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Effects of eye size on adults' aesthetic ratings of faces and 5-month-olds' looking times

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Abstract. In two experiments, we investigated the influence of eye size on adults' ratings of faces' attractiveness and 5-month-olds' looking times. Subjects viewed four pairs of female faces that were identical except for the size of the eyes. Whether they saw black-and-white drawings (experiment 1) or coloured photographs (experiment 2), adults rated the faces with larger eyes as more attractive than the faces with smaller eyes. Babies looked equally long at the drawn faces with larger and smaller eyes (experiment 1), but with the more realistic photographed faces, they looked slightly but significantly longer at the versions with larger eyes (experiment 2). Overall, our results suggest that a modest preference for larger eyes that has emerged by 5 months of age may contribute to the development of adult aesthetic preferences.

1 Introduction

The notion that perceptions of beauty do not depend entirely on cultural influences comes from two types of finding: (i) adults from diverse cultural regions agree on which faces in a set are more attractive (Bernstein et al 1982; Cunningham et al 1995; Maret and Harling 1985; Perrett et al 1994) and (ii) young babies look longer at faces rated as attractive by adults than at faces rated as unattractive (Langlois et al 1987, 1991; Samuels and Ewy 1985; Samuels et al 1994; Slater et al 1998). The purpose of our research is to explore the facial characteristics that influence infants too young to have been affected by cultural conditioning and to assess whether such characteristics influence adults similarly. This type of research may provide clues to the variables influencing the development of adult aesthetic preferences before extensive cultural learning.

Previous studies of adults' perceptions of attractiveness and infants' visual preferences have explored the influence of three variables: (i) the bilateral symmetry of the internal features, (ii) the height of the internal features, and (iii) the averageness of the features. While adults rate photographs of faces whose internal features are more symmetrical about a vertical axis as more attractive than faces with less symmetrical features (Grammer and Thornhill 1994; Thornhill and Gangestad 1993; Zebrowitz et al 1996), symmetry appears not to influence young infants: those aged 4 to 9 months looked equally long at photographs of faces manipulated so that they contained perfectly symmetrical features and at natural versions of the same faces with nonsymmetrical features (Samuels et al 1994). Nor do young infants respond to the height of the internal features in the same way as adults. Adults rate photographs or drawings of faces with their features at a medium height (ie medium-sized forehead and chin) as most attractive and they rate faces with their features at a high height (ie smaller forehead, larger chin) as least attractive. In contrast, 5-month-olds tended to look longer at faces with their features at a high height—which adults rated least attractive—than at faces with low features, and in no condition did they differentiate between faces with features at a medium height—which adults found most attractive—and those with low or high features (Geldart and Maurer 1996; Geldart et al, submitted). Thus, bilateral symmetry and height of features come to influence reactions to faces sometime after infancy, perhaps because there is a role for cultural learning and/or additional experience with faces.

Unlike bilateral symmetry and the height of the faces' internal features, the averageness of the facial features does influence both adults and infants in the same way. When comparing photographs of individual Caucasian faces with a composite averaged from the group of faces, Caucasian 6-month-olds looked longer at the averaged face, and Caucasian adults rated it as more attractive (Rubenstein et al 1997). Adults have been shown to rate such averaged faces as more attractive, regardless of the faces' race, the raters' race, and whether they view composites depicted in photographs or simple drawings (Grammer and Thornhill 1994; Langlois and Roggman 1990; Rhodes and Tremewan 1996; Thornhill and Gangestad 1993). Combined, the results suggest that facial averageness is one characteristic that contributes to the development of aesthetic preferences, perhaps because from early infancy we form mental prototypes of faces and then respond to faces that are similar to the prototype as familiar and appealing (eg see Langlois and Roggman 1990).

Although adults find 'averaged' faces attractive, other variables also influence their aesthetic judgments, and hence might have originated from a preference present from early infancy. In the studies reported here, we investigated the influence of eye size. Adults rate drawings or photographs of faces with larger eyes as more attractive than faces with smaller eyes, and this is true across faces of different age (ie infants, adults), sex, and race (Horvath et al 1987; Keating 1985; McArthur and Apatow 1983 – 1984; McArthur and Berry 1987; Sternglanz et al 1977). Adults' preferences for larger eyes may reflect their more general preference for 'babyish' faces (Hildebrandt and Fitzgerald 1979; McArthur and Apatow 1983 – 1984; Maier et al 1984)—in this case for faces with larger eye height and width in relation to a smaller head frame, and for expressive faces (Cunningham 1986; Cunningham et al 1995)—in this case for faces with wider pupils and larger eye height (as occurs with the raised eyelids of expressive faces).

