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Effects of the height of the internal features of faces on adults' aesthetic ratings and 5-month-olds' looking times

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Abstract. We examined the influence of the height of the internal features of faces on adults' ratings of attractiveness and on 5-month-olds' looking times. Subjects viewed drawings or coloured photographs of faces presented in pairs that were identical except that the internal features were at a low height, with a large forehead and small chin; at a high height, with a small forehead and large chin; or at a medium height. Adults rated faces with their features at the medium and low heights as more attractive than faces with their features at the high height, and, at least for drawings, rated faces with medium features as more attractive than faces with low features. Babies looked equally long at faces with their features at various heights except for looking slightly longer at faces with high rather than low features. The results suggest that the influence of feature height on reactions to faces is different for adults and 5-month-olds, and hence that it may be shaped by cultural learning and/or experience with faces sometime after early infancy.

1 Introduction

Two types of research suggest that perceptions of beauty are not based entirely on cultural influences. First, adults of different races residing in diverse cultural regions share similar opinions 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). Second, babies, including those as young as 2 days old, look longer at faces rated as attractive by adults than at faces rated as unattractive (Langlois et al 1987, 1991; Samuels et al 1994; Samuels and Ewy 1985; Slater et al 1998). Moreover, at least by 6 months of age, babies look longer at 'attractive' faces whether tested with faces of Caucasian men or women, Black women, or infants (Langlois et al 1991; Samuels and Ewy 1985). The purpose of our research is to determine the facial characteristics that influence adults' judgments of beauty and to examine the development of each influence to see whether it is present before extensive cultural conditioning. When a facial characteristic affects babies' looking times and adults' aesthetic ratings in the same way—as is true for eye size and facial averageness (Geldart et al 1999; Rubenstein et al 1997)—we infer that its influence on adults' perception of beauty does not originate from cultural input. When it has different effects on babies' looking and adults' aesthetic judgments, we infer that its influence arises from cultural conditioning and/or exposure to faces after infancy.

In the study reported here, we investigated the influence of the height of the internal features of faces. We created three versions of each face: a face with its features at a low height, having a large forehead and small chin; a face with its features at a high height, having a small forehead and large chin; and a face with its features at a medium or average height, with an average-sized forehead and chin. Previous studies have shown that the height of the internal features influences adults' perceptions of attractiveness, but there is inconsistency across studies in the pattern of influence. Caucasian adults rated drawings of infants' faces with features at a medium height as most attractive and those with features at a high height as least attractive (Sternglanz et al 1977). This pattern may be related to adults' preference for averaged faces (Grammer and Thornhill 1994; Langlois and Roggman 1990; Rhodes and Tremewan 1996)—in this case for faces with features

near an averaged position, and for 'babyish' faces (Hildebrandt and Fitzgerald 1979; Maier et al 1984; McArthur and Apatow 1983–1984; but see Berry 1991; Berry and McArthur 1985; Keating 1985; McArthur and Berry 1987)—in this case for faces with lower rather than higher features. However, when feature height has been manipulated in drawings of adults' faces, the results have been inconsistent: Korean adults rated faces with features in a middle position as most attractive (McArthur and Berry 1987), while Caucasian adults' ratings varied with the sex of the face (McArthur and Apatow 1983–1984). One purpose of our study was to clarify the effect of feature height on adults' aesthetic ratings of schematic drawings of adult faces and to test the generalisability of the findings with more realistic, colour photographs.

A second purpose was to investigate the influence of variations in the height of the internal features on babies' looking times. There are several reasons to suspect that infants may be sensitive to feature height. Beginning at two months of age, babies often fixate the internal features of a face and scan frequently between them (Hainline 1978; Haith et al 1977; Maurer and Salapatek 1976). By 2 to 3 months, they also process and remember something about those internal features: they look longer at the mother than at a stranger, even when identical scarves cover the hair (de Schonen et al 1986; Morton 1993); they look longer at a novel stranger than at a stranger to whom 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). From an early age babies can also discriminate among schematic faces on the basis of the positions of their internal features. In some comparisons, even newborns differentiate between a line drawing of a natural face and a drawing in which all of the features are inverted or in a scrambled position (Goren et al 1975; Johnson et al 1991; Lewis et al 1998; Maurer and Young 1983; Morton and Johnson 1991; Valenza et al 1996). By five months of age, if not earlier, babies respond to the deletion or repositioning of individual features, including the eyes and nose/mouth (Caron et al 1973; Maurer 1985). Finally, while young infants' poor visual acuity limits their perception of fine detail (eg Mayer et al 1995), they are nonetheless sensitive to the size of the elements of a pattern (Fantz et al 1975), and by two months, if not earlier, to their distribution (ie phase spectra) (Atkinson et al 1986; Dannemiller and Stephens 1988; Kleiner 1987; Kleiner and Banks 1987; Lewis et al 1998). Hence, we predicted that at least by five months of age infants might detect variations among faces in the size of the forehead, the size of the chin, and/or the positioning of the internal features relative to the frame.

