Human facial attributes, but not perceived intelligence, are used as cues of health and resource provision potential

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Avoiding disease and acquiring resources have been recurrent challenges throughout human evolution. These abilities are particularly relevant to mate preferences, as pathogens and resources can both be transferred between mates and to mutual offspring. Based on 689 participants’ attractiveness ratings of manipulated online dating profiles, we tested whether pathogen and resource concerns predicted revealed mate preferences for facial attractiveness, facial sexual dimorphism, and perceived intelligence and also whether these different trait preferences were intercorrelated. Supporting our predictions, pathogen concerns positively predicted men and women’s preferences for facial attractiveness and men’s preference for facial femininity, whereas women’s resource concerns negatively predicted their preference for facial masculinity. Unexpectedly, neither pathogen nor resource concerns predicted preference for greater perceived intelligence. Further, preference for perceived intelligence was negatively correlated with preference for facial attractiveness, which was positively correlated with preference for facial sexual dimorphism. These findings suggest that facial attributes are used in mate assessment as cues of health and likelihood of resource provisioning, whereas intelligence may primarily be used as a cue of other, distinct qualities. Key words: facial attractiveness, multiple cues, pathogen prevalence, resource scarcity, revealed preferences, sexual dimorphism.

INTRODUCTION

Men and women’s mate preferences show substantial consistency across cultures, for example, intelligence appears universally valued (Li et al. 2002; Marlowe 2004; Pillsworth 2008) and faces rated as attractive in one culture are also rated as attractive in other cultures (Cunningham et al. 1995). These findings suggest that these preferences may have been naturally or sexually selected, but a key challenge is determining what functions are served by our mate preferences and whether different preferred traits are used as cues of the same or different underlying qualities.

The predominant theory regarding facial attractiveness suggests that it is an indicator of good health, where “health” is used in a broad sense to include current health (e.g., minimally infected with disease), health proneness (e.g., immunocompetence; likelihood of future infection), and any genetic factors associated with health proneness (Gangestad and Scheyd 2005; Tybur and Gangestad 2011). According to this theory, individuals in good health during development are able to withstand environmental stressors (e.g., pathogens) that would otherwise cause developmental deviations that are perceived as unattractive (Thornhill and Moller 1997). Consistent with this possibility, facially attractive individuals report better health (Thornhill and Gangestad 2006), are perceived by others as more healthy (Rhodes et al. 2001), and show better health on objective measures (Rhodes et al. 2001). However, studies have also failed to replicate this latter link, and its existence and relation to evolved mate preferences remain subject to considerable debate (Weeden and Sabini 2005). If attractive faces do indicate good health, there are at least 2 ways it could be evolutionarily advantageous to prefer partners with attractive faces. First, facially attractive partners will be less likely to succumb to disease and less likely to infect their partner and offspring. Second, a facially attractive partner may confer genetic benefits to mutual offspring, in terms of both better health and greater mating success.

Facial sexual dimorphism (i.e., masculinity in men and femininity in women) is also thought to be an indicator of good health (Roberts and Little 2008). In men, facial masculinity is associated with exposure to high levels of testosterone during development (Bardin and Catterall 1981; Swaddle and Reierson 2002). For some time, it has been claimed that testosterone suppresses the immune system (Folstad and Karter 1992; Grossman 1985) and thus only men with strong immune functioning are able to support high levels of testosterone at critical developmental phases (Thornhill and Gangestad 2006). Masculine facial features might, therefore, serve as a reliable cue of good immune functioning (Zahavi 1975). In support of this possibility, testosterone has been shown to mediate the relationship between facial masculinity and immune response (Rantala et al. 2012). Also, masculine men are perceived as more healthy (Rhodes et al. 2003), and facial masculinity in men.
correlates with actual health (Rhodes et al. 2003; Thornhill and Gangestad 2006). The links between testosterone and immunosuppression, however, are far from simple, and the evidence is equivocal at best; for a recent review, see Scott et al. (2012). Some studies have failed to replicate this link between facial masculinity and certain health outcomes (Thornhill and Gangestad 2006), whereas evidence for an association between testosterone and immunocompetence is mixed, with some studies finding null (van Anders 2010) or negative results (i.e., decreased health; Booth et al. 1999; Muehlenbein and Bribiescas 2005). Feminine features have also been proposed as a cue of good health in women (Rhodes et al. 2003), but support for this possibility is mixed and the mechanisms are unclear.

