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An adult face bias in infants that is modulated by face race

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Abstract

The visual preferences of infants for adult versus infant faces were investigated. Caucasian 3.5- and 6-month-olds were presented with Caucasian adult versus infant face pairs and Asian adult versus infant face pairs, in both upright and inverted orientations. Both age groups showed a visual preference for upright adult over infant faces when the faces were Caucasian, but not when they were Asian. The preference is unlikely to have arisen because of low-level perceptual features because: (1) no preference was observed for the inverted stimuli, (2) no differences were observed in adult similarity ratings of the upright infant-adult face pairs from the two races, and (3) no differences between the infant and adult faces were observed across races in an image-based analysis of salience. The findings are discussed in terms of the social attributes of faces that are learned from experience and what this implies for developmental accounts of a recognition advantage for adult faces in particular and models of face processing more generally.

Keywords

visual preference; infant; adult; familiarity; age preferences; other-race effect

The ability to respond to conspecifics on multiple dimensions is an important skill that prepares the infant to function in a complex social world. Differentiating among subgroups of conspecifics can be studied early in development using spontaneous visual preference procedures (Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002). In a spontaneous visual preference procedure, infants are presented with pairs of pictures depicting objects from different categories. Infant looking time to the pictures within each pair is measured, and a preference is inferred if infants look significantly longer at pictures from one category than the other.

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Spontaneous preferences provide evidence that some classes of stimuli might be more attractive for cognitive reasons or for their low-level visual properties. For example, infants from an early age prefer to look at faces more than other categories of stimuli (Johnson, Dziurawiec, Ellis, & Morton, 1991), suggesting that they may have an innate preference for faces or at least develop rapidly a representation of this stimulus class which is predominant in their environment. Over the next few months of postnatal experience, face preferences become more specific, such that more frequently experienced categories of faces elicit more attention than less frequently experienced categories (e.g., gender, race), and these categories interact to drive preferences (Kelly et al., 2005; Liu et al., 2015a; Quinn et al., 2008).

In particular, 3- to 4-month-olds raised by female caregivers look longer at female than male adult faces, while infants raised by male caregivers look longer towards male than adult female faces (Quinn et al., 2002). Previous research also indicates that 3-month-old Caucasian infants exposed primarily to Caucasian faces look more to Caucasian than to Asian, African, or Pakistani faces (Bar-Haim, Ziv, Lamy, & Hodes, 2006; Kelly et al., 2005) and that 3-month-old Asian infants exposed primarily to Asian faces look more to Asian faces than to Caucasian, African, or Pakistani faces (Kelly et al., 2007a; Liu et al., 2015b).

When different social attributes of faces are compared, race may supersede gender. Caucasian 3-month-olds prefer female over male faces when the faces are Caucasian, but not when they are Asian (Quinn et al., 2008); likewise, Asian 3-month-olds prefer female over male faces when the faces are Asian, but not when they are Caucasian (Liu et al., 2015a). However, a preference for own-race faces is present for both female and male faces (Bar-Haim et al., 2006; Kelly et al., 2005, 2007a; Liu et al., 2015b). When female and male faces are changed from adult to child, infants generalize their preference for female faces from one age category to another (Quinn et al., 2010). It may be that infants have more experience with own-race child faces than other-race adult faces, thus allowing generalization of gender to occur across age but not race (Quinn et al., 2010). These findings suggest that there may be a hierarchy of face processing in which some social attributes receive priority over others.

The statistics of the early visual experience infants have with faces are consistent with the idea that familiarity is driving preferences for some social categories over others. For example, Caucasian infants are predominantly exposed to own- over other-race faces. On average, 92% to 96% of an infant's interactions during the first year are with own-race individuals (Rennels & Davis, 2008; Sugden, Mohamed-Ali, & Moulson, 2014). Another experiential bias exists in the age of faces infants encounter with adult faces being most frequent. In the first year, 77% to 81% of an infant's interactions are with their primary caregiver or other individuals from this age group (approximately 20–49 years) (Rennels & Davis, 2008; Sugden et al., 2014). The present study examined whether infants would prefer adult over infant faces, and the influence of face race on any age preference that might be observed.

Research with adults has assessed preference for faces of particular ages as well as the ability to recognize and process differently aged faces. In terms of preference, adults tend to prefer infant over adult faces (Luo, Li, & Lee, 2011), are more responsive to infantile face cues (Glocker et al., 2009; Hildebrandt & Fitzgerald, 1979; Little & Fusani, 2012), and have their attention captured more by infant than adult faces (Brosch, Sander, & Scherer, 2007; Proverbio, De Gabriele, Manfredi, & Adorni, 2011). These results may reflect a baby schema that elicits positive responses and caretaking behavior in adults (Glocker et al., 2009).

However, research with adults also shows that we are generally better at recognizing adult faces than child or infant faces, and that we use different processing strategies when viewing adult versus other-age faces (de Heering & Rossion, 2008; Harrison & Hole, 2009; Kuefner, Macchi Cassia, Picozzi, & Bricolo, 2008; Macchi Cassia, Picozzi, Kuefner, & Casati, 2009b). Experience with other-age faces has also been shown to influence adult abilities to process and recognise other-age faces. For example, preschool and primary school teachers are equally efficient at recognising child and adult faces (Harrison & Hole, 2009; Kuefner et al., 2008). In this instance, the ability to process child faces was enhanced by greater experience with children's faces. Similarly, maternity nurses show equally good recognition for adult and newborn faces (Macchi Cassia et al., 2009b). Taken together, these findings indicate that adult processing of differently aged faces is influenced by their experience with those age groups and that experience with another age group acquired in adulthood can modulate face-processing abilities.

