Perception, 2012, volume 41, pages 121 – 124

doi:10.1068/p7140

SHORT AND SWEET

Judging body weight from faces: The height – weight illusion

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Received 5 October 2011, in revised form 20 January 2012

Abstract. Being able to exploit features of the human face to predict health and fitness can serve as an evolutionary advantage. Surface features such as facial symmetry, averageness, and skin colour are known to influence attractiveness. We sought to determine whether observers are able to extract more complex features, namely body weight. If possible, it could be used as a predictor for health and fitness. For instance, facial adiposity could be taken to indicate a cardiovascular challenge or proneness to infections. Observers seem to be able to glean body weight information from frontal views of a face. Is weight estimation robust across different viewing angles? We showed that participants strongly overestimated body weight for faces photographed from a lower vantage point while underestimating it for faces photographed from a higher vantage point. The perspective distortions of simple facial measures (eg width-to-height ratio) that accompany changes in vantage point do not suffice to predict body weight. Instead, more complex patterns must be involved in the height – weight illusion.

Besides variables such as facial symmetry (eg Grammer and Thornhill 1994), averageness (eg Carbon et al 2010), and skin colour (eg Jones et al 2004), perceived human weight proves to be a reliable predictor for health and fitness (Coetzee et al 2009; Swami et al 2008). Perceived body weight also plays a significant role in judgments of attractiveness (Thornhill and Grammer 1999; Tovee et al 1998). Importantly, people make fairly accurate weight judgments on the basis of standardised facial images.

We do not often view faces from a vantage point centred on and aligned with the face. Are weight estimations still reliable and valid with changing vantage points? We investigated the impact of viewing angle on perceived human body weight in 2-D pictures. In order to ascertain a precise orientation of the face with respect to the vantage point of the camera, we selected 3-D face scans (di3d-technology) of 48 human models (24 female, aged $M = 23.5$ years, SD $= 16.0$ years, range 3 to 56 years), aligned them with respect to a virtual camera, and created 2-D images of the faces corresponding to a camera position aligned with the inter-ocular point and perpendicular to the vertical axis of the face. We then rendered the image from three camera heights (see figure 1): $-30°$ (elevated, which is equivalent to the head being pitched downwards by $-30°$ or a raised and tilted camera), $0°$ (frontal view), and $+30°$ (lowered, which is equivalent to the head pitched upwards by $+30°$ or a lowered and tilted camera). We refer to this manipulation as "viewing angle" in the following.

Thirty participants (eighteen female, $M = 36.8$ years, SD $= 17.2$ years, range 18 to 69 years) were exposed to all 48 faces. The experiment had two main factors which were hierarchically organised with model gender (gender of the shown face) as the superordinate and viewing angle as the subordinate order. Factors' levels were blocked and the sequences of them were counterbalanced across participants. The observers' task was to judge the body weight associated with these faces (in kilogrammes).

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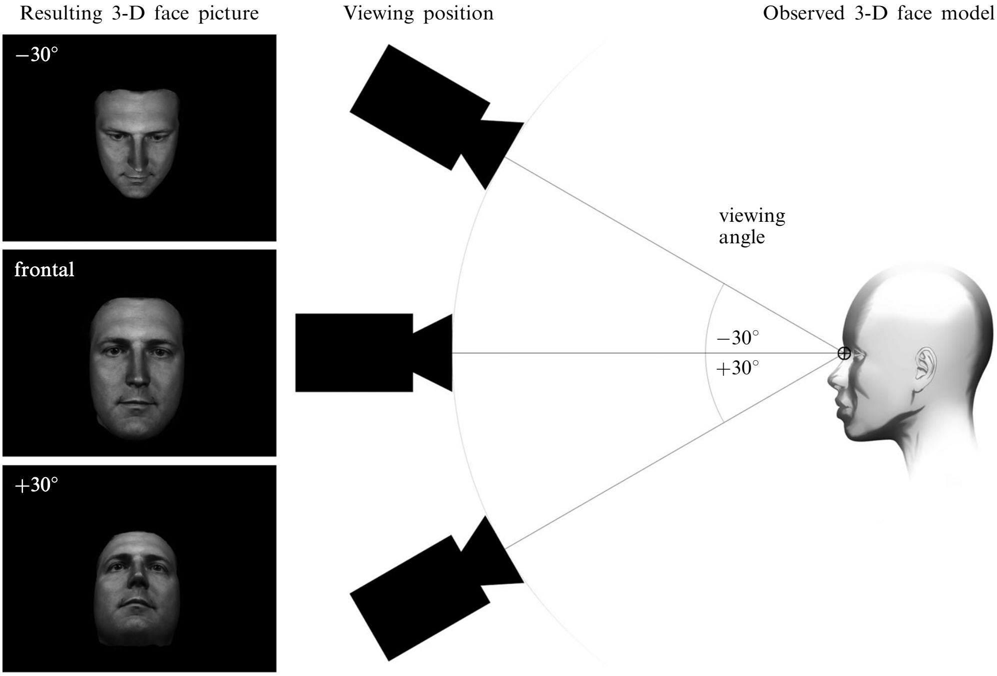