Facial femininity is strongly correlated with facial attractiveness in women, but in men the findings relating facial masculinity to facial attractiveness are inconsistent. Some studies show a preference for masculine faces (DeBruine et al. 2006), others a preference for feminine faces (Boothroyd et al. 2007; Perrett et al. 1998), and some a preference for neither (Said and Todorov 2011). Given the potential health advantages, the lack of clear preference for facial masculinity suggests there may be costs to choosing a facially masculine man as a mate. Consistent with this possibility, women report negative perceptions of masculine men’s parenting abilities, honesty, and commitment to monogamous relationships (Boothroyd et al. 2007), and masculine men themselves report less interest in long-term relationships (Boothroyd et al. 2008). In contrast, more feminine men tend to possess traits better suited for parenting, such as being more committed to long-term relationships and more nurturing to children (Boothroyd et al. 2008; McIntyre et al. 2006; van Anders et al. 2007). As a result, women may face a trade-off between cues of good health and cues of good parenting ability (Gangestad and Simpson 2000).

Because of their putative association with good health, physical attractiveness and sexual dimorphism may be expected to be more highly valued in environments of high pathogen prevalence. Consistent with this possibility, cross-cultural research has shown that individuals in countries with greater pathogen prevalence report greater preference for physical attractiveness (Gangestad and Buss 1993) and prefer more masculine male faces (DeBruine et al. 2010a; Penton-Voak et al. 2004). Corroborating this correlational research, recent experimental data have shown that when women are primed with pathogen-related cues, preferences for masculine traits and faces and for symmetrical faces are stronger (Lee and Zietsch 2011; Little et al. 2011). High levels of pathogen disgust sensitivity also predict preference for manipulated and naturally varying masculine male faces (DeBruine et al. 2010b), bodies, and voices (Jones et al. 2012). Some evidence suggests that high pathogen disgust is associated with assigning lower attractiveness ratings to unattractive targets (Park et al. 2012).

In environments where resources (e.g., food and shelter) are scarce, women may also adaptively shift their preference for sexual dimorphism in male faces. Some evidence suggests that women should prefer men with feminine features when resources are scarce because such features are putatively associated with relationship commitment and good parental qualities, which are advantageous qualities to have in a partner in harsh environments. In line with this possibility, experimental research suggests that when women are primed with cues of resource scarcity, they prefer more feminine traits and faces in men (Lee and Zietsch 2011; Little et al. 2007; Watkins et al. 2012). Conversely, studies have also found that when women have a greater access to resources in terms of increased status, preference for physical attractiveness increases (Moore and Cassidy 2007, 2010; Moore et al. 2010).

This body of research suggests that human mate preferences shift in order to optimize mate choice in given environments. However, existing research leaves important questions unanswered. First, the majority of the literature has relied on either explicit self-report of trait preferences (Gangestad and Buss 1993; Lee and Zietsch 2011) or forced-choice between 2 very similar, artificial composite faces that vary on either sexual dimorphism or symmetry (DeBruine et al. 2010a; Little et al. 2011). These methods are useful for obtaining hypothesized effects in tightly controlled settings, but it is unclear if the same effects emerge when people assess realistic potential mates who vary on multiple dimensions (including nonfacial traits), which is more ecologically valid and an important prerequisite for establishing evolutionary significance (Scott et al. 2012).

Second, although facial attributes are important in mate selection, mental traits such as intelligence are self-reported as even more important (Buss and Barnes 1986). Intelligence is thought to be an indicator of both “good genes” and resource provision potential (Miller 2000; Prokosch et al. 2005, 2009; Rozsa 2008; Yeo et al. 2011). High intelligence is associated with good health even when controlling for various possible confounds, purportedly because health and intelligence both reflect the same “good genes” (Arden et al. 2009). Furthermore, across 184 countries and among states within the United States, average intelligence scores are strongly linked to local pathogen prevalence (Epipig et al. 2010, 2011). It has been proposed that intelligence is used in mate assessment as a cue of health in a similar manner to facial attributes (Rozsa 2008); accordingly, cross-cultural research has found that preference for intelligence increases with pathogen prevalence (Gangestad et al. 2006). High intelligence is also associated with greater socioeconomic success (Strenz 2007) and lower likelihood of divorce (von Stumm et al. 2011), suggesting that intelligence enables greater resource provision. If intelligence were used in mate assessment as a cue of potential for resource provision, we would expect preference for intelligence to increase with greater resource concerns.

