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Facial experience during the first year

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ABSTRACT

Parents of 2-, 5-, 8-, and 11-month-olds used two scales we developed to provide information about their infants' facial experience with familiar and unfamiliar individuals during one week. Results showed large discrepancies in the race, sex, and age of faces that infants experience during their first year with the majority of their facial experience being with their primary caregiver, females, and other individuals of the same-race and age as their primary caregiver. The infant's age and an unfamiliar individual's sex were predictive of their time spent interacting with one another. Moreover, an unfamiliar individual's sex was predictive of the attention infants allocated during social interactions. Differences in frequency and length of interactions with certain types of faces, as well as in infant attention toward certain individuals, all likely contribute to the development of expertise in processing commonly experienced face types and deficiencies in processing less commonly experienced face types.

The theory that early experience with faces drives expertise in processing certain types of faces has gained substantial support over the last five years. Much like exposure to a particular language facilitates the development of specialized processing for that language and deficits in processing other languages (Werker & Tees, 1984), early exposure to particular types of faces facilitates the development of specialized processing for those face types and deficits in processing other face types (e.g., Nelson, 2001). Although infants are likely born with the ability to process any type of face, typical experience with faces results in specialized processing for upright faces (de Haan, Humphreys, & Johnson, 2002; de Haan, Pascalis, & Johnson, 2002; Fagan, 1972; Simion, Cassia, Turati, & Valenza, 2001; Slater, Quinn, Hayes, & Brown, 2000; Stucki, Kaufmann-Hayoz, & Kaufmann, 1987; Turati, Sangrigoli, Ruel, & de Schonen, 2004), same-species faces (Pascalis, de Haan, & Nelson, 2002), same-race or commonly experienced race faces (Bar-Haim, Ziv, Lamy, & Hodes, 2006; Hayden, Bhatt, Joseph, & Tanaka, 2007; Kelly et al., 2005, 2007; Sangrigoli & de Schonen, 2004), and female faces (Quinn, 2002; Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002; Ramsey, Langlois, & Marti, 2005).

Specialized or expert face processing can result in visual preferences for certain types of faces (Bar-Haim et al., 2006; Kelly et al., 2005, 2007; Quinn et al., 2002). Commonly experienced face types should be easier to process than less commonly experienced face types. This ease of processing produces feelings of positive affect and subsequently results in visual preferences for more commonly experienced faces (Winkielman & Cacioppo, 2001). Greater visual interest in a particular type of face (e.g., female) should increase experience with that type of face and facilitate learning about individuals within that group (Ramsey-Rennels & Langlois, 2006). Thus, early experience with faces has important implications for social development and, in particular, the development of concepts about different types of people based on appearance.

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Expert face processing also means development of better face recognition abilities for particular types of faces (Hayden et al., 2007; Pascalis et al., 2002; Quinn et al., 2002; Sangrigoli & de Schonen, 2004). Being able to discriminate between and recognize familiar and unfamiliar faces aids both children and adults as they interact with others in their social world (e.g., Bushnell, 2001; Carver et al., 2003; Field, Cohen, Garcia, & Greenberg, 1984; Juth, Lundqvist, Karlsson, & Öhman, 2005; Pascalis, de Haan, Nelson, & de Schonen, 1998; Schwarzer & Roebers, 2002; Vuilleumier, George, Lister, Armony, & Driver, 2005). The ability to discriminate faces within a particular category is necessary for forming social categories because it demonstrates the person is not simply treating all faces within the category as the same face. Rather, the person recognizes the categorical similarities among the faces while also realizing the uniqueness of each face (Quinn, 1987). Such perceptually based social categories may form the basis from which appearance-based stereotypes develop (e.g., Ramsey, Langlois, Hoss, Rubenstein, & Griffin, 2004; Zebrowitz-McArthur, 1982). Hence, there are several important social outcomes related to expertise in face processing that make it valuable to pursue its development.

Empirical research demonstrating an increase in specialized face processing abilities coinciding with a decrease in "general" face processing abilities over the course of the first year (e.g., Pascalis et al., 2002) suggests that infants may be particularly important to study in order to understand the development of face processing expertise. Relatively little data are available that examine infants' facial experience with others in their natural environment. The data that have been published focus primarily on infant interactions with their parents (e.g., Forbes, Cohn, Allen, & Lewinsohn, 2004; Golinkoff & Ames, 1979; Harrison & Magill-Evans, 1996; Hossain & Roopnarine, 1994; Landerholm & Scriven, 1981; Ninio & Rinott, 1988; Roopnarine, Brown, Snell-White, & Riegraf, 1995; Rustia & Abbott, 1993; Wille, 1995; Yogman, 1981). Such data are clearly important for understanding the quantity and quality of infant interactions with individuals who play important roles in their lives, but do little to inform researchers about infants' experience with other people. The main purpose of this study was to investigate infants' facial experience with parents *and* other individuals during the first year.

Infants show better recognition of and visual preferences for same-race faces during the first half of the first year within lab studies (Bar-Haim et al., 2006; Hayden et al., 2007; Kelly et al., 2005, 2007; Sangrigoli & de Schonen, 2004). This specialization in processing, however, is still malleable at this young age in that increased exposure within the lab to other-race faces can improve subsequent recognition abilities (Sangrigoli & de Schonen, 2004). In addition, frequent experience with other-race faces in the natural environment can eliminate same-race face visual preferences found in a lab setting (Bar-Haim et al., 2006). Thus, differences in facial experience are important. It is unclear, however, how much differential exposure infants have to same- and other-race faces in general and if these discrepancies change with age. Discrepancies in exposure may result not only from differences in frequency of interactions with same- and other-race individuals, but also from differences in how long same- and other-race individuals interact with infants, and from the attention infants allocate toward same- and other-race faces during natural social interactions. One goal of our study, therefore, was to quantify the discrepancy in infants' experience with same- and other-race faces and examine potential reasons for the discrepancy.

