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Female facial attractiveness increases during the fertile phase of the menstrual cycle

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The lack of obvious visible manifestations of ovulation in human females, compared with the prominent sexual swellings of many primates, has led to the idea that human ovulation is concealed. While human ovulation is clearly not advertised to the same extent as in some other species, we show here that both men and women judge photographs of women's faces that were taken in the fertile window of the menstrual cycle as more attractive than photographs taken during the luteal phase. This indicates the existence of visible cues to ovulation in the human face, and is consistent with similar cyclical changes observed for preferences of female body odour. This heightened allure could be an adaptive mechanism for raising a female's relative value in the mating market at the time in the cycle when the probability of conception is at its highest.

Keywords: facial attractiveness; mate choice; beauty; oestrus; monogamy

1. INTRODUCTION

Human females lack obvious visible manifestations of ovulation, compared with, for example, the prominent sexual swellings of chimpanzees and baboons (Dixson 1983). This has led to the widely held view that human ovulation is concealed, and a number of functional arguments have been invoked to explain this. For example, it has been argued that concealed ovulation and constant sexual receptivity may facilitate social monogamy (Morris 1967; Campbell 1974; Lovejoy 1981), ensure paternal care (Alexander & Noonan 1979; Strassman 1981; Turke 1988) and reduce levels of infanticide (Hrdy 1981), perhaps because it increases paternity uncertainty (Benshoof & Thornhill 1979). Several alternatives are reviewed by Pawlowski (1999), who argues that bipedality and environmental conditions, rather than sexual selection, may have led to the loss of visual manifestations of ovulation. Another view is that the ancestral state is one in which visible cues are absent, a state from which other primates have derived sometimes highly visible cues (Sillen-Tullberg & Møller 1993).

A few recent studies, however, suggest that subtle cues to ovulation may exist. For example, it has been shown that female body odour is more attractive to men when collected around ovulation compared with during the luteal phase of the cycle (Poran 1994; Singh & Bronstad 2001). In addition, soft tissue traits, such as ears, fingers and breasts, become more symmetrical in the days leading up to ovulation (Manning *et al.* 1996; Scutt & Manning 1996) and skin colour becomes lighter (Van den Berghe & Frost 1986). While it is not known whether these changes are perceptible, these results raise the intriguing possibility that visual cues to ovulation may exist and be perceived by potential partners. Facial appearance might also be subject to cyclical variation and be perceived by potential mates, particularly in view of the key role that facial attractiveness plays in human mate choice (e.g. Perrett *et al.* 1994, 1998). Here, we test this possibility by recording preferences for photographs of women taken during the follicular phase and the luteal phase of the cycle. We tested preferences of both male and female judges in two replicates of the same experiment: one in the UK and one in the Czech Republic.

2. METHODS

We took two digital photographs (in the late follicular and early–mid luteal phase) of 48 women: 23 at the University of Newcastle, UK, and 25 at Charles University, Prague, Czech Republic. For each group of women, follicular and luteal phase photographs were each taken in the same location, under standardized lighting conditions against a plain white background, and with the same camera (Newcastle: Nikon Coolpix 775; Prague: Fuji S602 Zoom). Women were instructed to adopt neutral, non-smiling expressions and to remove facial cosmetics (example image pairs are provided in figure 1). Women were aged between 19 and 33 years, reported having *ca.* 28-day menstrual cycles and were not using hormonal contraception. Follicular-phase images were taken 8–14 days (median of 12) into the cycle, the period of highest conception probability, and luteal-phase images between days 17 and 25 (median of 22); none was taken after day 25 to avoid pre-menstrual effects (e.g. disrupted sleep, water retention). Twenty-six women were photographed first in the follicular phase and 22 first in the luteal phase.

In both Newcastle and Prague, the local set of image pairs (of the same woman) were presented to male (mean age of 25 years, range of 19–44 years) and female (mean age of 23 years, range of 18–33 years) raters, who chose which image they found more attractive. Raters saw images on a liquid crystal display computer screen with 1024×768 pixel resolution, and indicated their preferences by mouse clicks. No time limits for choice indication were imposed; however, the time taken to make a choice within an image pair was usually 3–4 s. Raters performed this preference test twice: with digitally masked images (obscuring ears and hair) and with unmasked images (retaining these cues). Image order, left or right presentation and task order were randomized. We calculated the proportion of follicular images judged more attractive by each rater, for each of 63 male and 61 female raters in Newcastle, and 67 male and 70 female raters in Prague. Resulting distributions were checked for normality and then compared against random expectation (0.5) using one-sample *t*-tests.

