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Infant's visual preferences for facial traits associated with adult attractiveness judgements: Data from eye-tracking

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A B S T R A C T

Human preferences for facial attractiveness appear to emerge at an early stage during infant development. A number of studies have demonstrated that infants display a robust preference for facial attractiveness, preferring to look at physically attractive faces versus less attractive faces as judged by adults. However, to-date, relatively little is known about which traits of the face infants use to base these preferences upon. In contrast, a large number of studies conducted with human adults have identified that preference for attractive faces can be attributed to a number of specific facial traits. The purpose of the experiments here was to measure and assess infant's visual preference via eye-tracker technology for faces manipulated for one of three traits known to effect attractiveness judgments in adult preference tests: symmetry, averageness, and sexually dimorphic traits. Sixty-four infants (28 female and 36 male) aged between 12 and 24 months old each completed a visual paired comparison (VPC) task for one of the three facial dimensions investigated. Data indicated that infants displayed a significant visual preference for facial symmetry analogous to those preferences displayed by adults. Infants also displayed a significant visual preference for feminine versions of faces, in line with some studies of adult preferences. Visual preferences for facial non-averageness, or distinctiveness were also seen, a pattern opposite to that seen in adults. These findings demonstrate that infant's appreciation for facial attractiveness in adult images between the ages of 12 and 24 months of age is based on some, but not all, traits that adults find attractive.

1. Introduction

Observational and experimental findings suggest that humans display preferences for facial stimuli at an early age. Several studies have reported that infants and newborns are particularly attuned to facial stimuli and appear to spontaneously orient themselves towards and look longer at configurations that more closely represent a face versus those in a non-face like arrangement (Cassia, Turati, & Simion, 2004; Goren, Sarty, & Wu, 1975; Valenza, Simion, Cassia, & Umilta, 1996). A number of studies have also demonstrated that, within hours from birth, infants not only actively discriminate between

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their mother's face and those of female strangers, but also that the mothers face is preferred (looked at in preference) to those of a stranger (Bushnell, Sai, & Mullin, 1989; Field, Cohen, Garcia, & Greenberg, 1984; Pascalis, Deschonen, Morton, Deruelle, & Fabregrenet, 1995; Walton, Bower, & Bower, 1992).

As well as preferences for face-like stimuli and mother's faces, it also appears that visual preferences for facial attractiveness emerge at an early stage during infant development (Geldart, Maurer, & Carney, 1999; Langlois, Ritter, Roggman, & Vaughn, 1991; Langlois et al., 1987; Slater, Quinn, Hayes, & Brown, 2000; Slater, Von der Schulenberg, Brown, Badenoch, & Butterworth, 1998). A number of studies have demonstrated that by 2 months of age human infants display a robust preference for facial attractiveness: infants prefer to look at human faces rated as physically attractive by adults over less attractive faces (Langlois et al., 1987; Slater et al., 1998). These preferences for faces that adults find attractive are displayed towards a variety of human faces, including adult male and adult female faces (Langlois et al., 1991; Samuels & Ewy, 1985), infant faces (Van Duuren, Kendell-Scott, & Stark, 2003) and Caucasian and African American adult faces (Langlois et al., 1991), suggesting that infant preferences for facial attractiveness as judged by adults may be generalised across sex, age, and race. These preferences also appear to be dependent on orientation, and therefore face specific, as infant preferences for attractiveness are apparent only when faces are upright and not inverted (Slater et al., 2000).

Infants display face preferences that may be innate or develop and emerge early within their development. However, relatively little is known about *which* face traits infants prefer, despite a large number of studies conducted with human adults having identified that preference for attractive faces can be attributed to various facial traits. For example, generally, adults prefer average and symmetric face images (for reviews see Little, Jones, & DeBruine, 2011; Rhodes, 2006; Thornhill & Gangestad, 1999). In women's faces, femininity is generally preferred, but for men's faces studies report mixed findings with preferences for feminine and masculine male faces seen across studies (for reviews see Little et al., 2011; Rhodes, 2006; Thornhill & Gangestad, 1999).