In preliminary studies in which we presented faces sequentially in the centre of the visual field, adults rated faces with their features at a medium height as most attractive and faces with their features at the high height as least attractive (eg Henderson 1993; Henderson et al 1994). In contrast, 5-month-olds looked equally long at the three versions of faces with their features at different heights, but they did show significantly more positive affect for faces with high features than for faces with low features, at least when tested with black-and-white drawings. In the experiment reported here, we paired two versions of a face with its features at different heights and measured infants' distribution of looking time. We suspected that the paired presentation might be more sensitive because it forces babies to choose between faces and because it has been used in all previous studies reporting that babies look longer at attractive than at unattractive faces (eg Langlois et al 1987). Adults rated the relative attractiveness of the faces in each pair so that we could compare their ratings to babies' distribution of looking time, and so as to possibly force more discriminating aesthetic judgments.

For one group, we used black-and-white drawings so as to relate our findings to previous studies with adults (McArthur and Apatow 1983–1984; McArthur and Berry 1987) and so as to avoid irrelevant details (eg natural markings, highlights, shadows)

that could influence babies' looking or adults' aesthetic judgments. For a second group, we used colour photographs so as to examine the generality of the results with more realistic faces. 5-month-olds were tested 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) and because they notice changes in any of the features in drawings of faces (Caron et al 1973). 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 the height of the internal features before extensive cultural input.

2 Method

2.1 *Design*

Subjects in group 1 viewed black-and-white drawings of faces of one sex, then, after a 5-min break, faces of the other sex, with the order of the two blocks counterbalanced across subjects. Subjects in group 2 viewed two blocks of colour photographs of female faces. Within each block, each subject saw each of the three types of pairing (ie low with high; medium with high; low with medium) illustrated with a different face, with the face chosen counterbalanced across subjects. To control for any effects of side bias on infants' looking times, each pair of faces was presented first in one random left–right position and, following a nonfacial stimulus, in the reversed position. Thus, there were 11 trials for each block of trials (ie 6 pairings of faces separated by 5 patterns).

2.2 *Subjects*

Adults. Adults in each group were 72 (36 male) undergraduate students with a mean age of 21 years (age ranges: 19 to 29 years and 17 to 49 years in groups 1 and 2, respectively). In each group, the sample consisted of Caucasians ($n_1 = 61$ and $n_2 = 45$ in groups 1 and 2, respectively), Asians ($n_1 = 10$ and $n_2 = 22$), and Blacks ($n_1 = 1$ and $n_2 = 5$). One additional adult in group 2 was excluded because he gave more than one rating per face pair. All adults participated for points in a psychology course at McMaster University.

Infants. Infant subjects in each group were 72 (36 male) full-term 20- to 22-week-olds (mean age, 21.0 weeks) with no known abnormalities, a gestational age of 38 to 42 weeks at birth, and a birthweight 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 53 babies were tested but excluded from analyses because of fussiness ($n_1 = 5$ and $n_2 = 1$ in groups 1 and 2, respectively), low interobserver reliability (ie Pearson correlation between two observers' measurements of visual fixations < 0.80; $n_1 = 8$ and $n_2 = 10$), side bias[(1)] ($n_1 = 7$ and $n_2 = 11$), procedural error ($n_1 = 2$ and $n_2 = 5$), or equipment failure ($n_1 = 4$).

2.3 *Stimuli*

There were three versions of each of six black-and-white drawings and of six colour photographs of faces: a face with its features at a low height, with a large forehead and small chin; a face with its features at a high height, with a small forehead and large chin; and a face with its features at a medium height, with an average-sized forehead and chin. Faces with features at the low, medium, and high height had ratios of forehead to chin length of 2.4, 1.4, and 0.87, respectively. The location of the low features was set by the value of forehead length two standard deviations above the population mean for adult faces (Farkas 1981) divided by chin length two standard deviations below the mean. The location of the high features was set by the forehead length two standard deviations below the mean divided by chin length two standard

[(1)] We excluded data from infants who looked at faces on one side of the screen more than 80% of the time.

deviations above the mean. The ratio for medium height was the value of forehead length to chin length of the population means.

We used Mac-a-Mug® to manipulate the height of the features in each of three male and three female schematic faces. The six schematic faces included in the study were those in an original set of twenty-one for which changes in feature height most strongly affected adults' ratings of attractiveness (measured on a 5-point Likert scale: 1 = very unattractive; 5 = very attractive) with minimal variability among sixteen raters. Examples of the schematic faces are shown in figure 1.

