
Representation of the gender of human faces by infants: A preference for female

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Abstract. Six experiments based on visual preference procedures were conducted to examine gender categorization of female versus male faces by infants aged 3 to 4 months. In experiment 1, infants familiarized with male faces preferred a female face over a novel male face, but infants familiarized with female faces divided their attention between a male face and a novel female face. Experiment 2 demonstrated that these asymmetrical categorization results were likely due to a spontaneous preference for females. Experiments 3 and 4 showed that the preference for females was based on processing of the internal facial features in their upright orientation, and not the result of external hair cues or higher-contrast internal facial features. While experiments 1 through 4 were conducted with infants reared with female primary caregivers, experiment 5 provided evidence that infants reared with male primary caregivers tend to show a spontaneous preference for males. Experiment 6 showed that infants reared with female primary caregivers displayed recognition memory for individual females, but not males. These results suggest that representation of information about human faces by young infants may be influenced by the gender of the primary caregiver.

1 Introduction

The ability of young infants to perceptually group multiple objects from a common class into similarity-based clusters or categories has been the subject of considerable recent inquiry (Madole and Oakes 1999; Mandler 2000; Quinn and Eimas 1997). Much of the investigative effort has been designed to determine: (i) the category representations that infants of different ages form for generic object categories (eg Quinn and Eimas 1996b; Quinn et al 2001); (ii) their level of exclusivity (eg Quinn and Johnson 2000; Younger and Fearing 1999); (iii) the attributes that are the basis for the category representations of infants (Quinn and Eimas 1996a; Rakison and Butterworth 1998); and (iv) the mechanisms that enable the category representations of infants to develop into the knowledge-rich concepts of adults (eg Mandler 1992; Mareschal et al 2000; Oakes and Madole 2000; Quinn 2000d; Rakison and Poulin-Dubois 2001).

In some of the empirical work on early category representation, the category structures that infants form when presented with various species of animals have been examined (eg Eimas and Quinn 1994; Mandler et al 1991). A portion of this work has centered on how infants represent humans (Pauen 2000; Quinn and Eimas 1998), and parts of humans such as faces (Strauss 1979; Walton and Bower 1993) and their attributes, eg emotional expressiveness (Ludemann and Nelson 1988). In this vein, a few studies were devoted to the examination of how infants represent the gender of human faces (Cohen and Strauss 1979; Cornell 1974; Fagan 1976; Fagan and Singer 1979; Leinbach and Fagot 1993; Younger and Fearing 1999). In adults, gender categorization is rapid and accurate, and not reliant on simple external head cues such as hair length (Brown and Perrett 1993; Bruce et al 1993). In infants, Cornell (1974), using the

familiarization/novelty-preference procedure, presented infants with black-and-white photographs of either four male or four female faces, and found that 6-month-olds, but not 5-month-olds, demonstrated greater attention to a novel face from the novel gender over a novel face from the familiar gender. However, Cornell did not demonstrate that the 6-month-olds could discriminate between the faces within each gender category, thus leaving open the question of whether the infants had formed *category* representations of each gender. Moreover, only four faces were used to depict each gender, thus making it unclear whether 5-month-olds might have categorized gender if provided with additional familiarization experience. Another question left unanswered by the Cornell report were the cues that the 6-month-old infants used to categorize gender. It is possible that the single cue of hair length provided the infants with a sufficient basis to separate the two genders.

In a follow-up investigation to that of Cornell (1974), Fagan (1976) found that 7-month-old infants, familiarized with black-and-white photographs of a pair of faces from a given gender, generalized their familiarization to a novel face from the same gender and displayed a novelty preference for a novel face from a novel gender. In addition, the design of the study permitted the inference that the faces within a given gender were discriminable. These results can be interpreted as evidence that the infants formed individuated category representations for the familiar male and female faces and that these representations were sufficiently structured so as to include the novel instance from the familiar gender and exclude the novel instance from the novel gender. One limitation of this study was the small number of faces employed as stimuli (three male faces and three female faces), with the same novel face from the familiar gender serving as a test stimulus for every infant in the study. This design feature leaves open the question of whether infant responding may have been based on some idiosyncratic attribute characterizing these stimuli, but not necessarily diagnostic of gender in a larger sample of faces. Cohen and Strauss (1979), using a serial habituation procedure, overcame this limitation by presenting 7-month-olds with a larger number of female faces (ie the infants could see up to twelve different stimuli during habituation), and reported that the infants would generalize habituation to a novel female face. However, their study had the limitation that only female faces served as stimuli, with the consequence that no evidence of dishabituation to male faces was available.