Infant preferences for some *types* of face have been identified. For example, infants display visual preferences for neotonous or babyfaced faces (Geldart et al., 1999; Kramer, Zebrowitz, San Giovanni, & Sherak, 1995; McCall & Kennedy, 1980) and spend longer looking at baby-faced than at mature-faced adults that are equated for attractiveness (Kramer et al., 1995). Preferences for neotonous or baby-like faces appears to be robust in infant studies. In contrast to neotony preferences, the few studies that have attempted to measure the role that facial traits such as symmetry and averageness play in infant preferences for faces have obtained mixed results. Rubenstein, Kalakanis, and Langlois (1999) investigated the effect that facial averageness (vs. distinctiveness) had on the visual preferences displayed by 6-month old infants and found that infants looked significantly longer at an average version of a female face than at an individual, non-average female face. Rhodes, Geddes, Jeffery, Dziurawiec, and Clark (2002) investigated the visual preferences of 5- to 8-month old infants and found that infants were sensitive to differences in both symmetry and averageness (determined via the length of the longest look towards a face). However, unlike Rubenstein et al. (1999), Rhodes et al. found that infants displayed no significant visual preference towards more average or more symmetric faces. Similarly, no significant visual preference for facial symmetry was found by Samuels, Butterworth, Roberts, Graupner, and Hoyle (1994) who showed pairs of normal and symmetric versions of faces to 4- to 5-month old infants.

While these findings are mixed, they appear to suggest that facial traits such as symmetry and averageness may not be important in an infant's assessment of facial attractiveness. However, there are possible methodological issues regarding the quality and suitability of the stimuli used, and/or the procedural method conducted that may account for a lack of visual preference in some prior studies. For example, in terms of stimuli number, Rubenstein et al.'s study on facial averageness used only a small sample of 4 pairs of faces. In terms of stimuli type, Samuels et al. (1994) used symmetrical stimuli that were created by reflecting each half of the face along the vertical midline, a method known to produce versions of faces which often contain structural abnormalities, judged to be unattractive to adults (Langlois, Roggman, & Musselman, 1994). Additionally, prior studies were all conducted on infants less than 12 months of age and so preferences for these specific traits may simply be not apparent at the ages tested.

The purpose of the current experiments was to investigate infant's visual preference for faces manipulated for three traits known to effect attractiveness judgments in adult human preference tests: bilateral facial symmetry, facial averageness, and sexually dimorphic traits. It may be predicted that infants' posses some of the facial preferences displayed by adults because of shared brain mechanisms that lead to such preferences. For example, preferences for symmetry may arise out of general perceptual mechanism or else there may be specialised mechanisms that generate preferences for symmetry (see e.g., Little & Jones, 2003 for discussion). Here visual preference was recorded, measured and analysed directly via an eye-tracker monitor and software, an improvement over previous preference studies which have monitored and recorded infant's visual behaviour via human coding (Langlois et al., 1991; Rhodes et al., 2002; Rubenstein et al., 1999). This technology allowed us to obtain a more reliable and accurate measure of infant's visual behaviour in relation to the stimuli presented and removed the potential for possible experimenter error and bias when recording and coding visual behaviour. Additionally, we also examined older infants between 12 and 24 months old. In the current experiments, we presented pairs of stimuli made using state-of-the-art computer graphic software that consisted of two manipulated versions of each face (average/non-average, symmetric/asymmetric, masculinised/feminised) following the experimental methodologies of previous studies conducted into human adult preferences for various facial traits (for reviews see Little et al., 2011; Rhodes, 2006; Thornhill & Gangestad, 1999).

2. Methods

2.1. Participants

In total, sixty-four healthy, full-term Caucasian infants (28 female and 36 male) aged between 12 and 24 months old (mean age of 19 months and 10 days, SD = 4.3 months) participated in the three experiments. Mothers with their infants were recruited from a visitor centre at Edinburgh Zoo, UK.