We suspected that eye size might also influence babies' visual preferences. Even newborns are sensitive to the size of the elements of a pattern (Fantz et al 1975) and to the amount of visible energy it contains (eg Banks and Salapatek 1981), a characteristic that varies with element size. From two months of age, babies often look at the internal features of faces, especially the eyes, and frequently scan between the eyes (Hainline 1978; Haith et al 1977; Maurer and Salapatek 1976). By 2 to 3 months, they also notice differences in the internal features: they look longer at the mother than at a stranger, even when identical scarves cover the hair (de Schonen and Mathivet 1990; de Schonen et al 1986; Morton 1993); they look longer at a novel face than at a face to which they have been habituated, even when both are wearing scarves (Bushnell 1982); and after habituation to a face they react to some changes of facial expression (Barrera and Maurer 1981; Muir and Hains 1993; Nelson 1987). They also notice changes in the eyes: they look longer at a schematic face that includes eyes than at one with the eyes deleted (Maurer 1985), they vocalise more often to faces wearing glasses onto which eyes have been pasted than to faces with the eyes absent (Bloom 1974, 1975), and they look longer at faces with the eyes open rather than closed (Ames and Barnes, cited in Maurer 1985). By 3 to 4 months, they discriminate between faces with their gaze *en face* and averted (Hains and Muir 1996; Hood et al 1998; Johnson and Vecera 1993; Murray and Trevarthen 1985; Vecera and Johnson 1995) and, at least by 5 months, they discriminate between faces differing in the size of their eyes (Deruelle and de Schonen 1998). Thus, young infants look at the eyes and notice many changes in them, including their size. Our prediction was that, at least by 3 months of age, infants might show a visual preference for faces with larger eyes.

In two experiments, we manipulated faces' eye size and examined the effects on adults' aesthetic ratings and 5-month-olds' looking times. As in most previous studies with adults, we manipulated simultaneously the length and height of all aspects of the eye, including the iris and pupil, and we limited the stimuli to female faces (eg Cunningham 1986). So as to compare our findings with those of previous studies of babies' visual preferences for

attractive faces (eg Langlois et al 1987), and to give babies an opportunity to choose between faces, we measured infants' distribution of looking time to faces in which we paired two versions of a face with larger and smaller eyes. Adults viewed the same pairings and rated their relative attractiveness. In experiment 1 we used black-and-white drawings so as to avoid irrelevant details (ie natural markings, shading, highlights) that could influence babies' looking or adults' aesthetic judgments. To examine the generality of the results with more realistic faces, in experiment 2 we used colour photographs. Tests were performed on 5-month-olds because they are known to be able to transfer perceptions of real faces to their photographs, and from their photographs to schematic representations (DeLoache et al 1979). Although by 5 months of age infants have had a wealth of exposure to human faces, some of which they have learned to recognise (eg Bushnell et al 1989; Pascalis et al 1995), they have had minimal exposure to cultural standards of beauty, and so they afford an opportunity to examine the effect of eye size before extensive cultural input.

2 Experiment 1

The purpose of experiment 1 was to measure adults' ratings of relative attractiveness and 5-month-olds' distribution of looking times as they viewed pairs of schematic female faces varying in eye size.

2.1 *Method*

2.1.1 *Subjects.* **Adults.** Adult subjects were thirty-two (sixteen male) undergraduate students (mean age 19 years, range 18 to 27 years) participating for points in a psychology course. Twenty-four adults were Caucasian, seven were Asian, and one was Black.

Infants. There were forty (twenty male) infant subjects; they were full term, 20 to 22 weeks of age (mean age 21 weeks), with no known abnormalities, a gestational age of 38 to 42 weeks at birth, and a birth weight of at least 2500 g. Infants were recruited from a pool of mothers who had volunteered their babies at birth for later study. An additional twelve babies were tested but excluded from analyses because of low inter-observer reliability (ie Pearson correlation between two observers' measurements of visual fixations < 0.80; $n = 7$), procedural error ($n = 2$), or side bias[(1)] ($n = 3$).

2.1.2 *Stimuli.* We used Mac-a-Mug to create two versions of each of four black-and-white drawings of female faces: a face with smaller eyes and a face with larger eyes. Faces with larger and smaller eyes had ratios of eye width (ie distance from inner to outer corner) to face width (ie distance between the cheekbones at their widest points) of 0.28 and 0.20, and ratios of eye height (ie distance from top lid to bottom) to face height (ie distance from hairline to chin) of 0.09 and 0.04, respectively. Eye width was set at the value for the width of the eye 3 standard deviations above or below the population mean for adult faces (Farkas 1981) divided by the width of the face of the population mean. Eye height was set at the value for the height of the eye 3 standard deviations above or below the mean divided by the face height of the population mean. Changes in eye width and eye height were produced by enlarging or reducing the eyes of original drawings, a process that also caused proportional changes in the area of the iris and pupil. The four faces included in the study were those in an original set of nine for which changes in eye size most strongly affected adults' ratings of attractiveness with minimal variability among eighteen raters.[(2)] They are shown in figure 1.

