full bodies

(Walsh et al., 2018), letters (Walsh, Moreira, et al., 2024), words (Walsh, Moreira, et al., 2024), everyday objects (Millbank et al., 2025; Walsh et al., 2018), food (Millbank et al., 2025), isolated face parts (this study), and even faces of non-human animals (Monsen et al., in press). Indeed, as noted above, for several of these, an illusion in the opposite direction is found, including for eyes in the present study.

The visual mechanisms underlying the face size illusion remain uncertain. One potential mechanism is adaptive changes in the size of receptive fields in the visual pathways when looking at upright faces. Poltoratski and colleagues (2021) used fMRI to measure population receptive fields (pRFs) in the ventral visual pathway, finding that pRFs *increased* in size for upright compared to inverted faces. This increase is striking, given that spatial precision in the visual system is linked to small RFs (Hubel & Wiesel, 1974). The increased pRF size for upright faces may be a specific reflection of configural processing, which emphasises the larger-scale integration of features, rather than high spatial precision. In touch, size illusions have been linked to RF size such that small RFs are associated with larger perceived size, as in the ‘pixel model’ (Longo, 2022, 2025). The changes in RF size described by Poltoratski and colleagues could, analogously, account for the face size illusion.

In conclusion, these results replicate the face size illusion which has been reported in previous studies. Moreover, they show that this effect is specific to complete faces and does not occur for isolated face parts, such as eyes, noses, and mouths. Alongside results showing that face inversion alters perceived face shape (Thompson & Wilson, 2012), the face size illusion provides a novel window on face inversion effects which may have important implications for understanding the perceptual mechanisms underlying this phenomenon.

ORCID iD

Matthew R. Longo  <https://orcid.org/0000-0002-2450-4903>

Author Contribution(s)

Anna Doherty: Conceptualization; Formal analysis; Investigation; Methodology; Writing – original draft.

Eamonn Walsh: Conceptualization; Writing – review & editing.

Matthew R. Longo: Conceptualization; Data curation; Formal analysis; Methodology; Project administration; Software; Supervision; Visualization; Writing – original draft.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

- Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior Research Methods*, 52, 388–407. <https://doi.org/10.3758/s13428-019-01237-x>
- Araragi, Y., Aotani, T., & Kitaoka, A. (2012). Evidence for a size underestimation of upright faces. *Perception*, 41, 840–853. <https://doi.org/10.1068/p7058>
- Blais, C., Jack, R. E., Scheepers, C., Fiset, D., & Caldara, R. (2008). Culture shapes how we look at faces. *PLoS ONE*, 3(8), e3022. <https://doi.org/10.1371/journal.pone.0003022>

- Blythe, E., El Gouraini, N., Medeg, V., Garrido, L., & Longo, M. R. (in press). Spatial relations between hands shape visual perception of emotion. *Emotion*. <https://doi.org/10.1037/emo0001572>
- Blythe, E., Garrido, L., & Longo, M. R. (2023). Emotion is perceived accurately from isolated body parts, especially hands. *Cognition*, 230, 105260. <https://doi.org/10.1016/j.cognition.2022.105260>
- Bombard, D., Schmid, P. C., Schmid Mast, M., Birri, S., Mast, F. W., & Lobmaier, J. S. (2013). Emotion recognition: The role of featural and configural face information. *Quarterly Journal of Experimental Psychology*, 66, 2426–2442. <https://doi.org/10.1080/17470218.2013.789065>
- Breil, C., Huestegge, L., & Böckler, A. (2022). From eye to arrow: Attention capture by direct gaze requires more than just the eyes. *Attention, Perception, & Psychophysics*, 84(1), 64–75. <https://doi.org/10.3758/s13414-021-02382-2>
- Carbon, C.-C., & Wirth, B. E. (2014). Neanderthal Paintings? Production of Prototypical Human (*Homo Sapiens*) Faces Shows Systematic Distortions. *Perception*, 43(1), 99–102. <https://doi.org/10.1068/p7604>
- Cassidy, B. S., Wiley, R. W., Sim, M., & Hugenberg, K. (2022). Inversion reduces sensitivity to complex emotions in eye regions. *Social Cognition*, 40(3), 302–315. <https://doi.org/10.1521/soco.2022.40.3.302>
- Diamond, R., & Carey, S. (1986). Why faces are and are not special: An effect of expertise. *Journal of Experimental Psychology: General*, 115, 107–117. <https://doi.org/10.1037/0096-3445.115.2.107>
- Diego-Mas, J. A., Fuentes-Hurtado, F., Naranjo, V., & Alcañiz, M. (2020). The influence of each facial feature on how we perceive and interpret human faces. *I-Perception*, 11(5), 2041669520961123. <https://doi.org/10.1177/2041669520961123>
- Driver, J., Davis, G., Ricciardelli, P., Kidd, P., Maxwell, E., & Baron-Cohen, S. (1999). Gaze perception triggers reflexive visuospatial orienting. *Visual Cognition*, 6(5), 509–540. <https://doi.org/10.1080/135062899394920>
- 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, 175–191. <https://doi.org/10.3758/BF03193146>
- Friesen, C. K., & Kingstone, A. (1998). The eyes have it! Reflexive orienting is triggered by nonpredictive gaze. *Psychonomic Bulletin & Review*, 5(3), 490–495. <https://doi.org/10.3758/BF03208827>
- Goh, J. X., Hall, J. A., & Rosenthal, R. (2016). Mini meta-analysis of your own studies: Some arguments on why and a primer on how. *Social and Personality Psychology Compass*, 10(10), 535–549. <https://doi.org/10.1111/spc3.12267>
- Henderson, J. M., Williams, C. C., & Falk, R. J. (2005). Eye movements are functional during face learning. *Memory & Cognition*, 33(1), 98–106. <https://doi.org/10.3758/BF03195300>
- Hubel, D. H., & Wiesel, T. N. (1974). Uniformity of monkey striate cortex: A parallel relationship between field size, scatter, and magnification factor. *The Journal of Comparative Neurology*, 158(3), 295–305. <https://doi.org/10.1002/cne.901580305>
- Itier, R. J., & Batty, M. (2009). Neural bases of eye and gaze processing: The core of social cognition. *Neuroscience & Biobehavioral Reviews*, 33(6), 843–863. <https://doi.org/10.1016/j.neubiorev.2009.02.004>
- Janik, S. W., Wellens, A. R., & Goldberg, M. L., & Dell’L. F. Osso (1978). Eyes as the center of focus in the visual examination of human faces. *Perceptual and Motor Skills*, 47(3), 857–858. <https://doi.org/10.2466/pms.1978.47.3.857>
- Kano, F., Kawaguchi, Y., & Hanling, Y. (2022). Experimental evidence that uniformly white sclera enhances the visibility of eye-gaze direction in humans and chimpanzees. *eLife*, 11, e74086. <https://doi.org/10.7554/eLife.74086>
- Kobayashi, H., & Kohshima, S. (1997). Unique morphology of the human eye. *Nature*, 387, 767–768. <https://doi.org/10.1038/42842>
- Kobayashi, H., & Kohshima, S. (2001). Unique morphology of the human eye and its adaptive meaning: Comparative studies on external morphology of the primate eye. *Journal of Human Evolution*, 40(5), 419–435. <https://doi.org/10.1006/jhev.2001.0468>

