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Infant attention to same- and other-race faces ☆

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ABSTRACT

We recorded visual attention to same- and other-race faces in Hispanic and White 11-month-old infants, an age at which face processing is presumably biased by an own-race recognition advantage. Infants viewed pairs of faces differing in race or ethnicity as their eye movements were recorded. We discovered consistently greater attention to Black over Hispanic faces, to Black faces over White faces, and to Hispanic over White faces. Inversion of face stimuli, and infant ethnicity, had little effect on performance. Infants' social environments, however, differed sharply according to ethnicity: Hispanic infants are almost exclusively exposed to Hispanic family members, and White infants to White family members. Moreover, Hispanic infants inhabit communities that are more racially and ethnically diverse. These results imply that race-based visual attention in infancy is closely aligned with the larger society's racial and ethnic composition, as opposed to race-based recognition, which is more closely aligned with infants' immediate social environments.

1. Introduction

Studies of infant face perception represent an important opportunity to inform theories of social cognitive development, in particular the means by which we develop the ability to identify critical features of social categories such as race (Hugenberg, Young, Bernstein, & Sacco, 2010) sex (Ramsey, Langlois, & Marti, 2005), and age (Macchi Cassia, Pisacane, & Gava, 2012), and the means by which social context influences categorization of individuals from specific groups (Scott, Pascalis, & Nelson, 2007). In the present paper we examine 11-month-olds' oculomotor scanning patterns to faces to determine whether same-race faces recruit greater visual attention.

Infants provide no evidence of differentiating race at birth (Kelly et al., 2005), but the ability to discriminate perceptually based on race develops early. At 3 months, Black, Asian, and White infants distinguished between own-race and other-race faces in a simple preferential-looking paradigm, looking longer at own-race faces when these races were the majority in their culture, the familiar in-group (e.g., Bar-Haim, Ziv, Lamy, & Hodes, 2006; Kelly et al., 2005, 2007). Longer looking at own-race faces was not observed, however, in infants whose race was not the majority (Bar-Haim et al., 2006) or in biracial infants (Gaither, Pauker, & Johnson, 2012), implying an important role for the social environment in tuning infants' face attention. Infant face recognition, likewise, is shaped by the social environment. At 3 months, White and Asian infants from majority-race cultures recognized different faces of their race as well as different faces of other races (Kelly et al., 2007, 2009), but the ability to discriminate between faces from racial out-groups appears to decline after this time such that by 9 months, infants recognize same-race faces but have difficulty recognizing other-race faces (Kelly, Quinn, et al., 2007; Kelly et al., 2009), as do adults (Hugenberg et al., 2010). Added experience with a novel stimulus category (e.g., Asian faces) can reverse effects of perceptual narrowing, perhaps via improved stimulus recognition and encoding (Anzures et al., 2012).

Perceptual tuning for face characteristics may also guide development of infants' ability to categorize faces by race. After exposure to a series of Black or Asian faces (i.e., individual faces belonging to a single racial category), White 6-month-olds with limited experience with other-race faces distinguished between a new face from the familiar racial category compared to a new face from the novel race (i.e., Asian or Black, respectively), but 9-month-olds tested under identical conditions did not categorize either race (Quinn, Lee, Pascalis, & Tanaka, 2016). Additional experiments, however, revealed that White 9-month-olds formed a category for White faces that excluded Asian faces (Anzures, Quinn,

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Pascalis, Slater, & Lee, 2010) and formed a category of White faces that excluded Black or Asian faces, or a category of Black or Asian faces that excluded White faces (Quinn et al., 2016). Thus infants who lack experience with other-race faces appear to have difficulty constructing other-race categories, and instead may establish a broader distinction between same-race (e.g., White in-group) and other-race faces grouped together (e.g., Asian and Black out-groups). In sum, infants at birth do not exhibit attentional differences to faces based on race, but come to look longer own-race faces in racially homogeneous social environments by 3 months. Over the next 6 months infants' visual discrimination by race becomes tuned toward own-race faces, facilitating own-race recognition, and categorizing faces according to own- vs. other-race features.