[(1)] Excluding data from infants looking at faces on one side of the screen more than 80% of the time.

[(2)] The eighteen adults viewed the two versions of the nine faces presented sequentially in random order and rated their attractiveness using a 5-point Likert scale (1 = very unattractive; 5 = very attractive). In every case, they rated the version with larger eyes as more attractive (mean rating of the version with larger eyes = 3.0; range = 2.0 to 3.4). The mean rating of the four faces with larger eyes selected for further study was 3.0 (range = 2.8 to 3.4). A separate group of thirty adults rated the two versions of the four (out of nine) faces presented sequentially in random order, and again, in every case they gave the version with larger eyes a higher rating.

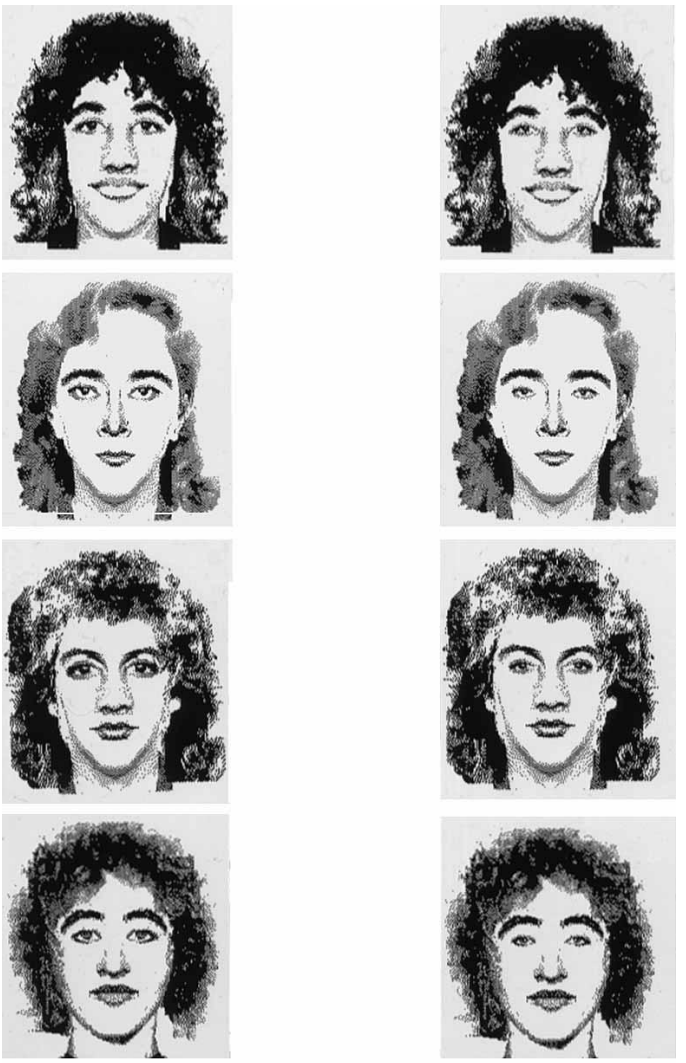

Figure 1. The four black-and-white drawings of female faces varying in eye size used in experiment 1. Faces were shown paired and approximately lifesize.

The faces were paired, with each pair consisting of the two versions of the same face. Each face was approximately lifesize (12 cm wide $\times$ 15 cm high) and formed an image of 9 deg $\times$ 11 deg when viewed from 75 cm (for adults) and 15 deg $\times$ 19 deg when viewed from 45 cm (for infants). The inner edges of the two faces were 5.5 cm apart (7 deg when viewed from 45 cm). This spacing was the minimum necessary to distinguish reliably a baby's visual fixations on the two faces yet ensure that, as the baby viewed the outer edge of one face, at least the nearer edge of the other face would be visible peripherally (Lewis and Maurer 1992).

2.1.3 *Design*. To control for any effects of side bias on infants' looking times, each pair of faces was presented first in one random left-to-right position and, after a nonfacial stimulus (eg checkerboard or bull's-eye), in the reversed position. We created eight different random orders, with the constraints that (i) across orders, each of the four face examples appeared equally often on each trial and (ii) within each order, the version of a face with larger eyes appeared first on the left half the time. Each nonfacial stimulus occurred in the same positions for all subjects. Thus, each subject

received fifteen trials (ie four pairings of faces and four left-to-right reversals, separated by seven patterns).

2.1.4 *Apparatus.* Babies sat on a platform facing a rear-projection screen (64 cm wide × 28 cm high) onto which the faces were projected from a Kodak carousel projector. Their view of the room was blocked by a black frame surrounding the screen and black curtains hanging beside them. Small peepholes on each side of the frame allowed two observers to stand behind the screen and watch an infant's eyes. They recorded their judgments of the infant's fixations via joysticks connected to a Commodore PET (2001 Series) computer.