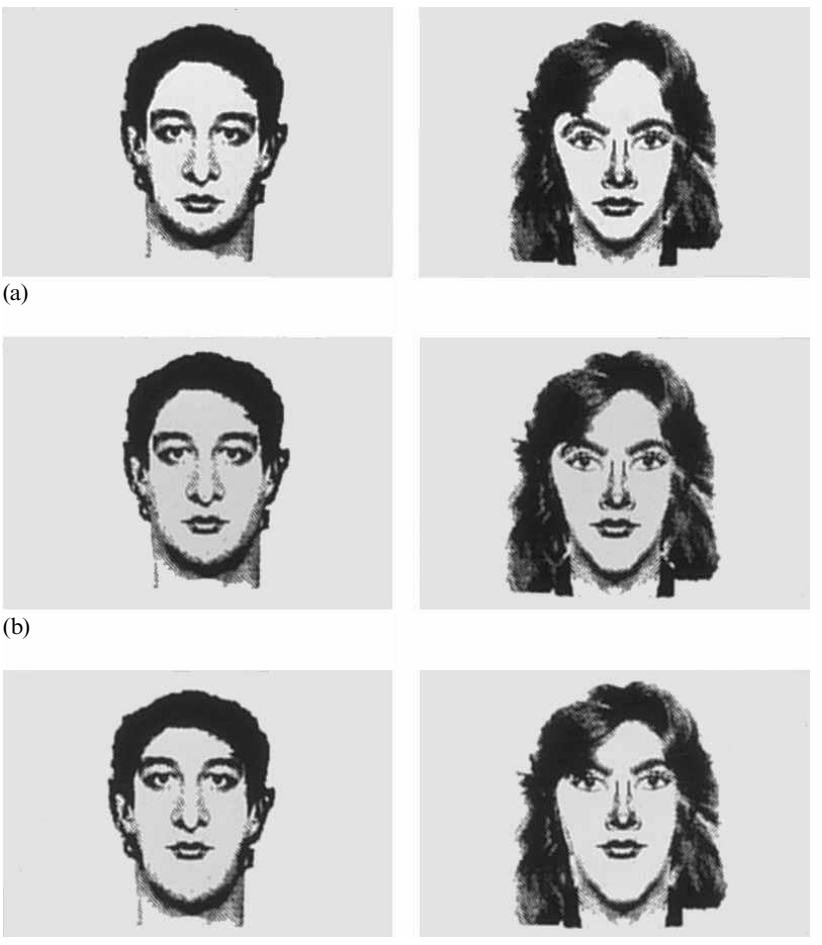

Figure 1. Examples of the black-and-white drawings of male and female faces with (a) features at the low height, (b) features at the medium height, and (c) features at the high height; all are here reduced in size. There were six (three male; three female) examples for each of the three heights.

We used Photoshop® to manipulate the feature height in colour photographs of the faces of six Caucasian females aged 17 to 25 years who were wearing little or no makeup, had no hair covering the face, and which had received mean attractiveness ratings close to average with minimal variability among thirty raters (on a 5-point Likert scale, mean rating: 3.1, range: 2.8 to 3.3; mean variance: 0.73, range: 0.49 to 0.93). We chose to manipulate faces with average ratings because we expected that they would yield greater variation in ratings after we changed the positions of the internal features than faces that began with more extreme ratings. All faces had been photographed outside

the testing area so that they would not be familiar to adult raters from the university. To mask external cues that might influence adults' or babies' reactions to faces, models posed with a neutral expression, wore a black cape to mask clothing, and removed paraphernalia from the head region (eg glasses, earrings). Flash units, positioned to the left and right of the face, with reflecting umbrellas were used to diffuse the light and minimise shadows. The six faces selected as final stimuli were those from the set of ten for which changes in feature height most strongly affected adults' aesthetic ratings with minimal variability among thirty raters. Figure 2 contains an example of the photographed faces, reduced in size and reproduced in black-and-white.


(a) (b) (c)

Figure 2. Examples of the colour photographs of female faces with (a) features at the low height, (b) features at the medium height, and (c) features at the high height; all are here reduced in size and reproduced in black-and-white. There were six examples of female faces for each of the three heights.

All faces were shown as slides projected onto a rear-projection screen (64 cm wide × 28 cm high), and in pairings consisting of a face with its features at two different heights, eg a face with its features at the low height paired with the same face with its features at the high height. Each face was near lifesize (12 cm wide × 16 cm high) and formed an image of 9 deg × 12 deg when viewed from 75 cm (for adults) and 15 deg × 20 deg when viewed from 45 cm (for infants). The inner edges of the two faces were 5.5 cm apart (7 deg viewed from 45 cm). This spacing was the minimum necessary to allow an observer to reliably distinguish a baby's visual fixation 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). To attract infants' attention to the screen, nonfacial stimuli (eg checkerboard, bulls eye) were shown for 5 s after every trial with a pair of faces.

2.4 *Apparatus*

Babies sat on a platform facing the screen onto which the faces were projected from a Kodak Carousel® projector. Small peepholes on each side of the frame allowed two observers to stand behind the screen and watch the infant's eyes. They recorded their independent judgments of the infant's fixations via joysticks connected to a Commodore PET (2001 Series) computer. Adult raters used a remote-control device to advance the slides.

2.5 *Procedure*

For adults. Adults rated the relative attractiveness of faces within each pair, 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—they are equal (0); the face on the right is somewhat more attractive (+1); the face on the right is much more attractive (+2)]. They viewed the same sequences as the infants, including the left–right reversals and nonfacial stimuli.

For infants. For each face pair, two observers independently recorded fixations 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. 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 (see Slater et al 1984). This method of measuring accumulated looking time may be more sensitive for measuring visual preferences than using trials of a fixed duration because it increases the chance that babies compare faces and gives equal weighting in the analysis to babies with long and short looking times (see Humphrey and Humphrey 1989). The observers were not aware of the facial pairings shown on each trial. The intertrial interval was 3 s.

