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The face size illusion is specific to human faces

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Abstract

The faces of conspecifics are a critical feature of our social world. The visual system includes specialised processes for perceiving upright faces, which are not engaged to the same extent when faces are inverted (the face inversion effect). Recently, a face size illusion has been described in which upright faces are perceived as physically smaller than identical inverted faces. This effect appears highly specific to faces and does not occur for other stimuli, such as objects, hands, bodies and letters. We investigated whether this face size illusion is specific to faces in general or to human faces in particular. On each trial, participants saw two faces, one upright and one inverted and judged which face appeared physically larger. Across blocks, participants saw faces of humans, monkeys and cats. For human faces, there was a clear bias for upright faces to be perceived as smaller than inverted ones, consistent with previous findings. No such effect was found for the faces of cats or monkeys, for which there was a significant bias in the opposite direction. These results provide further evidence for the specificity of the face size illusion, showing that it is specific not just to faces, but to human faces.

Keywords

Face perception; inversion effect; size perception; illusion

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Introduction

Faces are pivotal to humans socially. As early as just hours after birth, newborns orient towards upright faces (Goren et al., 1975; Johnson et al., 1991). Face perception is believed to involve a distinct type of 'configural' or 'holistic' processing, different from the featural processing involved in the perception of other types of visual stimuli (Maurer et al., 2002). Configural processing is often studied using face inversion effects, since inverting a face is thought to disrupt configural processing, while leaving featural processing undisturbed (Farah et al., 1995; Maurer et al., 2002; Yin, 1969). Inversion has been found to disrupt recognition of facial identity (Carey & Diamond, 1977; Yin, 1969), emotional expression (Bombari et al., 2013; McKelvie, 1995; Prkachin, 2003) and recognition of facial distortions (Searcy & Bartlett, 1996; Thompson, 1980). The face inversion effect has become a widely used tool for studying configural face processing. Neuroimaging research has linked this behavioural effect with regions of the ventral visual pathway known to be face-selective, such as the fusiform face area (Yovel & Kanwisher, 2005).

Another type of face inversion effect has been recently described in which faces are perceived as physically different in shape or size when inverted than when upright. For example, Thompson and Wilson (2012) found that faces appear

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thinner when inverted. Another set of studies has shown that faces also appear physically larger when inverted than when upright (Araragi et al., 2012; Walsh et al., 2018; Walsh, Moreira, et al., 2024; Walsh, Whitby, et al., 2024; Zhang et al., 2021). In an initial study, Araragi et al. (2012) showed two faces simultaneously, one upright and one inverted, which could have the same or different sizes. In each trial, participants decided whether the test stimulus was larger or smaller than the 'comparison' stimulus. The authors showed that, even when both faces had the exact same size, participants consistently perceived the upright faces to be smaller – and the inverted faces to be larger – than the comparison stimulus (inverted and upright, respectively). This effect existed for both real human faces and cartoon faces. Later studies have provided clear replications of this finding and shown further that the effect appears quite specific for faces. Walsh et al. (2018) found no evidence for any size illusion for inverted objects or hands, and found that inverted bodies showed an effect in the opposite direction, being perceived as smaller than upright bodies. More recently, Walsh, Moreira, et al. (2024) found that letters and words also showed an effect opposite to that found for faces, being perceived as larger when upright than when inverted. Another study by Millbank et al. (2025) found the same for items of food. This illusion thus appears to be highly face-specific, providing a novel window into the perceptual mechanisms underlying configural face processing.

Existing studies of the face size illusion have exclusively used images of human faces. Thus, while there is clear evidence that the illusion is specific to faces, it remains unclear whether it is specific to *human* faces. In other paradigms, studies investigating whether face processing mechanisms generalise to animal faces have reached inconsistent conclusions. On one side, there is evidence that face-selective brain regions such as the fusiform face area show similar responses to animal faces as to human faces (Kanwisher et al., 1999; Tong et al., 2000). Single-unit recording studies have found that face-selective neurons in visual (Perrett et al., 1982) cortex respond both to human faces and monkey faces, both in the monkey brain and the human brain (Decramer et al., 2021). Studies using representational similarity analysis of neural data to investigate the representational structures of the ventral visual pathway have found that images of human and animal faces lie close together in representational space, again both in human and monkey viewers (using functional magnetic resonance imaging and single-cell recordings, respectively, Kriegeskorte et al., 2008). The face-selective N170 event-related potential (ERP) component is evoked in a similar way by images of human faces and ape faces (Carmel & Bentin, 2002). Finally, individuals with prosopagnosia, who are impaired at recognising human faces have also been found to have impairments in recognising animal faces, both in acquired prosopagnosia following brain damage (Bodamer, 1947; Bornstein et al., 1969; Ellis & Florence, 1990; Landis et al., 1986) and in developmental cases (Epihova et al., 2023 – though the extent of the impairments in this case varied by type of animal).