Infants also show better recognition of and visual preferences for female relative to male faces during the first half of the first year, at least when their primary caregiver is female (Quinn et al., 2002). These visual preferences appear to maintain during the second half of the first year (Quinn, 2002), suggesting infants' exposure to male faces does not significantly increase during the second half of the first year. This finding is somewhat surprising because fathers typically become more involved in infant care as the infant gets older (Anderson, 1996; Bailey, 1994; Rustia & Abbott, 1993). One possibility is that although infant experience with father's face may increase toward the end of the first year, infants' experience with mother's face and other female faces might also increase, thus countering any experiential effects of increased exposure to father's face. Although infants' greater experience with mother than father is well documented (Bailey, 1994; Harrison & Magill-Evans, 1996; Hossain & Roopnarine, 1994; Roopnarine et al., 1995; Russell & Radojevic, 1992; Wille, 1995), researchers have only hypothesized that infants have more experience with non-parental female than male faces (Ramsey et al., 2005). Another goal of this study, therefore, was to examine infants' experience with mother and father's face, as well as infants' experience with other female and male faces, to determine if their quantitative experience with female and male faces changed during the course of the first year. We also assessed whether unfamiliar females and males differed in how long they interacted with infants, and whether infants showed greater interest in unfamiliar female relative to unfamiliar male faces during social interactions.

Another variable of interest that has not received much attention in the infant face perception literature is infant expertise in processing certain-aged faces. It seems probable that infants would have more experience with adults aged 21–39 because this is the age range during which most individuals have children (U.S. Department of Health and Human Services, 2005). Parents' friends or siblings are also likely to be within this age range. Given that the majority of studies in the infant face processing literature use photographs of college-aged students or adults who are around this age range (e.g., Bar-Haim et al., 2006; Cashon & Cohen, 2004; Kelly et al., 2005; Langlois et al., 1987; Ramsey et al., 2004), researchers may be measuring infant face perception at its most optimal level, particularly if the faces are also female and of the same-race as the infants' primary caregiver. Thus, another goal was to examine the ages of individuals with whom infants most commonly interacted, the length of interaction, and the amount of interest infants directed toward individuals of the same or different age as the primary caregiver.

In sum, we sought to quantify discrepancies in the percentage of infants' facial experience with certain face types (i.e., same- and other-race individuals, mother and father, females and males, and same- and other-age individuals). Same-race and same-age were defined as a person of the same-race or same-age as the infant's primary caregiver, respectively. We

also investigated how the demographics of the infant and the person interacting with the infant affected the length of the interaction and infant attention toward the individual. Based on infant development and the available literature, we made several predictions. In regard to infants' experience with faces, they should interact more with same-race relative to other-race individuals, mother relative to father, females relative to males, and same-age relative to other-age individuals. As infants develop, they sleep less and should interact more with both familiar and unfamiliar individuals, so the discrepancy in these experiences may decrease as infants get older. Females tend to be more verbal and emotionally expressive with infants during interactions than males (e.g., Forbes et al., 2004; Harrison & Magill-Evans, 1996), which may result in infants attending more to unfamiliar females than males and unfamiliar females subsequently interacting longer with infants than unfamiliar males. As per the literature showing infants visually prefer same-race faces and female faces, infants should allocate more attention toward unfamiliar same- than other-race individuals and toward unfamiliar females than males during social interactions (Bar-Haim et al., 2006; Kelly et al., 2005, 2007; Quinn et al., 2002).

1. Method

1.1. Participants

Families ($N = 51$) participated within two weeks of their infants' 2-, 5-, 8-, or 11-month-old birthday. Research assistants determined infant eligibility for the study using local birth announcements and then used online resources to find contact information for the infant's family. After mailing letters about the study to eligible families, research assistants called to follow-up on the letter and schedule an appointment. Nine families dropped out of the study after agreeing to participate. The remaining data from the interactions of 18 female and 24 male infants (10 or 11 infants in each age group) were used for analysis. Of those infants: 76% were Caucasian; 14% were mixed race; 5% were Black/African-American; 2% were Native American; and 2% did not report race. Fourteen percent of the infants were of Spanish/Hispanic/Latino ethnicity. Ninety-five percent of the infants had a female primary caregiver and 5% had a male primary caregiver. Although three families reported that both parents shared equally in caregiving, the data clearly indicated that the mother was the primary caregiver based on the time spent interacting with the infant relative to the father, so infants from these three families were coded as having a female primary caregiver. In regard to occupational status, parents were in the following occupations: 47% managerial or professional specialty; 22% technical, sales, and administrative support; 16% homemakers; 7% precision production, craft, and repair; 7% service; and 2% students. Educational background of the parents was: 62% with a degree from a 4-year college or more; 31% with some college education or technical school training; 6% H.S. graduates without college education; and 1% without a H.S. diploma.

1.2. Scale development

We needed an instrument that parents could use to record their infants' facial experience with others. Ideally, the scale would be easy for caregivers to use over a week's time, usable in any setting, and provide us with the information to answer our research questions. Because none of the interaction scales in the developmental literature were appropriate for answering our research questions, we developed two scales: the Infant-Individual Interaction Scale (IIIS); and the Infant-Caregiver and Family Member Interaction Scale (ICFMIS).