3 Data analysis

The data for adults consisted of their ratings of relative attractiveness of six pairings of schematic or photographed faces, and their left-to-right reversals. The data for infants consisted of the proportion of time spent looking at each member of six pairings of schematic or photographed faces and their left-to-right reversal, as judged by each of the two observers. The Pearson correlation between the proportions measured by the two observers across all twelve trials ranged from 0.80 to 1.0 (mean $r = 0.93$) for group 1 (schematic faces) and from 0.81 to 1.00 (mean $r = 0.96$) for group 2 (photographed faces). For each infant, we averaged the looking times recorded by the two observers during each trial.

So as to be more likely to capture adults' first impressions of faces, and because infants' visual preferences have been shown to be stronger during the first presentations of a pair of faces (see Geldart et al 1999; footnote 2), we analysed the data from only the first presentation of each pairing and ignored data from the left-to-right reversals. For subjects in group 1, we calculated three scores representing the three types of pairing (high paired with low, high paired with medium, medium paired with low) collapsed across the faces' sex, and subjected those scores to independent one-sample *t*-tests (two-tailed) to determine whether they differed significantly from 0, ie equal attractiveness (for adults) or equal looking (for babies). We averaged scores across male and female faces so as to limit the number of comparisons, and because preliminary analyses revealed that neither adults' nor infants' scores were influenced by order, sex of face, or by the interaction between order and sex (ANOVAs, all ps > 0.10). For group 2, we restricted the three one-sample *t*-tests to the scores from whichever set of photographed faces subjects had viewed first. We did so to reduce the probability of a Type I error, and because separate ANOVAs on adults' aesthetic ratings and infants' proportion of looking times revealed a significant interaction between order and set of faces ($p < 0.01$ for adults; $p < 0.05$ for babies).

4 Results

Adults. Adults in both groups rated the faces with their features at the low and medium height as significantly more attractive than the faces with their features at the high height (all ps < 0.001). Adults also rated the schematic drawings of faces with medium features as significantly more attractive than the faces with low features, $p < 0.01$, but this difference was not significant with the coloured photographs, $p > 0.10$. Figure 3 shows adults' mean relative attractiveness ratings of the drawings and photographs.

Infants. Infants' mean looking times in both groups did not differ significantly from a chance distribution whether the infants were shown pairs of faces with their features at the medium and high heights, $p > 0.10$, or at the medium and low heights, $p > 0.05$. However, babies looked significantly longer at the schematic faces with their features at the high height than at faces with their features at the low height,

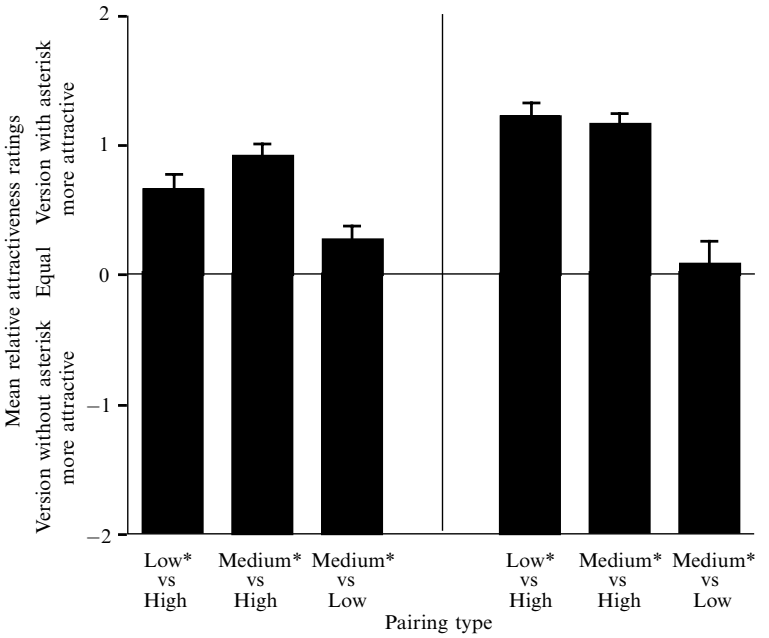

Figure 3. Adults' mean ratings of relative attractiveness (+1 SE) of each of the three types of pairing of schematic drawings of faces (left panel) and of coloured photographs of faces (right panel): versions of a face with features at the low and high heights (Low vs High); at the medium and high heights (Medium vs High); and at the medium and low heights (Medium vs Low). An asterisk depicts the version rated as more attractive.