3. RESULTS

Raters selected follicular-phase images as more attractive than luteal-phase images more often than expected by chance (figure 2). In Prague, raters preferred follicular images both when presented with the unmasked version of the images (males, $t_{66} = 4.2$, $p < 0.001$; females, $t_{69} = 8.4$, $p < 0.001$) and the masked versions (males, $t_{66} = 5.5$, $p < 0.001$; females, $t_{69} = 5.2$, $p < 0.001$). Similarly, in

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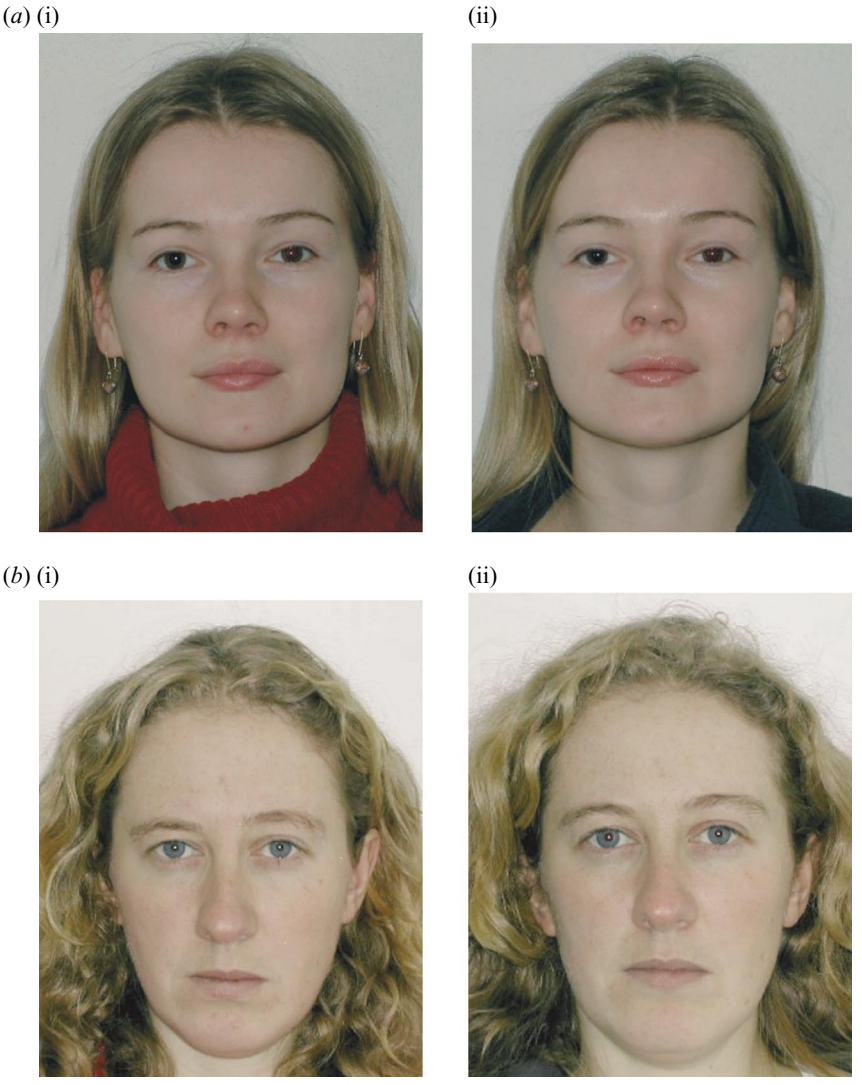

Figure 1. Image pairs of two women as examples of stimuli used: (*a*) is from Prague; and (*b*) is from Newcastle. One image in each pair was taken during the follicular phase (i) and one in the luteal phase (ii) of the cycle (in both cases, days 12 and 19, respectively).

Newcastle, women raters chose unmasked images ($t_{60} = 4.6$, $p < 0.001$) and men chose masked images ($t_{62} = 2.4$, $p = 0.020$), more often than expected. The proportion of masked follicular images picked by Newcastle women (51.9%) and the proportion of unmasked follicular images picked by Newcastle men (50.6%) were not significantly different from chance, although they were in the same direction (i.e. over 50%).

Women had stronger preferences for unmasked over masked follicular versions in both Newcastle (paired *t*-test: $t_{60} = 2.03$, $p = 0.046$) and Prague ($t_{69} = 2.36$, $p = 0.021$). Women also picked unmasked follicular images more often than men did (independent-samples *t*-test: Newcastle, $t_{62,60} = 2.91$, $p = 0.004$; Prague, $t_{66,69} = 1.97$, $p = 0.051$).