2.2. Original stimuli

Experimental stimuli were constructed via the use of computer transformation techniques (Benson & Perrett, 1993; Tiddeman, Burt, & Perrett, 2001), following methodology used in previous facial preference studies of human adults and infants (Perrett et al., 1998, 1999; Little & Hancock, 2002; Rhodes et al., 2002). Twenty original images of young adult males and females (10 male and 10 female) were selected at random from a larger, pre-existing set of stimuli. All images were colour, front-on view faces with neutral expressions. Photographs were taken under standardised lighting conditions and individuals were unfamiliar to the experimental participants. This original stimulus set was used to create 3 sets of 20 pairs of faces (10 male and 10 female pairs) manipulated for facial averageness, bilateral symmetry, and sexual dimorphism. Details of each manipulation can be found below.

2.3. Stimuli manipulations

Manipulated stimuli were constructed using Psychomorph whereby key locations (174 points) are manually marked around the main features (e.g. nose, eyes, mouth) and outline of each individual original face (e.g. jaw line, hair line) (see Perrett et al., 1998, 1999 for technical details). Three separate manipulations (facial averageness/bilateral symmetry/sexual dimorphism) were then applied to these original individual faces. The size of all resulting manipulated images was matched by standardisation of the inter-pupil distance and each image was cropped around the face and presented against a standardised black background (for an example see Fig. 1).

Two composites image, representing the average colour and shape of multiple face images, were made from sets of 50 male and 50 female images to be used for manipulations of averageness and sexual dimorphism from images randomly selected from the larger, pre-existing stimuli set of front view faces following techniques widely used to create composite images in previous preference studies involving manipulation of facial averageness and sexual dimorphism (Benson & Perrett, 1993; Little & Hancock, 2002).

2.3.1. Averageness

Average and non-average versions of each individual image were created by applying the vector difference in shape alone between the features of a same sex 50-image composite and an original image of the face selected for manipulation. The resulting transformations represented ±50% and −50% of the difference between the 50-image composite and the original face. Each image was made perfectly symmetrical (in shape alone). The completed stimuli set of 20 pairs of images (10 male and 10 female) consisted of 1 average and 1 non-average version of the same original face (see Fig. 1).

2.3.2. Symmetry

Symmetrical and asymmetrical versions of each individual base face were created by averaging the height and lateral position (relative to the midline, perpendicular to, and bisecting the interpupillary line) of each corresponding pair of feature markers on the left and right sides of the face. Using this method each of the 20 original faces (10 male and 10 female) could be remapped into their corresponding symmetric shape (for further details see Perrett et al., 1999). Faces were made symmetric in shape alone and the original textural cues of each face were maintained. Asymmetrical versions of each face were also produced by utilising the linear difference between the feature points of the symmetric and original images and manipulating each original Image 50% towards asymmetry. The completed stimuli set of 20 pairs of images consisted of 1 perfectly symmetrical and 1 +50% asymmetric version of the same original face (see Fig. 1).

2.3.3. Sexually dimorphic traits (femininity and masculinity)

The sexual dimorphism of each of the 20 original faces was manipulated using the vector difference in shape between an average male (a composite of 50 male faces) and an equivalent average female (a composite of 50 female faces). The resulting transformations represented ±50% and −50% of the difference between these average male and female composites to create feminised and masculinised versions of each of the original faces. Each image was also made perfectly symmetric (in shape alone). The completed stimuli set of 20 pairs of images (10 male, 10 female) consisted of 1 masculinised and 1 feminised version of the same original face (see Fig. 1).