Leinbach and Fagot (1993) further investigated the categorization of gender by infants aged 5 to 12 months, employing a serial habituation–dishabituation procedure and color photographs of male and female faces as stimuli. An unexpected asymmetry was reported: infants habituated to males looked more to a novel female than a novel male, whereas infants habituated to females did not look more to a novel male than a novel female. It is possible to interpret this pattern of results as evidence that the infants had formed a representation for male that excluded female, but not a representation for female that excluded male. The findings were intriguing, and led Leinbach and Fagot to speculate that “young infants simply prefer to look at a female face” (page 330). A spontaneous preference for female over male faces would facilitate any novel-category preference for female faces after familiarization with male faces, but would interfere with any novel-category preference for male faces after familiarization with female faces. However, no evidence of spontaneous preference or inquiry into the basis for such a preference was provided.

In a series of experiments, we investigated the male versus female face asymmetry reported by Leinbach and Fagot (1993). We sought to determine: (i) whether the asymmetry could be replicated; (ii) whether it could be generalized to other stimulus sets, age groups, and procedures; and (iii) what was its basis. To begin to answer these questions, we used the familiarization/novelty-preference procedure to examine the representation of gender of human faces by infants aged 3 to 4 months.

2 General method

2.1 Participants

With the exception of experiment 5, all infants in each experiment were reared with a female primary caregiver.

2.2 Apparatus

All infants in each experiment were tested in a visual-preference apparatus, modeled on the one described by Fagan (1976). The apparatus was a large, three-sided gray viewing chamber that was on wheels. It had a hinged, gray display panel onto which were attached two compartments to hold the posterboard stimuli. The stimuli were illuminated by a fluorescent lamp that was shielded from the infant's view. The center-to-center distance between compartments was 30.5 cm, and on all trials the display panel was situated approximately 30.5 cm in front of the infant. A 0.625 cm peephole, located midway between the two display compartments, permitted an experimenter to record the infant's visual fixations.

2.3 Stimuli

The stimuli consisted of colored photographs of the head and face regions of the human exemplars used by Quinn and Eimas (1998). There were nine men and nine women. The faces were all of models that appeared in a *Lands' End* catalogue, had neutral to positive emotional expression, and were judged to be of comparable attractiveness. Examples can be seen in the left panel of figure 1. Sixteen adult raters (eight male, eight female) judged the faces on a 5-point scale of attractiveness with 5 being