Developmentally, children have been shown to be similar to adults in terms of being generally better at recognizing adult faces. For example, 3-year-olds with limited experience with neonates or elderly people are more accurate at recognizing adult faces than newborn or elderly faces (Macchi Cassia, 2011; Macchi Cassia, Kuefner, Picozzi, & Vescovo, 2009a; Proietti, Pisacane, & Macchi Cassia, 2013). Likewise, 3-year-olds without an older sibling and 6-year-olds without a sibling are better at differentiating among adult faces than among child faces (Macchi Cassia, Pisacane, & Gava, 2012; Macchi Cassia, Proietti, & Pisacane, 2013). However, 3-year-olds with an older sibling have been found to be equally adept at differentiating faces within both age groups (Macchi Cassia et al., 2012).

The above findings and a comprehensive review by Macchi Cassia (2011) yield little evidence of an own age bias (OAB) occurring robustly across different age groups. Instead, research indicates that adults and children are better at recognizing adult faces than children's faces unless they have specific experience with the latter category. A recent study indicates that 9-month-olds recognize adult faces better than infant faces, whereas 3-month-olds recognize faces from both age classes equally well (Macchi Cassia, Bulf, Quadrelli, & Proietti, 2014a). Thus, it appears that early in development, perceptual processes become tuned to adult faces because these are the faces which infants experience most frequently.

With regard to age-based preferences in infants, with colour photographs of male and female faces, 10- and 18-month-olds did not show a preference for infant or adult faces (Lewis & Brooks, 1975). Similarly, no preference was observed at 7 to 8 months when stimuli were presented as silent movies containing both face and body information of males and females (Sanefuji, Ohgami, & Hashiya, 2005). Four-, 5-, and 6-month-olds discriminated infants and adults when presented with colour drawings or photographs of male faces (Fagan & Singer, 1979; McCall & Kennedy, 1980). However, infants did not look longer at the infant stimuli on initial presentation, take more trials to reach habituation, or spend more time looking at infants across familiarization trials.

Overall, while infants can discriminate infant and adult stimuli, there is no evidence that infants have a spontaneous preference for infants or adults. However, in all of the above studies, stimuli were presented individually. This observation induces a twofold ambiguity in interpretation. First, it could be that as humans, both infants and adults when considered in isolation are attention-worthy. It may be necessary to present pairs of photographs, forcing infants to divide their attention between the pictures, to observe a preference. Second, when presented sequentially, greater attention to a category of faces could reflect either spontaneous preference or a lack of efficiency in processing these faces (Ramsey-Rennels & Langlois, 2006). Therefore, to avoid the ambiguity associated with interpreting a null result from a sequential presentation task, the current study presented infant and adult stimuli in pairs.

Recently, Macchi Cassia, Luo, Pisacane, Li, and Lee (2014b) investigated how race and age experiences combine to influence the ability of 3-year-olds to discriminate within adult and child Caucasian and Asian faces. Caucasian and Chinese children with and without older siblings were tested. Children without an older sibling were better at discriminating adult faces, but only with own-race faces. Children with at least one older sibling were equally adept at discriminating own-race adult and child faces. The fact that the adult face bias was confined to own-race faces and the own-race bias was only observed for adult faces suggests that race and age information are represented at the same hierarchical level for 3-year-olds (Macchi Cassia et al., 2014b). Had the adult face bias been observed for both own-and other-race faces and the own-race bias been observed only for adult faces, then that pattern of outcomes would have been consistent with a model in which age superseded race. Alternatively, had the adult face bias been observed only for own-race faces and the own-race bias been observed for both adult and child faces, then that pattern of outcomes would have been consistent with a model in which race superseded age.

The present study examined whether Caucasian 3.5- and 6-month-olds show a preference for looking at adult compared to infant faces, and whether any age preferences detected are the same for own-race (Caucasian) versus other-race (Asian) faces. Three-and-a-half-month-old infants were selected as this age group demonstrates a preference for own-versus other-race faces (e.g., Kelly et al., 2005); thus, it seemed possible that this age group may also have a preference based on face age. It also seemed possible that any observed age preference at 3.5 months might be restricted to own-race faces given evidence that preferences for other social category attributes (i.e., gender) have been shown to be limited to own-race faces in this age group of infants (Quinn et al., 2008). Six-month-olds were additionally selected for testing because this age group has been tested to assess changing preferences for both own- versus other-race faces and male versus female faces (e.g., Liu et al., 2015a; Liu et al., 2015b).

Visual preference was examined by presenting pairs of infant and adult face photographs (race consistent within pairs), and measuring infant looking time for the members of each pair. Given that young infants typically prefer familiar stimuli in the social domain, it was hypothesised that Caucasian 3.5- and 6-month-old infants would attend more to Caucasian adult than Caucasian infant stimuli, since adults represent the most highly familiarised age group in the environment of infants. We also predicted that 3.5- and 6-month-old Caucasian infants would not show an age preference for other-race (Asian) faces, in line with the finding that infant gender preference is restricted to own-race faces (Liu et al., 2015a; Quinn et al., 2008) and the adult face bias is confined to own-race faces in 3-year-olds (Macchi Cassia et al., 2014b). To weaken potential low-level explanations for any preferences detected, stimuli were presented in an inverted orientation in a separate condition.

