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Inversion produces opposite size illusions for faces and bodies

Eamonn Walsh[a,b,*], Alexandra Vormberg[a,c,d], Josie Hannaford[a], Matthew R. Longo[a]

[a] *Department of Psychological Sciences, Birkbeck, University of London, UK*
[b] *Department of Basic and Clinical Neuroscience, Institute of Psychiatry, Psychology & Neuroscience, King's College London, UK*
[c] *Ernst Strüngmann Institute (ESI) for Neuroscience in Cooperation with Max Planck Society, Germany*
[d] *Frankfurt Institute for Advanced Studies (FIAS), Germany*

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ABSTRACT

Faces are complex, multidimensional, and meaningful visual stimuli. Recently, Araragi, Aotani, & Kitaoka (2012) demonstrated an intriguing face size illusion whereby an inverted face is perceived as larger than a physically identical upright face. Like the face, the human body is a highly familiar and important stimulus in our lives. Here, we investigated the specificity of the size underestimation of upright faces illusion, testing whether similar effects also hold for bodies, hands, and everyday objects. Experiments 1a and 1b replicated the face-size illusion. No size illusion was observed for hands or objects. Unexpectedly, a *reverse* size illusion was observed for bodies, so that upright bodies were perceived as larger than their inverted counterparts. Experiment 2 showed that the face illusion was maintained even when the photographic contrast polarity of the stimuli was reversed, indicating that the visual system driving the illusion relies on geometric featural information rather than image contrast. In Experiment 2, the reverse size illusion for bodies failed to reach significance. Our findings show that size illusions caused by inversion show a high level of category specificity, with opposite illusions for faces and bodies.

1. Introduction

Illusions and inversion effects provide an interesting window through which to study how the brain processes human faces and bodies, and whether they are processed by the brain in the same fashion. Recently, Araragi, Aotani, and Kitaoka (2012) demonstrated an intriguing face size illusion whereby an inverted face is perceived as larger than an identical upright face. The size illusion was evident for photographic faces, and cartoon faces, but was not present overall for face outlines (Araragi et al., 2012). Previous research has shown how inversion influences face processing, so that the recognition of inverted faces is more difficult than that of upright faces, suggesting that faces represent a “special” class of stimulus (Yin, 1969). Face inversion is believed to affect our ability to adopt configural processing, i.e. the perception of relations among the features of a stimulus such as a face or body (Maurer, Le Grand, & Mondloch, 2002), whilst leaving the ability to use featural processing intact (Carey & Diamond, 1977; Farah, Tanaka, & Drain, 1995; Maurer et al., 2002; Tanaka & Farah, 2003; Young, Hellawell, & Hay, 2013), though the exact nature of the mechanisms behind these processes remains controversial (McKone & Yovel, 2009; Murray, 2004; Richler, Gauthier, Wenger, & Palmeri, 2008; Richler, Tanaka, Brown, & Gauthier, 2008; Robbins & McKone, 2007; Rossion, 2008; Sekuler, Gaspar, Gold, & Bennett, 2004).

Many behavioural studies show that a face is less well recognised when inverted. An upright face is thought to be perceived holistically - whereby “the multiple parts of a face are simultaneously integrated into a single perceptual representation” (Rossion, 2008, 2009) - while an inverted face is perceived more as a collection of features (Farah, Wilson, Drain, & Tanaka, 1998). Supporting the holistic view, behavioural studies have shown that a face section is better recognised if it is presented in a whole face context than if it is presented in isolation (Tanaka & Farah, 1993), or when it is aligned with a complementary section of another face (Rossion, 2013). These effects are substantially reduced if the face is presented upside-down, demonstrating the so-called ‘face inversion effect’ (FIE), suggesting that such effects rely on internal representations derived from visual experience. While it is generally agreed that human faces undergo configural processing, a number of more recent studies have also described body inversion effects (BIE) for human bodies (Minnebusch, Suchan, & Daum, 2009; Reed, Stone, Bozova, & Tanaka, 2003; Reed, Stone, Grubb, & McGoldrick, 2006). The face inversion effect demonstrates that there is a larger inversion effect i.e. a greater cost to recognition, for faces than

* Corresponding author at: Institute of Psychiatry, Psychology & Neuroscience, King's College London, De Crespigny Park, Denmark Hill, London SE5 8AF, UK.
E-mail address: eamonn.walsh@kcl.ac.uk (E. Walsh).
URLS: http://neuroscience.iop.kcl.ac.uk/msc, https://kclpure.kcl.ac.uk/portal/eamonn.walsh.html (E. Walsh).

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other objects with a canonical upright. This holds true even when a within class discrimination task is used (Yin, 1969), and even when people are experts with those non-face objects (Carey & Diamond, 1977).

As for faces, recognition of inverted human bodies is impaired relative to upright presented bodies (Reed et al., 2003; Reed et al., 2006). The 'body inversion effect' has been shown to be as large as the FIE and considerably larger than the inversion effect for other object categories (Reed et al., 2003), such as everyday objects like houses or bottles (Minnebusch et al., 2009; Minnebusch, Keune, Suchan, & Daum, 2010; Reed et al., 2003; Robbins & Coltheart, 2012). Seitz (2002) reported better recognition performance for whole bodies compared to isolated body parts, suggesting a role for holistic processing in the perception of human bodies. Moreover, impaired face and body perception has been observed in people with prosopagnosia, providing further evidence that both stimulus types are processed configurally (Biotti, Gray, & Cook, 2017; Righart & de Gelder, 2007; Rivolta, Lawson, & Palermo, 2017).