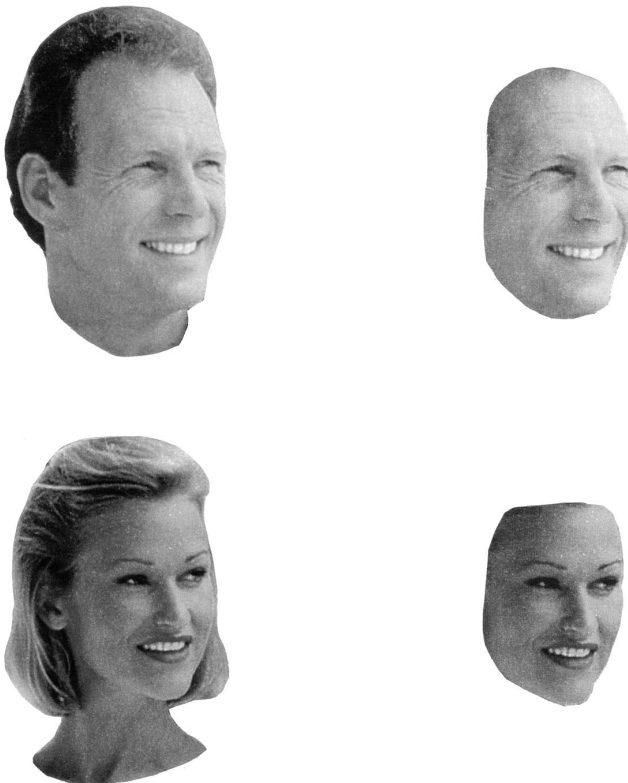


Figure 1. Examples of male and female stimuli used in the initial control experiment, experiment 1, and experiment 2 (left panel); and experiments 3, 5, and 6 (right panel). Inversions of the faces in the right panel were used in experiment 4. Stimuli shown to the infants were presented in full color.

'extremely attractive' and 1 being 'extremely unattractive'. The female faces had a mean rating of 3.23 (SD = 0.51) and the male faces had a mean rating of 3.29 (SD = 0.54). The male and female face sets were matched for direction of gaze, with four faces in each set depicting a direct gaze, and five faces depicting a slightly averted gaze.

2.4 Procedure

All infants in each experiment underwent the following general procedure. Each was brought to the laboratory by a parent and seated in a reclining position on the parent's lap. There were two experimenters both of whom were naïve to the hypotheses under investigation. The first experimenter positioned the apparatus so that the midline of the infant's head was aligned with the midline of the display panel. When the display panel was open, the infant could see the experimenter from the midsection up against the homogeneously light-colored background of the experimental room. The experimenter selected the appropriate stimuli as previously determined for the forthcoming trial and loaded them into the compartments of the display panel from a nearby table. The experimenter then elicited the infant's attention and closed the panel, thereby exposing the stimuli to the infant. Parents were unable to see the stimuli because the construction of the visual-preference-testing apparatus blocked their view of the display stage.

During each trial, the first experimenter observed the infant through the small peephole and recorded visual fixations to the left and right stimuli by means of two 605 XE Accusplit electronic stopwatches, one of which was held in each hand. Inter-observer reliability, as determined by comparing the looking times of twenty-six infants measured by the experimenter using the center peephole, and two additional naïve observers using peepholes to the left of the left stimulus compartment and to the right of right stimulus compartment, averaged 0.92. The additional observers served only in this role and not as experimenters. Between trials, the experimenter opened the panel, changed the stimuli, obtained the infant's attention, centered his or her gaze, and finally closed the panel. When estimates of spontaneous preference were obtained (experiments 2 through 5), the second experimenter did not participate other than to time the trials and signal when a trial was to end. In experiments that measured the discrimination or categorization of stimuli (initial control experiment, and experiments 1 and 6), the first and second experimenters changed places for the test trials. The experimenter who presented stimuli and measured infant fixations during familiarization now measured trial duration and signaled the end of each test trial, whereas the second experimenter presented the test stimuli and measured infant fixations. The two experimenters changed roles across infants. The second experimenter was always naïve with respect to the familiar category (experiment 1) or familiar stimulus that was presented when the discriminability of two exemplars was measured (initial control experiment and experiment 6).

Preliminary analyses were performed for looking times during familiarization and percentages of novelty in the initial control experiment and experiments 1 and 6, and for spontaneous preference percentages in experiments 2 through 5, to examine the effect of the gender of the participant (female versus male). In no case did the performance of the female infants differ from that of the male infants.