Method

Participants

Participants were 32 Caucasian full-term 3.5-month-olds (16 females; age range = 101–124 days) and 32 6-month-olds (15 females; age range = 164–199 days). A further 16 3.5-month-olds were excluded due to side bias ($n = 14$) or fussiness ($n = 2$). One 6-month-old was excluded due to fussiness, one due to experimental error, and four due to side bias (i.e., > 95% of total looking time to one side of the display). No infant had a twin or attended day care. In each age group, half of the infants were assigned to the upright condition, and the other half to the inverted condition, on a random basis.

Stimuli

The stimuli presented to infants were 24 colour images of faces divided into three different sets, each containing two Caucasian infant-adult face pairings, and two Asian infant-adult face pairings. Within each race, one pair of faces was male and one pair was female (see Figure 1). Adults ranged from 19 to 45 years and infants were 3.5 to 11 months. All faces were presented against a white background, and in frontal orientation with neutral expression. Pictures were cropped so that hairlines were visible, but also fairly uniform. Stimulus pairs were matched on hair colour, eye colour, face shape, and skin colour. Half the Caucasian face pairs were light-haired; the other half were dark-haired. Stimulus size and brightness were uniform. When projected onto the screen, each picture was 10 × 15 cm, separated by 12 cm. In the inverted condition, stimuli were identical except they were presented in an inverted orientation.

To investigate whether the level of discriminability within a given infant/adult pair was similar for the Caucasian and Asian faces, adults were asked to rate the pairs on similarity. A sample of 103 Caucasian adults (75% female, age range = 17–78 years, mean age = 40.3 years) rated each of the 12 infant/adult pairs for similarity on a scale of 1 to 5, with 1 being ‘Not at all similar’ and 5 being ‘Very similar, difficult to tell apart’. Ratings were averaged across the six Caucasian pairs versus the six Asian pairs. A paired-samples two-tailed t-test revealed that there was no significant difference in the similarity ratings for the Caucasian pairs ($M = 2.49$, $SD = .61$) versus Asian pairs ($M = 2.44$, $SD = .63$), $t(102) = .98$, $p = .323$. This result suggests that the discriminability of the infant/adult pairs was comparable for each race.

Procedure

Infants were seated on their mother's lap or in a high chair 60 cm away from a screen that displayed the images. The experimenter was not visible during testing, and the mother and experimenter remained silent. Each infant saw four pairs of photographs. Each pair contained one adult and one infant (different images for each trial). Left-right positioning of the adult and infant was counterbalanced across infants on the first trial and reversed on each successive trial. Presentation order of gender and race was counterbalanced across infants, as were the face stimuli chosen for presentation. Each pair of photographs was presented until 10 seconds of cumulative looking had been obtained (i.e., 20 seconds for the two pairs within a given race). An experimenter recorded infant looking time, which was captured via a digital camera positioned above the screen. An independent observer recoded 25% of the data for reliability. Both observers were blind to condition. Average level of interobserver agreement was high (Pearson $r = .96$).

Results

Preliminary examination of the data revealed no significant gender differences, so the data were combined across male and female participants for further analyses. In addition, there were no significant main effects or interactions involving trial order or gender of the stimuli, so these variables were not included in the analyses.

Looking times were converted to percentages, to indicate the percentage of time the infant attended to the adult face as a proportion of the total looking time. A 2 (Infant age: 3.5 vs. 6 months) × 2 (Stimulus race: Caucasian vs. Asian) × 2 (Orientation: Upright vs. Inverted) ANOVA revealed a significant main effect of orientation, $F(1,60) = 8.42$, $p = .005$, $\eta^2 = .12$, and a significant stimulus race × orientation interaction, $F(1,60) = 4.84$, $p = .032$, $\eta^2 = .07$. There were no other significant main effects (Infant age, $F < 1$; Stimulus race, $F[1,60] = 1.58$, $p = .214$) or interactions (all Fs < 1). This null age outcome indicates that the 3.5- and 6-month-old infants did not respond differentially to the adult faces.

To follow up the significant interaction and determine whether preferences were significantly different from chance (50%), two-tailed one-sample t-tests were applied at the group level and binomial probability was assessed at the individual level for the number of infants who showed preference scores above 50%. Mean preference for upright adult Caucasian faces (56.5%, $M = 11.30$ s, $SD = 1.66$ s) was significantly above chance $t(31) = 4.20$, $p < .001$, and 24 of 32 infants had preferences above 50%, binomial probability, $p = .007$. By contrast, mean preference for upright adult Asian faces (51%, $M = 10.19$ s, $SD = 2.39$ s) did not differ significantly from chance, $t(31) = .44$, $p = .661$, and only 13 of 32 infants had above-50% preferences (binomial probability, $p = .377$). Mean preferences for Asian (49.08%, $M = 9.10$ s, $SD = 1.54$ s) and Caucasian (47.66%, $M = 8.47$ s, $SD = 2.06$ s) inverted adult faces were not significantly different from chance, $t(31) = -0.79$, $p = .438$ and $t(31) = -1.43$, $p = .161$, respectively. Only 12 of 32 infants had preferences above 50% for the inverted Caucasian adult stimuli, $p = .215$, and 18 of 32 infants had above-50% preferences for the inverted Asian adult stimuli, $p = .597$. Group means are depicted in Figure 2.