Third, it is unknown how preference functions for different cues of mate quality relate to each other. Whether correlations between preferences for independent traits are positive, zero, or even negative would be crucial evidence in understanding the role of multiple traits in mate assessment and thus in inferring the selective forces acting on choice. If facial attractiveness, facial sexual dimorphism, and intelligence are all used as cues that increase the accuracy of judgments of the same underlying qualities (e.g., back-up cues for good health), we would expect preferences for each to positively correlate. If they are used because they reflect uncorrelated or negatively correlated underlying qualities (“multiple messages”), zero or negative correlations would be expected (for a review of possible functions for preferences for multiple cues, see Raaijmakers 2003).

In the current research, we addressed these questions by having participants rate the attractiveness of online dating profiles that systematically varied on facial attractiveness (based on preratings of the profile photos), facial sexual dimorphism (based on masculinized or feminized versions of these photos), and perceived intelligence (based on self-descriptions manipulated to vary in apparent intelligence). From participants’ attractiveness ratings, we were able to “reveal” their preferences for each trait, addressing issues of ecological validity of previous work that use explicitly stated preferences (i.e., self-reported preferences) or forced-choice tasks. We then tested for an association between participants’ revealed preferences and individual differences in pathogen concerns (as measured by pathogen disgust sensitivity) and resource scarcity (as measured by socioeconomic status; SES).
Sensitivity to sexual and moral disgust was also investigated to ensure any effect of pathogen disgust was not due to disgust in general. Regarding facial attributes we test 2 main hypotheses: 1) for both men and women, higher pathogen disgust (but not moral or sexual disgust) should predict stronger revealed preferences for facial attractiveness and sexual dimorphism, if in fact either are used as signals for health and 2) for women, greater resource concerns should predict stronger revealed preference for feminine male faces (i.e., a negative association with SES). We also hypothesized that 3) both pathogen and resource concerns should positively predict revealed preference for perceived intelligence. Finally, we hypothesized that 4) to some degree facial attractiveness, facial sexual dimorphism, and perceived intelligence are all used as cues of the same underlying qualities (i.e., good health and underlying genetic quality), and so expect preferences for each to positively intercorrelate.

**METHODS**

**Participants**

Participants were 430 men (mean ± SD = 23.07 ± 4.86 years) and 422 women (M ± SD = 24.07 ± 6.80 years) who were recruited from an online surveying website (http://www.socialsci.com) in return for redeemable online store credit. Participation was conditional on being heterosexual and not currently in a long-term relationship. Participants who completed the incorrect survey (i.e., males who completed the female survey and vice versa; 33 males, 5 females) did not identify as being heterosexual (34 males; 71 females), or did not report their age (6 males; 2 females) were removed from analyses. A further 1 male and 6 females were removed for completing the survey in an unrealistic time (<5 min), which suggested a lack of attention to the questions. This reduced the sample size to 356 males (mean ± SD = 23.27 ± 4.93 years) and 338 females (mean ± SD = 24.15 ± 6.18 years).

**Stimuli**

Participants were asked to rate the attractiveness of a series of individuals in ostensible online dating profiles. Each profile consisted of a facial photo, as well as a short personal description embedded into a realistic dating profile template. These profiles varied across 3 dimensions: facial attractiveness, facial sexual dimorphism, and perceived intelligence.

Facial photos were taken from stock image websites (e.g., http://www.gettyimages.com) and prerated (in the absence of other stimuli) for facial attractiveness on a 100-point scale (0 = very unattractive; 100 = very attractive) by 75 male and 65 female volunteers recruited via SocialSci. Each photo contained 1 target, facing the camera with a neutral expression. Thirty-two photos of each sex were chosen to equally represent the full spectrum of perceived intelligence (mean intelligence ± SD = 54.97 ± 20.21 and mean intelligence ± SD = 49.46 ± 20.59 for male and female descriptions, respectively). The target in each photo was then 30% morphed with either a masculine facial template or a feminine facial template developed through a combination of averaged male and female faces and perceived masculine and feminine caricatures (Johnston et al. 2001), effectively masculinizing or feminizing the target (see Supplementary Material for further details on the morphing process).