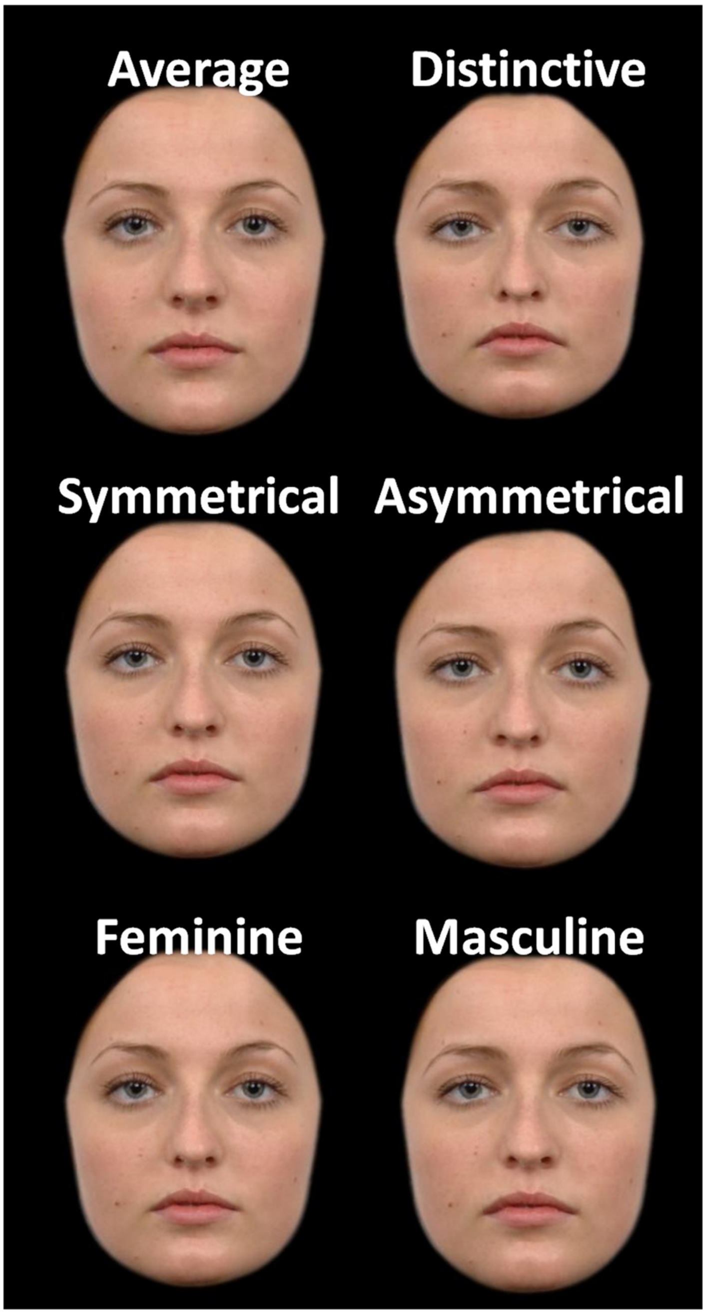

Fig. 1. Examples of paired composite (top) average (left) and distinctive/non-average (right); (middle) symmetrical (left) and asymmetrical (right); and (bottom) feminised (left) and masculinised (right) versions of female faces. Example transformed female image is from the Radboud Faces Database (Langner et al., 2010).

2.4. Apparatus

Pairs of manipulated stimuli were presented to participants on a 17″ thin film transistor technology (TFT) monitor (TOBII 1750). Calibration procedures were conducted using Clearview software (TOBII Technology, Sweden) allowing an optimal accuracy of 0.5 degrees and infants visual behaviour and fixations were recorded via infra-red light sources and cameras integrated into the TOBII monitor. Using corneal reflection techniques the TOBII eye-tracker records the *X* and *Y* coordinates of the infant's eye position in relation to the monitor which can then be used to ascertain an individual's visual behaviour. Timing and presentation of images was controlled via eye-tracker specific software (TOBII Technology, Sweden) and E-prime software (version 2.0.8.22).

2.5. Procedure

Following a similar experimental procedure to previous studies investigating infant preference for faces (Langlois et al., 1991; Rhodes et al., 2002), participants completed a standard visual paired comparison task (VPC) in which two manipulated versions of the same face were simultaneously presented on the eye-tracker monitor. The study consisted of 3 separate experiments, one for each of the experimental manipulations applied to the faces (averageness, symmetry, and sexual dimorphism). Each participant was randomly assigned to one of these three conditions. In total 21 participants (14 male and 7 female) completed the facial averageness preference test, 20 participants (12 male and 8 female) completed the symmetry preference test, and 23 participants (10 male and 13 female) completed the sexual dimorphism preference test. A one-way ANOVA with age as the dependent measure and condition (averageness/symmetry/sexual dimorphism) as a between-participant factor revealed no significant difference in age among the infants assigned to the different conditions, $F(2,62) = 1.00$, $p = .373$.