Further analyses compared performance in the experimental conditions. In particular, paired-sample t-tests revealed that infants looked significantly longer at the upright Caucasian adult faces than the upright Asian adult faces ($t[31] = 2.47$, $p = .019$), however there was no significant difference in looking time for the inverted Caucasian adult faces versus the inverted Chinese adult faces ($t[31] < 1$, $p = .476$). Independent sample *t*-tests indicated that infants looked significantly longer at the upright versus inverted Caucasian adult faces, ($t[62] = 3.87$, $p < .001$); however, there was no significant difference in looking time for the upright versus inverted Asian adult faces ($t[62] < 1$, $p = .994$).

One possible account for the differential responsiveness to the Caucasian versus Asian infant-adult pairs is that the differences between the infant-adult Caucasian pairs were greater than the differences between the infant-adult Asian pairs. Although the similarity ratings reported in the Method section and the inversion results argue against this possibility, we further tested it by performing a saliency analysis using the Saliency Toolbox designed by Walther and Koch (2006), as we have done in prior papers (e.g., Hu, Wang, Fu, Quinn, & Lee, 2014; Quinn, Lee, Pascalis, & Tanaka, 2016). This toolbox can calculate saliency for each area in a photo based on a psychologically plausible neural network model. This model is built on the assumption that more directed selective attention should be paid to areas with greater saliency for better recognition. During the analysis of salience, each upright face stimulus of a given age and race category was automatically divided into 150 * 112 grids. The saliency results for each of the face stimuli were spatially averaged to derive a mean saliency map for the Caucasian infant faces (Figure 3, top left panel), Caucasian adult faces (Figure 3, top center panel), Asian infant faces (Figure 3, bottom left panel), and Asian adult faces (Figure 3, bottom center panel). The analysis revealed that for all categories of faces, the most salient regions were along the lower (jaw-chin) external contour and in the eye region. The infant-adult differences of each race were then compared using the "gene mattest" procedure (2 [face race]×2[face age] between-subject ANOVA) in Matlab2010a, variance assumed to be unequal. Results showed that after adjustments for Type I error using the FDR method, there were no significant differences in saliency between the infant-adult contrast of faces from the two races, $F(1, 20) < 14.39$, $p > .272$, in all cases (Figure 3, right panel). The findings from the saliency analysis provide additional evidence to indicate that the preference for Caucasian upright adult faces did not arise from low-level stimulus properties.

Discussion

The present study investigated whether infants prefer infant or adult faces. Caucasian 3.5- and 6-month-olds showed a visual preference for adult over infant faces with Caucasian faces, but not with Asian faces. The preference would appear to be driven by frequent exposure to adult faces in the first months of life (Rennels & Davis, 2008; Sugden et al., 2014). In the present investigation, exposure to other infants was minimal given that all of the infant participants were reared at home.

One could alternatively argue that preference for adult over infant faces is innate. Infants may have developed through evolution an inherent representation of the face that matches more closely with an adult face. However, this possibility strikes us as unlikely given that the preference for adult faces by infants was modulated by face race. If representation of the adult face was innate, then one would not have expected it to be modulated by experience. One might counter-argue that an innate representation could resemble an adult own-race face, but the evidence indicates that newborns do not display a preference for own- over other-race adult faces (Kelly et al., 2005). By this reasoning, we favor an experientially-based account of the findings.

It should be acknowledged that without testing Asian infants, it is not possible to completely rule out low-level differences between the Caucasian and Asian faces, as the basis for allowing discrimination of Caucasian, but not Asian faces. However, we do not favour this account because of the inversion results and because the Caucasian (and Asian) pairs were matched on hair, eye, skin colour, and face shape, which minimised differences within a given pair of stimuli. It was also the case that Caucasian adults rated the infant/adult face pairs to be of comparable similarity across the two races and there was no significant difference in saliency between the infant-adult contrast of faces from the two races.

The data are consistent with Macchi Cassia's work indicating that adults, children, and infants as young as 9 months of age are typically better at recognizing adult than infant or child faces (Macchi Cassia, 2011; Macchi Cassia et al., 2009a, 2012a, 2013a, 2014a). Moreover, the present results have implications for how such an adult-age bias in face processing may develop. Predominant exposure to adult faces induces a visual preference for such faces at 3.5 and 6 months. A preference for familiar stimuli in the first six months of life is consistent with previous research on how infants process other social attributes of faces, including species, race, and gender (Bar-Haim et al., 2006; Heron-Delaney, Wirth, & Pascalis, 2011; Kelly et al., 2005; Liu et al., 2015b; Quinn et al., 2002). In the case of age, a preference for adult faces produces greater visual attention to such faces, even when faces from other age groups are present in the visual environment. By 9 months, greater visual attention to adult faces may translate into superior recognition of such faces. A similar account has been advanced to account for how infants come to demonstrate an own-race bias in face processing (Kelly et al., 2007b).