Despite not being able to use any of the published interaction scales, we found two items from the Sibling Interaction Scale (Caro & Derevensky, 1997) to be conceptually useful in developing the IIIS: (1) "sibling body position," which assessed the distance of the interacting sibling from the targeted sibling; and (2) "intensity of involvement," which assessed the amount of engagement or attention the targeted child directed toward the interacting child. Clearly, the distance between an infant and the person interacting with the infant is an important variable to assess due to the immaturity of the infants' visual system, particularly during the first few months (Courage & Adams, 1990; Slater, 2001). If the infant is unable to clearly see an individual's face, that experience is unlikely to contribute to the development of face processing expertise. Distance is an important consideration when determining how close infants should be to facial stimuli when designing empirical studies—younger infants sit much closer to the facial stimuli than older infants (e.g., compare Blass & Camp, 2004 to Rochat & Striano, 2002). Additionally, for our research questions, it was important to know the amount of time that the individual interacted with the infant as well as the infant's attention toward that individual's face to get a sense of how much real-time experience infants had with that person's face. Attention toward stimuli as measured by amount of looking is a commonly used measure in infant face perception studies (e.g., Kelly et al., 2005, 2007; Langlois et al., 1987; Quinn et al., 2002). Therefore, the IIIS contained three items, each with four options, for the caregiver to note: (1) the individual's estimated distance from the infant; (2) the amount of time that the individual interacted with the infant; and (3) the infant's attention or interest toward the individual. It also contained places to note the approximate age, sex, and race of the individual interacting with the infant (Fig. 1).

Upon completion of the development of the IIIS, we developed a more condensed version of the scale (the ICFMIS) that would simplify the recording of data for individuals who frequently interacted with the infant (e.g., parents, siblings, daycare workers). The ICFMIS made the task of recording frequent interactions more manageable. For the ICFMIS, we combined the corresponding points on each IIIS scale item to develop four categories: fleeting involvement; brief involvement; moderate involvement; and high involvement (Fig. 2). Caregivers simply noted the frequency of those interaction types. Although

Infant-Individual Interaction Scale

Participant Number: _____

Individual (check one): ❑ Friend/Family name: _____ ❑ Stranger (continue with age/gender/race information below)

Approximate age (check one):

❑ Birth-2 years ❑ 2-6 years ❑ 6-11 years ❑ 11-20 years ❑ 21-39 years ❑ 40-59 years ❑ 60+ years

Gender (check one): Female Male

Race (check all that apply):

❑ Asian ❑ Black/African-American ❑ Middle Eastern ❑ Other _____
❑ Pacific Islander ❑ Spanish/Hispanic/Latino ❑ White

1. The individual's estimated distance from the infant:

❑ Is over 6 feet away from the infant ❑ Is within 4-6 feet of the infant ❑ Is within 2-4 feet of the infant ❑ Is within two feet of the infant

2. The amount of time that the individual interacts with the infant:

❑ Interacts with the infant for 10 seconds or less ❑ Interacts with the infant for 10 seconds to one minute ❑ Interacts with the infant for 1 to 5 minutes ❑ Interacts with the infant for more than 5 minutes

3. The infant's attention or interest toward the individual:

❑ Infant made eye contact for less than 25% of the time. ❑ Infant made occasional eye contact for 25%- 50% of the time. ❑ Infant made eye contact for 50% - 75% of the time. ❑ Infant made eye contact for 75% or more of the time.

Fig. 1. The Infant-Individual Interaction Scale (IIIS) used to record interactions between infants and unfamiliar individuals.

Infant-Caregiver and Family Member Interaction Scale

Name of individual interacting with infant: _____ If caregiver, what is the child to caregiver ratio? _____

Date: _____ Participant Number: _____

Interaction Scenario	Approximate number of times the infant and person engaged in this type of interaction today:
1. Fleeting Involvement ➢ The person is over 6 feet away from the infant. ➢ The person interacts with the infant for less than ten seconds. ➢ The infant engaged in eye contact for less than 25% ofthe time.	_____
2. BriefInvolvement ➢ The person is 4-6 feet away from the infant. ➢ The person interacts with the infant for 10 seconds to 1 minute. ➢ The infant made occasional eye contact for 25%-50% ofthe time.	_____
3. Moderate Involvement ➢ The person is 2-4 feet away from the infant. ➢ The person interacts with the infant for 1- 5 minutes. ➢ The infant engaged in eye contact for 50%-75% ofthe time.	_____
4. High Involvement ➢ The person is within 2 feet ofthe infant. ➢ The person interacts with the infant for over 5 minutes. ➢ The infant engaged in eye contact for over 75% ofthe time.	_____

Fig. 2. The Infant-Caregiver and Family Member Interaction Scale (ICFMIS) used to record interactions between infants and familiar individuals

this collapsing of the three items into one category resulted in some information loss, the purpose was to make the scale user-friendly for caregivers and avoid a potentially higher participant dropout rate.

1.3. Procedure

Parents came into the lab and received training on how to use the two scales to record their infant's interactions during a 1-week period of time. The experimenter collected demographic information from the parent about individuals with whom the infant frequently interacted and explained that the parent would use the ICFMIS for any interactions the infant had with those individuals. For each individual with whom the infant frequently interacted, parents received enough ICFMIS sheets to record interactions for eight days. For less familiar individuals or strangers, the experimenter explained that the parent would use the IIIS. Parents received a booklet containing 50 IIIS sheets. No participants reported running out of surveys, so the amount of ICFMIS and IIIS sheets that parents received was sufficient for the week of data collection. The experimenter then provided specific interaction scenarios to illustrate what parents would check on the scales in particular situations. Training included tips for parents on how to estimate the infant's distance from the interacting person, how to keep track of the length of the interaction, and how to assess the infant's interest in the person. Experimenters also asked parents if the upcoming week would be a typical week for their infant or if there would be any differences in their typical interactions (e.g., people coming to visit or a family member going out of town). If anything atypical was going to occur, the experimenter requested that the parent delay using the surveys until the data would reflect a more typical week. None of the families delayed survey use for this reason.

Research assistants contacted the parent by telephone within two days following the training to check study progress and answer any questions the parent had. When the parent returned the survey data, an experimenter conducted a brief post-survey interview and asked if the parent had any difficulties completing the survey and if the social interactions the infants experienced that week were representative of the typical interactions they had with others.