2.6. Calibration

Prior to testing, each participant was individually calibrated to the eye-tracker monitor. Infants were seated on their parent's lap approximately 60 cm in front of the TOBII monitor. Parents were asked to avert their gaze from the eye-tracker monitor during the calibration process. The position of the monitor was manipulated by the experimenter to suit the height of each individual so that the integrated infrared cameras of the TOBII monitor could accurately detect the infant's corneal reflection. Infants were shown a bright red dot which appeared in a 5-point calibration sequence displayed on the TOBII monitor. Calibration output was checked for accuracy and repeated where necessary.

2.7. Experimental trials

Following calibration, participants were tested using a VPC task consisting of 20 trials in total (10 pairs of manipulated male and 10 pairs of female faces). Although the initial calibration procedure removed the possibility that parents, rather than infants, eye movements could be recorded, parents were asked to avert their gaze from the eye-tracker monitor throughout the entirety of the experiment. Infants remained seated on their parents lap approximately 60 cm from the TOBII monitor throughout the experiment. Parents were informed of the purpose and design of the experiment via on-screen instruction, and infants were required to simply observe the paired images displayed on the monitor.

During each trial, manipulated versions of an individual adult face (e.g. symmetrical vs. asymmetrical) were presented in pairs to the infant (image size = 640×1000 pixels) in 24-bit colour on the TOBII eye-tracker monitor. Each pair of faces was presented for 5 s followed by a black screen and fixation point consisting of a large cartoon image presented centrally on the screen used to attract the infants attention to the monitor. To ensure infant's gaze was directed solely at the monitor, a new trial began only when the infant's attention was focused on the fixation point presented in the centre of the eye-tracker monitor for a duration of 1 s at which point the fixation image disappeared and a new pair of manipulated images were presented.

The order of stimuli presentation was randomised between subjects and presentation of stimuli (left/right) was counterbalanced within subjects. Trials were excluded if external disturbances (e.g. noise) caused distraction or the infant was orientated away from the stimuli for more than 50% of the presentation time in each trial. Various measures of looking behaviour were record via TOBII software and here we focus on the mean fixation length at each of the images in the pair. Using TOBII software, areas of interest (AOI) were defined on stimuli in order to compare the looking behaviour displayed towards each pair of faces. The AOIs defined for all faces were equal in area (48.46% of the total area) and encompassed the entire face in all presentations. Looking duration for each trial was measured based on these AOIs and a mean fixation length was calculated for each sex and type of face in the particular test (e.g., mean fixation length for asymmetric male, symmetric male, asymmetric female, and symmetric female faces was calculated for the symmetry preference test).

3. Results

Visual preference for each trait was calculated by taking the average fixation length for average, symmetric, and feminine images and subtracting the average fixation length for less average, asymmetric, and masculine images. We ran mixed-model ANOVAs with sex of face as a within-participant factor and with age entered as a covariate. Follow-up tests were conducted as one-sample t-test (test value = 0) using difference scores calculated from each individual's total fixation length.

3.1. Average vs. non-average faces

The mixed model ANOVA revealed no significant effect of sex of face, $F(1,19) = 0.61$, $p = .446$, and no interaction between sex of face and age, $F(1,19) = 0.21$, $p = .652$. There was no main effect of age, $F(1,19) = 2.77$, $p = .112$.

We therefore collapsed means across male and female faces. A one-sample t-test revealed that infants displayed a significant visual preference for non-average vs. average versions of faces, $M = -1.34$, $SE = .53$, $t(20) = -2.53$, $p = .02$, Fig. 2.

3.2. Symmetrical vs. asymmetrical faces

The mixed model ANOVA revealed no significant effect of sex of face, $F(1,18) = 0.01$, $p = .945$ and no significant interaction between sex of face and age, $F(1,18) = 0.25$, $p = .623$. There was no main effect of age, $F(1,18) = 1.30$, $p = .269$.

A one sample t-test revealed that overall infants displayed a significant visual preference for symmetrical vs. asymmetrical versions of male and female faces, $M = 1.41$, $SE = .35$, $t(19) = 4.00$, $p = .001$, Fig. 2.