Here, we investigate attention to same-and other-race faces in 11-month-old infants, addressing the possibility that greater attention to own-race faces persists following the presumed developmental period of perceptual tuning toward own-race face characteristics just described, or whether (and how) they might become altered. Current evidence for differences in visual attention as a function of face race in infants older than 3 months is mixed: A study comparing Asian infants' responses to sequential presentations of own- (Asian) and other-race (Black or White) faces yielded no evidence for race preferences in 9-month-olds (Liu et al., 2011); similar effects were reported in studies of White infants viewing White vs. Black faces (Wheeler et al., 2011) and White vs. Asian faces (Xiao, Quinn, Pascalis, & Lee, 2014). However, a recent report testing Asian infants with little exposure to other races found greater attention to own-race faces in 3-month-olds, no differences in attention at 6 months, and greater attention to other-race faces in 9-month-olds (Liu et al., 2015). (Notably, stimuli were presented side-by-side, which may be a more sensitive means of testing differences in race-based attention than sequential presentation due to reduced memory demands.)

Liu et al. (2015) suggested that the patterns of longer looking to other-race faces they reported reflected a transition from an early familiarity preference to a later novelty preference stemming from increasing exposure to own-race faces. Other-race faces might be conspicuous also by virtue of infant identification of in- and out-groups if race has achieved *psychological salience* as a marker of groups (Bigler & Liben, 2006, 2007). Out-groups may naturally come to recruit attention as the capacity for social categorization develops between 6 and 9 months (Anzures et al., 2010; Quinn et al., 2016).

Other developments in infancy, in contrast, might be predicted to yield greater attention to own-race faces. At 11–12 months, for example, infants preferred others similar to themselves in a choice task (Mahajan & Wynn, 2012), implying a general in-group or similarity bias also seen in children (Hailey & Olson, 2013). Some theories of social category formation propose that in-group bias stems not from emerging attitudinal preferences, but rather from perceptual expertise in social information processing from exposure to individuals in specific groups, fostering extraction of relevant visual cues and processing strategies such as configural visual scanning (Hugenberg et al., 2010; Sporer, 2001). Thus *processing fluency* may favor attention to in-group (viz., own-race) category members. Consistent with this possibility, studies of infant eye movement patterns revealed developments between 6 and 9 months in attention to specific facial features when viewing own-race faces—attention to the nose, for example, in Chinese infants (Liu et al., 2011) and attention to the eyes in White infants (Wheeler et al., 2011)—features that help adults identify in-group individuals (e.g., Hu, Wang, Fu, Quinn, & Lee, 2014). In addition, 8-month-olds processed own- but not other-race faces holistically, evinced by the disruptive effect of inversion on face recognition (cf. Maurer, LeGrand, & Mondloch, 2002); inversion had little effect on 4-month-olds' performance (Ferguson, Kulkofsky, Cashon, & Casasola, 2009).

Other studies suggest a third possibility: a loss of race-based attention differences after 3 months. As noted previously, infants who have increased exposure to and familiarization with other-race faces do not demonstrate greater looking at own-race faces (Bar-Haim et al., 2006; Gaither et al., 2012). Importantly, older infants do not appear to use race to guide their behavior in a toy-choice task. When offered a toy by a Black or White actor, White 10-month-olds were equally likely to select toys offered by the own- and the other-race individual (Kinzler & Spelke, 2011).

Infant attention to own- and other-race faces in infancy, therefore, remains poorly understood, yet it is central to understanding development of biases toward in- and out-group members, and, therefore to theories of social cognition and social development. Taken together the studies just reviewed suggest that, at least among infants with limited cross-race exposure, race may become psychologically salient and utilized as a basis for social categorization by 9 months, but these processes seem to be fluid and context-dependent in infancy. To clarify these issues, we observed 11-month-old infants from two ethnic groups—Hispanic and White, whom we later demonstrate to have substantial differences in daily experience to racial and ethnic minorities—and presented them with Black, Hispanic, and White faces. As noted previously, our study addresses the possibility that greater attention to own-race faces, observed in young infants, persists following the presumed developmental period of perceptual tuning toward own-race face characteristics, or if not, how they can best be explained. Results will tell us the extent to which the own-race recognition advantage (discussed previously) and/or the immediate social environment influence infants' attention to same- and other-race faces. Testing Hispanic and White infants will tell us the extent to which infants exhibit ethnicity-based as well as race-based attention differences, because each pair of faces contrasted either race (Black vs. Hispanic and Black vs. White) or ethnicity (Hispanic vs. White).