There is also evidence that animal faces may be processed differently from human faces. In contrast to the robust N170 seen for ape faces (Carmel & Bentin, 2002), in other studies no N170 was found for faces of non-primate animals (Bentin et al., 1996) or of monkeys (de Haan et al., 2002). Other evidence comes from the studies of agnosia. While some cases of prosopagnosia generalise to animal faces, as discussed in the previous paragraph, other cases appear specific for human faces (Bruyer et al., 1983; Landis et al., 1986; McNeil & Warrington, 1993). For example, patient W.J. was a sheep farmer who developed profound prosopagnosia for human faces following a stroke (McNeil & Warrington, 1993). Despite this, W.J. retained a striking ability to recognize the faces of his sheep, though in this case, it is possible that patient W.J. was using the patterns of the skin dark spots to recognise the sheep, and not the faces per se. Conversely, patient C.K. showed a profound agnosia for objects, but had a remarkable sparing of his ability to recognise human faces (Moscovitch et al., 1997). C.K. could successfully compare the identity of two human faces when both images were upright and also when both were inverted, but not when one was upright and the other inverted. In contrast, for animal faces, C.K.'s performance was not disrupted when comparing an upright to an inverted face. Moscovitch and colleagues suggested that animal faces do not engage the orientation-specific face perception processes that upright human faces do.

Developmental studies of human infants have suggested that the specificity of face perception mechanisms to human faces may emerge from a process of 'perceptual narrowing' as a result of experience. While in adult humans, there is a large difference in amplitude of the N170 ERP component between upright and inverted human faces, no such difference is found for monkey faces (de Haan et al., 2002). In 6-month-old infants, an analogous component does appear for human and monkey faces, but is not affected by inversion in the same manner. In a looking time paradigm, Pascalis et al. (2002) tested the ability of infants and adults to discriminate between the identities of human and monkey faces. Participants were familiarised with one face, then showed that same face together with a novel face. Adults and 9-month-old infants looked longer at novel human faces, but showed no difference for monkey faces, suggesting that they were unable to distinguish the identities of two monkeys. In striking contrast, 6-month-old infants looked longer at novel faces regardless of whether they were humans or monkeys. Further evidence comes from a study in which infants were regularly exposed to monkey faces between 6 and 9 months of age (Pascalis et al., 2005). Unlike the infants in the previous study who had only been regularly exposed to human faces, these infants retained the ability to discriminate monkey faces when tested at 9 months. This suggests that young infants can discriminate individuals from many species and progressively lose this sensitivity for types of stimuli they are not exposed to, mirroring results from studies of auditory phoneme processing in language (Lewkowicz & Ghazanfar, 2009). Where animal faces are a sufficient part of the observer's 'visual diet', face-specific processes may extend to those animals. For example, one study found that dog experts are impaired at recognising individual dogs when images were shown inverted (Diamond & Carey, 1986), although other research has not replicated this effect (Robbins & McKone, 2007).

Here, we investigated whether the face size illusion described in previous research (Araragi et al., 2012; Walsh et al., 2018; Walsh, Moreira, et al., 2024; Walsh, Whitby, et al., 2024; Zhang et al., 2021) is specific to human faces or generalises to animal faces, specifically to faces of monkeys and cats. On each trial, participants saw two faces, one upright and one inverted and judged which face appeared physically larger. The size of the inverted face was manipulated across trials according to the method of constant stimuli. This allowed us to quantify the magnitude of the illusion by estimating the size of the inverted stimulus, which was perceived as the same size as the upright stimulus. We expected that for human faces, the upright face would be perceived as smaller than the inverted stimulus, consistent with previous research. The key question was whether a similar illusion would occur for animal faces. If the perceptual processes producing the illusion are specific to human faces, the illusion should not occur for monkey and cat faces.