2.5 Initial control experiment

If the infants are unable to discriminate between the members of a familiar category, then any experiment designed to investigate categorization is reduced to a test of discrimination, and any preference for the face from the novel category constitutes only a preference for a novel stimulus over a familiar stimulus. For this reason, an initial control experiment was conducted with the stimuli just described to assess the within-category discrimination abilities of infants. In this experiment, two identical examples of a particular face of a given gender were shown to a group of sixteen

infants aged 3 to 4 months (mean age = 99.00 days, SD = 10.71 days; nine females, seven males) for four 15 s trials (ie eight pictures of the same face). The infants were then administered two 10 s preference test trials which paired the familiar face with a novel face (ie two different faces were present on both test trials). Half of the infants were tested with female faces, the other half with male faces, and the particular face pairings were randomly selected for each infant. The infants familiarized with a female face displayed a reliable mean preference for the novel female face of 72.97% (SD = 18.58%, $t_7 = 3.50$, $p < 0.001$, one-tailed), and infants familiarized with a male face showed a significant mean preference for the novel male face of 67.79% (SD = 9.33%, $t_7 = 5.39$, $p < 0.0005$, one-tailed). The results of the initial control experiment demonstrate that the infants can differentiate among the female faces and can also distinguish among the male faces, the stimuli to be used in experiment 1. This outcome thus allows us to proceed ahead with experiment 1 as an investigation of categorization.

3 Experiment 1

In the first experiment, infants were presented with color photographs of eight male or female faces during a series of familiarization trials, and then shown a novel male face paired with a novel female face on a set of preference test trials. The expectation, based on the results of Leinbach and Fagot (1993), is that infants familiarized with male faces will display a subsequent preference for a female face over a novel male face, whereas infants familiarized with female faces will divide attention between a novel female face and a male face.

3.1 Method

3.1.1 *Participants.* Participants were thirty-two healthy, full-term infants aged 3 to 4 months (mean age = 98.82 days, SD = 17.12 days). Eighteen infants were female and fourteen were male. Two additional infants were tested, but did not complete the experiment because of fussiness.

3.1.2 *Procedure.* In experiment 1, sixteen infants were familiarized with eight female faces and sixteen infants with eight male faces. The eight stimuli were randomly selected separately for each infant from each set of nine stimuli and presented at the rate of two per trial for four 15 s trials. Which two of the eight stimuli were shown on a given trial was likewise randomly determined. Immediately after familiarization and without interrupting the procedure, two 10 s test trials were presented. The stimuli for these trials paired a novel female face with a novel male face. The novel face from the familiar category was the remaining instance from that category (ie the one not presented during familiarization) and the novel instance from the novel category was randomly selected and different for each infant. The left–right positioning of the test-trial stimuli was counterbalanced across infants on the first test trial and reversed on the second test trial.

3.2 Results and discussion

3.2.1 *Familiarization trials.* Individual looking times were summed over the left and right copies of the stimuli on each trial and then averaged across the first two trials and the last two trials. The averaging allows the looking-time data for familiarization to be divided into first-half and last-half results. In this way, one can examine whether there is a decrement in responsiveness from the first to the last half of familiarization. The mean fixation times along with their standard deviations are shown in table 1. An analysis of variance (ANOVA) with trial block (1–2 versus 3–4) \times familiarization category (female versus male), performed on the individual looking time scores, revealed only a main effect of trials ($F_{1,30} = 4.80$, $p < 0.05$). The decrement in looking

Table 1. Mean fixation times during the familiarization trials and mean preference scores for the novel gender during the preference test trials in experiment 1. Standard deviations are shown in parentheses.

Familiarization category	Fixation time/s		Novelty preference/%	
	trials 1–2	trials 3–4	t^a	
Female	10.26 (2.60)	9.72 (3.21)	49.73 (17.57)	–0.06
Male	10.12 (1.43)	8.45 (3.38)	70.66 (15.03)	5.50**

^a for mean versus chance

** $p < 0.0005$, one-tailed

time across trials provides evidence of a decline in responsiveness with repetitive stimulation that is consistent with the presence of habituation (Cohen and Gelber 1975).