1.4. Data preparation

There were three dependent variables of interest for examining the research questions: (1) the percentage of total facial experience (PTFE) represented by each face the infant saw during the week (data collected from both the IIIS and ICFMIS); (2) the time unfamiliar individuals spent interacting with the infant (TIME) as recorded on the IIIS; and (3) the attention or interest infants showed toward unfamiliar individuals (ATT) as recorded on the IIIS. By 2–3 months of age, infants primarily allocate their attention toward the eyes when scanning faces (Maurer & Salapatek, 1976; Turati, Valenza, Leo, & Simion, 2005), so ATT reflected the percentage of eye contact infants made with the individual during the interaction. Data included in the analyses were from social interactions that occurred at a distance within infants' hypothesized visual abilities: (a) for 2-month-olds, the person needed to be within 2 ft (61 cm) of the infant; (b) for 5-month-olds, the person needed to be within four to 6 ft (122–183 cm) of the infant; and (c) for 8- and 11-month-old infants, all interactions were included. The literature does not specify the distances at which infants can see faces at various ages, so we used a combination of visual development findings and face perception studies noting the distances at which infants sat from the stimulus faces to establish the visual ability criteria. For example, research studies demonstrated 2-month-olds' ability to see faces within 1–2 ft (35–61 cm) from themselves (Bartrip, Morton, & de Schonen, 2001; Blass & Camp, 2004; Gamé, Carchon, & Vital-Durand, 2003; Hunnius & Geuze, 2004; Nelson & Horowitz, 1983). Researchers likely chose this short distance between 2-month-olds and the facial stimuli due to infants' poor visual acuity at this age (Courage & Adams, 1996; Hainline & Abramov, 1992). In contrast, there is substantial improvement in infants' visual capabilities between the ages of 2 and 5 months (Banks, 1985; Courage & Adams, 1996; Prodohl, Wurtz, & Malsburg, 2003). The literature reflects this development in that the distance between 5-month-olds and the facial stimuli tested has been as long as 5 ft (150 cm; Rochat & Striano, 2002). By the second half of the first year, visual acuity and other visual perception abilities are at a near adult-like level (Courage & Adams, 1990; Slater, 2001). Consequently, we hypothesized that 8- and 11-month-olds would be better able to see faces further away than 6 ft (183 cm).

For the IIIS interaction data that met the above distance criterion, we multiplied the mean values of the range checked for interaction length (TIME) and percentage of infants' attention or interest toward the individual (ATT) to calculate the amount of experience infants had with a face (see Table 1). For example, if the individual's interaction with the infant lasted between 10 s and 1 min and the infant's attention or interest toward that individual was for 75% or more of the time, we multiplied 35 by 87.5%, so the amount of the infant's experience with that face was 30.63 s. If the individual interacted with the infant

Table 1
The mean values assigned to the various scale points for items 2 and 3 on the IIIS

Interaction length		Infant attention	
Raw data	Numerical value (s)	Raw data (%)	Numerical value
10 s or less	5	<25	.125
10 s to 1 min	35	25–50	.375
1–5 min	180	50–75	.625
More than 5 min	360	>75	.875

Table 2
Values assigned for interaction length and infant attention toward frequently encountered individuals as noted on the ICFMIS

Interaction type	Interaction length (s)	Infant attention
Fleeting involvement	5	.125
Brief involvement	35	.375
Moderate involvement	180	.625
High involvement	360	.875

more than once, then we added all those experiences together to produce a total time for the infants' experience with that face (EXP).

For the ICFMIS, we used the same mean values shown in Table 1 and applied those values to the type of interaction. See Table 2 for the value conversion for each type of interaction on the ICFMIS. We added together the experience for each interaction infants had with a particular familiar individual across the course of a week (EXP).

By adding together the EXP for all faces an infant encountered during one week, we arrived at an estimate of their total time attending to faces during the week (e.g., 15.5 h). For each particular face, we then calculated PTFE—a percentage of how much that particular face represented their total experience with faces.

1.5. Data analyses

Due to the nested structure of the data (interactions with individuals nested within infants), we used hierarchical linear models (HLM 6.02a) to analyze our TIME and ATT data. Nested data structures occur when there are multiple observations (i.e., interactions with faces) that vary in number or measurement occasion for each unit (i.e., infant), thereby complicating the assumptions of homoscedasticity and independence necessary in traditional linear multiple regression analyses (Kreft & de Leeuw, 1998; Raudenbush & Bryk, 2002). To determine the appropriateness of using HLM for each particular analysis, we ran intercepts-only models. Intercepts-only models allow for the examination of interclass correlations, thereby indicating the proportion of variance at the second and subsequent levels of the model (Hox, 2002).

We also examined the normality of the distribution for the dependent and predictor variables in each analysis. If distributions were skewed and logarithmic transformations of the data improved skew, we used the transformed values for these variables. If, however, logarithmic transformations of the data worsened skew or produced minimal change or kurtosis we kept the raw data values (Schwab, 2007). Based on these criteria, the age range of the individual interacting with the infant was the only predictor variable that we transformed (henceforth referred to as log_age).

Model building proceeded according to Raudenbush and Bryk's (2002) recommended strategy. Predictor variables for each model were included one at a time based on theory and we compared the fit of each resulting model to the previous less complex model. This procedure required evaluating the Chi-square statistic (difference between deviance statistics) with degrees of freedom equal to the difference between estimated parameters. Lower deviance is considered a better fit for the data.

2. Results

After excluding data for individuals who interacted with the infant beyond the a priori distance restrictions ($n = 82$ faces for the 2-month-olds and seven faces for the 5-month-olds), we included data from a total of 497 unfamiliar faces and 169 familiar faces in our analyses.

2.1. Percentage of total facial experience (PTFE) with certain types of faces

To determine discrepancies in infants' exposure to same- and other-race faces, mother and father's face, female and male faces other than mother and father, and same- and other-age individuals, we determined infants' average PTFE for each of these categories of faces for each infant age group (see Table 3). Based on these percentages, we calculated discrepancy ratios that represented how much more times experience infants had with the more familiar types of faces (i.e., same-race, mother, other female, and same-age faces) relative to the less familiar types of faces (i.e., other-race, father, other male, and other-age faces). The discrepancy ratios are plotted in Fig. 3.