To vary the apparent intelligence of the individuals, real self-descriptions were adapted from dating websites and then prerated (in the absence of other information) for intelligence by 136 male and 131 female volunteers recruited via Facebook. Because we adapted the self-descriptions from real dating websites, we were unable to measure the actual intelligence of those who wrote them; however, our use of real self-descriptions had the advantage of preserving realism. Also, previous research has shown that intelligence can be accurately perceived at greater than chance (Murphy et al. 2003). Based on these perceived intelligence ratings, 64 self-descriptions (32 for each sex) were chosen to equally represent the full spectrum of perceived intelligence (mean intelligence ± SD = 54.97 ± 20.21 and mean intelligence ± SD = 49.46 ± 20.59 for male and female descriptions, respectively).

Photographs of attractive and less attractive individuals were morphed to be more masculine or more feminine and then randomly paired with statements that conveyed high or low perceived intelligence, which produced 128 profiles of each sex. Participants rated a subset of 32 of these profiles, such that they rated each individual photo once, with the target photo either masculinized or feminized, and paired with either an intelligent or less intelligent personal description. Thus, each participant rated 16 masculinized and 16 feminized targets, as well as 16 intelligent and 16 less intelligent self-descriptions. Participants rated the profiles in a random order and did not rate the same individual or personal description more than once. See Figure 1 for example profiles.

**Procedure and measures**

The survey was completed online, with participants choosing the time and location, but with the condition that it was to be completed in 1 sitting. Participants first rated a set of 32 ostensible personal ads of members of the opposite sex (as described above) on a 100-point sliding scale (0 = very unattractive; 100 = very attractive). Participants were told that the personal ads were taken from a dating website.

Next, participants completed a questionnaire that included the Disgust Scale (Tybur et al. 2009), which is a 21-item questionnaire in which participants rate the degree to which they find statements disgusting on a 7-point scale (0 = not disgusting at all; 6 = extremely disgusting). Three domains of disgust are assessed: pathogen, moral, and sexual disgust. Pathogen disgust refers to aversion to exposure to pathogen contagions that could threaten one’s health, such as “Accidently touching a person’s bloody cut.” Moral disgust refers to aversion to social transgressions, such as “Intentionally lying during a business transaction.” Sexual disgust measured aversion to sexual deviance or unwanted sexual contact, such as “A stranger of the opposite sex intentionally rubbing your thigh in an elevator.” Participants’ score on the pathogen disgust scale was used as a proxy for pathogen concerns. Participants who were missing data for more than 1 item for any disgust scale were removed from further analysis. This reduced the female sample size to 331 participants (no cases required removal from the male dataset). For participants who had missing data for only 1 item, the missing item was replaced with the grand mean of that item from participants of the same sex.

Also included was a 1-item SES measure (Adler et al. 2000) that asked participants to rate their perceived standing compared with others on the 3 dimensions of SES: income, education, and occupation, on a 10 point scale (10 = best off; 1 = worst off). Although only a single item, this measure has previously been shown to correlate with more objective measures of SES (Adler et al. 2000). SES was used as a proxy for resource concerns, such that individuals who report lower SES were assumed to have less access to resources due to lower social and financial standing.

The questionnaire also included demographic information and brief measures of personality and sexual
behavior and attitudes, which were not directly relevant to the hypotheses in this study and so are not described further here.

Analyses

Each participant rated 32 profiles, resulting in 11,391 and 10,656 observations for males and females, respectively. These data are hierarchical in nature, such that each of the 32 attractiveness ratings of each profile made by each participant (Level 1) is nested within the participants themselves (Level 2). As such, the data were analyzed using Hierarchical Linear Modelling in the HLM software package (for an explanation of this technique and its advantages over other approaches to analyzing hierarchical data, see Raudenbush and Bryk 2002). On Level 1, participants’ preferences for each trait were revealed by the associations between their attractiveness ratings of the profiles and the profiles’ facial attractiveness (based on preratings), perceived intelligence (based on preratings), and facial sexual dimorphism (based on whether the photo was masculinized or feminized). We tested our hypotheses by determining whether Level 2 predictors (participants’ SES and pathogen disgust) moderate these associations. Participants’ age was also included as a Level 2 predictor to take into account any effect age may have on revealed preferences, whereas sexual and moral disgust were included to check that the effect of pathogen disgust did not simply reflect an effect of general disgust. All predictors...
were included simultaneously in 1 model, which allowed us to assess the unique contribution of each predictor on revealed preferences. Separate analyses were conducted for men and women. To facilitate interpretation, all predictors were standardized except for the dichotomous Level 1 predictor of facial sexual dimorphism, which was coded 0 (morphed in the direction of the opposite sex) or 1 (morphed in the direction of the same sex). See Supplementary Material for additional detail on the analyses conducted.