2.1.5 *Procedure.* We began by explaining the procedure and obtaining informed consent from the adult participant or parent.

Adults. Adults were tested individually while standing 75 cm from the screen. Adults rated the relative attractiveness of the faces within each pair, by using a 5-point scale [ie the face on the left is much more attractive (−2); the face on the left is somewhat more attractive (−1); the faces do not differ in attractiveness (0); the face on the right is somewhat more attractive (+1); the face on the right is much more attractive (+2)]. They used a remote control device to advance the projector after each rating. So as to obtain their first impressions of faces, we asked adults not to move backwards through the series. They saw the nonfacial stimuli but did not rate them.

Infants. Babies sat in an infant seat positioned so that their eyes were 45 cm from the projection screen. The procedure began with a presentation of a blank slide. Then the baby saw a sequence of one pairing of a face with smaller versus larger eyes followed by one nonfacial pattern until he/she saw all eight pairings of faces. For trials with faces, two observers recorded fixations independently by pressing one of two buttons on the joystick when they judged the baby to look at the face on the left or right side, respectively. Their judgments were based on the reflection of the stimuli over the centre of the baby's pupil. A trial began when the baby first fixated one of the faces, as judged by either observer, and continued until each observer had measured 10 s of looking time (Slater et al 1984). After each trial with faces, a nonfacial stimulus was shown for 5 s. The intertrial interval was 3 s.

2.2 *Data analysis*

So as to be more likely to capture adults' first impressions of faces, we included their ratings from only the first trial for each of the four pairings. Adults' ratings of relative attractiveness of the versions with smaller and larger eyes did not differ across the four examples of female faces: an ANOVA on ratings of relative attractiveness, with one within-subjects factor (four faces), was not significant ($F_{3,93} = 1.415$, $p > 0.10$). Therefore, for each adult we averaged the ratings across the four faces and used a one-sample *t*-test to determine whether the mean ratings differed significantly from 0 (ie equal attractiveness for the versions with smaller and larger eyes).

The data from babies consisted of the proportion of time spent looking at each member of eight pairings of faces, as judged by each of the two observers. The Pearson correlation between the proportions measured by the two observers across the eight trials ranged from 0.8 to 1.0 (mean $r = 0.96$). By averaging the proportions across the two observers and across the left-to-right reversals we created four scores for each baby: proportion of looking to versions with larger eyes in four female faces.

An ANOVA on the four mean proportion scores, with one within-subjects factor (face example), was not significant ($F_{3,117} = 0.288$, $p > 0.10$). Therefore, we averaged the proportions across the four faces for each baby to create one score: mean proportion of looking to version with larger eyes. This proportion score was subjected to a one-sample *t*-test to determine whether it differed significantly from a chance value of 0.50.

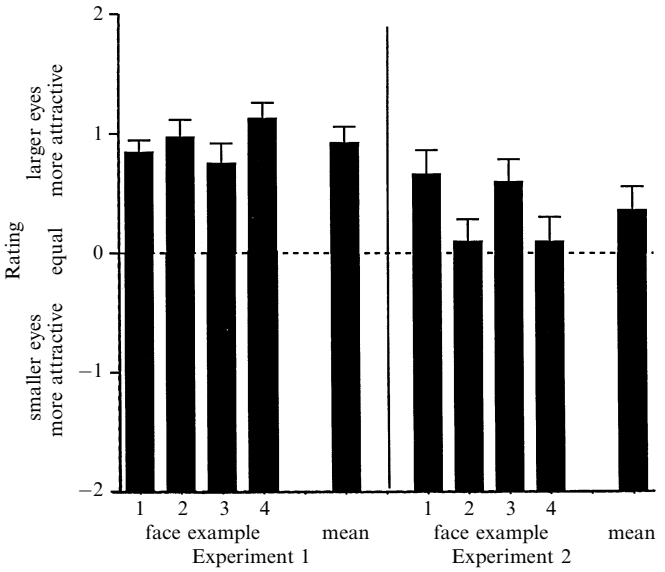

Figure 2. Adults' mean ratings of relative attractiveness (+1 standard error) of the four pairings of faces varying in eye size in experiment 1 (left side) and experiment 2 (right). Face examples 1–4 for experiments 1 and 2 are shown in figures 1 and 4, respectively.

In a second set of analyses more similar to those used with adults, we determined babies' proportion score from only the first presentation of the two versions of each of the four female faces.

2.3 *Results*

2.3.1 *Adults' ratings of relative attractiveness.* Adults rated the faces with larger eyes as more attractive than the faces with smaller eyes ($t_{31} = 12.61$, $p < 0.0001$). All but one of the thirty-two adults showed this pattern. Figure 2 shows the mean relative attractiveness ratings.