2.1.1. Race of face

As can be seen in Fig. 3, infants had the largest discrepancy ratio in their experience with same- and other-race individuals relative to discrepancies in interactions with the two sexes and interactions with same- and other-age individuals. Although this discrepancy ratio decreased during the second half of the first year, infants continued to have substantially more experience with same- than other-race faces. Infants were most likely to get exposure to other-race faces if their parents were of different races or if a person familiar to their family was of a different race. Otherwise, the majority of infants had very limited exposure to other-race faces. On average, 92% (S.D. = 17%) of infant interactions during the first year were with their primary caregiver and other same-race individuals.

Table 3
Average percentage of infants' total facial experience (PTFE) with certain types of faces (and standard deviations) for each age group

	2 month-olds	5 month-olds	8 month-olds	11 month-olds
Race of face				
Same-race	96.37% (10.34)	96.85% (4.39)	88.27% (23.27)	88.26% (21.46)
Other-race	3.63%	3.15%	11.73%	11.74%
Parent				
Mother	57.44% (18.89)	49.73% (20.74)	51.45% (12.87)	46.98% (14.42)
Father	29.92% (16.05)	17.34% (10.56)	19.77% (9.52)	19.10% (13.74)
Sex of face				
Other female	7.98% (11.74)	16.44% (13.72)	24.58% (19.08)	28.99% (24.45)
Other male	4.67% (7.55)	16.50% (13.70)	4.20% (3.52)	4.93% (9.21)
Age of face				
Same-age	89.80% (12.27)	68.33% (24.12)	79.19% (13.21)	70.37% (24.69)
Other-age	10.20%	31.67%	20.81%	29.64%

2.1.2. Sex of face

Because only two of the infants had a male primary caregiver, the sex of face data included in Table 3 and Fig. 3 are for infants with a female primary caregiver only. Infants had an average of 2.46 times as much experience with mother's face than with father's face when the mother was the primary caregiver. The discrepancy ratio in experience with mother and father's face increased the most between 2 and 5 months of age and then stayed fairly consistent (see Fig. 3). We did not find that infant interactions with father increased during the second half of the first year at least in relation to infants' overall interactions; rather, fathers' interactions accounted for a greater percentage of infants' overall interactions at 2 months of age compared to the older age groups. For the two infants with a male primary caregiver, they had 1.98 times more exposure to father's face than mother's face.

The discrepancy in infant experience with other female and male faces (i.e., faces other than mother and father) increased substantially between 5 and 8 months. Whereas there was no discrepancy in 5-month-olds' experience with other female and male faces at 5 months, infants had almost six times the experience with other female than other male faces at 8 and 11 months (see Table 3). Although we had a sample size of only two infants with a male primary caregiver, these infants also spent substantially more time interacting with other females than other males, potentially countering any effects of greater experience with father than mother's face.

Overall, infants with female primary caregivers spent about 2/3 of their time interacting with females (including mother and other females) at 2 and 5 months of age, and 3/4 of their time interacting with females at 8 and 11 months of age. On average, 71% (S.D. = 25%) of these infants' interactions during the first year were with a female.

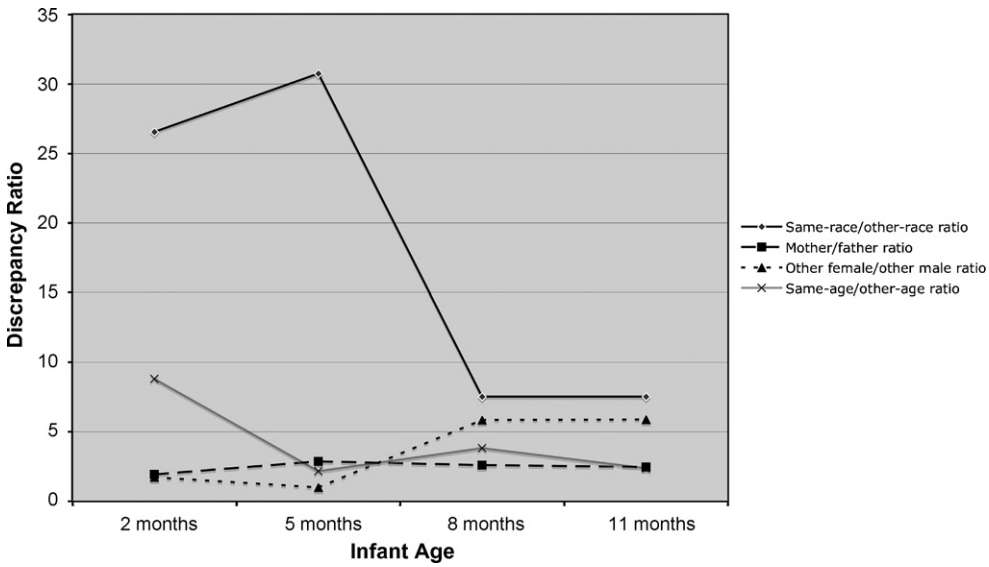

Fig. 3. Ratios showing the discrepancy between infants' experience with familiar face types (same-race, mother, other female, and same-age faces) and less familiar faces types (other-race, father, other male, and other-age faces) across the first year.

2.1.3. Age of face

Ninety-three percent (39 out of 42) of the infants had a primary caregiver aged 21–39 years. The other three infants had a primary caregiver aged 40–59 years. Infants spent the most time interacting with people from the primary caregiver's age group: On average, 77% (S.D. = 21%) of their interactions during the first year were with their primary caregiver and other individuals from this age group. For infants with a primary caregiver aged 21–39, the other age group with whom these infants most commonly interacted was the 2–6-year-olds [9% (S.D. = 12%) of interactions]. If infants had siblings, most were aged 2–6, so that is why interactions with this age group were the next most common.