Consistent with an experientially-based account, we did not expect 3.5- and 6-month-olds to prefer adults over infants for other-race faces since infants spend limited time in interactions with other-race individuals in the first year of life (Rennels & Davis, 2008; Sugden et al., 2014). The current results are consistent with Macchi Cassia et al.'s (2014b) finding that 3-year-olds without an older sibling were better at discriminating adult than child faces if they were own-race, as compared with other-race, indicating an important influence of race on age processing. Additionally, the lack of preference for other-race adult faces is in line with Quinn et al. (2008) and Liu et al. (2015a), who reported that the gender preferences of 3-month-olds are only evident for own- but not other-race faces.

The findings also have theoretical implications for models of how different social attributes of faces are processed. That is, they are relevant to the question of whether different social attributes of faces are processed by infants independently in parallel (Bruce & Young, 1986) or in a hierarchy in which some attributes are prioritized over others? Previous research suggests that race supersedes gender (Liu et al., 2015a; Quinn et al., 2008). For example, changing the race of a face from own- to other-race eliminates the female face preference in 3-month-olds (Liu et al., 2015a; Quinn et al., 2008), yet a preference for own-race faces is present for both female and male faces (Kelly et al., 2005, 2007a; Liu et al., 2015b). With regard to age and gender, when female and male faces are changed from adult to child stimuli, infants generalize their preference for female faces from one age category to another (Quinn et al., 2010). Thus, for age and gender, changing face age does not affect the gender preference of infants (Quinn et al., 2010). Likewise, the current study demonstrates that changing face gender does not remove the age preference observed for Caucasian adults. These results are consistent with age and gender being processed in parallel or at the same level in a hierarchy. For age and race, the current results show that changing race blocks the preference for adult over infant faces. What is not known, however, is whether changing face age from adult to infant would block infant preference for own-race faces. Although an own-race bias was observed only for adult faces in 3-year-olds (Macchi Cassia et al., 2014b), it is unclear whether such a bias would be present at 3 to 6 months. Further data will be needed to determine what may turn out to be a complex processing scheme for the different social attributes of faces. Adding to the complexity is the possibility that the dynamics of the scheme could change from infancy to childhood.

A possible explanation for the proposed hierarchy is that infants process race information ahead of gender and possibly age information because there are greater differences between faces of different races than between the faces of different genders or the faces of different ages in the face space of infants. However, we favour an experiential explanation for the hierarchy, because the statistics of face race (ratio of own-race to other-race at greater than 9:1) are stronger than the statistics of face gender or age (which are approximately 7:3 or 8:2) (Rennels & Davis, 2008; Sugden et al. 2014).

Of additional theoretical significance is that infants in the current study did not use a “like me” representation as is evident in imitation studies (Meltzoff, 2007). Use of a “like me” representation would have presumably produced the opposite preference, namely, a preference for infant over adult faces. When displaying social preferences, infants may rely more on a representation that approximates the caregiver (i.e., “like caregiver”), or at least a representation that is close to the faces experienced most frequently in the everyday environment (Quinn et al., 2010). The different results taken together suggest that infants may use multiple reference points to guide responding in the social world.

Many infants gain more experience with other peers as they get older (via day-care or playgroups or both); however, they are also exposed to an increasing number of adults and variety of adult faces. Future research should therefore investigate changes in age preferences as a function of the participant’s age as well as their individual experiences with a range of ages. It is possible that experiences obtained through being part of a larger family, or through regular care arrangements outside the home might impact on these visual preferences.

In summary, this study provides the first known investigation of infant preference for different age groups using a visual paired-comparison procedure, which is likely more sensitive than the sequential presentation task for detecting age preferences in infancy.

Overall, the findings show that Caucasian 3.5- and 6-month-old infants have a preference to attend to adult over infant Caucasian faces. This preference appears to be driven by frequent exposure to and subsequent familiarity with adult faces as compared with infant faces, which are encountered less frequently in the first 6 months of life.

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References

Bar-Haim Y, Ziv T, Lamy D, Hodes RM. Nature and nurture in own-race face processing. Psychological Science. 2006; 17:159–163. DOI: 10.1111/j.1467-9280.2006.01679.x [PubMed: 16466424]

Brosch T, Sander D, Scherer KR. That baby caught my eye… attention capture by infant faces. Emotion. 2007; 7:685–689. DOI: 10.1037/1528-3542.7.3.685 [PubMed: 17683225]

Bruce V, Young A. Understanding face recognition. British Journal of Psychology. 1986; 77:305–327. DOI: 10.1111/j.2044-8295.1986.tb02199.x [PubMed: 3756376]

de Heering A, Rossion B. Prolonged visual experience in adulthood modulates holistic face perception. PloS ONE. 2008; 3:e2317.doi: 10.1371/journal.pone.0002317 [PubMed: 18509528]

Fagan JF, Singer LT. The role of simple feature differences in infants' recognition of faces. Infant Behavior and Development. 1979; 2:39–45. DOI: 10.1016/S0163-6383(79)80006-5 [PubMed: 25593377]

Glocker ML, Langleben DD, Ruparel K, Loughead JW, Gur RC, Sachser N. Baby schema in infant faces induces cuteness perception and motivation for caretaking in adults. Ethology. 2009; 115:257–263. DOI: 10.1111/j.1439-0310.2008.01603.x [PubMed: 22267884]

Harrison V, Hole GJ. Evidence for a contact-based explanation of the own-age bias in face recognition. Psychonomic Bulletin and Review. 2009; 16:264–269. DOI: 10.3758/PBR.16.2.264 [PubMed: 19293092]

