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Integrating physical and social cues when forming face preferences: Differences among low and high-anxiety individuals

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This study investigated individual differences in the integration of social (i.e., direction of social interest) and physical (i.e., apparent health) cues in a face preference test. While low-anxiety individuals demonstrated preferences for social engagement from healthy-looking faces, but not from unhealthy-looking faces, high-anxiety individuals preferred social engagement from both healthy and unhealthy individuals. Importantly, anxious individuals were not simply less discriminating in their face preferences generally: anxiety levels were positively related to the strength of overall preferences for positive social interest. Collectively, our findings show that perceptions of gaze and expression can be modulated by aspects of facial appearance and that systematic variation among individuals exists in the extent to which this modulation occurs. Furthermore, since previous studies have demonstrated hypersensitive amygdala responses among anxious individuals when viewing faces, our findings suggest that the amygdala may play an important role in determining how different facial cues are integrated in person perception.

INTRODUCTION

Although many researchers have suggested that facial attractiveness is a simple physical property of faces, findings from recent fMRI and behavioral studies demonstrate that people integrate social cues (e.g., expression and gaze direction) and physical cues when forming face preferences (Jones, DeBruine, Little, Conway, & Feinberg, 2006; Kampe, Frith, Dolan, & Frith, 2001; O'Doherty et al., 2003). Brain-imaging studies show that differential responses in brain regions implicated in processing rewards (medial orbito frontal cortex and ventral thalamus) when viewing attractive and unattractive faces are more pronounced when the faces viewed are engaging

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with the viewer (i.e., are shown with direct gaze or are smiling) than when the faces are not engaging with the viewer (i.e., are shown with averted gaze or neutral expression; Kampe et al., 2001; O'Doherty et al., 2003). These findings suggest that attractive faces have high reward value, particularly when they show interest in the viewer (Kampe et al., 2001; O'Doherty et al., 2003). Furthermore, Jones et al. (2006) found that preferences for attractive faces are stronger when the faces are smiling at the viewer than when they are smiling elsewhere or have neutral expressions. Collectively, these findings demonstrate that responses to physical attractiveness are qualified by the extent to which the face shows positive social interest in the viewer. This may reflect a mechanism that facilitates allocation of more social effort to the most attractive individuals who appear likely to reciprocate this interest (Jones et al., 2006; Mason, Tatkow, & Macrae, 2005; O'Doherty et al., 2003). Although many sources of individual differences in preferences for physical cues associated with facial attractiveness have been identified (e.g., effects of menstrual cycle phase on preferences for masculinity and apparent health in faces; Jones et al., 2005b, 2005a; Penton-Voak et al., 1999), individual differences in how people integrate physical attractiveness and social cues have not yet been investigated.

Many studies have implicated the amygdala in processing gaze direction (Calder et al., 2002; George, Driver, & Dolan, 2001; Hoffman & Haxby, 2000; Kawashima et al., 1999) and expressions such as smiling, anger and fear (Adams, Gordon, Baird, Ambady, & Kleck, 2003; Pegna, Khateb, Lazeyras, & Seghier, 2005; Zald, 2003). Other findings suggest that the amygdala is important for directing attention to emotional signals (Johnston, 2005; Vuilleumier, Armony, Driver, & Dolan, 2003) or the eyes (Adolphs et al., 2005). As social anxiety is associated with hypersensitive amygdala responses when viewing faces (Birbaumer et al., 1998), anxious individuals may be particularly attentive to gaze and expressions when forming face preferences.

In light of the above, here we compared anxious and non-anxious individuals' preferences for positive social interest from attractive and unattractive faces. We compared viewer-directed and other-directed smiles because the effect of gaze direction on the strength of preferences for physical attractiveness is stronger for judgments of smiling faces than judgments of faces with neutral expressions (Jones et al., 2006). We used computer graphic methods (Rowland & Perrett, 1995; Tiddeman, Burt, & Perrett, 2001) to independently and systematically manipulate the apparent health (and therefore attractiveness; Jones et al., 2005b, 2005a) of video clips of face images and to manipulate dynamic cues signaling the direction of the depicted individuals' social interest (i.e., viewer-directed and other-directed smiles). This method for manipulating the appearance of face images ensures that cues signaling the direction of social engagement are identical in the high and low apparent health images (Rowland & Perrett, 1995; Tiddeman et al., 2001).