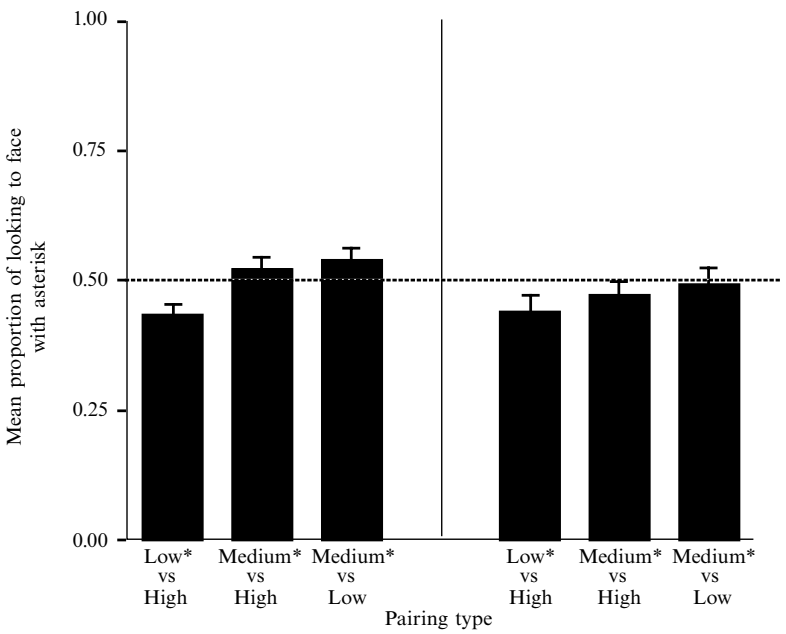

Figure 4. Mean proportion of looking time by 5-month-olds (+1 SE) to each of the three types of pairing of schematic drawings of faces (left panel) and of coloured photographs of faces (right panel): versions of a face with features at the low and high heights (Low vs High); at the medium and high heights (Medium vs High); and at the medium and low heights (Medium vs Low). The bars indicate the proportion of looking time for the member of each pair depicted by an asterisk. The proportion of looking time to the other member of the pair is equal to this value subtracted from 1.00.

$t_{71} = 2.95$, $p < 0.01$, and they tended to do the same with the photographs ($p = 0.06$).[2] Figure 4 shows the distribution of infants' looking time for each type of pairing for drawings (left side) and for photographs (right side). It indicates the proportion of the 10-s presentation that infants spent looking at the member of the pair that is marked with an asterisk.

5 Discussion

The height of the internal features of faces had different effects on adults' ratings of attractiveness and 5-month-old infants' looking times. Like the adults in our preliminary study who viewed faces presented one at a time rather than in pairs, adults rated faces with their features at the medium or low heights as more attractive than faces with their features at the high height. At least for drawings, they also rated faces with their features at the medium height as more attractive than faces with their features at the low height. These findings may be related to previous reports that adults rate an averaged composite of male faces or of female faces as more attractive than most of the individual faces included in the composite (Grammar and Thornhill 1994; Langlois and Roggman 1990; Rhodes and Tremewan 1996). In those studies, averaged composites were produced by computer digitising the luminance levels in each part of the face, and then averaging the values for a series of faces. As more and more faces were averaged together, the size and shape of each feature approached mean values and it moved towards an average position (Langlois et al 1994). Our faces with features at the medium height contain features in the same positions as the features in averaged composites, although the individual features themselves were not average. Adults may respond favourably to such faces because of their familiarity. On the basis of concept-learning theory (Rosch 1978), Langlois and Roggman (1990; see also Langlois et al 1994) suggest that after exposure to many faces, we extract a prototype and respond to faces that resemble the prototype, such as an averaged face, or by extension a face with average proportions, as though they were familiar and appealing. Even without a mental 'face' prototype, we could respond favourably to average-looking faces because they are most similar to the large number of examples that have been stored in memory (see Brooks 1987).

Adults also rated faces with high features as less attractive than faces with low features. This finding is consistent with one previous study of Caucasian adults asked to rate drawings of female faces differing only in the feature height (McArthur and Apatow 1983 – 1984) and with several reports that adults rate females with characteristics of babies' faces, including a larger forehead and smaller chin, as more attractive than females with less babyish features (eg Cunningham 1986; McArthur and Apatow 1983 – 1984; McArthur and Berry 1987). However, adults also rated male schematic faces with features in the low position as more attractive than faces with high features, which contradicts earlier reports that adults judge male faces with their features at a high height as *more* attractive than male faces with their features at medium or low heights (McArthur and Apatow 1983 – 1984; McArthur and Berry 1987), and that they rate male faces with mature features, including a larger chin, as more attractive than male faces with less mature features (Cunningham et al 1990; Keating 1985; but see Berry and McArthur 1985). Our results suggest that, under some circumstances, the babyishness of two features — the forehead and chin — makes both male and female faces more attractive.

[2] Infants' mean looking times in both groups did not differ significantly from chance for any of the three possible pairings when we analysed their proportion scores averaged across both trials, a pattern similar to that observed in a different study of babies' looking times to faces varying in eye size (Geldart et al 1999). Analyses based on only the first trial may be more sensitive because averaging across both trials could mask visual preferences if infants look at their preferred version of a face during its first presentation, and then, as a result of becoming bored with that face, they either look randomly during the second trial or they look longer at the other now novel version of the face during the second presentation.

Adults' ratings of attractiveness might also reflect adults' sensitivity to the golden section: the proportion for splitting a figure that adults find most pleasing (Farnsworth 1932; Piehl 1978; reviewed in Green 1995). The golden section, or a ratio of approximately $40:60$, is achieved when the ratio of the shorter segment to the longer segment is the same as the ratio of the longer segment to the whole. In the faces we used, the ratios, with the shorter segment defined by the distance from the top of the forehead to the eyebrows, and the longer segment defined as the distance from the eyebrows to the chin, were $50:50$, $40:60$, and $30:70$ for the low, medium, and high features, respectively. Thus, adults rated faces with proportions farthest from the golden section as less attractive than faces with proportions closer to it.