2.3.2 *Infants' looking times.* Infants' proportion of looking time to the faces with larger eyes did not differ significantly from a chance value of 0.50, whether we included both trials with each pairing or only the first presentation ($t_{39} = 0.72$ and $t_{39} = 0.75$, $p > 0.10$ in each case). Figure 3 shows the mean proportion of looking time to the faces with larger eyes.

2.4 *Discussion*

When shown pairings of schematic female faces differing in eye size, adults rated the faces with larger eyes as more attractive than the faces with smaller eyes. In contrast, 5-month-olds looked equally long at the two faces within each pair.

Our results for adults are similar to many previous studies showing that adults rate drawings or photographs of female faces with larger eyes as more attractive than faces with smaller eyes (eg Cunningham 1986; McArthur and Apatow 1983–1984). Although all but one adult rated faces with larger eyes as more attractive, the mean rating of relative attractiveness was not high: it was closer to the value on the Likert scale labelled "somewhat more attractive" than "much more attractive". Similarly, pilot subjects who saw these faces presented sequentially rated the versions with larger eyes as significantly more attractive, but their mean rating was closer to "average" than to "very attractive". Adults' reactions to eye size might have been stronger had they viewed different examples of faces, a larger number of exemplars, and/or more realistic, photographed faces rather than simplified line drawings.

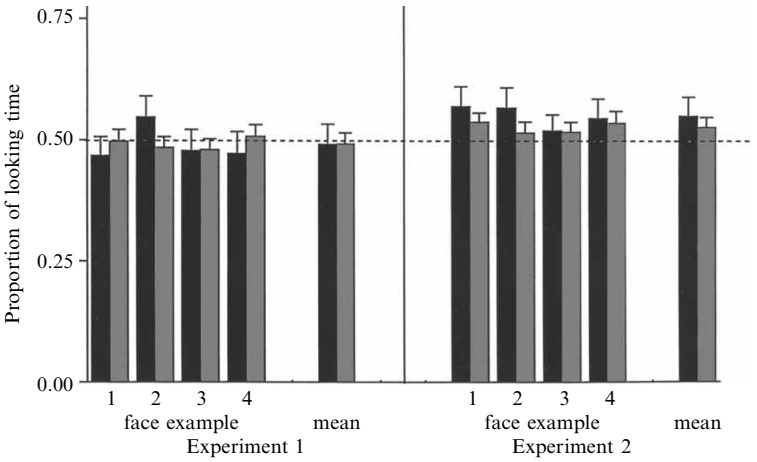

Figure 3. 5-month-olds' mean proportion of looking time (+1 standard error) to the four faces with larger eyes. Proportions are shown for experiment 1 (left side) and experiment 2 (right). The grey bars show results from both trials with each face pairing; the black bars, for the first trial with each pairing. Face examples 1 – 4 for experiments 1 and 2 are shown in figures 1 and 4, respectively.

Unlike its influence on adults' ratings of attractiveness, eye size did not influence 5-month-olds' visual fixations on faces. However, we have two concerns about the facial stimuli used in experiment 1. First, Langlois et al (1987) found that infants' visual preferences for 'attractive' over 'unattractive' faces were stronger when they viewed two faces which adults rated as very different in attractiveness. Babies might be more likely to differentiate eye sizes in faces where the difference has a larger effect on adults' ratings than the stimuli in experiment 1, as might be the case when viewing different examples of faces and/or more realistic, colour photographs of faces varying in eye size. Second, infants may have processed the black-and-white drawings differently from the way they process real faces. Infants 1-month-old scan almost exclusively the external contours of real faces (Haith et al 1977; Maurer and Salapatek 1976) but scan more frequently the interior of schematic faces (Maurer 1983), a finding that suggests that young infants may extract different kinds of information from real and schematic stimuli. While babies by 5 months of age can transfer perceptions of a three-dimensional object to its photographic representation, and from a photograph to its schematic representation (DeLoache et al 1979), the babies may have had difficulty perceiving the similarity between faces in the real world and our less realistic drawings. Previous studies reporting a relationship between infants' looking times and adults' aesthetic ratings used more realistic images, either black-and-white (Samuels and Ewy 1985) or colour photographs of faces (Langlois et al 1987, 1991; Samuels et al 1994; Slater et al 1998). Such stimuli may also be better than drawings at maintaining babies' interest and enabling them to demonstrate visual preferences. In experiment 2 we tested the generality of our findings by using colour photographs of faces varying in eye size.

3 Experiment 2

The purpose of experiment 2 was to measure adults' ratings of relative attractiveness and 5-month-olds' distribution of looking times as they viewed pairs of colour photographs of female faces varying in eye size. The method was the same as in experiment 1, except that we varied eye size by only 2, as opposed to 3, standard deviations above and below the mean.