Given previous findings for the effects of cues of social interest on the extent to which attractive and unattractive faces cause different responses in neural substrates implicated in processing rewards (Kampe et al., 2001; O'Doherty et al., 2003), we predicted that low-anxiety individuals would demonstrate stronger preferences for perceiver-directed smiles when viewing healthy-looking faces than when viewing relatively unhealthy-looking faces. However, if social anxiety, which is associated with hypersensitive amygdala responses when viewing faces (Birbaumer et al., 1998), disrupts normal integration of physical cues of attractiveness and social signals of others' attitudes and intentions when processing faces, then anxious individuals may prefer perceiver-directed smiles in both healthy and unhealthy faces. By contrast, if anxious individuals prefer perceiver-directed smiles in healthy faces, but not unhealthy faces, then this would suggest that greater amygdala responses associated with social anxiety do not affect how physical and social cues are integrated in person perception. Thus, comparing the selectivity of anxious and non-anxious individuals' preferences for perceiver-directed smiles may offer insight into the role of the amygdala in the integration of diverse facial cues in person perception.

METHOD

Stimuli

To test for differences in how relatively anxious and non-anxious people integrate facial cues associated with social engagement and health, we first manufactured video sequences (see Rowland & Perrett, 1995, and Tiddeman et al.,

2001, for technical details of the computer graphic methods used for this) in which a composite female face (an average of 10 individual female faces), initially depicted with a neutral expression, either oriented its gaze from an averted position to a direct position while smiling (simulating prosocial behavior being directed towards the viewer) or oriented its gaze from a direct position to an averted position while smiling (simulating prosocial behavior being directed away from the viewer). Video clips consisted of 15 frames playing at a rate of 15 frames per second. Gaze direction was varied in these video clips by morphing from a composite with direct gaze towards a version in which the position of the irises had been shifted to the left. This method of manipulating gaze direction in face images has been used in previous studies of the effects of gaze direction on expression perception (e.g., Jones et al., 2006) and ensures that other aspects of the face images are not altered.

Next, we manufactured healthy and unhealthy versions of the video clips. To ensure cues to the direction of social engagement were identical in healthy and unhealthy versions of the video clips, we used a prototype-based transformation method (see Rowland & Perrett, 1995, and Tiddeman et al., 2001, for technical details of this method). Briefly, prototype-based transformation alters the properties of a face using the vector differences between two prototypes. Prototypes are composite images that are constructed by averaging the shape, color and texture of a group of faces, such as male or female faces. Prototypes can then be used to transform images by calculating the vector differences in position between corresponding points on two prototype images and changing the position of the corresponding points on a third image by a given percentage of these vectors. The differences between color values at each corresponding pixel can be similarly transformed.

Here we manipulated the apparent health of the composite face shown in the video clips by transforming each frame of the video clips using healthy and unhealthy prototype faces. Healthy versions of the video clips were manufactured by adding 150% of the vector differences in shape, color and texture between a healthy prototype and an unhealthy prototype to the face image in each frame of the video clips. Using the same methods, unhealthy versions of the video clips were manufactured by subtracting 150% of the vector differences in shape, color and texture between a healthy prototype and an unhealthy prototype. Healthy and unhealthy prototypes were manufactured by averaging the shape, color and texture information (see Rowland & Perrett, 1995; Tiddeman et al., 2001) from 15 female faces judged particularly healthy and 15 female faces judged particularly unhealthy. These faces were taken from a sample of 60 white women (17–23 years old) that had been rated for health by 20 independent raters (10 male, all aged 18–26 years old, interrater agreement: Cronbach's alpha = .84). This process created 2 versions of each of the original video sequences, each version being identical in terms of cues associated with social engagement (smiling, gaze direction) but varying in health of appearance (see Figure 1). Previous studies have established that manipulating the apparent health of face images in this way influences attributions of both health and attractiveness (e.g., Jones et al., 2005b).