Method

Participants

Forty individuals in the United Kingdom ($N=33$) and Norway ($N=7$) participated in 2022 and 2023 after giving informed consent. Participants were recruited through the social network of the researchers ($N=19$) and from Prolific ($N=21$; https://www.prolific.co/). Data from an additional two participants were excluded on the basis of poor model fit (see below). The 40 participants included 14 males, 24 females and 2 who preferred not to indicate their gender. There were missing data on the age of 3 participants, leaving the age range from 19 to 54 years (*M*: 34.5; *SD*: 10.2). Procedures were approved by the School of Psychological Sciences Research Ethics Committee at Birkbeck.

An a priori power analysis using G*Power 3.1 (Faul et al., 2007), assuming a medium effect size ($d_z=0.5$) for the *t*-tests comparing the human condition with the two animal conditions, with power of 0.80 and an alpha of $p=.05$, indicated that 35 participants were needed. The present study is thus appropriately powered to detect such an effect.

Stimuli

The top left panel of Figure 1 shows examples of the stimuli used in this experiment. Across blocks, we presented faces from three different types of animals: humans, monkeys and cats. The human stimuli set was acquired through The Chicago Face database (Ma et al., 2015), a face database of racially diverse people. Previous studies of the face size illusion have shown the effect using cartoon images (Araragi et al., 2012; Zhang et al., 2021), faces from the Japanese ATR Facial Expression Image Database (Araragi et al., 2012), the Karolinska Directed Emotional Faces database (Millbank et al., 2025; Walsh et al., 2018; Walsh, Moreira, et al., 2024; Walsh, Whitby, et al., 2024), photos of Chinese celebrities from the internet (Zhang et al., 2021) and photos of each participant (Zhang et al., 2021). The use of the Chicago Face Database stimuli in the present study thus generalises the illusion to a new stimulus set. Four human faces were chosen, two males and two females, with neutral facial expressions. The monkey stimuli were created from photographs retrieved from Adobe stock and from images under creative commons licence. Four macaque monkeys were chosen, looking as straight towards the camera as possible. The cat stimuli consisted of photographs of four different cat breeds, also facing the camera. The sex of cats and monkeys was not controlled for, as the researchers were unable to recognise the gender of the animals. All images were edited with Photoshop 2023 software (Adobe, San Jose, CA, USA), removing the backgrounds, and closely cropped to only include the faces.

Main experimental task

The experiment was built and run on the Gorilla experiment platform builder (Anwyl-Irvine et al., 2020). Participants were required to complete the experiment using either a tablet or a computer; smartphones were not allowed to ensure that varying screen sizes did not substantially affect the results.

The top right panel of Figure 1 shows the time course of experimental trials. Participants were told that they would be shown faces of humans, monkeys and cats in different sizes. On each trial, two faces were shown on either side of a fixation cross, one upright and the other inverted. The two faces were identical except for their orientation and (except for the 0% condition) their physical size. The participant's task was to select the face that appeared physically larger. Before each trial, a fixation cross was presented on the centre of the screen for 500 ms. The two stimuli remained on the screen until one was chosen.

The upright image was always 500 pixels in height. The physical size of stimuli varied depending on the specific computer used by participants. Across trials, the size of the inverted stimuli was manipulated according to the method of constant stimuli. The linear dimensions were altered in the same way for image length and width, keeping the aspect ratio of the stimulus constant. Seven sizes of the inverted stimulus were used, corresponding to an increase in the linear dimensions of the image of −9%, −6%, −3%, 0%, +3%, +6% and +9% (i.e. 455, 470, 485, 500, 515, 530, 545 pixels).

There were 6 blocks of 56 trials each, resulting in a total of 336 trials. Within each block, each inverted size was shown eight times, with the left/right position of the two faces counterbalanced. The trials within each block were

