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Women's hormone levels modulate the motivational salience of facial attractiveness and sexual dimorphism

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Abstract The physical attractiveness of faces is positively correlated with both behavioral and neural measures of their motivational salience. Although previous work suggests that hormone levels modulate women's perceptions of others' facial attractiveness, studies have not yet investigated whether hormone levels also modulate the motivational salience of facial characteristics. To address this issue, we investigated the relationships between within-subject changes in women's salivary hormone levels (estradiol, progesterone, testosterone, and estradiol-to-progesterone ratio) and within-subject changes in the motivational salience of attractiveness and sexual dimorphism in male and female faces. The motivational salience of physically attractive faces in general and feminine female faces, but not masculine male faces, was greater in test sessions where women had high testosterone levels. Additionally, the reward value of sexually dimorphic faces in general and attractive female faces, but not attractive male faces, was greater in test sessions where women had high estradiol-to-progesterone ratios. These results provide the first evidence that the motivational salience of facial attractiveness and sexual dimorphism is modulated by within-woman changes in hormone levels.

1. Introduction

Facial attractiveness is a particularly salient social cue that influences many important social outcomes. For example, people prefer to mate with, date, associate with, hire, and vote for attractive individuals (see Langlois et al., 2000 for a meta-analytic review). Several lines of evidence also demonstrate that physically attractive faces have motivational salience. For example, the extent to which people will key press to increase the length of time for which they can view faces is correlated with the physical attractiveness of the faces (Aharon et al., 2001; Levy et al., 2008; Hahn et al., 2013). Additionally, compared to viewing physically unattractive faces, viewing physically attractive faces elicits greater activation in brain regions implicated in motivation

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and the processing of rewards, such as the nucleus accumbens and medial orbitofrontal cortex (see Bzdok et al., 2011 and Mende-Siedlecki et al., 2013 for meta-analytic reviews). Moreover, behavioral measures of motivational salience predict neural measures of faces' reward value better than do perceptions of attractiveness measured by ratings (Aharon et al., 2001).

Several lines of evidence suggest that changes in women's hormone levels during the menstrual cycle may affect their perceptions of others' facial attractiveness (see Gildersleeve et al., 2014 for a meta-analytic review). For example, studies have reported that women's preferences for masculine men are positively correlated with their estradiol (e.g., Roney and Simmons, 2008; Roney et al., 2011) or testosterone (e.g., Welling et al., 2007; Bobst et al., 2014) levels. By contrast with the relatively large number of studies investigating how women's *perceptions* of others' attractiveness covary with changes in women's hormone levels, no previous studies have tested for effects of women's hormone levels on the *motivational salience* of facial attractiveness. This is surprising, given the importance of attractiveness for social interaction (Langlois et al., 2000) and research suggesting that women's testosterone (Hermans et al., 2010) or estradiol (Dreher et al., 2007) modulates the extent to which financial incentives activate brain regions involved in motivation and the processing of reward.

In light of the above, we investigated the hormonal correlates of within-woman changes in the motivational salience of male and female facial attractiveness. Women (none of whom were using any form of hormonal supplement, such as hormonal contraceptives) were each tested once a week for five weeks (i.e., each woman completed five weekly test sessions). In each of these test sessions, the motivational salience of male and female facial attractiveness was assessed and a saliva sample was collected. The motivational salience of faces was measured using a standard key-press task that has previously been shown to be a particularly good predictor of neural measures of the reward value of faces (Aharon et al., 2001). Saliva samples were analyzed for estradiol, progesterone, and testosterone levels.

Many previous studies of hormone-mediated responses to faces have emphasized the potential importance of sexually dimorphic facial characteristics, particularly in men's faces (reviewed in Gildersleeve et al., 2014). Since the relationship between men's facial attractiveness and sexual dimorphism is complex (reviewed in Roney et al., 2011), with many studies finding no correlation between sexual dimorphism and attractiveness, we also tested for possible effects of hormone levels on the motivational salience of sexual dimorphism in faces. Given that sexual dimorphism and attractiveness are more reliably and highly correlated in female than male faces (see Rhodes, 2006 for a meta-analytic review), the effects of hormone levels on responses to attractiveness and sexual dimorphism in female faces may be more similar than the corresponding effects for male faces.

2. Methods

2.1. Participants

Fifty heterosexual women (mean age = 21.2 years, SD = 2.89 years) participated in the study. All participants were students at the University of Glasgow (Scotland, UK). None of these women were currently pregnant, breastfeeding, or taking any form of hormonal supplement, and all indicated that they had not taken any form of hormonal supplement in the 90 days prior to participation. All participants provided written, informed consent.

2.2. Face stimuli

Stimuli were full-color face images of 50 white adult men (mean age = 24.2 years, SD = 3.99 years) and 50 white adult women (mean age = 24.3 years, SD = 4.01 years). Photographs were taken under standardized photographic conditions and depicted individuals who were posed front on to the camera with neutral emotional expressions and direct gaze. Images were aligned on pupil position and masked so that clothing was not visible.

In order to establish the attractiveness of the faces for comparison with motivational salience, the 50 male faces were rated for attractiveness by 100 heterosexual women and 100 heterosexual men (mean age = 24.7 years, SD = 5.87 years) using a 1 (much less attractive than average) to 7 (much more attractive than average) scale. A different set of 100 heterosexual women and 100 heterosexual men (mean age = 25.0 years, SD = 5.56 years) rated the 50 female faces using the same 7-point scale. Participants were randomly allocated to rate either male or female faces. Trial order within each block was fully randomized.

Inter-rater agreement was high for attractiveness ratings of both the male (Cronbach's $\alpha = 0.99$) and female (Cronbach's $\alpha = 0.99$) faces. Because mean ratings derived from female and male raters' scores were highly correlated for both male ($r = 0.97$, $N = 50$, $p < 0.001$) and female ($r = 0.96$, $N = 50$, $p < 0.001$) faces, we combined ratings from female and male raters to produce a single attractiveness score for each face. These facial attractiveness scores were used in our main analyses (see Section 3).

In order to establish the sexual dimorphism of the faces for comparison with motivational salience, the 50 male faces were rated for masculinity by 100 heterosexual women and 100 heterosexual men (mean age = 24.4 years, SD = 5.32 years) using a 1 (much less masculine than average) to 7 (much more masculine than average) scale. A different set of 100 heterosexual women and 100 heterosexual men (mean age = 24.3 years, SD = 5.19 years) rated the 50 female faces for femininity using a 1 (much less feminine than average) to 7 (much more feminine than average) scale. Other than the rating scale used, the procedure was identical to the procedure used to collect attractiveness ratings.

Inter-rater agreement was high for sexual dimorphism ratings of both the male (Cronbach's $\alpha = 0.99$) and female (Cronbach's $\alpha = 0.99$) faces. Because mean ratings derived from female and male raters' scores were highly correlated for both male ($r = 0.97$, $N = 50$, $p < 0.001$) and female ($r = 0.97$, $N = 50$, $p < 0.001$) faces, we combined ratings from female and male raters to produce a single sexual dimorphism score for each face. These sexual dimorphism scores were used in our main analyses (see Section 3).

Attractiveness and sexual dimorphism ratings were highly correlated for female faces ($r = 0.86$, $N = 50$, $p < 0.001$). The correlation between attractiveness and sexual dimorphism