RESULTS

An empty model of participants’ attractiveness ratings of the dating profiles with no predictors showed that the intraclass correlation values (i.e., the proportion of the total variance that is between-individual variance) were 0.25 and 0.22 for males and females, respectively. This indicates that variance in participants’ attractiveness ratings of the dating profiles existed at both levels (i.e., profile attractiveness ratings varied due to differences between profiles and due to differences between participants). This confirms that HLM is appropriate for analysis of these data. Comparing a model including all predictors with the empty model revealed that, for males and females, respectively, 34% and 42% of the within-individual variation in attractiveness ratings could be accounted for by the facial attractiveness, facial sexual dimorphism, and perceived intelligence of the profiles. The variance components from the HLM analysis are reported in Supplementary Material.

The γ coefficients from the HLM analysis are reported in Table 1. The intercept refers to the average slope between the Level 1 predictor and participants’ ratings of attractiveness. For instance, for every standard deviation increase in a female profile’s prerated facial attractiveness, male participants rated that profile 6.43U more attractive. All Level 1 slopes were significant and in the expected directions, such that participants preferred facially attractive, intelligent, and sexually dimorphic profiles.

The γ coefficients for Level 2 predictors (age, SES, pathogen, moral, and sexual disgust) refer to the change in Level 1 slope given 1 unit change in the Level 2 predictor; these coefficients represent the effect of the Level 2 predictors on revealed preferences for each trait and include most of our main hypothesis tests (boldface type in Table 1).

**Table 1.** HLM (γ) coefficients (and standard errors) and associated f statistics for age SES, pathogen disgust, moral disgust, and sexual disgust in the model predicting revealed preference slopes for facial attractiveness, facial sexual dimorphism, and perceived intelligence