While adults' aesthetic ratings were influenced by the height of the internal features, this variable did not influence 5-month-olds' reactions in the same way. Infants did not look longest at the faces with medium features that the adults rated as most attractive. However, there was some evidence that babies were influenced by the feature height, but in a direction opposite to adults: when viewing black-and-white drawings, babies looked significantly longer at the faces with their features at the high height than at the faces with their features at the low height; when viewing colour photographs, they showed a tendency in the same direction ($p = 0.06$). The pattern is similar to that observed in our previous study (Henderson et al 1994) in which 5-month-olds expressed slightly, but significantly, more positive affect to the same schematic faces with high features than to the faces with low features.

Young infants' mild preference for faces with high features that adults find least attractive might arise from familiarity. Young babies typically view faces from below the chin, a perspective that causes foreshortening of the face so that the chin is prominent and the features at the top are compressed. Such a foreshortened face resembles our faces with their features at the high height. Those faces might also seem familiar to babies because of the expressions of interest and positive affect that adults typically adopt when face-to-face with a baby (eg Hains and Muir 1996). Those expressions involve shortening the forehead—by raising the eyebrows, and enlarging the chin region—by opening the mouth and dropping the jaw. Thus, infants may show the most visual and affective responses to faces with high features because they are most similar to those with which they are familiar.

The results indicate that feature height influences both 5-month-olds and adults, but not in the same way. However, for neither group did this variable exert a strong effect. Babies' preference for high features in drawings was statistically significant, but the difference between means was small. Likewise, adults' preference for medium and low features over high features was significant but not strong: the mean rating of relative attractiveness was closer to the value on the Likert scale labelled "somewhat more attractive" than it was to the value labelled "much more attractive". Our faces differed in only one feature, and it is known that adults' aesthetic judgments are influenced strongly by characteristics in addition to feature height (eg Cunningham 1986; Langlois and Roggman 1990). Adults' attractiveness ratings in this experiment are similar to those reported in other studies that manipulated only one characteristic of faces in drawings [eg eye size, height of features (McArthur and Apatow 1983–1984; McArthur and Berry 1987; see also Geldart et al 1999)], but are less extreme than those reported in experiments with drawings of faces in which many features were manipulated simultaneously (eg McArthur and Apatow 1983–1984; McArthur and Berry 1987) and in other studies with nonadulterated colour photographs of faces that will have differed in many features (eg Cunningham et al 1995; Langlois et al 1987). We tested a large number of subjects in order to have significant statistical power to detect a possibly small effect of the manipulation of a single facial characteristic.

In any case, our findings suggest that the height of the internal features of a face comes to influence aesthetic preferences in an adult way sometime after early infancy, perhaps as a result of more extensive cultural input and/or significant experience with faces from an en-face perspective. A similar pattern of results has been reported for the bilateral symmetry of the internal features, which influences adults' ratings of attractiveness (Grammer and Thornhill 1994; Thornhill and Gangestad 1993; Zebrowitz et al 1996) but not the looking times of 4- to 9-month-olds (Samuels et al 1994). In contrast, the faces' eye size or its averageness have similar effects on adults and infants. Adults rate faces with larger eyes as more attractive than faces with smaller eyes and 5-month-olds look longer at the versions with larger eyes (Geldart et al 1999). Adults rate averaged composite faces as more attractive than individual exemplars (Grammer and Thornhill 1994; Langlois and Roggman 1990; Rhodes and Tremewan 1996) and, at least for faces of their own race, 6-month-olds look longer at the averaged faces (Rubenstein et al 1997). Thus, some characteristics of faces appear to influence infants' visual preferences from an early age and may contribute to the development of aesthetic preferences without cultural conditioning. Other influences—such as the height of the internal features—appear to change after early infancy, likely as a result of additional experience with faces and/or cultural norms.

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References

Atkinson J, Braddick O, Wattam-Bell J, 1986 "Development of the discrimination of spatial phase in infancy" *Vision Research* **26** 1223 – 1239

Barrera M E, Maurer D, 1981 "The perception of facial expressions by the three-month-old" *Child Development* **52** 203 – 206

Bernstein I H, Lin T D, McClellan P, 1982 "Cross- vs. within-racial judgments of attractiveness" *Perception & Psychophysics* **32** 495 – 503

Berry D S, 1991 "Attractive faces are not all created equal: Joint effects of facial babyishness and attractiveness on social perception" *Personality and Social Psychology Bulletin* **17** 523 – 531

Berry D S, McArthur L, 1985 "Some components and consequences of a babyface" *Journal of Personality and Social Psychology* **48** 312 – 323

Brooks L R, 1987 "Decentralized control of categorization: The role of prior processing episodes", in *Concepts and Conceptual Development* Ed. U Neisser (Cambridge: Cambridge University Press) pp 141 – 174

Bushnell I W R, 1982 "Discrimination of faces by young infants" *Journal of Experimental Child Psychology* **33** 298 – 308

Bushnell I, Sai F, Mullen J, 1989 "Neonatal recognition of the mother's face" *British Journal of Developmental Psychology* **7** 3 – 15