Overall, measures of holistic processing suggest that not only faces but also bodies are "special", i.e., processed differently to other objects (Moro et al., 2012). Inversion impairs recognition and size perception for faces and at least recognition for bodies, and these inversion effects are generally thought to reflect holistic processes. The present study investigates the specificity of the size underestimation illusion reported by Araragi et al., (2012). Specifically, we were interested in whether the illusion results from the operation of configural processing in general, in which case it should also occur for body stimuli as well as faces, or whether it reflects the operation of face-specific mechanisms, in which case it should not occur for any other stimuli. We used the method of constant stimuli to measure the bias to perceive inverted stimuli as bigger than upright stimuli for faces, bodies, hands, and non-body everyday objects.

2. Experiment 1a

Experiment 1a, used a large sample (N = 124) to investigate whether the size underestimation of upright faces reported by Araragi and colleagues (Araragi et al., 2012) also holds for bodies and hands. Object stimuli were included to investigate the size of the illusion for inanimate objects.

2.1. Method

2.1.1. Participants

One hundred and forty-six psychology undergraduate students at Birkbeck, University of London took part in an in-class experiment in a group setting as part of a research methods class. Ethical approval was obtained from the Departmental Research Ethics Committee prior to testing. The data for 22 participants whose goodness of fit (R^2) was less than a threshold (< 0.2) for any condition (object, face, body, hand) were excluded from the dataset (see Analysis section below). The data for the remaining 124 participants (mean age 30.2 years, SD = 8.2; 8 left-handed by self-report; 97 female) were included in the final analysis.

2.1.2. Stimuli

The stimulus set (16 stimuli) consisted of greyscale images of 4 frontal view headless bodies (2 male and 2 female) and 4 faces (2 male and 2 female), 4 hands (2 male and 2 female), and 4 inanimate objects (globe, jug, armchair, and coffee-pot), all of which have a canonical 'upright' orientation. The face stimuli (neutral emotional expression) were selected from the Karolinska Directed Emotional Faces (KDEF) database (Lundqvist, Flykt, & Öhman, 1998, http://www.emotionlab.se/resources/kdef).

2.1.3. Design

2.1.4. Procedure

Participants were tested simultaneously in a large computer lab. Participants sat with their face approximately 40 cm in front of the monitor. In a two-alternative forced choice (2AFC) task, participants pressed either the 'q' or 'p' key on the computer keyboard with the

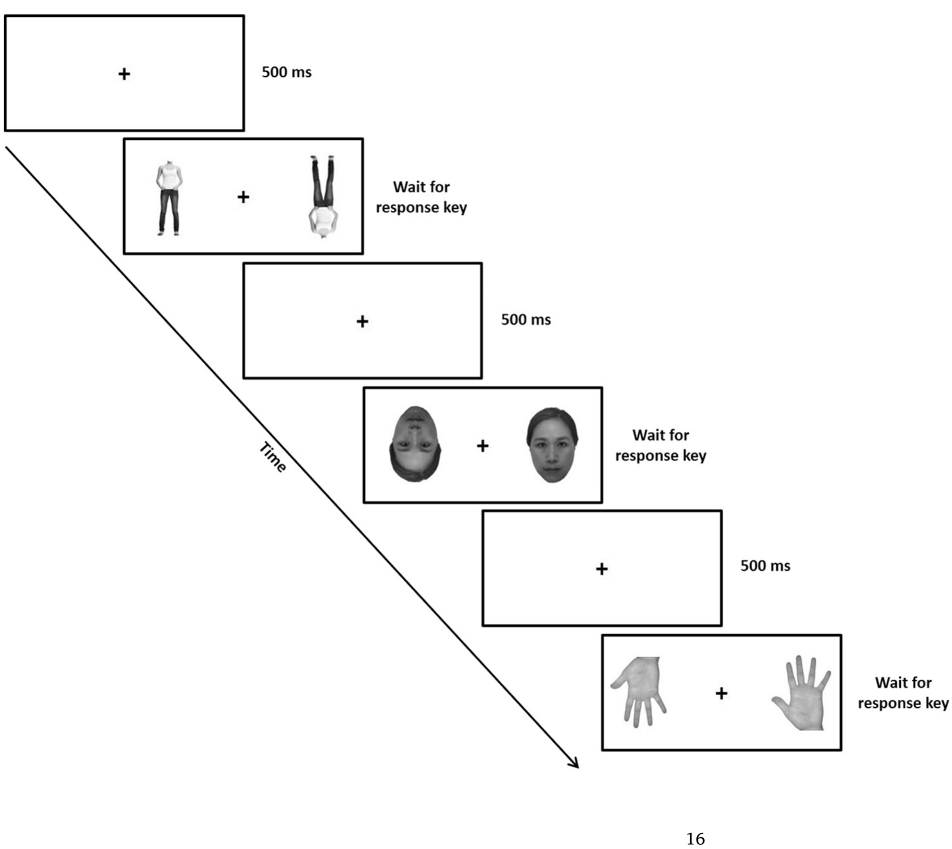

Fig. 1. Schematic showing 3 typical trials from Experiments 1a and 1b. A fixation cross was presented centrally for 500 ms, followed by two images of the same object, face, body, or hand. One image was always inverted, while the other was always upright. One image was always a standard size, while the size of the other image could vary (see text for details). The participant judged which of the two stimuli appeared physically larger by pressing a left or right button, which also triggered the next trial.