3.1 *Method*

3.1.1 *Subjects.* **Adults.** Adult subjects were thirty-two (sixteen male) undergraduate students (mean age 20 years; range 18 to 27 years) participating for points in a psychology course. Twenty-five adults were Caucasian and seven were Asian.

Infants. The forty (twenty male) infant subjects were full term and aged 20 to 22 weeks (mean age 21.5 weeks). An additional eleven babies were tested but excluded from analyses because of side bias ($n = 1$), low interobserver reliability ($n = 6$), procedural error ($n = 1$), or fussiness ($n = 3$).

3.1.2 *Stimuli.* **Selecting photographed faces.** From a sample of ninety-seven Caucasian female faces that were photographed for a previous study (see Geldart and Maurer 1996; Geldart et al, submitted), we selected fifteen for manipulation on the basis of the following criteria: neutral expression; little or no makeup; no hair covering the face; aged 17 to 23 years (mean age 21 years); and mean attractiveness rating close to average (mean rating 3.1; range 2.8 to 3.3), with minimal variability among thirty raters (mean variance 0.73; range 0.49 to 0.93). We expected that natural photographs rated by adults as 'average' might yield greater variation in ratings after making the eyes larger and smaller than if we had begun with faces rated at the extreme values of attractiveness.

Manipulating faces and selecting final stimuli. Colour slides of faces were transferred to a compact disk for viewing on a Macintosh LC 475. We used Adobe Photoshop to create two versions of each of ten faces, one with smaller eyes and another with larger eyes. Faces with larger and smaller eyes had ratios of eye width to face width of 0.27 and 0.21, and ratios of eye height to face height of 0.08 and 0.05, respectively. These ratios were based on the values 2 standard deviations above and below the mean for faces and were calculated by using the same procedure as in experiment 1.[(3)]

The four faces selected as final stimuli were those from the set of ten for which changes in eye size most strongly affected adults' ratings of attractiveness with minimal variability among thirty raters.[(4)] Figure 4 illustrates the pairs of faces in experiment 2. Each face was shown in colour and approximately lifesize (12 cm wide $\times$ 16 cm high), and formed an image of 9 deg $\times$ 12 deg when viewed from 75 cm (for adults) and 15 deg $\times$ 20 deg when viewed from 45 cm (for infants).

3.1.3 *Design and procedure.* The design and procedures for adults and infants were the same as in experiment 1.

3.2 *Data analysis*

Adults' mean ratings of each of the four pairings of photographed faces were subjected to separate one-sample *t*-tests to determine whether the rating for each pairing differed from 0, or equal attractiveness for the smaller and larger versions. We did so because an ANOVA on adults' ratings of relative attractiveness for the two versions in each of the four facial pairings, with one within-subjects factor (face example), was significant

[(3)] We began by creating two versions of each of fifteen faces, with the sizes defined as in experiment 1 as 3 standard deviations from the population mean. Interestingly, adults' aesthetic ratings were not in the predicted direction for the majority of the faces, and many of them reported that the faces with larger eyes looked unnatural. This was confirmed by a separate group of thirty adults who judged it highly likely that the faces with larger eyes had been manipulated/tampered with (mean = 2.6 on a 3-point scale), a value significantly higher than their manipulation rating for faces with smaller eyes (mean = 1.8, $t_{29} = 11.16$, $p < 0.0001$). To make the faces appear more natural, we remanipulated ten of the original photographs so that the eye size varied by only 2, as opposed to 3, standard deviations from the population mean.

[(4)] The thirty adults viewed the two versions of the ten faces sequentially in a random order, and rated their attractiveness by using a 5-point scale (1 = very unattractive; 5 = very attractive). Their mean ratings of attractiveness for the versions with larger and smaller eyes were 3.0 and 2.6, respectively. The means for the four faces chosen for the final study were: (1) 3.5 and 2.5; (2) 3.0 and 2.5; (3) 3.1 and 2.3; and (4) 3.2 and 2.4.

Figure 4. The four photographs of female faces varying in eye size used in experiment 2. Faces were shown paired, approximately lifesize, and in colour.

($F_{3,93} = 4.83$, $p < 0.01$). As in experiment 1, we also averaged the ratings across the four faces for each subject to yield one overall rating for relative attractiveness and then subjected those scores to a one-sample *t*-test.

The infants' mean proportion scores were analysed in the same way as in experiment 1. An ANOVA on the proportion of looking at the versions with larger eyes for the four face examples, with one within-subjects factor (face example), was not significant ($F_{3,117} = 0.392$, $p > 0.10$). The Pearson correlation between the proportions measured by the two observers across the eight trials for each baby ranged from 0.8 to 1.0 (mean $r = 0.93$).

