Personality and facial morphology: Links to assertiveness and neuroticism in capuchins (*Sapajus* [*Cebus*] *apella*)

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ABSTRACT

Personality has important links to health, social status, and life history outcomes (e.g. longevity and reproductive success). Human facial morphology appears to signal aspects of one's personality to others, raising questions about the evolutionary origins of such associations (e.g. signals of mate quality). Studies in non-human primates may help to achieve this goal: for instance, facial width-to-height ratio (fWHR) in the male face has been associated with dominance not only in humans but also in capuchin monkeys. Here we test the association of personality (assertiveness, openness, attentiveness, neuroticism, and sociability) with fWHR, face width/lower-face height, and lower face/face height ratio in 64 capuchins (*Sapajus apella*). In a structural model of personality and facial metrics, fWHR was associated with assertiveness, while lower face/face height ratio was associated with neuroticism (*erratic* vs. *stable behaviour*) and attentiveness (*helpfulness* vs. *distractibility*). Facial morphology thus appears to associate with three personality domains, which may act as a signal of status in capuchins.

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1. Introduction

Human personality is associated with differences in important behaviours, ranging from work (Ferguson, Heckman, & Corr, 2011) to well-being (Weiss, Bates, & Luciano, 2008). Research into the biological and evolutionary origins of personality may be of value in understanding these associations. One approach is the examination of links between individual differences in facial structure and behaviour (Plavcan, 2012; Plavcan, Vanschaik, & Kappeler, 1995; Weston, Friday, Johnstone, & Schrenk, 2004), including personality (e.g. Kramer & Ward, 2010; Penton-Voak, Pound, Little, & Perrett, 2006). For instance, facial width-to-height ratio (fWHR: the ratio of the bizygomatic-width to upper face height: see Fig. 1) shows links to dominance–like traits (Carré & McCormick, 2008) though not all studies have found these to be significant (Deaner et al., 2012; Özener, 2012). fWHR has also been associated with achievement striving (Lewis, Lefevre, & Bates, 2012), and with deception and untrustworthiness (Haselhuhn & Wong, 2012; Stirrat & Perrett, 2010).

Recently, links between personality and facial phenotype have been reported by Lefevre et al. (submitted for publication) in a non-human species, the brown capuchin monkey (*Sapajus apella*). Similar to humans, capuchin fWHR predicted individual differences in assertive behaviour and alpha status. Such findings therefore suggest that comparative studies between humans and non-human primates may shed light on the biological and evolutionary basis of appearance-personality associations.

Here we extend this initial work with the same population of capuchins. Because both personality and facial morphology are multi-dimensional, we assessed two additional measures of facial morphology, previously found to be sexually dimorphic in humans (Penton-Voak et al., 2001), but not previously assessed in non-human primates. Second, we moved beyond the single personality trait of assertiveness available to Lefevre et al. to include the full five domains of the Hominoid Personality Questionnaire (Weiss et al., 2009) assessed in capuchins (Morton et al., 2013).

The two new facial metrics assessed were lower face/face height, and face width/lower face height (see Fig. 1). Unlike fWHR (which shows species-specific differences in sexual dimorphism: Kramer, Jones, & Ward, 2012; Lefevre et al., 2012; Özener, 2012), both face width/lower face height and lower face/face height are

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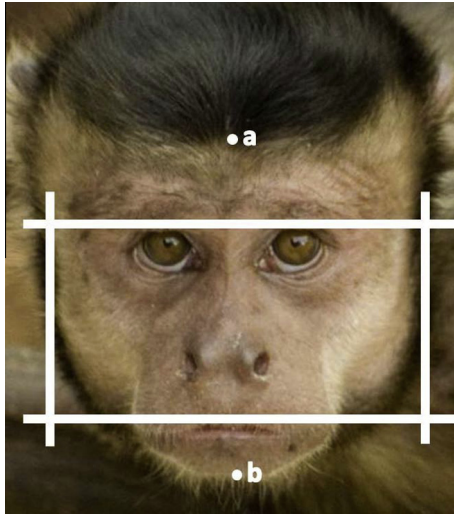*E-mail addresses:* v.a.d.wilson@sms.ed.ac.uk, tim.bates@ed.ac.uk (V. Wilson).

Fig. 1. Measures and measuring points used for morphometric calculations. *Note:* Horizontal lines show the distance between the upper lip and highest point of the eyelids (upper face height), vertical lines show the bizygomatic width. fWHR was calculated as width divided by height using these spans. Face width/lower face height was calculated as the bizygomatic width divided by the distance between the highest point of the eyelids and the lowest point of the chin (marked "b"). Lower face/face height was calculated as the distance between the highest point of the eyelids and the lowest point of the chin divided by the length of the whole face (a–b).

reliably sexually dimorphic in humans (Lefevre et al., 2012; Penton-Voak et al., 2001). Human face width/lower face height is correlated with fWHR, whereas lower face/face height may be independent of fWHR (Lefevre et al., 2012), and the two are weakly inversely correlated (Penton-Voak et al. (2001). We used a broad assessment of personality – the Hominoid Personality Questionnaire (Weiss et al., 2009), assessing five personality domains in capuchins: Assertiveness (identified by item loadings on *Bullying/Aggressive* vs. *Gentle/Cautious*); Openness (*Inventive/Inquisitive* vs. *Quitting*); Attentiveness (*helpfulness* vs. *distractibility*); Neuroticism (*erratic* vs. *stable behaviour*), and Sociability (*Affectionate, Friendly* vs. *Solitary/Depressed*) (Morton et al., 2013).