3.2.2 Preference test trials. Each infant's looking time to the novel-category test stimulus was divided by the looking time to both test stimuli (across the two test trials) and then converted to a percentage score. Table 1 displays the mean novel-category preference scores for the female and male familiarization conditions. As can be seen, t -tests comparing the preference scores to the chance value of 50% revealed that performance of the infants familiarized with male faces was reliably above chance, but that of infants familiarized with females was not significantly different from chance. Infants familiarized with males preferred females, but infants familiarized with females did not prefer males. The asymmetry reported by Leinbach and Fagot (1993) for infants aged 5 to 12 months was thus extended to the ages of 3 to 4 months observing an independent set of stimuli. The combined results suggest that the phenomenon may be of a general nature.

4 Experiment 2

In experiment 2, we explored one possible explanation for the asymmetry uncovered in experiment 1, namely, that infants might have a spontaneous preference for female faces. Such a preference would work in accord with any novel-category preference for female faces after familiarization with male faces and thus produce a robust novel-category preference. However, a spontaneous preference for female over male faces would work against any novel-category preference for male faces after familiarization with female faces. In this case, the two competing preferences would cancel each other, and thus produce a null result.

4.1 Method

4.1.1 Participants. Participants were sixteen healthy, full-term infants aged 3 to 4 months (mean age = 101.62 days, SD = 5.56 days). Eight infants were female and eight were male. One additional infant was tested, but did not complete the experiment because of fussiness.

4.1.2 Procedure. Each infant was presented with six 10 s preference trials, each of which paired a different male face with a different female face. The face pairings were randomly selected for each infant on each trial. The left–right positioning of the two categories was counterbalanced across infants on the first test trial and reversed on each successive trial.

4.2 Results and discussion

A category preference score for female faces was calculated for each infant by dividing the summed looking time to female faces over all six trials by the summed looking time to both categories over the six trials. This score was then converted to a percentage

and averaged across infants to yield a mean category preference score for female faces. The mean preference for females of 64.10% (SD = 13.60%) was reliable ($t_{15} = 4.12$, $p < 0.001$, two-tailed). The asymmetry reported in experiment 1 thus appears to be the result of a spontaneous preference for female faces. A spontaneous preference for females that was operative in experiment 1 could have facilitated a novel-category preference for females after familiarization with males, and interfered with a novel-category preference for males after familiarization with females.

5 Experiment 3

In experiment 3, we pursued a low-level sensory explanation for the spontaneous preference for female faces. In particular, we asked whether the spontaneous preference for female faces might be attributable to higher external contrast information resulting from a greater amount of hair surrounding the internal face region of the stimulus. Experiment 2 was thus repeated, but in this instance with face stimuli without external hair cues.

5.1 Method

5.1.1 *Participants.* Participants were sixteen healthy, full-term infants aged 3 to 4 months (mean age = 98.38 days, SD = 6.93 days). Eight infants were female and eight were male. Three additional infants were tested, but one did not complete the experiment because of fussiness, and two were excluded from the data analysis because of position preference (greater than 95% of their looking time was to one side of the display stage).

5.1.2 *Procedure.* The procedure was identical to that of experiment 2, except that the hair cues were removed from the female and male face stimuli. Examples are presented in the right panel of figure 1.

5.2 Results and discussion

The mean spontaneous preference score for the female faces without hair was 61.24% (SD = 10.50%; $t_{15} = 4.28$, $p < 0.001$, two-tailed). This finding indicates that the preference for the female faces is still present when only the internal features are shown and is thus not the result of higher external contrast created by a greater amount of hair.

6 Experiment 4

In experiment 4, we examined a second low-level sensory explanation for the spontaneous preference for female faces. Specifically, we questioned whether the spontaneous preference for female faces was due to higher contrast of the internal features, possibly resulting from greater use of cosmetics. We thus repeated experiment 3, but in this instance the faces without hair were inverted. The rationale was that, if the female preference was due to higher contrast of the internal features, then the preference should be preserved with the inversion manipulation, given that the internal features are present in both upright and inverted faces. Alternatively, if the spontaneous preference for female faces is based on processing of the internal features in their upright orientation, then we would expect chance responding (ie a no-preference result).