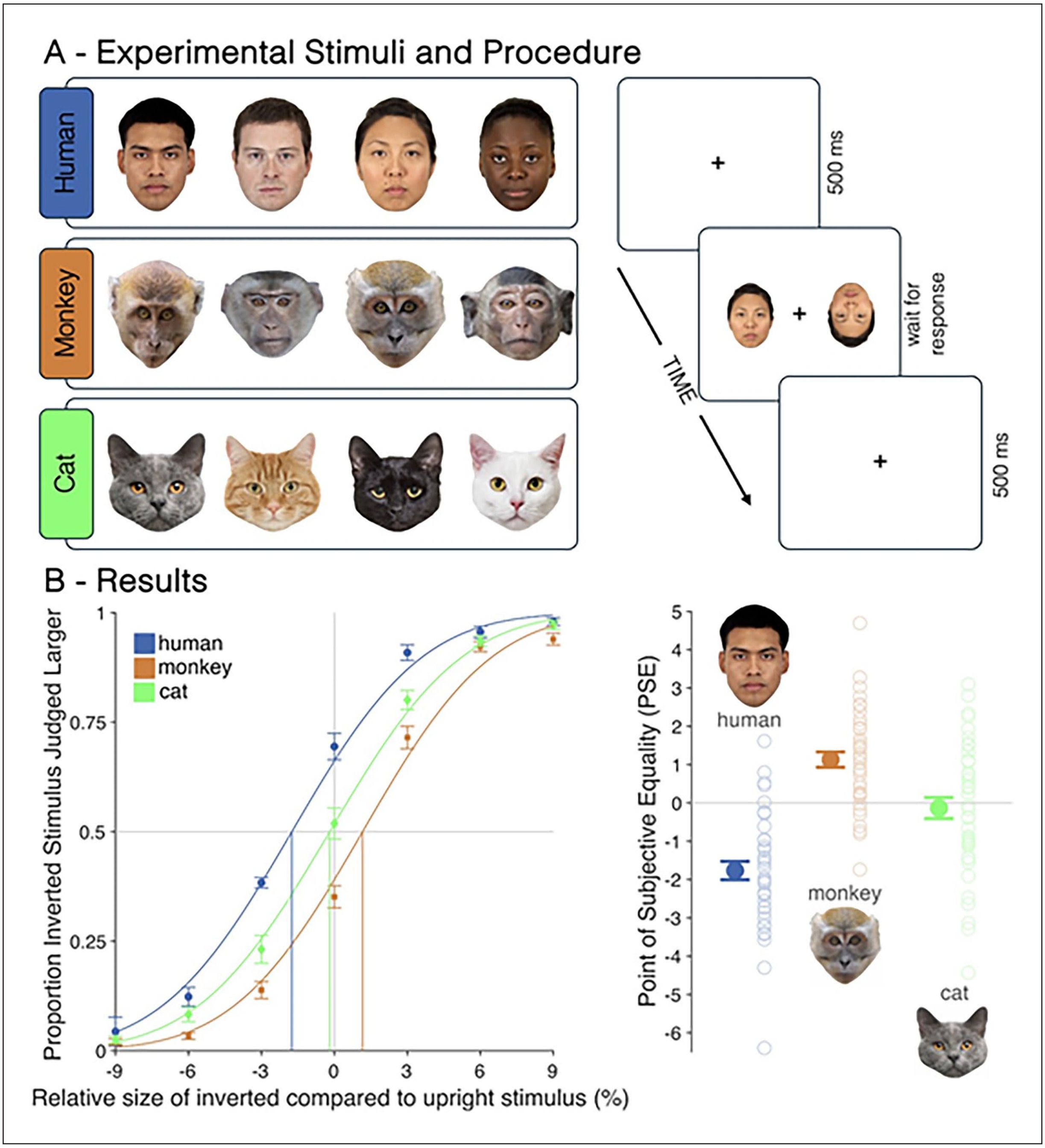

Figure 1. (Panel A) Left: The face stimuli used in the study, consisting of the faces of four humans, four monkeys and four cats. Right: Schematic representing three trials from the human face condition. (Panel B) Left: Psychometric functions showing the proportion of trials in which the inverted stimulus was judged as larger as a function of the relative size of the inverted compared to the upright stimulus. Right: Mean PSE values for the three types of animals. For human faces (blue bar), PSEs were significantly negative, indicating an illusion to perceive faces as smaller when upright than when inverted, consistent with previous studies. For monkey faces (orange bar), there was a significant effect in the opposite direction, while for cat faces (green bar), there was no apparent inversion effect. Error bars show 1 standard error of the mean.
Note. PSE = point of subjective equality.

presented in random order. Each block consisted of stimuli from a single category (cat, human, or monkey). The order of the first three blocks was counterbalanced across participants according to a Latin square. Blocks 4 to 6 occurred in the reverse order as blocks 1 to 3.