Given the evidence for an association between fWHR and assertiveness, and the relative independence of assertiveness from other dimensions of personality (Morton et al., 2013), we predicted that assertiveness would remain as the key indicator of fWHR, even after controlling for other personality variables. Secondly, we wished to establish whether the two additional facial metrics discussed above are sexually dimorphic in capuchins. Penton-Voak et al. (2001) reported that lower face/face height was inversely correlated ($r = -.32$) with face width/lower face height in humans. We therefore tested the association of the two new facial metrics to personality, and whether these were independent predictors or shared variance of personality traits. To our knowledge, neither has been tested for association with personality in either humans or non-human primates. We tentatively predicted that, like fWHR, face width/lower face height would be associated with assertiveness in capuchins based on its shared dependence on face width. The possible links of lower face/face height to personality are unclear, and thus were not specified ahead of analysis.

2. Method

2.1. Sample

The sample consisted of 64 individuals of *Sapajus* recruited across three sites. 6 females (mean age 8.2 ± 4.0 years) and 10

males (mean age 11.4 ± 13.4 years) were recruited from the Living Links to Human Evolution Research Centre, University of St Andrews, Edinburgh Zoo (Macdonald & Whiten, 2011). The Language Research Center, Georgia State University provided 13 females (mean age 15.3 ± 11.8 years) and 9 males (mean age 10.9 ± 5.8 years). Finally 10 females (mean age 12.8 ± 9.2 years) and 16 males (mean age 6.6 ± 4.5 years) were recruited from the Laboratory of Comparative Ethology at the National Institute of Health. The study was non-invasive, approved by local ethics committees, and complied with the 2012 regulations of the Association for the Study of Animal Behaviour.

2.2. Facial measures

Measures were based on frontal facial photographs. Prior to measurement, photographs were horizontally aligned and scaled according to inter-pupillary distance (using the Psychomorph software package; http://users.aber.ac.uk/bpt/jpsychomorph (Tiddeman, Perrett, & Burt, 2001). fWHR was then computed as the ratio of bizygomatic-width (maximum horizontal distance from the left to the right facial boundary) to upper face height (vertical distance from the mid-point of the upper lip to the highest point of the eyelids; see Fig. 1). Lower face/face height and face width/lower face height (Penton-Voak et al., 2001) were calculated as shown in Fig. 1. Measurement reliability was good (ICC = .86) based on a subset of photographs (N = 18) measured twice. In addition, measures from several photographs per individual (mean = 4.69, SD = 2.44) were averaged in order to maximise the signal to noise ratio. All images were taken within 1 calendar year, thus controlling for longitudinal changes.

2.3. Personality measures

The personality ratings were collected for each animal individually using the Hominoid Personality Questionnaire (Weiss et al., 2009). This 54-item measure has been validated in chimpanzees (*Pan troglodytes*) (Weiss et al., 2009), orang-utans (*Pongo spp.*) (Weiss, King, & Perkins, 2006), rhesus macaques (*Macaca mulatta*) (Weiss, Adams, Widdig, & Gerald, 2011), and brown capuchin monkeys (Morton et al., 2013). The items consist of adjective markers, accompanied by one to three short behavioural descriptions. For example, the item *Fearful* is described as "*Subject reacts excessively to real or imagined threats by displaying behaviors such as screaming, grimacing, running away or other signs of anxiety or distress*." Items are scored on a 7-point Likert scale ranging from 1: display either total absence or negligible amounts of the trait, to 7: display extremely large amounts of the traits.

All personality data used in this study are described fully in Morton et al. (2013). Briefly, ratings were collected for 127 monkeys. Between one and seven raters, each familiar with the monkeys, conducted the ratings, and to maintain independence of scoring were asked not to discuss their ratings with other raters. Inter-rater reliability was calculated for all monkeys with two or

Table 1
Means (and standard deviations) for personality dimensions and facial metrics.

Trait	Female	Male
Assertiveness	3.79 (1.13)	3.88 (0.93)
Openness	4.03 (0.69)	4.40 (0.69)
Sociability	4.74 (0.67)	4.74 (0.72)
Attentiveness	4.68 (0.65)	4.79 (0.54)
Neuroticism	4.0 (0.61)	4.10 (0.53)
fWHR	2.14 (0.14)	2.20 (0.17)
Face width/lower face height	1.41 (0.08)	1.45 (0.09)
Lower face/face height	0.75 (0.04)	0.74 (0.04)