6.1 Method

6.1.1 *Participants.* Participants were sixteen healthy, full-term infants aged 3 to 4 months (mean age = 98.12 days, SD = 7.35 days). Eight infants were female and eight were male. Two additional infants were tested, but were excluded from the data analysis, one due to position preference and the other because of experimenter error.

6.1.2 *Procedure.* The procedure was identical to that of experiment 3, except that the female and male face stimuli without hair were inverted.

6.2 Results and discussion

In response to the inversion manipulation, the infants no longer preferred the female faces (mean = 52.82%, SD = 15.11%, $t_{15} = 0.67$, $p > 0.20$, two-tailed). This result indicates that the spontaneous preference for the female face was not due to higher-contrast internal features that could result from greater use of cosmetics. The spontaneous preference for female faces thus appears to be dependent on processing of the internal features in their upright orientation.⁽¹⁾

7 Experiment 5

Given that the evidence obtained in experiments 3 and 4 did not support either of the lower-level sensory explanations for the female-face preference displayed by young infants, we began to examine a cognitive explanation for the preference, namely, that infants might prefer female over male faces because of greater familiarity with female faces. It is known that young infants will display a spontaneous preference for their mother's face over a strange female face, even in the absence of external hair cues (eg Bartrip et al 2001). It is also known that female faces differ structurally from male faces, albeit in complex ways (Burton et al 1993; O'Toole et al 1997, 1998). Finally, it is worth noting that a majority of infants in the first three months of life are reared with female primary caregivers, and this was true for all of the infants in the experiments thus far reported. It therefore seemed reasonable to suggest that infants might generalize their experiences with primary caregivers who are female to female faces more generally. The argument is that young infants reared with a female primary caregiver may become experts at processing female faces relative to processing male faces. Adult participants display an other-race effect in identification of human faces that may be the result of differential experience (O'Toole et al 1991), and we are suggesting that young infants may display an other-gender effect in the processing of human faces that results from early differential experience.

If young infants reared with female primary caregivers become 'female experts', then it should be possible to reverse the gender preference in infants reared with male primary caregivers. Experiment 3 was thus repeated, but in this instance with infants reared with male primary caregivers.

7.1 Method

7.1.1 Participants. Although the base rate of infants reared primarily by their fathers is small, we have been able to test six such infants aged between 3 and 4 months since beginning data collection for this project in January 1997. The mean age of these infants was 102.17 days, SD = 9.45 days. Four of the infants were male and two were female.

7.1.2 Procedure. The procedure was identical to that used in experiment 3.

7.2 Results and discussion

The mean spontaneous preference for male faces was 58.92% (SD = 10.10%). Although this preference was reliably different from chance at only the one-tailed level of significance ($t_5 = 2.16$, $p < 0.05$, one-tailed), it was clearly in the predicted direction.

⁽¹⁾ It should be acknowledged that the results of the inversion manipulation do not completely rule out an interpretation of the female-face preference based on sensory power differences in the internal face region. This is because, although the inversion manipulation will not affect the magnitude of the contrast of the internal features, it will change the sign of the contrast. For example, starting from the bottom of the face, any black-to-white contrast in the face will become white-to-black and vice-versa. As a consequence, one could argue that during the first few months of life, as the visual cortex is maturing, cells will respond to contrast in some parts of the visual field and not in others. However, we believe that this potential explanation of experiment 4 is weakened by the results of experiment 5.

Moreover, the mean spontaneous preference of 41.08% (SD = 10.10%) for females obtained in this experiment was reliably different from the mean spontaneous preference for females obtained in experiment 3 ($t_{20} = 4.05$, $p < 0.001$, two-tailed). Although the outcome of experiment 5 is not definitive because of the small sample, it is consistent with the idea that infant attention to human face stimuli may be biased toward the gender with which the infant has greater experience.