2. Method

2.1. Design

We recruited Hispanic and White infants and presented them with pairs of Black, Hispanic, and White women's faces (Fig. 1). Each pair contrasted either race (Black vs. Hispanic, Black vs. White) or ethnicity (Hispanic vs. White). Stimulus pairings were structured such that each face was presented twice across the experiment, paired once with each of the two other types (e.g., a Black face was paired once with a Hispanic face and again with a White face). Pairings were randomized with the constraint that no face type could appear more than three times in a row on either side. Infants viewed the face pairs as their eye movements were recorded with an eye tracker. The dependent variables were dwell times (accumulated visual fixations) in an area of interest (AOI) surrounding each face (Fig. 2) to gauge overall differences in attention to faces of different races, as well as dwell times for AOIs encompassing eyes, nose, and mouth of each face, to probe for any race- or ethnicity-specific patterns of visual attention to facial features. Because inversion of faces impairs recognition (Farah, Tanaka, & Drain, 1995), and configural face processing (Maurer et al., 2002), separate groups of Hispanic and White infants were recruited to view inverted faces so we could analyze for effects of inversion on overall attention to faces and to facial features. We also collected data about each infant's social environment (exposure to different racial/ethnic groups in the family and

Fig. 1. Black (top row), Hispanic (middle row), and White (bottom row) faces used as stimuli.

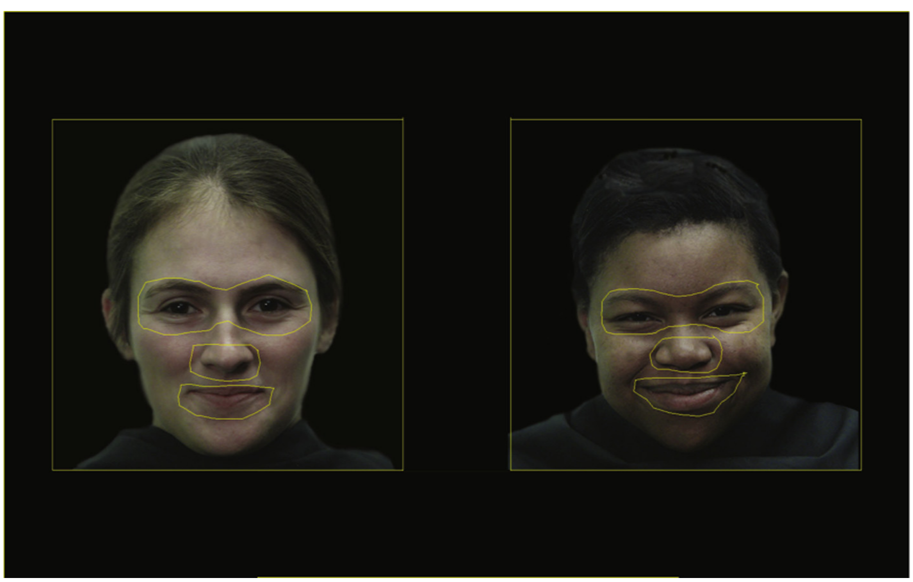

Fig. 2. Areas of interest encompassing the faces (boxes) and facial features.

community) with a demographic questionnaire given to the parents prior to testing.

2.2. Participants

We analyzed data from 40 Hispanic infants (20 females, *M* age = 11.0 months, *SD* = 0.99) and 37 White infants (23 females, *M* age = 11.0 months, *SD* = 0.92). Sample size was based on our experience testing infants in similar experiments examining attention to pairs of faces (e.g., Escudero, Robbins, & Johnson, 2013; Kim & Johnson, 2013; Kim & Johnson, 2014, 2015). Participants were considered to be Hispanic or White if identified as such by the parents. All Hispanic infants had at least one self-identified Hispanic or Latino/a parent; for 28 infants, both parents self-identified as Hispanic or Latino/a. All White infants had at least one self-identified White or Caucasian parent; for 30 infants, both parents self-identified as White or Caucasian. An additional 10 infants were observed but their data were not included for analysis because they did not provide at least 300 ms of accumulated dwell times on at least half the trials, due to fussiness or disinterest. Parents were compensated for their participation with a small toy or t-shirt for their infant.