Heron-Delaney M, Wirth S, Pascalis O. Infants' knowledge of their own species. *Philosophical Transactions of the Royal Society of London*. Series B, Biological Sciences. 2011; 366:1753–1763. DOI: 10.1098/rstb.2010.0371

Hildebrandt KA, Fitzgerald HE. Facial feature determinants of perceived infant attractiveness. Infant Behavior and Development. 1979; 2:329–339. DOI: 10.1016/S0163-6383(79)80043-0

Hu C, Wang Q, Fu G, Quinn PC, Lee K. Both children and adults scan faces of own and other races differently. Vision Research. 2014; 102:1–10. DOI: 10.1016/j.visres.2014.05.010 [PubMed: 24929225]

Johnson MH, Dziurawiec S, Ellis H, Morton J. Newborns' preferential tracking of face-like stimuli and its subsequent decline. Cognition. 1991; 40:1–19. DOI: 10.1016/0010-0277(91)90045-6 [PubMed: 1786670]

Kelly DJ, Liu S, Ge L, Quinn PC, Slater AM, Lee K, Pascalis O. Cross-race preferences for same-race faces extend beyond the African versus Caucasian contrast in 3-month-old infants. Infancy. 2007a; 11:87–95. DOI: 10.1080/15250000709336871 [PubMed: 18974853]

Kelly DJ, Quinn PC, Slater AM, Lee K, Ge L, Pascalis O. The other-race effect develops during infancy: Evidence of perceptual narrowing. Psychological Science. 2007b; 18:1084–1089. DOI: 10.1111/j.1467-9280.2007.02029.x [PubMed: 18031416]

Kelly DJ, Quinn PC, Slater AM, Lee K, Gibson A, Smith M, Pascalis O. Three-month-olds, but not newborns, prefer own-race faces. Developmental Science. 2005; 8:F31–F36. DOI: 10.1111/j.1467-7687.2005.0434a.x [PubMed: 16246233]

Kuefner D, Macchi Cassia V, Picozzi M, Bricolo E. Do all kids look alike? Evidence for an other-age effect in adults. Journal of Experimental Psychology: Human Perception and Performance. 2008; 34:811–817. DOI: 10.1037/0096-1523.34.4.811 [PubMed: 18665727]

Lewis, M., Brooks, J. Infants' social perception: A constructivist view. In: Cohen, L., Salapatek, P., editors. Infant perception: From sensation to cognition. New York: Academic Press; 1975. p. 101-148.

Little AC, Fusani L. Manipulation of infant-like traits affects perceived cuteness of infant, adult and cat faces. Ethology. 2012; 118:775–782. DOI: 10.1111/j.1439-0310.2012.02068.x

Liu S, Xiao NG, Quinn PC, Zhu D, Ge L, Pascalis O, Lee K. Asian infants show preference for own-race but not other-race female faces: the role of infant caregiving arrangements. Frontiers in Psychology. 2015a; 6:593.doi: 10.3389/fpsyg.2015.00593 [PubMed: 25999902]

Liu S, Xiao WS, Xiao NG, Quinn PC, Zhang Y, Chen H, Lee K. Development of visual preference for own- versus other-race faces in infancy. Developmental Psychology. 2015b; 51:500–511. DOI: 10.1037/a0038835 [PubMed: 25664830]

Luo LZ, Li H, Lee K. Are children's faces really more appealing than those of adults? Testing the baby schema hypothesis beyond infancy. Journal of Experimental Child Psychology. 2011; 110:115–124. DOI: 10.1016/j.jecp.2011.04.002 [PubMed: 21536307]

Macchi Cassia V. Age biases in face processing: The effects of experience across development. British Journal of Psychology. 2011; 102:816–829. DOI: 10.1111/j.2044-8295.2011.02046.x [PubMed: 21988386]

Macchi Cassia V, Bulf H, Quadrelli E, Proietti V. Age-related face processing bias in infancy: Evidence of perceptual narrowing for adult faces. Developmental Psychobiology. 2014a; 56:238–248. DOI: 10.1002/dev.21191 [PubMed: 24374735]

Macchi Cassia V, Kuefner D, Picozzi M, Vescovo E. Early experience predicts later plasticity for face processing: Evidence for the reactivation of dormant effects. Psychological Science. 2009a; 20:853–859. DOI: 10.1111/j.1467-9280.2009.02376.x [PubMed: 19493318]

Macchi Cassia V, Luo LZ, Pisacane A, Li H, Lee K. How race and age experiences shape young children's face processing abilities. Journal of Experimental Child Psychology. 2014b; 120:87–101. DOI: 10.1002/dev.21191 [PubMed: 24398416]

Macchi Cassia V, Picozzi M, Kuefner D, Casati M. Why mix-ups don't happen in the nursery: Evidence for an experience-based interpretation of the other-age effect. The Quarterly Journal of Experimental Psychology. 2009b; 62:1099–1107. DOI: 10.1080/17470210802617654 [PubMed: 19142827]

Macchi Cassia V, Pisacane A, Gava L. No own-age bias in 3-year-old children: More evidence for the role of early experience in building face-processing biases. Journal of Experimental Child Psychology. 2012; 113:372–382. DOI: 10.1016/j.jecp.2012.06.014 [PubMed: 22857798]