8 Experiment 6

An implication of female expertise for infants raised with female primary caregivers is that young infants may become more efficient at processing the exemplar-specific details of individual female faces relative to male faces. To test the processing of female versus male face information by infants, infants aged 3 to 4 months reared with female primary caregivers were presented with eight male or female faces. Infants familiarized with males were then preference tested with a novel versus familiar male face, and infants familiarized with females were preference tested with a novel versus familiar female face. The rationale of this experiment is that if individual exemplars are remembered and represented, then the novel exemplar from the familiar category will be preferred. If the exemplars are not remembered, then both of the test-trial stimuli should be looked at approximately equally. Quinn and Eimas (1998) have previously employed the same methodology to examine the nature of young infants' representation for human versus nonhuman animal stimuli.

8.1 Method

8.1.1 *Participants.* Participants were sixteen healthy, full-term infants aged 3 to 4 months (mean age = 103.50 days, SD = 8.52 days). Nine infants were female and seven were male. One additional infant was tested, but did not complete the experiment because of fussiness.

8.1.2 *Stimuli.* The stimuli were those used in experiment 3.

8.1.3 *Procedure.* The familiarization procedure was identical to that used in experiment 1 with half of the infants familiarized with eight male faces and the other half familiarized with eight female faces over the course of four 15 s familiarization trials (two exemplars per trial). After familiarization, two 10 s preference test trials were administered. For infants familiarized with male faces, these trials paired a familiar male face and a novel male face. Infants familiarized with female faces were presented with a familiar female face paired with a novel female face. The left–right positioning of the novel and familiar stimuli was counterbalanced across infants on the first test trial and reversed on the second test trial. The different exemplars from each category and their pairings were randomly determined for each infant.

8.2 Results and discussion

8.2.1 *Familiarization trials.* As in experiment 1, individual looking times were summed over the left and right copies of the stimuli on each times and then averaged across the first two trials and the last two trials. The mean fixation times along with their standard deviations are shown in table 2. An analysis of variance (ANOVA) with trial block (1–2 versus 3–4) \times familiarization category (female versus male), performed on the individual looking-time scores, revealed only a main effect of trials ($F_{1,14} = 4.69$, $p < 0.05$). The significant trials effect indicates that there was a reliable decrement in looking time from the first to the second half of familiarization that is consistent with the presence of habituation.

Table 2. Mean fixation times during the familiarization trials and mean preference scores for the novel exemplar during the preference test trials in experiment 6. Standard deviations are shown in parentheses.

Familiarization category	Fixation time/s		Novelty preference/%	
	trials 1–2	trials 3–4		<i>t</i> ^a
Female	8.44 (3.27)	8.04 (3.51)	61.79 (17.43)	1.91*
Male	9.44 (2.08)	7.26 (2.66)	45.50 (16.50)	−0.77

^a for mean versus chance

* $p < 0.05$, one-tailed

8.2.2 Preference test trials. The mean novelty-preference scores are shown in table 2 along with their corresponding standard deviations and *t* values versus chance (50%). The scores reveal that infants familiarized with male faces did not display a differential preference between a familiar and novel male face. In contrast, infants familiarized with females displayed a preference for the novel female face. The results are consistent with the idea that infants were representing the male faces in terms of a summary structure (ie a male prototype), whereas the female faces were represented as individual exemplars.⁽²⁾ These findings provide support for the idea that infants reared with female primary caregivers are more expert at processing the details that define individual female faces relative to male faces.

9 General discussion

The findings from the current experiments, taken together, indicate that the early representation of information about human faces is likely to be influenced by the gender of the primary caregiver. In particular, infants reared with a female primary caregiver prefer female over male faces, a preference that (i) is strong enough to block a novel-category preference for male faces after familiarization with female faces; (ii) is based on processing of the internal features in their upright orientation; and (iii) is not clearly attributable to low-level sensory cues like external hair length or higher-contrast internal features. The evidence points to the idea that the female-face preference is based on the cognitive variable of familiarity, an idea that receives support from the reversal of the preference in the small sample of infants reared with primary caregivers who are male. The preference for the gender of the primary caregiver appears to be an acquired, expertise-based effect—a conclusion that is bolstered by the finding that infants reared with female caregivers more readily represent information about individual female faces than about individual male faces.