<table>
<thead>
<tr>
<th></th>
<th>Male raters</th>
<th></th>
<th>Female raters</th>
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<tbody>
<tr>
<td></td>
<td>γ (SE)</td>
<td>T</td>
<td>Appro. df</td>
<td>γ (SE)</td>
</tr>
<tr>
<td>Revealed preference for facial attractiveness</td>
<td>6.43 (0.29)</td>
<td>22.23*** 350</td>
<td>7.93 (0.31) 25.47*** 327</td>
<td>0.74 (0.44) 1.70 327</td>
</tr>
<tr>
<td>Intercept</td>
<td>-0.90 (0.29) -3.07** 350</td>
<td>-0.51 (0.33) -0.56 327</td>
<td>-0.51 (0.31) 1.63 327</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.41 (0.30) 1.41 350</td>
<td>0.51 (0.31) 1.63 327</td>
<td>0.51 (0.31) 1.63 327</td>
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<tr>
<td>Pathogen disgust</td>
<td>1.42 (0.31) 4.64*** 350</td>
<td>0.96 (0.33) 2.88** 327</td>
<td>0.96 (0.33) 2.88** 327</td>
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<tr>
<td>Moral disgust</td>
<td>-1.05 (0.30) -3.44*** 350</td>
<td>-1.18 (0.35) -3.55** 327</td>
<td>-1.18 (0.35) -3.55** 327</td>
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<tr>
<td>Sexual disgust</td>
<td>0.15 (0.31) 0.50 350</td>
<td>0.06 (0.33) 0.18 327</td>
<td>0.06 (0.33) 0.18 327</td>
<td></td>
</tr>
<tr>
<td>Revealed preference for facial sexual dimorphism</td>
<td>4.44 (0.45) 9.72*** 350</td>
<td>2.68 (0.40) 6.73*** 327</td>
<td>2.68 (0.40) 6.73*** 327</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>-0.51 (0.46) -1.15 350</td>
<td>-0.02 (0.12) -0.05 327</td>
<td>-0.02 (0.12) -0.05 327</td>
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<tr>
<td>Age</td>
<td>0.46 (0.46) 1.00 350</td>
<td>0.55 (0.40) 2.38* 327</td>
<td>0.55 (0.40) 2.38* 327</td>
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<tr>
<td>Pathogen disgust</td>
<td>1.55 (0.49) 2.78** 350</td>
<td>0.43 (0.43) 1.01 327</td>
<td>0.43 (0.43) 1.01 327</td>
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<tr>
<td>Moral disgust</td>
<td>-0.20 (0.48) -0.42 350</td>
<td>-0.82 (0.42) -2.38 327</td>
<td>-0.82 (0.42) -2.38 327</td>
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<tr>
<td>Sexual disgust</td>
<td>-0.57 (0.49) -1.18 350</td>
<td>0.04 (0.42) 0.09 327</td>
<td>0.04 (0.42) 0.09 327</td>
<td></td>
</tr>
<tr>
<td>Revealed preference for perceived intelligence</td>
<td>8.15 (0.37) 22.09*** 350</td>
<td>10.13 (0.41) 24.71*** 327</td>
<td>10.13 (0.41) 24.71*** 327</td>
<td></td>
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<tr>
<td>Intercept</td>
<td>-0.92 (0.35) -2.60** 350</td>
<td>-0.85 (0.43) -2.00* 327</td>
<td>-0.85 (0.43) -2.00* 327</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-0.19 (0.35) -0.24 350</td>
<td>0.45 (0.41) 1.10 327</td>
<td>0.45 (0.41) 1.10 327</td>
<td></td>
</tr>
<tr>
<td>Pathogen disgust</td>
<td>0.74 (0.37) -2.01* 350</td>
<td>0.74 (0.44) -1.70 327</td>
<td>0.74 (0.44) -1.70 327</td>
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<tr>
<td>Moral disgust</td>
<td>1.66 (0.37) 4.33*** 350</td>
<td>1.55 (0.43) 3.37** 327</td>
<td>1.55 (0.43) 3.37** 327</td>
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</tr>
<tr>
<td>Sexual disgust</td>
<td>-1.00 (0.37) -2.68** 350</td>
<td>-1.04 (0.45) -2.42* 327</td>
<td>-1.04 (0.45) -2.42* 327</td>
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</table>

Associations relevant to the main hypotheses are in bold. Note that predictors have been standardized to increase interpretability.

*P < 0.05; **P < 0.01; ***P < 0.001.
Figure 2. for graphical representations of our main significant results (i.e., those in bold in Table 1).

### Associations of SES and disgust scores with revealed mate preferences for perceived intelligence

We predicted that preference for perceived intelligence would be positively associated with pathogen and resource concerns (i.e., a negative association with SES). For both men and women, the effect of pathogen disgust on revealed preference for perceived intelligence trended in the opposite direction from predictions, with male rater’s pathogen disgust significantly associated with weaker preference for female intelligence. This finding is inconsistent with intelligence being used as a cue of a mate’s health. The association between SES and preference for perceived intelligence was also nonsignificant, which is inconsistent with the idea that intelligence is used as a cue for likely resource provisioning. In contrast, and unexpectedly, both moral disgust and sexual disgust were significantly associated with preference for perceived intelligence in men and women.

### Intercorrelations between revealed mate preferences for different traits

To represent the relationships between revealed preferences for different traits in an easily interpretable manner, difference scores were created for each participant for each trait by subtracting their mean rating of the 16 least facially attractive/intelligent/sexually dimorphic profiles (based on preratings for the former 2 traits or whether the photo had been masculinized or feminized in the case of sexual dimorphism) from their mean rating of the other 16 profiles. As
such, a greater difference score indicated greater revealed preference for that trait. As can be seen in Table 2, correlations between preferences for facial attractiveness and facial sexual dimorphism were substantial and positive in both men and women, as would be expected if the 2 traits were used as cues of the same underlying factor (e.g., health). Contrary to expectations, preference for perceived intelligence correlated substantially and negatively with preference for facial attractiveness in both men and women, and in women, it also correlated negatively with preference for masculine faces. These results are inconsistent with the possibility that intelligence is used in mate assessment primarily as a cue of the same underlying factor as facial attractiveness and sexual dimorphism (i.e., health).