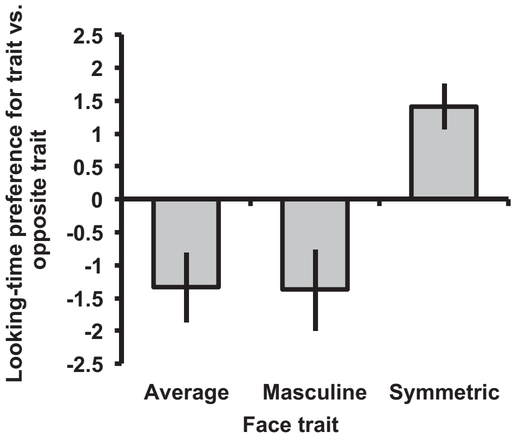

Fig. 2. Infant visual preferences for facial averageness vs. non-averageness, masculinity vs. femininity, and symmetry vs. asymmetry based on the difference between lengths of time looking at each face of a pair (±1 SEM).

3.3. Feminine vs. masculine faces

The mixed model ANOVA revealed no significant effect of sex of face, $F(1,21) = 2.67$, $p = .117$, and no significant interaction between sex of face and age, $F(1,21) = 3.27$, $p = .085$, although this interaction was close to significant. There was no main effect of age, $F(1,21) = 0.33$, $p = .572$.

A one sample *t*-test revealed that, overall, infants displayed a significant visual preference for feminised vs. masculinised faces, $M = -1.38$, $SE = .62$, $t(22) = 2.22$, $p = .037$, Fig. 2. To follow up the close to significant interaction, separate correlations between preference for femininity and participant age were carried out for male and female faces. The close to significant interaction reflected that, while neither correlation was significant, age was positively related to preferences for masculinity for female, $r = .138$, $p = .530$, but negatively related to preferences for masculinity for male, $r = -.294$, $p = .173$, faces. Comparing the *r* values after using Fisher's *r*-to-*z* transformation demonstrated that the slopes were not significantly different from each other ($z = 1.36$, $p = .174$).

4. Discussion

We found that infants aged between 12 and 24 months discriminated between faces manipulated across dimensions known to influence attractiveness judgements in human adults (Little et al., 2011; Rhodes, 2006; Thornhill & Gangestad, 1999). In line with adult preferences, our data indicated that infants spent significantly longer looking at symmetrical over asymmetrical faces. Infants also looked longer at feminine faces over masculine faces, a finding in line with general preferences for femininity seen for female faces in adult studies (Little et al., 2011; Perrett et al., 1998; Rhodes, 2006). Studies of adult preferences for femininity in male faces, however, have provided mixed results, with studies showing preferences for femininity, no preferences, and preferences for masculinity (Little et al., 2011; Perrett et al., 1998; Rhodes, 2006). Interestingly, studies suggest that preferences for masculinity in male faces are weaker pre-puberty in girls (Little et al., 2010), which is suggestive that adult-like preferences for masculinity in male faces may in part rely on hormonal changes at puberty. If true, infant preferences for feminine male faces may represent preferences closer to pre-pubertal girls than adults. Unlike human adults, who commonly display a preference for facial averageness (e.g., Little & Hancock, 2002), infants displayed a significant visual preference for the non-average rather than the average versions of faces. As looking time has been found to be closely linked to stimulus attractiveness (Langlois et al., 1987; Quinsey, Ketsetzis, Earls, & Karamanoukian, 1996), and numerous studies have employed this measure as a proxy for declared preference in both human infants (Dion, 1977; Langlois et al., 1987; Turati, Valenza, Leo, & Simion, 2005), and non-human primates (Waitt & Little, 2006), we assume that the visual preferences for facial symmetry and femininity identified here account for infants preferences for facial attractiveness in general (e.g., Langlois et al., 1987), and correspond with the declared preferences made by adults for facial symmetry and femininity (Perrett et al., 1998, 1999).

In terms of infants displaying significant preferences for facial symmetry, previous studies show that from an early age (4-months old) infants can discriminate vertical symmetry from other forms of symmetry, and from asymmetric patterns (Bornstein et al., 1981; Bornstein and Krinsky, 1985; Fisher et al., 1981). As bilateral facial symmetry is proposed to function as a biological signal to an individual's underlying genetic quality and health (Thornhill & Gangestad, 1999), it may be advantageous from an evolutionary perspective to display a significant preference for this particular facial trait even at an early stage in human development.