Macchi Cassia V, Proietti V, Pisacane A. Early and later experience with one younger sibling affects face processing abilities of 6-year-old children. International Journal of Behavioral Development. 2013; 37:160–165. DOI: 10.1177/0165025412469175

McCall RB, Kennedy CB. Attention of 4-month infants to discrepancy and babyishness. Journal of Experimental Child Psychology. 1980; 29:189–201. DOI: 10.1016/0022-0965(80)90015-6 [PubMed: 7365421]

Meltzoff AN. 'Like me': a foundation for social cognition. Developmental Science. 2007; 10:126–134. DOI: 10.1111/j.1467-7687.2007.00574.x [PubMed: 17181710]

Proietti V, Pisacane A, Macchi Cassia V. Natural experience modulates the processing of older adult faces in young adults and 3-year-old children. PLoS ONE. 2013; 8:e57499.doi: 10.1371/journal.pone.0057499 [PubMed: 23460867]

Proverbio AM, De Gabriele V, Manfredi M, Adorni R. No race effect (ORE) in the automatic orienting toward baby faces: When ethnic group goes not matter. Psychology. 2011; 2:931–935. DOI: 10.4236/psych.2011.29140

Quinn PC, Conforto A, Lee K, O'Toole AJ, Pascalis O, Slater AM. Infant preference for individual women's faces extends to girl prototype faces. Infant Behavior and Development. 2010; 33:357–360. DOI: 10.1016/j.infbeh.2010.03.001 [PubMed: 20434777]

Quinn PC, Lee K, Pascalis O, Tanaka JW. Narrowing in categorical responding to other-race face classes by infants. Developmental Science. 2016; 19:362–371. DOI: 10.1111/desc.12301 [PubMed: 25899938]

Quinn PC, Uttley L, Lee K, Gibson A, Smith M, Slater AM, Pascalis O. Infant preference for female faces occurs for same- but not other-race faces. Journal of Neuropsychology. 2008; 2:15–26. DOI: 10.1348/174866407X231029 [PubMed: 19334302]

Quinn PC, Yahr J, Kuhn A, Slater AM, Pascalis O. Representation of the gender of human faces by infants: a preference for female. Perception. 2002; 31:1109–1121. DOI: 10.1068/p3331 [PubMed: 12375875]

Ramsey-Rennels JL, Langlois JH. Infants' differential processing of female and male faces. Current Directions in Psychological Science. 2006; 15:59–62. DOI: 10.1111/j.0963-7214.2006.00407.x

Rennels JL, Davis RE. Facial experience during the first year. Infant Behavior and Development. 2008; 31:665–678. DOI: 10.1016/j.infbeh.2008.04.009 [PubMed: 18554724]

Sanefuji W, Ohgami H, Hashiya K. Infants' preference for infants and adults. Proceedings of 2005 4th IEEE International Conference on Development and Learning. 2005 doi: doi.ieeecomputersociety.org/10.1109/DEVLRN.2005.1490950.

Sugden NA, Mohamed-Ali MI, Moulson MC. I spy with my little eye: Typical, daily exposure to faces documented from a first-person infant perspective. Developmental Psychobiology. 2014; 56:249–261. DOI: 10.1002/dev.21183 [PubMed: 24285109]

Walther D, Koch C. Modeling attention to salient proto-objects. Neural Networks. 2006; 19:1395–1407. DOI: 10.1016/j.neunet.2006.10.001 [PubMed: 17098563]

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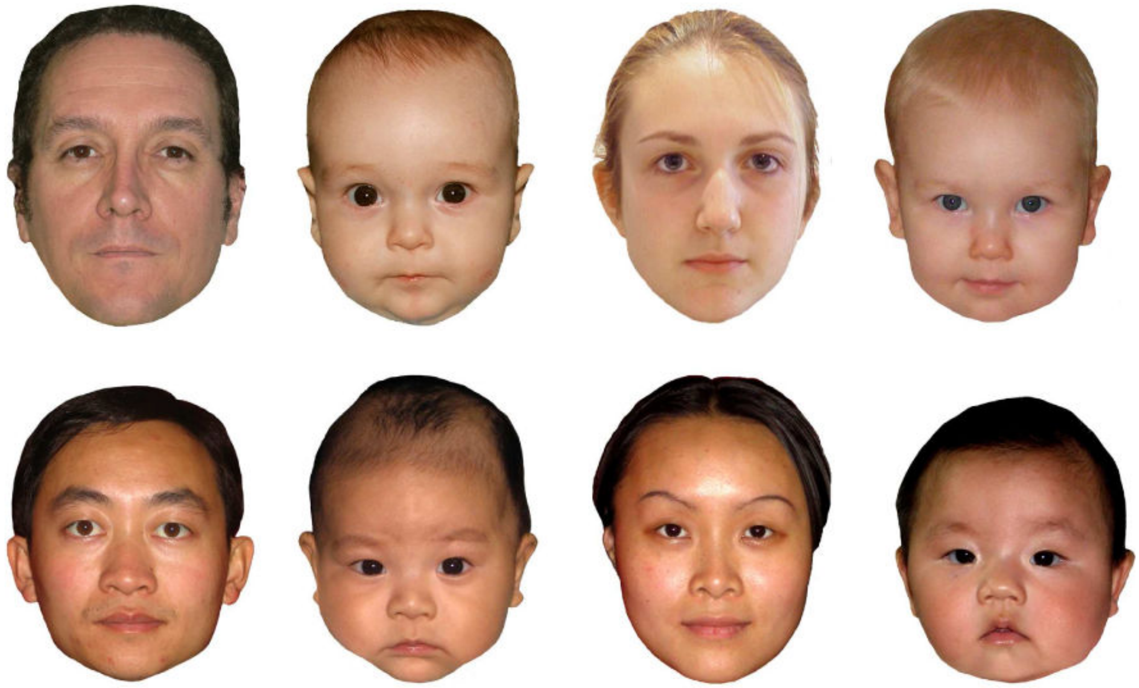

Figure 1.
Examples of the Caucasian and Asian adult and infant faces presented to Caucasian infants.