2.3. Stimuli

Stimuli consisted of 18 color images of female undergraduates (age range = 18–22 years) from three distinct racial/ethnic groups: Black, Hispanic, or White (Fig. 1). Each racial/ethnic group was represented by six individuals. Photographs were taken in front of a white background with controlled lighting. Using Photoshop, faces were cropped to remove the neck and background detail from the original image, and were then set on a black background. Faces were approximately 6.9 × 5.3 cm in size (6.8 × 5.2° visual angle at the infant's viewing distance) and were separated by a 1.6 cm (1.5°) gap. Faces were smiling without displaying teeth and with their hair pulled back. As noted subsequently, the three face categories differed in brightness and contrast, but this did not seem to affect performance. Stimuli appeared on a 22 in. monitor set to 1680 × 1050 screen resolution with a refresh rate of 60 Hz.

2.4. Procedure

Parents provided consent for their infant's participation and were asked to complete a demographic form with information about the child's and parents' race/ethnicity and estimated time with parents and family members or in day care (hours per day). We also recorded each family's zip code. Following consent, infants were seated on a parent's lap 60 cm from the monitor on which images were displayed. An SR Research EyeLink 1000 eye tracker was used to record infants' eye movements. After being seated infants viewed a clip from the Muppet Show as adjustments were made to the eye tracker, followed by calibration of the point of gaze using a standard five-point calibration routine. Trials lasted 4 s and commenced when infants looked at an animated attention-getter (with sound) presented in the center of the screen. The study was terminated after 36 trials or until infants became too fussy or disinterested to continue.

3. Results

3.1. Visual attention to face pairs

We examined infants' looking at pairs of Black vs. Hispanic, Black vs. White, and Hispanic vs. White faces in upright and inverted orientations with a series of mixed analyses of variance (ANOVA) with the within-subjects factor Face (Black vs. Hispanic, Black vs. White, or Hispanic vs. White) and the between-subjects factor Ethnicity of the infant (Hispanic vs. White). Preliminary analyses examining sex of the infant as an independent variable revealed no significant main effects or interactions (i.e., no sex differences in performance); therefore data were collapsed across sex in the analyses we report below. Forty infants (20 Hispanic, 20 White) viewed faces in the upright orientation and contributed data for $M = 32.38$ trials ($SD = 5.05$); 37 infants (20 Hispanic, 17 White) viewed faces in the inverted orientation and contributed data for $M = 33.32$ trials ($SD = 4.64$).

3.1.1. Upright orientation

The Face × Ethnicity ANOVA for the Black vs. Hispanic upright comparison revealed a main effect of Face, $F(1,38) = 10.85$, $p = 0.002$, partial $\eta^2 = 0.22$, the result of longer dwell times in Black face AOIs, and no other significant effects (Fig. 3, top). (Twenty-seven of 40 infants tested looked longer at the Black face, two-tailed sign test $p = 0.039$.) For the Black vs. White upright comparison, the ANOVA revealed a main effect of Face, $F(1,38) = 33.21$, $p < 0.001$, partial $\eta^2 = 0.47$, again the result of longer dwell times in Black face AOIs, and no other significant effects. (Thirty-three infants looked longer at the Black face, $p < 0.001$.) For the Hispanic vs. White upright comparison, the ANOVA revealed a main effect of Face, $F(1,38) = 16.77$, $p < 0.001$, partial $\eta^2 = 0.31$, the result of longer dwell times in Hispanic face AOIs, and no other significant effects. (Twenty-seven infants looked longer at the Hispanic face, $p = 0.039$.) Both Hispanic and White infant groups looked longer at the Hispanic women's faces, $t(19) = 3.42$, $p = 0.003$, and $t(19) = 2.31$, $p = 0.032$, respectively.