Procedure

Participants ($N = 128$; mean age = 20.43 years, $SD = 6.08$; 71 female) viewed these full-color video clips, which were displayed in a randomized order, one video clip at a time, and rated the attractiveness of the person depicted in each video clip using a 1 (*low*) to 7 (*high*) scale. Participants rated the attractiveness of each video clip twice: once where the direction of eye movement was left to right and once where each frame in the video clip had been mirror reversed and in which the direction of eye movement was right to left. Filler trials were interspersed throughout the test. These filler trials consisted of face images that had not been manipulated in apparent health or cues associated with social engagement. Participants also reported their age and sex and completed assessments of trait anxiety: Beck Anxiety Inventory (Beck, Epstein, Brown, & Steer, 1988) and the State Trait Anxiety Inventory (STAI; Spielberger, 1968/1977).

Scores on the two anxiety measures were positively related ($r = .50$, $p < .001$) and were reduced to a single factor that explained $\sim 75\%$ of the variance in scores (loadings for both anxiety measures onto this factor were $> .8$). Participants scoring below the mean on this composite measure ($N = 69$) were assigned to the low anxiety group and participants scoring

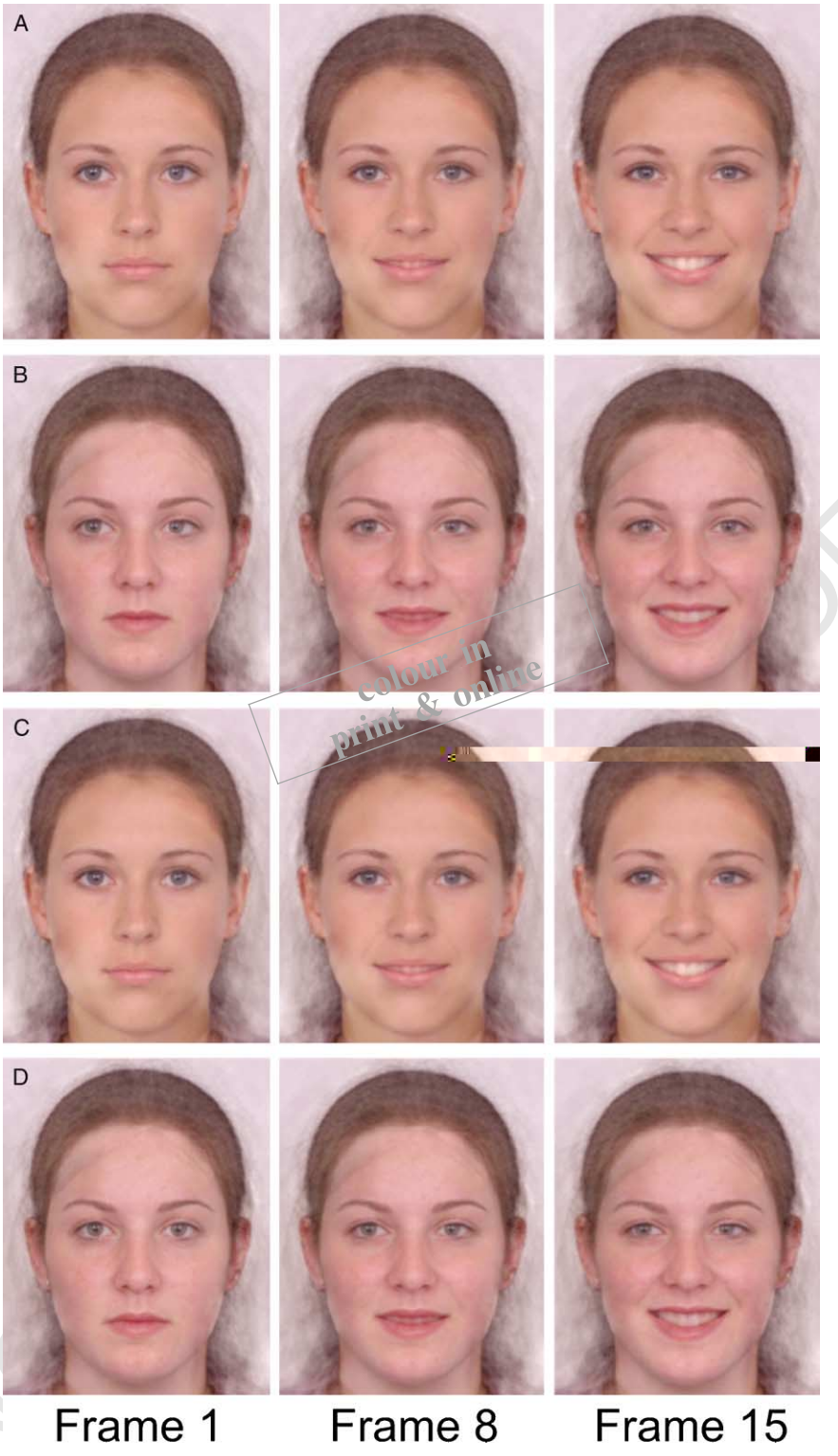

Figure 1. First (1st), middle (8th) and last (15th) frames from video clips used in the study. Sequences of images were manufactured in which a face image either directed social interest towards participants (Sequences A and B) or away from participants (Sequences C and D). The face images in these sequences had also been manipulated to appear particularly healthy (Sequences A and C) or unhealthy (Sequences B and D). Participants viewed these video clips in a randomized order and rated the attractiveness of the person depicted.

above the mean on this composite measure ($N = 59$) were assigned to the high anxiety group.

RESULTS