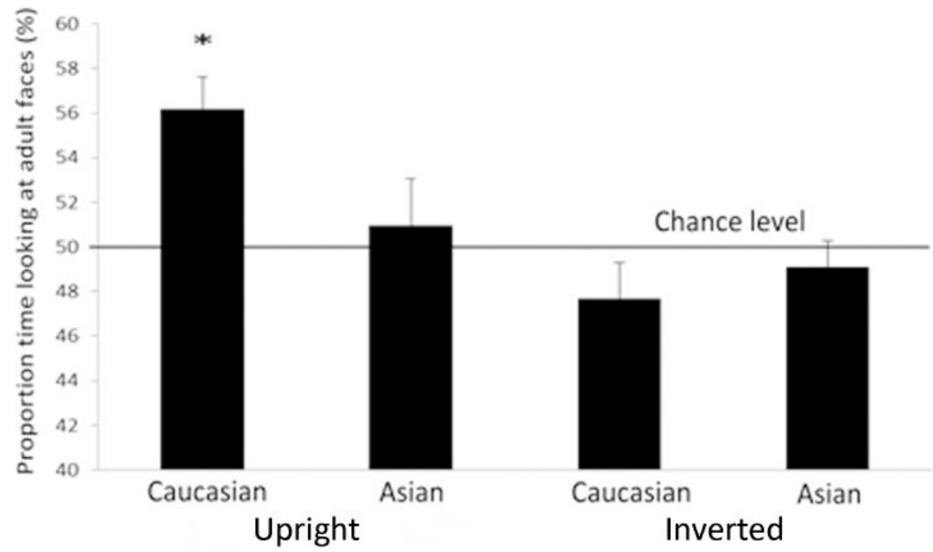

Figure 2.
Infant preference for Caucasian and Asian upright and inverted adult faces.

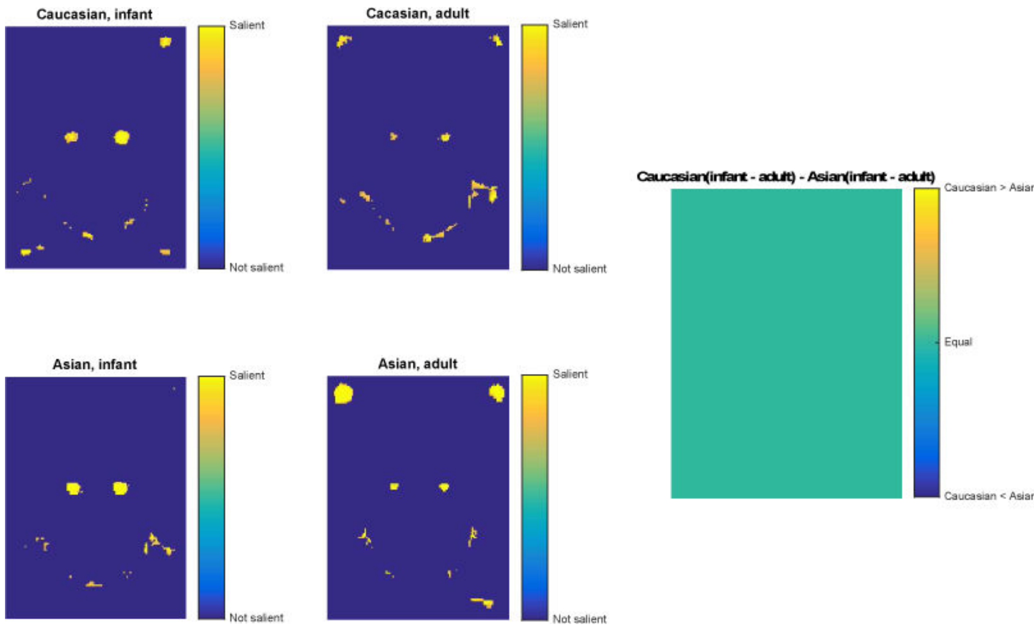

Figure 3.

Mean saliency maps for the infant and adult Caucasian faces (top left and center columns), for the infant and adult Asian faces (bottom left and center columns), and the difference between the Caucasian and Asian infant-adult contrast of faces (right column). X and Y axes represent the mean horizontal and vertical coordinates of each pixel of the faces (as measured in the proportion of the corresponding axis of a face). For the left and center columns, the colors on the top of the temperature bar refer to the mean saliency values of the faces, with warm colors denoting high saliency and cold colors denoting low saliency. The figure in the right column indicates that there was no significant saliency difference between the Caucasian infant-adult face contrast and the Asian infant-adult face contrast.