4. DISCUSSION

Our results indicate that the perceived attractiveness of womens' faces varies across the menstrual cycle and is higher in the periovulatory than in the luteal phase. This increase in facial attractiveness is clearly subtle and the mean effect size is small. Even such subtle effects, however, can have substantial reproductive benefits if they raise value in the mating market (Noe & Hammerstein 1994). In addition, this information may be just one of a suite of cues, also including behaviour (e.g. increased flirtatiousness (Matteo & Rissman 1984)), odour attractiveness (Singh & Bronstad 2001) and, potentially, symmetry of soft tissue traits (Scutt & Manning 1996) that may act together to emphasize a woman's fertile condition (Tarín & Gómez-Piquer 2002) and result in increasing frequency of male-initiated encounters (Harvey 1987). More work is needed to determine the nature of the facial changes involved, but candidate cues would include variation in lip colour and size, pupillary dilation and skin colour and tone (Van den Berghe & Frost 1986). Our results also show that potentially additive information about the stage of the menstrual cycle is available in hair style and/or condition (hairstyle was usually but not always constant across the two samples). Surprisingly, this information appears to be used only by other women, suggesting that women may be more aware or better able to discriminate these subtle differences, and that men might fail to detect some available cues to fertility.

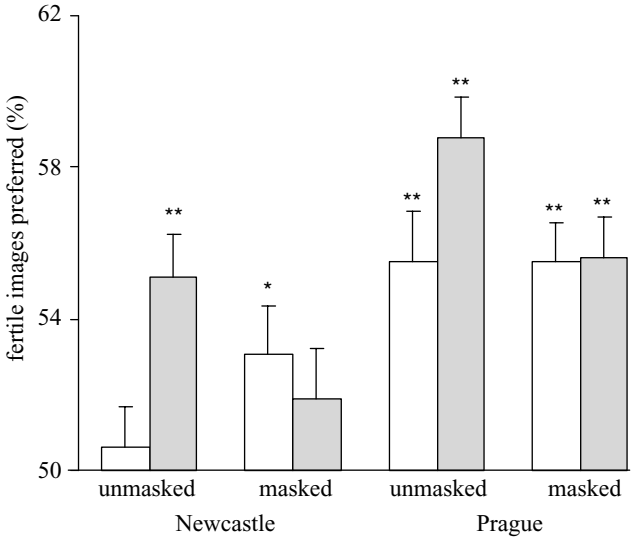

Figure 2. Mean preferences for fertile phase over luteal phase images of the same woman. Fertile images are preferred more often than expected by chance (one sample *t*-tests, $^{*}p < 0.05$, $^{**}p < 0.001$). Images ($n = 23$ from Newcastle, $n = 26$ from Prague) were digitally masked (obscuring hairstyle and condition) or unmasked (retaining these cues). Raters were 63 males (open bars) and 61 females (grey bars) (Newcastle), and 67 males (open bars) and 70 females (grey bars) (Prague).

Enhanced attractiveness around the time of ovulation could potentially lead (or have led in ancestral times) to reproductive benefits for females, in two ways: it could enlarge the pool of potential mates or extra-pair partners, or it could act more specifically as a fertility signal that is detectable only by long-term partners. We were unable to test whether men would be at an advantage in picking the ovulating version of their partner, but we did ask a subsample ($n = 36$) of the women who had been photographed to choose which of their own two images was most attractive. Nineteen women (53%) chose the unmasked follicular phase image of themselves, whereas for the masked images, 22 (61%) preferred the follicular image. These choices are comparable with those from the main sample, and suggest that familiarity with changes in their own face does not result in a marked improvement in discrimination. The absence of a strong learning effect suggests that ovulatory cues may be available to all potential partners rather than being privy to long-term mates, although it remains possible that male partners may be able to learn these cues to a greater degree than women themselves.

The idea that cycle-associated changes enlarge the pool of potential mates is consistent with evidence that womens' preferences for mens' faces vary cyclically: women in the fertile phase are more attracted to male faces possessing traits associated with high genetic quality (e.g. masculine faces (Penton-Voak *et al.* 1999; Penton-Voak & Perrett 2001)) than during the remainder of the cycle. These cycle-associated preference shifts, coupled with our finding that womens' faces are also more attractive to men around ovulation, suggest an intriguing mechanism by which women could both seek and attract high-quality mates during the fertile window, thereby increasing offspring quality in two different but complementary ways.

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