Attractiveness ratings were analyzed using a mixed-design ANOVA, within-subjects factors: Apparent Health of Face (healthy, unhealthy), Direction of Prosocial Behavior (towards participant, away from participant); between-subjects factors: Participant Anxiety Level (low, high), Participant Sex (male, female); covariate: Participant Age. This analysis revealed a three-way interaction among direction of prosocial behavior, apparent health of face and participant anxiety level, $F(1, 123) = 4.63$, $p = .033$; see Figure 2, and a main effect of health of face, $F(1, 123) = 30.07$, $p < .001$. Faces with high apparent health were rated as more attractive than faces with low apparent health. There were no other significant effects (all Fs < 3.2, ps $> .07$).

As predicted, the low anxiety group preferred prosocial behavior that was directed at them rather than away from them when judging faces that appeared healthy, $t(68) = 2.62$, $p = .011$; perceiver-directed: $M = 5.07$, $SD = 0.95$; other-directed: $M = 4.86$, $SD = 1.05$, but not when judging faces that appeared unhealthy, $t(68) = -0.27$, $p = .789$; perceiver-directed: $M = 3.67$, $SD = 1.10$; other-directed: $M = 3.69$, $SD = 1.14$. By contrast, the high anxiety group preferred prosocial behavior that was directed at them rather than away from them when judging both healthy faces, $t(58) = 3.67$, $p = .001$; perceiver-directed: $M = 4.89$, $SD = 1.25$; other-directed: $M = 4.66$, $SD = 1.21$, and unhealthy faces, $t(58) = 2.88$, $p = .006$; perceiver-directed: $M = 3.70$, $SD = 1.21$; other-directed: $M = 3.38$, $SD = 1.13$.

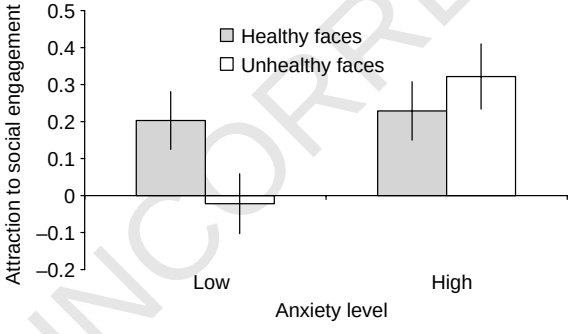

Figure 2. The three-way interaction among direction of social engagement, apparent health of face in video clip and participant anxiety, $F(1, 123) = 4.63$, $p = .033$. Bars show mean preferences for social engagement (i.e., attractiveness rating of faces engaging with participant minus attractiveness rating of faces disengaging with them) and standard error for these scores.