- Langton, S. R. H., & Bruce, V. (1999). Reflexive visual orienting in response to the social attention of others. *Visual Cognition*, 6(5), 541–567. <https://doi.org/10.1080/135062899394939>
- Longo, M. R. (2022). Distortion of mental body representations. *Trends in Cognitive Sciences*, 26, 241–254. <https://doi.org/10.1016/j.tics.2021.11.005>
- Longo, M. R. (2025). *The invisible hand: Neurocognitive mechanisms of human hand function*. MIT Press.
- Lundqvist, D., Flykt, A., & Öhman, A. (1998). *The Karolinska Directed Emotional Faces—KDEF, CD ROM from Department of Clinical Neuroscience, Psychology section, Karolinska Institutet*, ISBN 91-630-7164-9.
- Ma, D. S., Correll, J., & Wittenbrink, B. (2015). The Chicago face database: A free stimulus set of faces and norming data. *Behavior Research Methods*, 47, 1122–1135. <https://doi.org/10.3758/s13428-014-0532-5>
- Ma, D. S., Kantner, J., & Wittenbrink, B. (2021). Chicago face database: Multiracial expansion. *Behavior Research Methods*, 53(3), 1289–1300. <https://doi.org/10.3758/s13428-020-01482-5>
- Maurer, D., Grand, R. L., & Mondloch, C. J. (2002). The many faces of configural processing. *Trends in Cognitive Sciences*, 6, 255–260. [https://doi.org/10.1016/S1364-6613\(02\)01903-4](https://doi.org/10.1016/S1364-6613(02)01903-4)
- McKelvie, S. J. (1995). Emotional expression in upside-down faces: Evidence for configurational and componential processing. *British Journal of Social Psychology*, 34, 325–334. <https://doi.org/10.1111/j.2044-8309.1995.tb01067.x>
- McKone, E., & Yovel, G. (2009). Why does picture-plane inversion sometimes dissociate perception of features and spacing in faces, and sometimes not? Toward a new theory of holistic processing. *Psychonomic Bulletin & Review*, 16(5), 778–797. <https://doi.org/10.3758/PBR.16.5.778>
- Millbank, H., Walsh, E., & Longo, M. R. (2025). Inversion produces opposite size illusions for faces and food. *Perception*, 54(4), 252–265. <https://doi.org/10.1177/03010066251316456>
- Monsen, S., Walsh, E., Cadete, D., Garrido, L., Ferrè, E. R., & Longo, M. R. (in press). The face size illusion is specific to human faces. *Quarterly Journal of Experimental Psychology*. <https://doi.org/10.1177/17470218251351017>
- Morikawa, K., Matsushita, S., Tomita, A., & Yamanami, H. (2015). A real-life illusion of assimilation in the human face: Eye size illusion caused by eyebrows and eye shadow. *Frontiers in Human Neuroscience*, 9, 139. <https://doi.org/10.3389/fnhum.2015.00139>
- Pellicano, E., & Rhodes, G. (2003). Holistic processing of faces in preschool children and adults. *Psychological Science*, 14(6), 618–622.
- Pellicano, E., Rhodes, G., & Peters, M. (2006). Are preschoolers sensitive to configural information in faces? *Developmental Science*, 9(3), 270–277. <https://doi.org/10.1111/j.1467-7687.2006.00489.x>
- Piepers, D. W., & Robbins, R. A. (2012). A review and clarification of the terms “holistic,” “configural,” and “relational” in the face perception literature. *Frontiers in Psychology*, 3, 559. <https://doi.org/10.3389/fpsyg.2012.00559>
- Poltoratski, S., Kay, K., Finzi, D., & Grill-Spector, K. (2021). Holistic face recognition is an emergent phenomenon of spatial processing in face-selective regions. *Nature Communications*, 12(1), 224. <https://doi.org/10.1038/s41467-021-24806-1>
- Prins, N., & Kingdom, F. A. A. (2009). *Palamedes: Matlab routines for analyzing psychophysical data*. <http://www.palamedestoolbox.org>
- Prkachin, G. C. (2003). The effects of orientation on detection and identification of facial expressions of emotion. *British Journal of Psychology*, 94, 45–62. <https://doi.org/10.1348/000712603762842093>
- Rakover, S. S. (2012). A feature-inversion effect: Can an isolated feature show behavior like the face-inversion effect? *Psychonomic Bulletin & Review*, 19(4), 617–624. <https://doi.org/10.3758/s13423-012-0264-4>
- Rakover, S. S., & Teucher, B. (1997). Facial inversion effects: Parts and whole relationship. *Perception & Psychophysics*, 59(5), 752–761. <https://doi.org/10.3758/BF03206021>
- Rhodes, G., Brake, S., & Atkinson, A. P. (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)