While preferences for non-average (distinctive) faces appear surprising, findings from previous studies support preferences for non-average faces. For example, Rhodes et al. (2002) found that, in infants at 3–4 months, the longest look towards faces was longer for non-average rather than average faces. Consequently, Rhodes et al. suggest that infants display a weak preference for non-average faces. One plausible explanation for infant's preferences for non-average faces may be an attentional bias for unexpected/unusual stimuli rather than a preference for attractiveness. Indeed, a number of experiments have found that infants display visual preferences for unusual stimuli (Rochat and Hespos, 1996; Spelke, 1985). As faces that are high in averageness are typically low in distinctiveness (Rhodes, 2006) it is likely that non-average faces appear unusual or distinctive. This may be particularly apparent in our test because images in each pair were either uniquely distinctive or moved towards the same average. In other words, infants were shown pairs in which one of the pair, the average face, was similar to images seen in previous trials while the distinctive face was more different to images seen in previous trials. Therefore preferences for non-average faces may occur because of their novel appearance which may negate any visual preferences for facial averageness due to attractiveness (see also Rhodes et al., 2002). Future studies investigating infant visual preferences could pair manipulated versions of average stimuli with normal rather than non-average faces in order to avoid this 'oddity effect' or find ways to prevent distinctiveness to be confounded with novelty.

To our knowledge, our study is the first investigating infant's visual preferences for sexually dimorphic facial traits. We found that infants displayed a significant visual preference for femininity in both male and female faces. Previous studies, however, have examined neotony, or babyfacedness, a factor aligned to the masculine/feminine dimension. Indeed, Rhodes et al. (2002) predicted that infants should display visual preferences for feminised versus masculinised versions of faces as female faces are more neotonous than male faces (Zebrowitz, 1997), and infants have been shown to exhibit significant visual preferences for neotonous facial traits (Geldart et al., 1999; Kramer et al., 1995; McCall & Kennedy, 1980). Consequently, the preference for feminine male faces seen here may reflect this preference for neotonous traits. Alternatively, as Quinn, Yahr, Kuhn, Slater, and Pascalis (2002) suggest for preferences for female faces, preferences for more feminine faces may reflect a bias for female faces in general as a consequence of infants increased exposure to female rather than male faces during early development. Visual preferences for female versus male faces have been observed in infants 3- to 4-months old (Quinn et al., 2002). As all primary caregivers in their experiment were female, Quinn et al. (2002) propose that infant preferences for female faces could arise due to a preferential response to faces (and facial features) that more closely resemble those of their primary caregiver.

In conclusion, we addressed 12- to 24-month old infant preferences for facial traits associated with adult attractiveness using state-of-the-art computer manipulated faces and eye-tracker technology. The significant visual preferences for facial symmetry identified here correspond with human adult preferences for this trait (Perrett et al., 1999). Furthermore, the patterns of preference for facial averageness and sexual dimorphic traits appear to fit previous predictions and hypotheses regarding infant preferences (Quinn et al., 2002, 2008; Rhodes et al., 2002). Femininity may be preferred because infants possess preferences for neotony or because their preferences are biased by experience towards faces more similar to their primarily care-giver, most often the mother (Quinn et al., 2002). Preferences for distinctiveness in infants versus averageness in adults is more puzzling, but could simply reflect that infants are more interested in surprising stimuli (Rochat and Hespos, 1996; Spelke, 1985) or that infants may have a poor representation of a population level average, a factor thought to determine adult preferences for averageness (Rhodes et al., 2003). Given this pattern of results, it is plausible that infant visual preference faces match adult attractiveness ratings because some traits, like symmetry, are attractive to both groups. However, for some traits there may be a mismatch in preference which could result in images that are attractive to adults but not infants and vice versa. In this way, while we see broad agreement on attractiveness between infants and adults, it is probably not true that preferences are identical, and it would be surprising if infants were born with a template dictating the optimally attractive face. Indeed, infants likely develop some adult-like preferences through experience of the world or through the maturation of other cognitive abilities as they age.

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