3.3 *Results*

3.3.1 *Adults' ratings of relative attractiveness.* Adults rated the versions of faces 1 and 3 with larger eyes as more attractive than their counterparts with smaller eyes ($t_{31} = 3.22$ and $t_{31} = 3.13$, $p < 0.01$ in each case), but the effect was not significant in face examples 2 and 4 ($t_{31} = 0.5$ and $t_{31} = 0.45$, $p > 0.10$ in each case). Many more adults rated the version with larger eyes as more attractive when viewing face example 1 (72% rated the larger eyes as more attractive; 25% rated the smaller eyes as more attractive) and face example 3 (65% for larger eyes; 25% for smaller eyes) than when viewing face examples 2 (47% for larger eyes; 34% for smaller eyes) and 4 (47% for larger eyes; 41% for smaller eyes). In any case, when adults' ratings were averaged across the four faces, there was also a significant effect, with the versions with larger eyes rated as more attractive ($t_{31} = 2.31$, $p < 0.05$; figure 2, right bars). 63% of the adults demonstrated this preference in their averaged rating.

3.3.2 *Infants' looking times.* A one-sample *t*-test indicated that babies' mean proportion score differed significantly from a chance value of 0.50 ($t_{39} = 2.219$, $p < 0.05$). As shown in figure 3, babies looked longer at the faces with larger eyes than at the faces with smaller eyes. We obtained a similar result when we analysed the data from only the first presentation of the four pairings: babies looked significantly longer at the versions with larger eyes ($t_{39} = 2.174$, $p < 0.05$). Further, whether we looked at the data averaged across both trials or from only the first presentation with faces, we found that more of the babies showed a visual preference for faces with larger eyes (ie 60% and 65%, respectively) than either a preference for smaller eyes (ie 35% and 33%, respectively) or no preference (ie 5% and 3%, respectively).

We used an unpaired *t*-test to compare infants' mean proportion of looking to faces with larger eyes in experiments 1 and 2, and found that they were significantly longer for photographs (0.53) than for drawings (0.49) ($t_{78} = 2.092$, $p < 0.05$).

3.4 *Discussion*

In experiment 2, adults rated coloured photographs of female faces as more attractive when they contained larger eyes. In addition, 5-month-olds looked longer at the photographs of faces with larger eyes than at the faces with smaller eyes. In this experiment, unlike experiment 1, eye size influenced adults and young infants in the same way.

The effect of eye size on adults' ratings of relative attractiveness was not as strong with photographs as in experiment 1 with drawings: the effect was shown by a smaller percentage of subjects (ie 63% vs 97% in experiment 1), and it was not significant for every face. This pattern may be related to the way we selected facial images in experiment 2. In experiment 2, but not in experiment 1, we created the two versions of larger and smaller eyes from a set of faces that in their natural form had been rated by adults as only 'average' in attractiveness. Thus, adults' preferences for faces with larger eyes may not have been as strong in experiment 2 because they were asked to judge the attractiveness of faces that are in many ways only average looking. Interestingly, however, the pattern of results is consistent with the known tolerance of adults for distortion in schematic drawings (ie caricatures) (eg Benson and Perrett 1991). When viewing the drawings in experiment 1, adults based their judgments of relative attractiveness on differences in eye size and apparently ignored whether the drawings looked distorted. But when viewing the more realistic photographs in experiment 2, adults reacted not only to the size of the eyes but also to whether they looked natural. In a pilot experiment with unusually large eyes that were 3 standard deviations above the mean, adults saw the face as unnatural and unattractive (see footnote 3). When the eyes were set 2 standard deviations above the mean, adults found them more attractive than smaller eyes, but perhaps because those eyes also deviated from the norm, the preference was smaller than in the first experiment with drawings.

Although babies looked significantly longer at the photographs with larger eyes both during the first presentation and when the results are averaged across the two trials with the left-to-right reversal, a comparison of the two bars in figure 3 (right) suggests that the preference was stronger during the first presentation. We reported a similar difference in a previous study in which we used the same paired procedure to evaluate 5-month-olds' visual preferences for faces with their internal features at different heights (Geldart and Maurer 1996). We speculate that babies look longer at their preferred version of a face during its first presentation, and then, as a result of becoming bored or habituated to faces, they either show random looking during the second presentation or they look longer at the other now novel version of the face during the second presentation. Thus, a single paired trial may be more sensitive to picking up babies' visual preferences. The left-to-right reversal is, nevertheless, useful for identifying babies with a strong side bias.

4 General discussion

Whether viewing black-and-white drawings or colour photographs of female faces, adults rated faces with larger eyes, containing larger eye height, eye width, pupil, and iris, as more attractive than faces with smaller eyes. These results are consistent with previous reports (Horvath et al 1987; Keating 1985; McArthur and Apatow 1983–1984; McArthur and Berry 1987; Sternglanz et al 1977) and with the literature showing preferences for more babyish faces and for more expressive faces (Cunningham 1986; Cunningham et al 1995; Hildebrandt and Fitzgerald 1979; McArthur and Apatow 1983–1984; Maier et al 1984).