2.2. Interaction length (TIME)

To examine what variables contributed to the length of the interaction (TIME) between infants and unfamiliar individuals (IIIS data), we used a three-level model with TIME as the first level unit, the individual's characteristics (same-race/other-race, sex, same-age/other-age, and log_age) as the second-level variables, and infant characteristics (age, sex, race of primary caregiver, age of primary caregiver, and sex of primary caregiver) as the third-level variables. Interclass correlations of .55 at the second-level and .28 at the third-level demonstrated a three-level model was appropriate for the analysis.

The full model for TIME consisted of TIME as the first level; same-race, individual's sex, and log_age as second-level predictors; and infant age as the third-level predictor. An initial model of third-level predictors with random slopes indicated that slopes for same-race and individual's sex did not vary significantly; therefore, the final model restricted those third-level slopes to fixed effects. This model fit the data significantly better than the intercepts-only model, $\chi^2(4) = 31.21$, $p < .001$. Investigation of the error terms revealed that there was significant variability among infants in their average TIME scores, $\chi^2(35) = 97.78$, $p < .001$ and among individuals, $\chi^2(417) = 556.09$, $p < .001$. The relationship between log_age and TIME also varied significantly across infants, $\chi^2(35) = 56.69$, $p < .02$, indicating the appropriateness of using random effects for the log_age slope and that the variation between log_age slopes explained a significant portion of the variance. The large standard deviation associated with the third-level interaction on the relationship between log_age and TIME variance (S.D. = .86) in comparison to the level one intercept and interaction deviations (range = .26–.75) indicated that there was a large amount of variance explained by the model.

Infant age was negatively associated with the relationship of individual's sex and TIME, $t(493) = -2.1$, $p < .05$. Younger infants had longer interactions with unfamiliar individuals than older infants. In addition, infants typically experienced longer interactions with unfamiliar females than unfamiliar males and this discrepancy in interaction length increased as infants got older. One exception is that 2-month-olds experienced slightly longer interactions with unfamiliar male than unfamiliar female faces (note in Fig. 4 that the bars indicating interaction length are larger for interactions with unfamiliar female than male faces at all ages except 2 months).

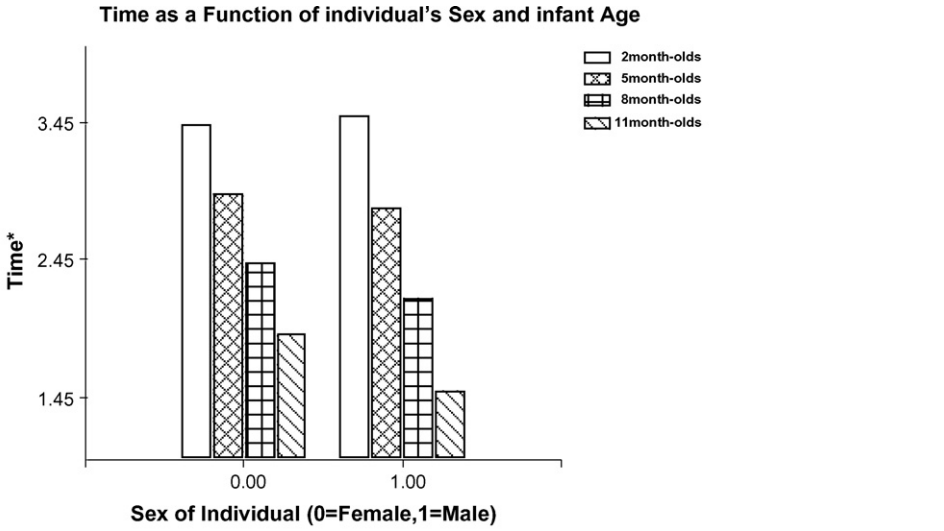

Fig. 4. The effects of an unfamiliar individual's sex and infant age on interaction length.

* Interest is the percentage of time the infant attended to the individual's face (1 = less than 25%; 2 = 25-50%; 3 = 50-75%; 4 = over 75%)

Fig. 5. The effects of an unfamiliar individual's sex on infant attention toward that individual.

2.3. Attention toward less familiar individuals (ATT)

To determine how infants' experience with their primary caregiver's characteristics affected their attention toward unfamiliar individuals, we used a three-level model with ATT as the first level unit, the individual's characteristics (same-race/other-race, sex, same-age/other-age, and log_age) as the second-level variables, and infant characteristics (age, sex, race of primary caregiver, age of primary caregiver, and sex of primary caregiver) as the third-level variables. Interclass correlations of .57 at the second level and .21 at the third level demonstrated a three-level model was appropriate for the analysis.

The optimal model specification for ATT included ATT as the first level and individual's sex as a second-level predictor. Addition of third-level predictors did not improve the model. Modeling individual's sex with random slopes and intercepts as the second-level predictor fit the data significantly better than the intercepts-only model, $\chi^2(3) = 16.17$, $p = .001$, which only considered variability in individuals and infants. Investigation of the error terms revealed that there was significant variability among infants in their average ATT scores, $\chi^2(31) = 125.94$, $p < .001$ and among individuals, $\chi^2(423) = 615.65$, $p < .001$. The relationship between the individual's sex and ATT also varied among infants, $\chi^2(34) = 139.68$, $p < .001$. The large standard deviation associated with the level one variance (S.D. = .72) in comparison to the intercept, interaction, and slope deviations (range = .39–.51) indicated that there was a large amount of variance still unexplained and that the model could be further improved.

On average, ATT was related to primary caregiver: For infants with male primary caregivers, the intercept of ATT decreased by about .04 on a scale of 1–4, suggesting they attended slightly less toward others than infants with a female primary caregiver. Because there were only two infants with a male primary caregiver, we interpret these results with caution. ATT slope also changed as a function of the individual's sex such that infants paid more attention to female than male faces (Fig. 5).