Questionnaires

To assess the familiarity the participants had with cats and monkeys, we obtained responses about whether participants currently owned pet cats or monkeys (‘Do you currently have a pet [cat/cats or monkey/monkeys]?') and whether they had done so in the past ('Have you ever had a pet [cat/cats or monkey/monkeys]?'). We also measured how much participants liked both cats and monkeys ('How much do you like [cats or monkeys]?') and how familiar they were with each type of animal ('How familiar are you with [cats or monkeys]?' using a 0 to 100 scale, where 0 was 'not at all' and 100 'a lot'. The results revealed that 14 participants currently have cats, and an additional 9 have had cats previously. Unsurprisingly, no participants have had pet monkeys. Overall, participants judged themselves more familiar with cats than with monkeys (*M*: 64.3 vs. 27.9), $t(39)=7.01$, $p<.001$, $d_z=1.122$, and also liked cats more than monkeys (*M*: 66.2 vs. 53.4), $t(39)=2.07$, $p=.04$, $d_z=0.328$.

Finally, we administered the Autism Spectrum Quotient (AQ-10) questionnaire (Allison et al., 2012). The average AQ-10 score was 3.7 (*SD*: 1.9), ranging from 0 to 8. Further analyses were outside the scope of this paper.

Transparency and openness

The study was not preregistered. The stimuli used, raw data and analysis scripts are available on the Open Science Framework webpage: https://osf.io/pg4dv/.

Analysis

The analysis was based on previous studies (Walsh et al., 2018; Walsh, Moreira, et al., 2024; Walsh, Whitby, et al., 2024). For each participant, separate psychometric curves were fitted for the three conditions. The number of responses where the inverted stimulus (human, monkey, cat face) was judged larger was modelled as a function of the difference in size between the inverted and upright stimuli by fitting a cumulative Gaussian curve using maximum likelihood estimation with the Palamedes toolbox (Prins & Kingdom, 2009) in MATLAB version R2017a (Mathworks, Natick, MA, USA). For each curve, the point of subjective equality (PSE; i.e. the mean of the best-fitting Gaussian), slope (the inverse of the standard deviation) and the goodness-of-fit (R^2) were calculated.

The PSEs show the actual difference in size between the inverted and upright stimuli when the participant perceived them as equal in size. If there was no size illusion and the inverted and upright stimuli were perceived as the same size, one would expect the PSE to be an average of 0. Moreover, if a negative PSE was obtained, it would mean that the participants judged the inverted stimuli to be larger than an equal-sized upright counterpart. Conversely, a positive PSE would indicate the opposite – that the upright was perceived as larger than the same size inverted face. The presence of an illusion in each condition was thus assessed using one-sample *t*-tests to compare the mean PSEs to 0. Differences between conditions for R^2, PSEs and slopes were assessed using repeated-measures analysis of variance (ANOVA). Where Mauchley's test indicated a violation of the sphericity assumption, the Greenhouse–Geisser correction was applied.

We used a goodness-of-fit criterion for inclusion, excluding any participant who had an R^2 value less than .50 for any of the three conditions, consistent with recent studies using this paradigm (Millbank et al., 2025; Walsh, Moreira, et al., 2024; Walsh, Whitby, et al., 2024). As noted above, two participants were excluded on this basis and were replaced to meet our desired sample size.

Item analysis

To investigate size illusions for each stimulus individually, the same psychometric functions were fit to data from each face identity. One-sample *t*-tests were used to compare mean PSE for each face to 0, with Holm–Bonferroni correction for multiple comparisons.

To analyse the effects of the condition on PSE values, which represents the point of subjective equality for face size between upright and inverted faces, we used a linear mixed-effects model with Condition as a fixed effect (three levels: human, monkey, cat) and both Subjects and Items (Stimuli) as random effects. The model was specified as:

$$\text{PSE} \sim \text{Condition} + \left(1 \middle| \text{Subject}\right) + \left(1 \middle| \text{Item}\right).$$

Subjects were included as a random effect to account for within-subject variability. Each condition included four distinct stimuli (faces), and individual faces may contribute to variability in their perceived size due to their unique features. By including Item as a random effect, the model accounts for these differences, preventing stimulus-specific biases and ensuring results generalise beyond the specific faces used. Each of the 12 stimulus faces was treated as an independent item in the analysis. By modelling Subjects and Items as random effects, the model accounts for individual differences and stimulus-specific variability, allowing us to isolate the true effect of Condition on PSE.