- Searcy, J. H., & Bartlett, J. C. (1996). Inversion and processing of component and spatial-relational information in faces. *Journal of Experimental Psychology: Human Perception and Performance*, 22, 904–915. <https://doi.org/10.1037/0096-1523.22.4.904>
- Tanaka, J. W., & Farah, M. J. (1993). Parts and wholes in face recognition. *Quarterly Journal of Experimental Psychology*, 46A(2), 225–245. <https://doi.org/10.1080/14640749308401045>
- Tanaka, J. W., & Sengco, J. A. (1997). Features and their configuration in face recognition. *Memory & Cognition*, 25(5), 583–592. <https://doi.org/10.3758/BF03211301>
- Thompson, P. (1980). Margaret Thatcher: A new illusion. *Perception*, 9, 483–484. <https://doi.org/10.1068/p090483>
- Thompson, P., & Wilson, J. (2012). Why do most faces look thinner upside down? *I-Perception*, 3(10), 765–774. <https://doi.org/10.1068/i0554>
- Tomasello, M., Hare, B., Lehmann, H., & Call, J. (2007). Reliance on head versus eyes in the gaze following of great apes and human infants: The cooperative eye hypothesis. *Journal of Human Evolution*, 52(3), 314–320. <https://doi.org/10.1016/j.jhevol.2006.10.001>
- Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software*, 36(3). <https://doi.org/10.18637/jss.v036.i03>
- Walker-Smith, G. J., Gale, A. G., & Findlay, J. M. (1977). Eye movement strategies involved in face perception. *Perception*, 6(3), 313–326. <https://doi.org/10.1068/p060313>
- Walsh, E., Moreira, C., & Longo, M. R. (2024). Opposite size illusions for inverted faces and letters. *Cognition*, 245, 105733. <https://doi.org/10.1016/j.cognition.2024.105733>
- Walsh, E., Vormberg, A., Hannaford, J., & Longo, M. R. (2018). Inversion produces opposite size illusions for faces and bodies. *Acta Psychologica*, 191, 15–24. <https://doi.org/10.1016/j.actpsy.2018.08.017>
- Walsh, E., Whitby, J., Chen, Y.-Y., & Longo, M. R. (2024). No influence of emotional expression on size underestimation of upright faces. *Plos One*, 19, e0293920. <https://doi.org/10.1371/journal.pone.0293920>
- Xiao, W. S., Fu, G., Quinn, P. C., Sun, Y.-H., Xiao, N. G., Wang, Q., Chen, G., Pascalis, O., Damon, F., & Lee, K. (2014). The eye-size illusion: Psychophysical characteristics, generality, and relation to holistic face processing. *Perception*, 43(4), 265–274. <https://doi.org/10.1068/p7647>
- Yin, R. K. (1969). Looking at upside-down faces. *Journal of Experimental Psychology*, 81, 141–145. <https://doi.org/10.1037/h0027474>
- Zhang, Y., Wang, L., & Jiang, Y. (2021). My own face looks larger than yours: A self-induced illusory size perception. *Cognition*, 212, 104718. <https://doi.org/10.1016/j.cognition.2021.104718>