It should be noted that there are necessary trade-offs for extreme preferences in our study design. A participant cannot exhibit maximal preferences for all 3 traits simultaneously because the traits varied independently. To assess whether this inherent constraint in the design could explain the negative correlation between preferences for perceived intelligence and facial attractiveness, we examined the effect of excluding participants with strong preferences for either trait (>1.5 SD above the mean). This analysis revealed that the negative correlation remained similar in magnitude and significant ($P < 0.001$) in both men and women when extreme raters were excluded, suggesting that design constraints were not driving the observed negative correlation between these preferences.

**DISCUSSION**

In this study, we tested whether pathogen and resource concerns could predict revealed mate preferences for facial attractiveness, facial sexual dimorphism, and perceived intelligence and also whether these different trait preferences were intercorrelated.

**Associations of SES and disgust scores with revealed mate preferences for facial attributes**

Consistent with evolutionary hypotheses, women with greater resource concerns showed weaker preference for facial masculinity and both men and women with greater pathogen concerns showed stronger preference for facial attractiveness. The predicted positive association between pathogen disgust and preference for facial sexual dimorphism was partially supported, as men with greater pathogen disgust showed a relative preference for feminized women, but the corresponding association was not significant in women.

These findings provide evidence from a naturalistic mate assessment setting that perception of facial attractiveness may be amplified by an individual’s pathogen concerns. This result dovetails with other research suggesting that physical attractiveness is associated with good health (Gangestad and Buss 1993; Rhodes et al. 2001; Thornhill and Gangestad 2006; Young et al. 2011). Both pathogen disgust and preference for attractive mates may be phenotypically plastic responses to high pathogen risk, in which case pathogen-sensitive people who choose healthy, attractive mates could avoid becoming infected (but see Boots and Knell 2002) and/or procure inheritable immunity for their offspring. Although other links between pathogen sensitivity and preference strength remain possible, for now the evidence favors avoidance of infection, genetic benefits to offspring, or a combination thereof.

These findings also support the notion that facial sexual dimorphism is similarly used by men as a cue of health or genetic quality in women, consistent with previous research using different methodologies (DeBruine et al. 2010a, 2010b; Little et al. 2011). It is unclear why women did not show a similar effect for sexual dimorphism of male faces, given the strong cross-cultural and experimental findings supporting this association (DeBruine et al. 2010b; Lee and Zietsch 2011; Little et al. 2011); however, the effect was in the predicted direction; so, it is possible that the lack of statistical significance is a false negative. Importantly, women’s preference for facial masculinity significantly correlated with their SES as hypothesized, such that women with greater resource concerns showed a relative preference for feminized male faces. This finding suggests that women may use the masculinity of male faces as a cue to likelihood of resource provision, perhaps because more feminine men tend to be more faithful and committed in relationships than more masculine men (McIntyre et al. 2006; vananders et al. 2007). Previous findings of a positive relationship between women’s SES and explicit preference for physical attractiveness (Moore and Cassidy 2007, 2010; Moore et al. 2010) were not found in our revealed preferences data. The fact that preference for masculinized versus feminized male faces was the only significant correlate of SES suggests that facial sexual dimorphism is perceived as a particularly relevant cue to a man’s likelihood of resource provision. Despite our interpretation, we note that the links between fitness and masculinity, a man’s ability to procure and defend resources and tendency to invest resources in his partner and offspring have yet to be resolved. An alternative interpretation could be that lower SES women might have lower self-perceptions of their own mate value and might, then, be less ambitious in the priority they place on a mate’s masculinity. Further research is needed to understand the role of facial cues on mate preferences and how these preferences benefit fitness.

**Associations of SES and disgust scores with revealed mate preferences for perceived intelligence**

Unexpectedly, the association of perceived intelligence preferences with pathogen concerns trended in the opposite direction to our hypotheses for both men and women, such that greater pathogen and predicted weaker preference for perceived intelligence. In particular, the negative effects of pathogen concerns were relatively strong (indeed, statistically significant in the case of men); so, we can be reasonably certain that there is no underlying positive association.