We used the lmer4 package (Bates et al., 2015) for R and ANOVA to test the significance of the fixed effect in the model. The anova() function, applied to a mixed-effects model, compares the goodness-of-fit between nested models. This analysis was conducted using the lmerTest package (Kuznetsova et al., 2017), which applies Satterthwaite's method to approximate degrees of freedom for the *F*-tests, which adjusts for the hierarchical structure of the data by accounting for variability across Subjects and Items. For the fixed effect of Face Type, the test determines whether including this term significantly improves model fit by calculating an *F*-statistic and providing a corresponding *p*-value.

As a further check, we tested whether the effect of Condition varied across Items by comparing models with and without a random slope. Since the random slope did not improve model fit or explain additional variance, we kept the model with random intercepts only.

Results

The results are shown in Panel B of Figure 1. There was a good overall fit of the psychometric functions to the data, with mean R^2 values of .970, .969 and .972, in the human, monkey and cat conditions, respectively. The R^2 values did not differ significantly across conditions, *F*(1.73, 67.59) = 0.18, *p* = .801, η_p^2 = .005.

To investigate the basic size illusion, we tested whether the PSE for each condition was significantly different from 0 using one-sample *t*-tests. For human faces, there was a clear bias for upright faces to be judged as smaller than inverted faces (*M*: −1.76, *SD*: 1.52), *t*(39) = −7.36, *p* < .001, Cohen's *d* = 1.634. A total of 35 of 40 participants had a PSE less than 0, significantly more than chance according to a sign test, *p* < .0001. This provides a clear replication of the size illusion, which has been reported previously (Araragi et al., 2012; Walsh et al., 2018). Conversely, for monkey faces there was a significant effect in the opposite direction (*M*: 1.13, *SD*: 1.26), *t*(39) = 5.650, *p* < .001, *d* = 0.893. A total of 33 of 40 participants had a PSE greater than 0, significantly more than chance according to a sign test, *p* < .0001. This demonstrates that upright monkey faces were perceived as larger than the same-sized inverted faces. For cat faces, there was no significant illusion (*M*: −0.13, *SD*: 1.74), *t*(39) = −0.48, *p* = .632, *d* = 0.076. A total of 19 of 40 participants had a PSE greater than 0, not different from chance according to a sign test, *p* = .875.

An ANOVA revealed a significant difference in PSE across conditions, *F*(1.67, 65.35) = 50.45, *p* < .001, η_p^2 = .564. Follow-up *t*-tests with Holm–Bonferroni correction for multiple comparisons indicated that the magnitude of biases was significantly different for human faces compared to both monkey faces, *t*(39) = 13.25, *p* < .0001, d_z = 2.094, and cat faces, *t*(39) = 3.83, *p* < .001, d_z = 0.606. There was also a significant difference between monkey and cat faces, *t*(39) = 5.32, *p* < .0001, d_z = 0.841.

An ANOVA on the slopes of the psychometric functions showed no significant differences across conditions, *F*(1.14, 44.36) = 0.65, *p* = .445, η_p^2 = .016.

To test if there was a relationship between the liking or familiarity of monkeys and cats and PSE scores, we correlated these scores with PSEs for each type of animal. For monkeys, there was no significant correlation between PSE scores and either familiarity *r*(38) = −.255, *p* = .112 or liking *r*(38) = −.238, *p* = .139. Similarly, for cats, there was no correlation between PSEs and familiarity *r*(38) = −.095, *p* = .559 or liking *r*(38) = −.117, *p* = .468.

Item analysis

Table 1 shows mean PSEs for each of the 12 individual face stimuli used. Clear evidence for the face size illusion was apparent in all four human faces. A significant effect in the opposite direction was found for three of the four monkey faces, and the fourth monkey face showed a trend in the same direction. Finally, no significant illusion was apparent for any of the four cat faces.

Table 1. Mean PSEs for each of the individual face stimuli.

Category	Identity	PSE	*t*(39)	*d*
Human	1	−1.03 (1.93)	−3.38*	0.534
	2	−2.44 (1.96)	−7.88*	1.245
	3	−1.41 (1.82)	−4.90*	0.775
	4	−2.15 (1.82)	−7.47*	1.181
Monkey	1	0.42 (1.73)	1.55	0.245
	2	1.55 (1.94)	5.05*	0.799
	3	1.07 (1.68)	4.05*	0.640
	4	1.44 (1.69)	5.37*	0.849
Cat	1	−0.01 (2.11)	−0.03	0.005
	2	0.31 (2.04)	0.95	0.151
	3	−1.00 (2.40)	−2.63	0.417
	4	0.178 (2.11)	0.53	0.084

Note. The *t*-statistics and Cohen's *d* are for one-sample *t*-tests comparing each mean to 0. *T*-tests marked with (*) indicate a significant difference from 0 using Holm–Bonferroni correction for multiple comparisons. PSE = point of subjective equality.