Eye size not only influenced adults' aesthetic judgments, but it also influenced 5-month-olds' visual fixations. In experiment 2 with colour photographs, infants looked longer at the faces with larger eyes than at the faces with smaller eyes. The effect of eye size was not significant in experiment 1 with black-and-white drawings perhaps because 5-month-olds process them differently from real faces [cf Maurer (1983) and Maurer and Salapatek (1976) for infants' visual scanning patterns for schematic versus real faces] or because they have trouble perceiving the similarity between faces in the real world and the less realistic drawings of experiment 1. In any case, the different results from the two experiments suggest that the many previous studies with line drawings of faces [reviewed in Johnson and Morton (1991) and Maurer (1985)] may underestimate young babies' capabilities in everyday human-face perception.

The finding that the faces' eye size influences adults' aesthetic preferences and infants' visual preferences in the same direction gives support to our hypothesis that this variable contributes to the development of the perception of beauty. Preferences for larger eyes may develop from a more general preference for patterns with elements of larger physical size, more contour, and/or more energy at low spatial frequencies to which young babies are most sensitive (eg Banks and Salapatek 1981; Fantz et al 1975). However, the 5-month-olds responded to variations in eye size when viewing colour photographs in experiment 2 but not when viewing black-and-white drawings of faces in experiment 1, and the differences between the faces with larger and smaller eyes in size and amount of contour were *smaller* in the photographs. This suggests that, at least by 5 months of age, babies' preference is not based merely on physical size or contour but rather on their experience with faces in the real world, which is easier to generalise to the coloured photographs than to the line drawings.

Aesthetic preferences for larger eyes might originate from visual preferences for the faces containing highly expressive features to which young babies are exposed often. Adults typically respond to babies during face-to-face interaction with wide-eyed expressions of interest and positive affect (eg Hains and Muir 1996), and so it is possible that young babies come to recognise features as they look during such interactions, including

the larger eye height produced by raised eyelids, the raised eyebrows, and the widened mouth. It is unlikely that the 5-month-olds in experiment 2 used another eye cue associated with expressive faces—larger pupils—because the contrast was low between the pupil and the brown iris in all of the photographed faces. In any event, viewing expressive faces in the real world might cause babies to look longer at novel examples of faces with larger eyes, perhaps in the same way that previous experience with faces causes them to look longer at their mother's face than at the face of a female stranger even when they see her wearing a novel hair scarf (de Schonen et al 1986; Morton 1993), and to look longer at a schematic positive-contrast face than at its negative-contrast version (Dannemiller and Stephens 1988).

Although we have shown that it is possible to isolate one variable, eye size, that influences both adults' and infants' reactions to faces, we have also shown that eye size, at least on its own, has only a subtle effect. Changes in eye size produced only small shifts in adults' perceptions of attractiveness and in babies' looking times. We varied eye size to extreme values (but all within normal limits of variation in the population) so as to maximise any effect on adults' aesthetic ratings and infants' looking times. However, it is possible that the optimal size is less large. In addition, participants compared faces differing in only one feature, and it is known that adults' aesthetic judgments are influenced strongly by characteristics in addition to the size of the eyes (eg Cunningham 1986; Langlois and Roggman 1990; McArthur and Apatow 1983 – 1984). As would be expected, adults' ratings of attractiveness in these studies are similar to those reported in other experiments that manipulated only one characteristic of faces, the height of the internal features, in black-and-white drawings (ie McArthur and Apatow 1983 – 1984; McArthur and Berry 1987), but are lower than those reported in experiments using black-and-white drawings of faces in which many features in addition to eye size were manipulated (eg McArthur and Apatow 1983 – 1984; McArthur and Berry 1987) and in other studies using nonadulterated colour photographs of faces (eg Cunningham et al 1995; Langlois et al 1987).

Just as there are many facial characteristics that guide adults' aesthetic judgments, there may be other characteristics that guide babies' visual fixations, either alone or when combined with optimal eye size. Another likely influence is the averageness of the facial features, a variable that influences adults' aesthetic ratings (Grammer and Thornhill 1994; Langlois and Roggman 1990; Rhodes and Tremewan 1996) and, at least for faces of their own race, 6-month-olds' visual preferences (Rubenstein et al 1997). This influence develops at an early age, but depends on early experience with faces, as our results suggest may be the case for eye size. Other variables, such as the height of the faces' internal features and their bilateral symmetry, appear to become influential only after early infancy, possibly as a result of cultural learning and/or more experience with faces (Geldart et al, submitted; Samuels et al 1994).

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