### Table 2

<table>
<thead>
<tr>
<th>Sex of rater</th>
<th>Perceived intelligence</th>
<th>Facial attractiveness</th>
<th>Facial sexual dimorphism</th>
</tr>
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<tbody>
<tr>
<td>Male (N = 356)</td>
<td>$r = -0.26$ (−0.36, −0.16)</td>
<td>$r = 0.27$ (0.37, 0.17)</td>
<td>$r = -0.07$ (−0.04, 0.17)</td>
</tr>
<tr>
<td>Female (N = 338)</td>
<td>$r = 0.29$ (−0.09, −0.19)</td>
<td>$r = 0.45$ (0.35, 0.55)</td>
<td>$r = -0.15$ (−0.24, −0.02)</td>
</tr>
</tbody>
</table>
The association between perceived intelligence preferences and resource concerns was also nonsignificant for both men and women. These findings are inconsistent with the notion that intelligence is primarily used as a cue of good health or resource provision and with previous cross-cultural findings (Gangestad et al. 2006). Given the many findings showing that intelligence is valued in a mate, it is likely that intelligence is used not as an additional indicator of health or provisioning potential, but rather as a cue of other, distinct qualities. One possibility is that intelligence is a marker of low overall genetic mutation load (Miller 2000; Prokosch et al. 2005; Yeo et al. 2011) rather than of health via immunocompetence; the latter is thought to be related to diversity of alleles in the major histocompatibility complex (Havlícek and Roberts 2009; Lie et al. 2010), and there is no reason to expect immunocompetence to relate to overall mutation load.

Intercorrelations between revealed mate preferences for different traits

The correlations between mate preferences for different cues revealed a positive relationship between preferences for facial attractiveness and facial sexual dimorphism in both men and women. Because facial sexual dimorphism was manipulated independent of the variation in facial attractiveness, this finding suggests that these 2 cues are used in part to assess the same underlying factor of mate quality. This finding complements cross-cultural evidence that individuals’ facial symmetry (a component of attractiveness) and sexual dimorphism covary within African hunter-gatherer and European populations (Little et al. 2008), which is consistent with the possibility that the 2 traits to some extent reflect the same underlying factor. Although the 2 cues may act as indicators of the same underlying quality, 1 or both cues could also indicate other qualities; for example, it is possible that health is indicated by both facial sexual dimorphism and facial attractiveness, whereas likelihood of resource provision is only indicated by facial sexual dimorphism (of men), as suggested by our results involving pathogen and resource concerns.

Surprisingly, preference for perceived intelligence was negatively correlated with men and women’s preference for facial attractiveness and women’s preference for sexual dimorphism. These findings further suggest that cues of intelligence are not used to judge the same mate quality as indicated by facial attributes (i.e., health). Intelligence may primarily be used as a cue of largely distinct aspects of mate quality.

Limitations

Certain considerations warrant caution when interpreting these results. First, the dating profiles varied in numerous ways that were not strictly controlled (e.g., extraneous personality information in the personal descriptions). Although this variation had the important advantage of preserving realism, it also introduced noise into the data that could have obscured true associations between the variables of interest. We attempted to minimize this problem through the use of a large sample, and as such we were able to detect even small associations. Second, our profile manipulations and individual difference measures could potentially covary with other unmeasured factors that influence the observed effects. As such, we cannot rule out other, more complex explanations for the documented effects. Third, although online dating is a common mode of mate choice in modern Western societies (Morgan et al. 2010), and thus of interest in its own right, it remains unclear to what extent mate preferences exhibited in this format generalize to in-person mate assessment, which is the ancestral norm and remains by far the most common form of mating assessment to this day. On the other hand, the fact that we found effects derived from evolutionary theory in this adaptively novel setting could be interpreted as an indication of the robustness of the effects.

Conclusions

Our findings suggest that facial attributes are used as cues of mate quality in terms of both health and likelihood of resource provision in a realistic mate assessment setting. Our findings further suggest that intelligence is not primarily used as a cue of these same qualities, indicating that intelligence may be used as a cue of different aspects of mate quality.

SUPPLEMENTARY MATERIAL

Supplementary material can be found at http://www.beheco.oxfordjournals.org/.

ETHICAL APPROVAL

This study has been cleared in accordance with the ethical review processes of The University of Queensland and within the guidelines of the National Statement on Ethical Conduct in Human Research.

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