Caron A J, Caron R F, Caldwell R C, Weiss S J, 1973 "Infant perception of the structural properties of the face" *Developmental Psychology* **9** 385 – 399

Cunningham M R, 1986 "Measuring the physical in physical attractiveness: Quasi-experiments on the sociobiology of female facial beauty" *Journal of Personality and Social Psychology* **50** 925 – 935

Cunningham M R, Barbee A P, Pike C L, 1990 "What do women want? Facialmetric assessment of multiple motives in the perception of male facial physical attractiveness" *Journal of Personality and Social Psychology* **59** 61 – 72

Cunningham M R, Roberts A R, Wu C, Barbee A P, Druen P B, 1995 "'Their ideas of beauty are, on the whole, the same as ours': Consistency and variability in the cross-cultural perception of female physical attractiveness" *Journal of Personality and Social Psychology* **68** 261 – 279

Dannemiller J L, Stephens B R, 1988 "A critical test of infant pattern preference models" *Child Development* **59** 210 – 216

DeLoache J S, Strauss M S, Maynard J, 1979 "Picture perception in infancy" *Infant Behavior and Development* **2** 77 – 89

Fantz R L, Fagan J F III, Miranda S B, 1975 "Early visual selectivity", in *Infant Perception: From Sensation to Cognition* Eds L B Cohen, P Salapatek (New York: Academic Press) pp 249 – 342

Farkas L G, 1981 *Anthropometry of the Head and Face in Medicine* (New York: Elsevier)
Farnsworth P R, 1932 "Preference for rectangles" *Journal of General Psychology* **7** 479 – 481
Geldart S, Maurer D, Carney K, 1999 "Effects of eye size on adults' aesthetic ratings of faces and 5-month-olds' looking times" *Perception* **28** 361 – 374
Goren C, Sarty M, Wu P, 1975 "Visual following and pattern discrimination of face-like stimuli by newborn infants" *Pediatrics* **56** 544 – 549
Grammer K, Thornhill R, 1994 "Human facial attractiveness and sexual selection: The roles of averageness and symmetry" *Journal of Comparative Psychology* **108** 233 – 242
Green C D, 1995 "All that glitters: A review of psychological research on the aesthetics of the golden section" *Perception* **24** 937 – 968
Hainline L, 1978 "Developmental changes in the scanning of face and nonface patterns by infants" *Journal of Experimental Child Psychology* **25** 90 – 115
Hains S M J, Muir D W, 1996 "Infant sensitivity to adult eye direction" *Child Development* **67** 1940 – 1951
Haith M, Bergman T, Moore M, 1977 "Eye contact and face scanning in early infancy" *Science* **198** 853 – 855
Henderson H A, 1993 "What makes a face beautiful? The effect of the vertical placement of internal features in human faces on babies' looking times and adults' ratings of attractiveness", unpublished BSc thesis, McMaster University, Hamilton, Ontario, Canada
Henderson H, Maurer D, Geldart S, 1994 "What makes a face attractive?", poster presented at the 13th Biennial Meeting of the International Society for the Study of Behavioral Development, Amsterdam, The Netherlands, June 28 – July 2
Hildebrandt K A, Fitzgerald H E, 1979 "Facial feature determinants of perceived infant attractiveness" *Infant Behavior and Development* **2** 329 – 339
Humphrey G K, Humphrey D E, 1989 "The role of structure in infant visual pattern perception" *Canadian Journal of Psychology* **43** 165 – 182
Johnson M H, Dziurawiec S, Ellis H D, Morton J, 1991 "Newborns' preferential tracking of face-like stimuli and its subsequent decline" *Cognition* **40** 1 – 19
Keating C F, 1985 "Gender and the physiognomy of dominance and attractiveness" *Social Psychology Quarterly* **48** 312 – 323
Kleiner K A, 1987 "Amplitude and phase spectra as indices of infants' pattern preferences" *Infant Behavior and Development* **10** 49 – 59
Kleiner K A, Banks M S, 1987 "Stimulus energy does not account for 2-month-old preferences" *Journal of Experimental Psychology: Human Perception and Performance* **13** 594 – 600
Langlois J H, Ritter J M, Roggman L A, Vaughn L S, 1991 "Facial diversity and infant preferences for attractive faces" *Developmental Psychology* **27** 79 – 84
Langlois J H, Roggman L A, 1990 "Attractive faces are only average" *Psychological Science* **1** 115 – 121
Langlois J H, Roggman L A, Casey R J, Ritter J M, Rieser-Danner L A, Jenkins V Y, 1987 "Infant preferences for attractive faces: Rudiments of a stereotype?" *Developmental Psychology* **23** 363 – 369
Langlois J H, Roggman L A, Musselman L, 1994 "What is average and what is not average about attractive faces?" *Psychological Science* **5** 214 – 220
Lewis T L, Maurer D, 1992 "The development of the temporal and nasal visual fields during infancy" *Vision Research* **32** 903 – 911
Lewis T L, Mondloch C J, Budreau D R, Maurer D, Dannemiller J L, Stephens B R, Kleiner K A, 1998 "Face perception in young infants", poster presented at the 11th Biennial International Conference on Infant Studies, Atlanta, Georgia, April 2 – 5
McArthur L Z, Apatow K, 1983 – 1984 "Impressions of babyfaced adults" *Social Cognition* **4** 315 – 342
McArthur L Z, Berry D S, 1987 "Cross-cultural agreement in perceptions of babyfaced adults" *Journal of Cross-Cultural Psychology* **18** 165 – 192
Maier R A Jr, Holmes D L, Slaymaker F L, Reich J N, 1984 "The perceived attractiveness of preterm infants" *Infant Behavior and Development* **7** 403 – 414
Maret S M, Harling C A, 1985 "Cross-cultural perceptions of physical attractiveness: Ratings of photographs of whites by Cruzans and Americans" *Perceptual and Motor Skills* **60** 163 – 166
Maurer D, 1985 "Infants' perception of facedness", in *Social Perception in Infants* Eds T M Field, N A Fox (Norwood, NJ: Ablex) pp 73 – 100
Maurer D, Salapatek P, 1976 "Developmental changes in the scanning of faces by young infants" *Child Development* **47** 523 – 527