Table 2. Mean (*SD*) of reaction time (in seconds) under each condition.

Inverted size	Human	Monkey	Cat
−9%	1.28 (0.42)	1.07 (0.30)	1.26 (0.32)
−6%	1.50 (0.47)	1.25 (0.48)	1.36 (0.42)
−3%	1.67 (0.74)	1.35 (0.53)	1.48 (0.48)
0%	1.69 (0.69)	1.52 (0.72)	1.69 (0.60)
3%	1.37 (0.51)	1.59 (0.80)	1.61 (0.64)
6%	1.18 (0.37)	1.32 (0.55)	1.30 (0.35)
9%	1.05 (0.25)	1.08 (0.34)	1.15 (0.34)
Mean	1.39 (0.44)	1.31 (0.50)	1.41 (0.40)

A linear mixed-effects model assessed the effect of Condition (Face Type) on PSE, with Condition as a fixed effect and Subject and Item as random effects. The model showed a significant main effect of Condition, *F*(2, 9) = 24.23, *p* < .001, η_p^2 = .84, indicating that PSE values, which reflect perceived size differences between upright and inverted faces, varied by face type. That is, the presence and magnitude of the face inversion effect depended on whether the faces were of humans, monkeys or cats.

Reaction time

Reaction times (RTs) are shown in Table 2. There was a significant main effect of condition, *F*(2, 78) = 3.59, *p* < .05, η_p^2 = .084, with RTs for monkey faces being slightly faster overall than for cats and humans. There was also a significant main effect of inverted size, *F*(1.87, 72.81) = 31.98, *p* < .0001, η_p^2 = .451. This effect reflects the fact that RT was slower when the upright and inverted stimuli were similar in size than when the inverted stimulus was much smaller or larger than the upright stimulus; responses were slower when the judgement was more difficult.

Finally, there was a significant interaction between condition and inverted size, $F(5.86, 228.36) = 10.12, p < .0001, \eta_p^2 = .206$. This interaction provides further support for the different size illusions discussed above. Specifically, for human stimuli, responses were slower when the inverted stimulus was slightly smaller than the upright stimulus than when it was slightly larger. Conversely, for monkey stimuli, responses were slower when the inverted stimulus was slightly larger than the upright stimulus. In each case, responses are slowest for stimuli near the PSE. Thus, the RT results complement the analysis of psychometric functions reported above, providing further evidence for different effects of inversion on perceived size across species.

Discussion

Our results provide further insight into the face size illusion. Consistent with previous findings (Araragi et al., 2012; Walsh et al., 2018; Walsh, Moreira, et al., 2024; Walsh, Whitby, et al., 2024; Zhang et al., 2021), human faces were perceived as physically smaller when upright than when inverted. Critically, however, the present results show that this illusion (negative PSE) is specific to human faces. No comparable illusion was apparent for either monkey faces or cat faces. For monkey faces, in fact, there was a significant effect in the opposite direction (positive PSE), with upright monkey faces perceived as larger than inverted ones, while for cat faces, no size illusion in either direction was observed. Together, these results provide further evidence for the specificity of the face size illusion, showing that it is not merely specific to faces, but specific to human faces when tested in adult human participants.

The face size illusion has a high level of specificity to faces. While the illusion is present for cartoon drawings of faces, a mere face outline does not elicit a size illusion (Araragi et al., 2012). No size illusion has been found for stimuli such as human hands (Walsh et al., 2018). In other cases, there is an effect opposite to that seen for faces, with upright bodies (Walsh et al., 2018), letters (Walsh, Moreira, et al., 2024) and food items (Millbank et al., 2025) perceived as larger than inverted ones. The present results show an even higher level of specificity, indicating that it is only human faces that are perceived as smaller when upright.