⁽²⁾ Although at first glance the results obtained for male faces in experiment 6 may appear to be inconsistent with the results reported for male faces in the initial control experiment, we believe that there is no contradiction. The initial control experiment measures differentiation of one face from another in the context of a simple discrimination task (only a single face presented during familiarization), whereas experiment 6 measures exemplar memory in the context of a categorization task (eight faces presented during familiarization). Although the results of the initial control experiment demonstrate that infants can discriminate one male face from the next, when the infants are exposed to eight male faces in experiment 6, they may be blended or averaged together so that the previously exposed and novel male faces are seen as equally novel/familiar. There is a parallel with studies of young infants' categorization of form information (Bomba and Siqueland 1983). After exposure to distorted versions of a prototype shape, infants aged 3 and 4 months prefer to look at a previously seen exemplar than at the previously unseen prototype, since the latter presumably fits better with the infant's representation and is perceived as familiar. The individual exemplar information has been lost and is not recognized as familiar. This does not happen with the female faces. Because of the more advanced processing status of the female faces, infants process both the exemplar-specific and summary category-level information.

The data are theoretically significant because they bear on the question of whether performance in laboratory experiments is based exclusively in terms of what infants learn during the course of a laboratory session or whether infants are tapping into pre-existing concepts that have been formed prior to arriving at the laboratory (Mareschal and Quinn 2001; Oakes and Madole 2000; Quinn 2002b, 2002c). The results reported here suggest that infant performance in the laboratory is likely to be influenced by experiences occurring prior to the experiment. An additional task for future research is to determine precisely how long-term experiential knowledge interacts with short-term experiential knowledge acquired during a series of familiarization trials to produce a particular pattern of looking on preference test trials.

The data are also interesting in light of claims that different methodologies for measuring infant categorization may be measuring qualitatively different underlying processes (Mandler 2000). For example, it has been suggested that looking-time measures of categorization (eg familiarization/novelty-preference procedure) tap only the activity of low-level perceptual operations, whereas object exploration and inductive generalization measures of categorization tap a more abstract, conceptual level of processing. However, in the current study, infants appeared to be able to relate the photographs of the human faces shown in the laboratory with the live human faces encountered in daily life. Such transfer is suggestive of an underlying mechanism that has the capability of representing an abstract perceptual resemblance across photographs and live exemplars.

The data have further implications for the early formation of internal structure in the category representations of young infants. In particular, the results are consistent with the idea that in the case of a category of female faces (at least among those infants reared with female primary caregivers), a single exemplar face (mom) may carry more weight in the representation than multiple other faces. The findings do not tell us directly exactly how the weighting of individual exemplars in category representations is established, but in the present case the richness, frequency, duration, and affective quality of the infant's interactions with the primary caregiver may make this exemplar more heavily weighted than other human exemplars.

The outcomes of the experiments are, moreover, consistent with a perceptual-learning model of acquired expertise in the category representations of young infants (Quinn 2002a). A number of studies conducted with young infants suggest that the early categorization of living and nonliving things proceeds from broad, global representations to more tightly tuned, basic-like representations in the first few months of life, and eventually to individual exemplars if there is sufficient experience (reviewed in Quinn 2000d). For example, Quinn and Eimas (1998) reported that infants aged 3 to 4 months were more likely to represent individual humans than nonhuman animals at the expert, exemplar level. The results from experiment 6 extend these findings by demonstrating that, within the category of humans, there may be an additional expert advantage for the gender with which the infants have more experience (as determined by the gender of the primary caregiver). The outcomes obtained with human infant research participants also have an analogue with data obtained from nonhuman animals. For example, Humphrey (1974) reported that monkeys tend to represent other monkeys at the level of individual exemplars, whereas members of other animal species are represented at the category level. The overall pattern of findings is thus consistent with the general idea that the first broad category representations of infants may emerge as a consequence of the initial settings of the sensory-perceptual system. Subcategories may emerge subsequently through experience.

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