2.4. Post-survey interview

Post-survey results indicated that 31 families (74%) reported having a typical week, four (9.5%) had more interactions than usual, four (9.5%) had fewer interactions than usual, and three (7%) did not answer the question. Thirty families (71.5%) reported they had been very accurate, four (9.5%) reported they had been accurate, three (7%) reported that one parent had been very accurate and one not, two (5%) reported having some accuracy problems, and three (7%) did not answer the question. Similarly, 30 families (71.5%) reported that the IIIS and ICFMIS were easy to use, six (14%) made suggestions for improvement, four (9.5%) preferred the IIIS to the ICFMIS, one (2.5%) reported that the scales were difficult, and one (2.5%) abstained from answering the question.

2.5. Scale reliability and validity

2.5.1. Reliability

To determine if caregivers used the ICFMIS similarly during the first and second halves of the week, we calculated split-half reliability and compared both raw scores and means for the chronological week (i.e., starting on the first day parents began the study) and for the Sunday–Saturday week (i.e., one weekend day included in each half). Raw score reliabilities were very high for the chronological week (Guttman split-half coefficient = .91) and the Sunday–Saturday week (Guttman split-half coefficient = .90). Comparison of the means from the first four days and the next three days for both the chronological and Sunday–Saturday week were also highly reliable (Guttman split-half coefficients = .84). Given the reliability of the ICFMIS, it suggests parents also used the similarly designed IIIS reliably.

2.5.2. Construct validity

The ICFMIS appears to show convergent validity (i.e., that the survey data are related to previously published data on infant behavior and interactions with others). Specifically, we replicated the finding that infants, in general, have substantially more interactions with mother than with father (Bailey, 1994; Harrison & Magill-Evans, 1996; Hossain & Roopnarine, 1994; Roopnarine et al., 1995; Russell & Radojevic, 1992; Wille, 1995). Moreover, with the IIIS data, we replicated other findings showing infants' greater visual interest in and attention toward female than male faces (Quinn, 2002; Quinn et al., 2002).

Additionally, when contrasting groups, infants who were expected to differ in their experience with faces did differ. Infants whose parents reported dad as the primary caregiver spent significantly more time interacting with dad than mom, and infants whose parents reported mom as the primary caregiver spent significantly more time interacting with mom than dad. Furthermore, infants with parents from two different racial groups were much more likely to interact with other-race individuals than infants with parents from the same racial group.

3. Discussion

Our results showed large discrepancies in the race, sex, and age of faces that infants experienced during their first year with the majority of their interactions being with their primary caregiver, females, and other individuals of the same-race and age as their primary caregiver. Other findings indicated how the infant's age and an unfamiliar individual's sex were predictive of their time spent interacting with one another. Moreover, we found that an unfamiliar individual's sex was predictive of the attention infants allocated toward that individual during social interactions.

3.1. Race of face

The particularly large discrepancies in infants' experience with same- and other-race faces is likely a very important contributor to the early development of same-race visual preferences and better recognition of same-race faces (Bar-Haim et al., 2006; Hayden et al., 2007; Kelly et al., 2005, 2007; Sangrigoli & de Schonen, 2004). Despite the slight increase in experience with other-race faces during the second half of the first year, the discrepancy between older infants' experience with same- and other-race faces remained substantial. Our data suggest that this discrepancy in experience may be due to the greater frequency of interactions with individuals of the same-race rather than the time same- and other-race individuals spend interacting with the infant or the attention infants allocate toward same- and other-race individuals during the interactions. Thus, differences in the frequency of experience with same- and other-race individuals may be sufficient for same-race preferences and superior recognition abilities to emerge.

We did not find that same-race had a significant effect on the length of interactions (TIME), although it was part of the model that best fit the TIME data and this model explained a large amount of the variance in interaction lengths. Therefore, same-race may serve as a potential moderator or mediator of another variable's effects on how long unfamiliar individuals interact with infants and should be considered in future examinations of infant interactions.

Same-race also did not have a significant effect on infant attention (ATT). Given the research showing 3-month-olds' visual preferences for same-race faces (Bar-Haim et al., 2006; Kelly et al., 2005, 2007), this finding was somewhat surprising. The IIIS, however, did not assess whether the person interacting with the infant was competing with other individuals for the infants' attention or was the only face in the infant's visual field. Same-race familiarity may attract infants' attention when competing with other-race faces, but other-race novelty may attract and keep infants' attention when the other-race individual is the only one interacting with the infant or the only one in the infant's visual field. Differences in such visual interest occur in infant attention toward female and male faces: Infants look longer at female than male faces when paired together (Quinn, 2002; Quinn et al., 2002), but look longer at male faces when shown alone than female faces when shown alone (Ramsey et al., 2005). Having same-race familiarity preferences in some social interactions and other-race novelty preferences in other social interactions could make it appear that infant attention toward individuals is unaffected by race. Future investigations of infants' facial experience should assess if the individual is competing with others for the infant's attention and, if so, compare the demographics of the individual with whom that person is competing.

3.2. Sex of face

Although the discrepancy in infants' experience with female and male faces was not as large as their discrepancy in experience with same- and other-race faces, it was quite substantial nonetheless. Moreover, at 8 and 11 months of age, the discrepancy ratio of infants' experience with female relative to male faces other than their parents came close to the discrepancy ratio of their experience with same- relative to other-race faces. This differential experience appeared to be at least partly due to unfamiliar females engaging in longer interactions with infants than unfamiliar males, particularly the older the infant got. Furthermore, infants showed greater attention toward unfamiliar female than unfamiliar male faces during actual social interactions, thereby compounding the effects of the longer social interactions. Heightened attention toward female faces may also contribute to why interactions with females lasted longer than interactions with males. For example, females tend to be more verbal and more emotionally expressive than males when interacting with infants (e.g., Forbes et al., 2004; Golinkoff & Ames, 1979; Landerholm & Scriven, 1981), which may cause infants to be particularly attentive toward females during social interactions (e.g., Balaban & Waxman, 1997), and this attention may reinforce or encourage females to continue interacting with the infant.