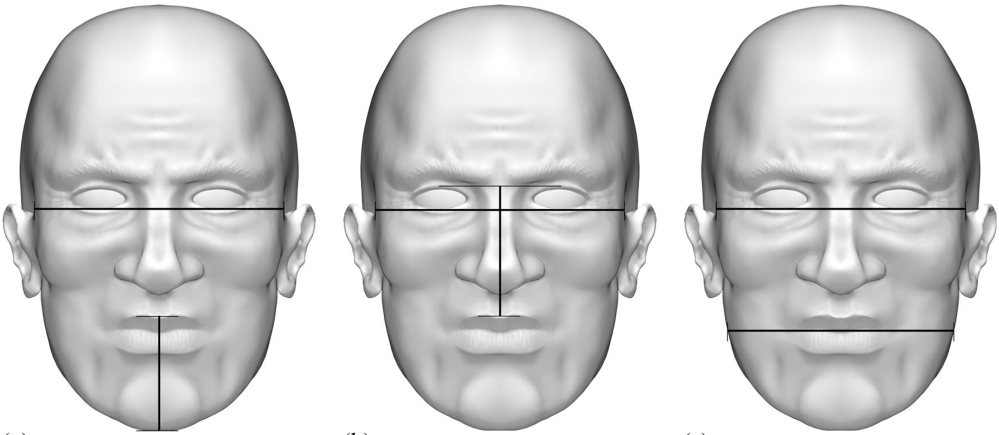
Figure 1. Illustration of used viewing angles (eg +30°: observer's vantage point is below the observed face).

Weight estimations showed very high reliabilities across participants (table 1), which matches previous findings (Coetzee et al 2009). A two-way by-items mixed-design ANCOVA with the between-subjects variable model gender, the within-subjects variable viewing angle (−30°, frontal, +30°), and the covariate model age (age of the face models) was conducted. Viewing angle showed a large effect ($F_{2,90} = 78.1$, $p < 0.0001$, $\eta_p^2 = 0.634$), revealing a strong influence of changes to the vantage point: the higher the observer, the lighter the judged body weight. We also found effects of model gender ($F_{1,45} = 5.13$, $p = 0.0284$, $\eta_p^2 = 0.102$) and model age ($F_{1,45} = 144.04$, $p < 0.0001$, $\eta_p^2 = 0.762$), which was not surprising owing to the fact that female and young faces are commonly associated with lower body weight.

Table 1. Average weight estimations and reliabilities (Cronbach's α) for different viewing angles split by model gender.

Gender	Viewing angle	M	SD	Range	Cronbach's α
Female	−30°	41.10	4.42	[24.88 – 47.98]	0.986
	frontal	50.22	3.61	[38.88 – 57.56]	0.993
	+30°	61.07	5.07	[52.50 – 77.50]	0.990
Male	−30°	49.78	4.94	[27.75 – 55.16]	0.992
	frontal	58.96	3.81	[50.13 – 66.25]	0.996
	+30°	72.26	5.02	[62.13 – 81.94]	0.988

How can this height – weight illusion be explained? Proportion changes in the projected image could serve as a cue to body weight, such as the width ratio of upper versus lower face. A lower vantage point causes a relatively wider lower face in the projected image. To test if these geometric changes are associated with greater body weight, we measured cheek-to-jaw-width ratio, width-to-upper-height ratio and width-to-lower-height ratio following Coetzee et al's (2010) suggestion (see figure 2 and table 2 for results).



(a) (b) (c)

Figure 2. Measures used to calculate facial cues according to Coetzee et al (2010). (a) Width-to-lower-facial-height ratio: cheekbone width divided by lower facial height. (b) Width-to-upper-facial-height ratio: cheekbone width divided by upper facial height. (c) Cheek-to-jaw-width ratio: cheekbone width divided by jaw width.

Table 2. Parameters of facial geometry (averaged across all faces) by viewing angle. Distances are measured in pixels.

Viewing angle	*M*	SD	*M*	SD	Range
	cheekbone width		cheekbone-to-jaw-width ratio		
−30°	274.35	23.42	1.62	0.13	[1.35 – 1.88]
Frontal	324.17	25.25	1.73	0.05	[1.10 – 1.32]
+30°	274.73	21.88	0.95	0.03	[0.87 – 1.02]
	upper facial height		width-to-upper-height ratio		
−30°	139.69	15.88	1.97	0.12	[1.72 – 2.30]
Frontal	168.71	25.68	1.95	0.19	[1.58 – 2.33]
+30°	111.54	21.54	2.53	0.35	[1.95 – 3.46]
	lower facial height		width-to-lower-height ratio		
−30°	65.02	8.97	4.27	0.50	[3.44 – 5.80]
Frontal	124.01	14.95	2.63	0.22	[2.20 – 3.10]
+30°	138.19	17.17	2.01	0.18	[1.55 – 2.38]
	jaw width				
−30°	170.25	17.98			
Frontal	276.67	22.21			
+30°	289.83	23.71			

Only the correlation between the ratio of width-to-upper-facial-height and weight was significant for the viewing angles up versus frontal ($r = 0.415$, $p < 0.01$), all other correlations between relative geometric changes and weight estimation were not. However, the effect of viewing angle is not tightly predicted by the change of these geometrical cues. Observers appeared to be able to partially compensate for the changes in perspective geometry. For instance, when lowering the camera the average weight change (+22%) was associated with an even larger change in width-to-upper-facial-height ratio (+30%). Thus, other factors than straightforward projective geometry must be involved in the height – weight illusion.

Acknowledgments. We would like to thank Vera M Hesslinger and Sabine Albrecht at the Department of General Psychology and Methodology, University of Bamberg for assisting in data analysis.

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ISSN 0301-0066 (print) ISSN 1468-4233 (electronic)

PERCEPTION

VOLUME 41 2012

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