Maurer D, Young R, 1983 "Newborns' following of natural and distorted arrangements of facial features" *Infant Behavior and Development* **6** 127 – 131

Mayer D L, Beiser A S, Warner A F, Pratt E M, Raye K N, Lang J M, 1995 "Monocular acuity norms for the Teller Acuity Cards between ages one month and four years" *Investigative Ophthalmology & Visual Science* **36** 671 – 685

Morton J, 1993 "Mechanisms in infant face processing", in *Developmental Neurocognition: Speech and Face Processing in the First Year of Life* Eds B de Boysson-Bardies, S de Schonen, P Juscyk, P MacNeilage, J Morton (Dordrecht: Kluwer) pp 93 – 102

Morton J, Johnson M, 1991 "Conspec and conlern: A two-process theory of infant face recognition" *Psychological Review* **98** 164 – 181

Muir D W, Hains S M J, 1993 "Infant sensitivity to perturbations in adult facial, vocal, tactile, and contingent stimulation during face-to-face interactions", in *Developmental Neurocognition: Speech and Face Processing in the First Year of Life* Eds B de Boysson-Bardies, S de Schonen, P Juscyk, P MacNeilage, J Morton (Dordrecht: Kluwer) pp 171 – 185

Nelson C A, 1987 "The recognition of facial expressions in the first two years of life: Mechanisms of development" *Child Development* **58** 889 – 909

Pascalis O, Schonen S de, Morton J, Deruelle C, Fabre-Grenet M, 1995 "Mother's face recognition in neonates: a replication and an extension" *Infant Behavior and Development* **18** 79 – 86

Perrett D I, May K A, Yoshikawa S, 1994 "Facial shape and judgments of female attractiveness" *Nature (London)* **368** 239 – 242

Piehl J, 1978 "The golden section: The 'true' ratio?" *Perceptual and Motor Skills* **46** 831 – 834

Rhodes G, Tremewan T, 1996 "Averageness, exaggeration, and facial attractiveness" *Psychological Science* **7** 105 – 110

Rosch E, 1978 "Principles of categorization", in *Cognition and Categorization* Eds E Rosch, B B Lloyd (Hillsdale, NJ: Lawrence Erlbaum Associates) pp 27 – 47

Rubenstein A J, Langlois J H, Kalakanis L E, Larson A D, Hallam M J, 1997 "Why do infants prefer attractive faces?", poster presented at the meeting of the Society for Research in Child Development, Washington, DC, April 3 – 6

Samuels C A, Butterworth G, Roberts T, Graupner L, Hole G, 1994 "Facial aesthetics: Babies prefer attractiveness to symmetry" *Perception* **23** 823 – 831

Samuels C A, Ewy R, 1985 "Aesthetic perception of faces during infancy" *British Journal of Developmental Psychology* **3** 221 – 228

Schonen S de, Gil de Diaz M, Mathivet E, 1986 "Hemispheric asymmetry in face processing in infancy", in *Aspects of Face Processing* Eds H D Ellis, M A Jeeves, F Newcombe, A W Young (Dordrecht: Martinus Nijhoff) pp 199 – 208

Slater A, Rose D, Morison V, 1984 "Newborn infants' perception of similarities and differences between two- and three-dimensional stimuli" *British Journal of Developmental Psychology* **2** 287 – 295

Slater A, Von der Schulenburg C, Brown E, Badenoch M, Butterworth G, Parsons S, Samuels C, 1998 "Newborn infants prefer attractive faces" *Infant Behavior and Development* **21** 345 – 354

Sternglanz S H, Gray J L, Murakimi M, 1977 "Adult preferences for infantile facial features: An ethological approach" *Animal Behavior* **25** 108 – 115

Thornhill R, Gangestad S W, 1993 "Human facial beauty. Averageness, symmetry and pathogen resistance" *Human Nature* **4** 237 – 269

Valenza E, Simion F, Macchi Cassia V, Umiltà C, 1996 "Face preference at birth" *Journal of Experimental Psychology: Human Perception and Performance* **22** 892 – 903

Zebrowitz L A, Voinescu L, Collins M A, 1996 "'Wide-eyed' and 'crooked-faced': Determinants of perceived and real honesty across the life span" *Personality and Social Psychology Bulletin* **22** 1258 – 1269