In addition to these discrepancies in infant interactions with unfamiliar females and males, infants also had almost 2.5 times greater experience with their mother than father's face over the course of the first year. If fathers do indeed get more involved in infant caregiving as the infant gets older (Anderson, 1996; Bailey, 1994; Rustia & Abbott, 1993), it occurs after the first year or the increased experience is inconsequential because of a similar increase in mother's interactions with the infant. Given these discrepancies in infant interactions with both familiar and unfamiliar females and males, it is not surprising that infants display visual preferences for female faces when paired with male faces, show better recognition of female than male faces, and more easily categorize female than male faces (Quinn, 2002; Quinn et al., 2002; Ramsey et al., 2005).

It is important to note that although we found a significant difference in infant attention toward unfamiliar females and unfamiliar males, the difference was not that large. Plus, the model that best fit the ATT data included only the sex of the individual interacting with the infant, leaving a large amount of the variance unexplained. There was some indication that infants with male primary caregivers may show slightly less attention toward others than infants with female primary caregivers, but with a sample size of only two fathers, we are hesitant to make strong conclusions without more data. As with our recommendation regarding infant interactions with same- and other-race faces, future research should examine whether infant attention differs when a female and male are competing for the infant's attention compared to when there is just one face within the infant's visual field (Ramsey et al., 2005). Moreover, the relationship between the mother and infant, as indicated by infant affect and behaviors during exploration, separation and reunion with mother, may provide links to understanding infant attention toward unfamiliar female faces and possibly unfamiliar male faces (Swingler, Sweet, & Carver, 2007). Finally, the emotional and verbal expressiveness of the person interacting with the infant may be an important variable to include in understanding infant attention toward unfamiliar individuals (Forbes et al., 2004; Harrison & Magill-Evans, 1996).

3.3. Age of face

The majority of infant interactions across the four age groups were with their primary caregiver and individuals within the same-age range. To our knowledge, researchers have not examined how age affects infant face processing and development of face processing expertise. Some evidence to suggest that it is more difficult (i.e., takes longer) for infants to process other-aged faces comes from research showing it was necessary to increase the trial length from 10- to 15-s in order for infants to exhibit a visual preference for attractive relative to unattractive infants (Van Duuren, Kendell-Scott, & Stark, 2003). In studies using attractive and unattractive adult faces similar in age to the primary caregiver, 10-s trials were sufficient to elicit infants' visual preferences for attractive faces (Langlois et al., 1987). More research, however, is necessary to determine if infants show visual preferences for faces the same-age as their primary caregiver relative to other-aged faces and if infants more easily recognize same-age than other-age individuals.

We did not find that log_age had a significant effect on the length of interactions (TIME), although it was part of the model that best fit the TIME data and this model explained a large amount of the variance in interaction lengths. Log_age may serve as a potential moderator or mediator of another variable's effects on how long unfamiliar individuals interact with infants and should be considered in future research examining infant interactions. Although our ATT analysis did not find that infant attention was affected by the individual's age, it would be useful to know if there were other faces competing for the infant's attention or not.

3.4. Developmental change

As indicated in Fig. 3, the discrepancy ratio for same-race/other-race and same-age/other-age decreased from the beginning to the end of the first year, although it increased for other female/other male and stayed relatively the same for mother/father. At no point in development, however, did any of the discrepancies reverse, with there being only one instance of equal experience (5-month-olds' experience with female and male faces other than their parents). Generally, there was at least two times more experience and as much as 30 times more experience with the familiar face types than with the

less familiar face types. Even if these discrepancies do reduce later in development, with the specialized face processing that develops during the first year (e.g., Nelson, 2001), these discrepancies clearly have important implications.

The TIME analysis revealed another developmental change: The length of social interactions between infants and unfamiliar individuals decreased as the infants got older. This decrease is likely due to the change in infant abilities. At 2 months, infants are not very mobile, so they should be attentive and easier to interact with at this age. By 8 months, most infants have begun crawling and are much more active in general. Subsequently, it should be more difficult to interact with and engage infants for long periods of time. At the older ages of 8 and 11 months, it may be particularly important for individuals to be emotionally and verbally expressive when interacting with these active infants, which may be why females are more successful at having longer interactions with infants than are males.

3.5. Strengths and limitations

One caveat is that it was not possible to have a trained researcher collect the data; a researcher simply could not be with an infant and their family 24 h a day for an entire week. Moreover, having a researcher present to complete the scales would have substantially changed the infants' experience with faces because the researcher would be an "unnatural" face the infant would continually experience. Although parents completed the scales rather than a trained researcher, we feel these data provide an appropriate estimation of infants' differential experience with certain face types. First, an experimenter provided the parents with comprehensive training on how to use the scales. With this training, the majority of parents reported that the scales were easy to use and felt that they recorded the data accurately. Second, our reliability check showed that parents used the ICFMIS (and presumably the IIIS) in a consistent manner. This reliability is important because if parents were slightly off on the TIME or ATT estimations in a consistent manner (e.g., consistently over- or underestimating the length of the interaction), it should not have significantly affected the PTFEs or other analyses because it would affect coding of all interactions (e.g., interactions with both females and males). Last, data collected from the ICFMIS and IIIS showed convergent validity.

The demographic information we collected regarding the infant and individual interacting with the infant explained a great deal of variance in interaction length (TIME). It appears that adding some information to the IIIS about who (if anyone) is competing for the infant's attention, however, might be useful in better understanding infant attention toward others (ATT).

Because our sample consisted of infants from heterosexual two-parent families, the findings may not generalize to infants from same-sex two-parent families, one-parent families, or infants who live with extended family members. Plus, families who withdrew from the study tended to have more children ($M = 2.78$ children; mode = 4 children) than families who completed the study ($M = 1.76$ children; mode = 1 child), so larger families may have more difficulty using the scales relative to smaller families.

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