Next we tested for relationships between anxiety level and the overall strength of preferences for perceiver-directed smiles and health using linear regression. In the first analysis, dependent variable: strength of preference for healthy faces; independent variables: participant age, participant sex, anxiety level, the overall model was not significant, $F(3, 124) = 0.80$, adjusted $R^2 = -.005$, $p = .495$, and there were no significant relationships between any of the independent variables and strength of preference for healthy faces (all absolute ts < 1.40, all absolute standardized betas $< .13$, all ps $> .16$). Although the overall model in the second analysis, dependent variable: strength of preference for perceiver-directed smiles; independent variables: participant age, participant sex, anxiety level, was also not significant, $F(3, 124) = 2.40$, adjusted $R^2 = .032$, $p = .071$, there was a significant association between anxiety level and the strength of preference for perceiver-directed smiles ($t = 2.49$, standardized beta $= .22$, $p = .014$). There were no other significant effects (all absolute ts $< .33$, all absolute standardized betas $< .03$, all ps $> .74$). Collectively, these regression analyses show that anxiety level was positively related to the overall strength of preference for perceiver-directed smiles, but did not predict the overall strength of preference for healthy faces.

DISCUSSION

Low-anxiety individuals demonstrated preferences for positive social interest directed towards them by healthy-looking, attractive faces, but not positive social interest directed towards them by unhealthy-looking, unattractive faces. This finding complements findings from brain-imaging studies that showed that activity in brain regions implicated in the processing of rewards when viewing attractive faces is dependent on the extent to which the face appeared to be engaging with the viewer (either by directing gaze towards the viewer or by smiling at the viewer; Kampe et al., 2001; O'Doherty et al., 2003). This finding also complements past behavioral evidence that found that cues associated with social engagement increased the strength of preferences for attractive faces (Jones et al., 2006). By contrast with our findings for low-anxiety individuals,

high-anxiety individuals demonstrated preferences for social interest directed towards them by both healthy- and unhealthy-looking faces. In other words, anxious individuals were less selective about the source of social engagement than low-anxiety individuals were. It is noteworthy that anxious individuals were not simply less discriminating in their face preferences generally: anxiety levels were positively related to the strength of overall preferences for positive social interest (i.e., viewer-directed smiles).

The amygdala is implicated in attention to emotional stimuli (Johnston, 2005; Vuilleumier et al., 2003) and the eyes (Adolphs et al., 2005), and anxiety is associated with hypersensitive amygdala responses (Birbaumer et al., 1998). This may cause anxious individuals to be preoccupied with social cues when processing faces and to integrate physical and social cues in a manner that is qualitatively different to that which is evident in non-anxious individuals. Thus, our findings suggest that the amygdala may play an important role in the integration of different facial cues.

While it is well established that anxiety levels are positively related to incidence of illness among individuals (e.g., Rawson, Bloomer, & Kendall, 1994), explanations of this relationship have typically emphasized the effects of anxiety and stress on immune system function (Glaser & Kiecolt-Glaser, 2005) or the availability of social support (Rawson et al., 1994). However, as an aversion to interacting with unhealthy individuals will reduce the likelihood of contracting illnesses during social interactions (Jones et al., 2005b), our results suggest the novel hypothesis that anxious individuals may also increase their chances of contracting illness by not discriminating between approaches from healthy and unhealthy individuals during social interactions.

Collectively, our findings reveal individual differences in how physical and social cues are integrated in person perception and suggest that anxious individuals' preoccupation with social engagement from faces disrupts the integration of this information with that from physical cues, causing anxious individuals to be less discerning about the type of faces in which they consider positive social interest attractive. Although there has been little research into the effects of facial appearance on perceptions of expression and gaze, our findings show that perceptions of gaze and expression can be modulated by aspects of facial appearance (e.g., apparent health) and that systematic variation among individuals exists in the extent to which this modulation occurs. Furthermore, our findings suggest that hypersensitive amygdala responses when anxious individuals view faces can disrupt the selectivity of their preferences for perceiver-directed smiles, suggesting that the amygdala may play an important role in determining how information from diverse facial cues is integrated in person perception.

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