Upright monkey faces were perceived as larger than equivalent-sized inverted monkey faces. This outcome is opposite to that seen for human faces, but comparable to the reverse size effect reported in previous studies for headless human bodies (Walsh et al., 2018), letters and words (Walsh, Moreira, et al., 2024) and food items (Millbank et al., 2025). This suggests a fundamental difference in the way in which human and monkey faces are processed. One potential source of insight into this difference comes from eye-tracking research investigating how humans scan faces of other humans versus monkeys (Dahl et al., 2009). When human observers were asked to look at other human faces, they spent more time looking at the eye regions than the nose and mouth regions. In contrast, when faces were inverted, this bias disappeared. In contrast, however, when human observers looked at monkey faces, no bias to look at the eyes was apparent regardless of whether faces were upright or inverted. It is thus an interesting possibility that the underestimation of upright human faces might relate to the specific patterns of gaze behaviour shown when humans visually explore these stimuli. The link between the face size illusion and eye movements is speculative, but it will be interesting in future research to investigate how scan patterns for upright and inverted faces might influence perceived size. An exciting challenge for primate research is to explore the face size illusion in other species, such as in chimpanzees and monkeys (Parr et al., 2000).

One difference between human faces and monkey and cat faces that may be relevant to the differences in the face size illusion is the overall contour of the face. The human faces are approximately oval shaped, while the monkey faces are more triangular. The cat faces, in turn, have pointy ears, producing a conspicuous external contour. It is unclear to what extent these broad shape differences might affect size illusions. The original study reporting the face size illusion (Araragi et al., 2012) directly compared cartoon faces to the same faces with the internal features removed, leaving only the contour of the face. The complete faces were perceived as smaller than the empty outlines. This result shows that the effect cannot be entirely due to the external contour of the images. Nevertheless, it is possible that gross differences in face shape between species of animals may have some influence on the magnitude of size illusions. This will be an interesting question for future research.

There was no apparent bias for cat faces, which placed them intermediate between human and monkey faces. Epihova et al. (2023) found that individuals with developmental prosopagnosia were impaired in their ability to recognise monkey faces, but no such impairment was seen for cat faces. Considering this with the findings of no inversion effect for objects (Walsh et al., 2018) and cat faces in our present study, one can hypothesise that cat faces are processed in a manner comparable to objects. Thereby making the size judgement of cat faces unaffected by inversion. That dog faces caused a significant recognition effect in Epihova et al.'s (2023) study encourages that future studies should consider exploring if there is a face size illusion, in either direction, for a broader variety of animal faces than investigated here.

Why do human faces, monkey faces, bodies and familiar and unfamiliar letters all show an illusion (i.e. a PSE that is significantly different from zero), but cat faces, hands and everyday objects do not? Human bodies, monkey faces, letters and words show an effect opposite, that is, a positive PSE, to that found for human faces, while hands, cat faces and everyday objects show no size illusion (i.e. PSE does not differ from zero). The direction of the illusion (negative PSE) appears to be human face-specific and may help elucidate the perceptual mechanisms underlying human face processing. How can the direction, presence or absence of a size illusion in different stimuli be explained? One possibility is that there is some specific visual property of human faces that drives the effect. Alternately, visual stimuli that evoke a strong perceptual salience may be more susceptible to size illusions. Faces, bodies, letters and words are highly salient visual stimuli that automatically attract our attention due to their biological and linguistic significance. This heightened perceptual salience may amplify perceptual distortions, leading to illusions of size. Also, faces, bodies, letters and words are embedded within social and linguistic contexts that imbue them with additional meaning and significance, which may modulate perceptual processing and contribute to size illusions through top-down influences. However, Walsh, Moreira, et al. (2024) also found that a size illusion (positive PSE) was present for letters from an unfamiliar alphabet and pseudowords that carry little or no meaning. Familiarity with stimuli may influence the magnitude of size illusions. Human faces, bodies, letters and words are familiar and frequently encountered visual stimuli in daily life, leading to well-established perceptual representations in the brain. Prior knowledge and expectations about the size of these stimuli may contribute to size illusions. However, in the current study, most participants reported a greater familiarity with cats (PSE not different than zero) than with monkeys (positive PSE). Faces, bodies, letters and words are typically processed in both a configural and holistic fashion, with attention to specific features (e.g. eyes, limbs, letters) and their overall arrangement, respectively. Stimuli that are processed hierarchically, with attention to fine details as well as global configurations, may be more prone to size illusions.

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Data accessibility statement

The data and materials from the present experiment are publicly available at the Open Science Framework website: https://osf.io/pg4dv/.

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