3.1.2. Inverted orientation

Results were similar to those from the upright orientation. The Face × Ethnicity ANOVA for the Black vs. Hispanic inverted comparison revealed a main effect of Face, $F(1,35) = 18.12$, $p < 0.001$, partial $\eta^2 = 0.34$, the result of longer dwell times in Black face AOIs, and no other significant effects (Fig. 3, bottom). (Twenty-seven of the 37 infants tested looked longer at the Black face, $p = 0.008$.) For the Black vs. White inverted comparison, the ANOVA revealed a main effect of Face, $F(1,35) = 10.76$, $p = 0.002$, partial $\eta^2 = 0.26$, again the result of longer dwell times in Black face AOIs, and no other significant effects. (Twenty-six infants looked longer at the Black face, $p = 0.020$.) For the Hispanic vs. White inverted comparison, the ANOVA revealed a marginally significant main effect of Face, $F(1,35) = 3.54$, $p = 0.068$, partial $\eta^2 = 0.09$, the result of somewhat longer dwell times in Hispanic face AOIs, and no other significant effects. (Twenty-eight infants looked longer at the Hispanic face, $p = 0.003$.)

3.1.3. Visual attention in White vs. Hispanic infants

As noted in the previous two paragraphs, there were no statistically significant differences in patterns of visual attention to face pairs between Hispanic and White infants. To confirm that both ethnic groups exhibited similar looking patterns, we conducted planned comparisons (paired sample t-tests) to analyze attention toward Black vs. Hispanic faces, Black vs. White faces, and Hispanic vs. White faces (across upright and inverted orientations) in Hispanic and White infants separately.

Outcomes were similar for both infant ethnic groups. Hispanic infants showed reliably greater attention to Black vs. Hispanic faces (Black face $M = 1518.38$ ms, $SD = 368.85$; Hispanic face $M = 1158.97$, $SD = 295.39$, $t(39) = 4.94$, $p < 0.001$), to Black vs. White faces (Black face $M = 1486.96$ ms, $SD = 365.50$; White face $M = 1133.38$, $SD = 302.89$, $t(39) = 5.52$, $p < 0.001$), and to Hispanic vs. White faces (Hispanic face $M = 1446.75$ ms, $SD = 411.20$; White face $M = 1184.23$, $SD = 330.78$, $t(39) = 3.08$, $p = 0.004$). Likewise, White infants showed reliably greater attention to Black vs. Hispanic faces (Black face $M = 1391.04$ ms, $SD = 397.29$; Hispanic face $M = 1220.95$, $SD = 282.37$, $t(36) = 2.61$, $p = 0.013$), to Black vs. White faces (Black face $M = 1414.71$ ms, $SD = 387.01$; White face $M = 1135.29$, $SD = 342.72$, $t(36) = 3.66$, $p = 0.001$), and to Hispanic vs. White faces (Hispanic face $M = 1361.04$ ms, $SD = 362.75$; White face $M = 1189.71$, $SD = 320.99$, $t(36) = 2.93$, $p = 0.006$).

3.1.4. Stimulus characteristics

To examine the possibility that the differences in visual attention we observed arose from low-level stimulus characteristics, we used the Photoshop "luminosity" function (a weighting of R, G, and B channels, possible range = 0–255) to estimate perceived brightness (the overall mean luminosity) and contrast (the standard deviation of the luminosity) of each face AOI (i.e., AOIs encompassing the entire face, not the facial features). Black faces (M luminosity = 30.80) were darker than both Hispanic and White faces ($M = 44.52$ and 44.99, $ts(10) = 4.49$ and 5.85, $ps = 0.001$ and <0.001, respectively), but Hispanic and White faces were not significantly different in brightness ($t(10) = 0.13$, *ns*). Black faces (luminosity $SD = 38.89$) were also of lower contrast than both Hispanic and White faces ($M = 54.81$ and 53.73, $ts(10) = 6.34$ and 6.05, respectively, $ps < 0.001$), but Hispanic and White faces were not significantly different in contrast ($t(10) = 0.38$, *ns*). It seems unlikely, then, that these low-level properties of the images, which were not reliably different for the Hispanic and White faces viewed by the infants, played a meaningful role in guiding infants' attention.

We also used the Saliency Toolbox (www.saliencytoolbox.net) to identify the most salient face in each possible pairing of Black vs. Hispanic, Black vs. White, and Hispanic vs. White faces. The Saliency Toolbox is a set of Matlab functions and scripts that

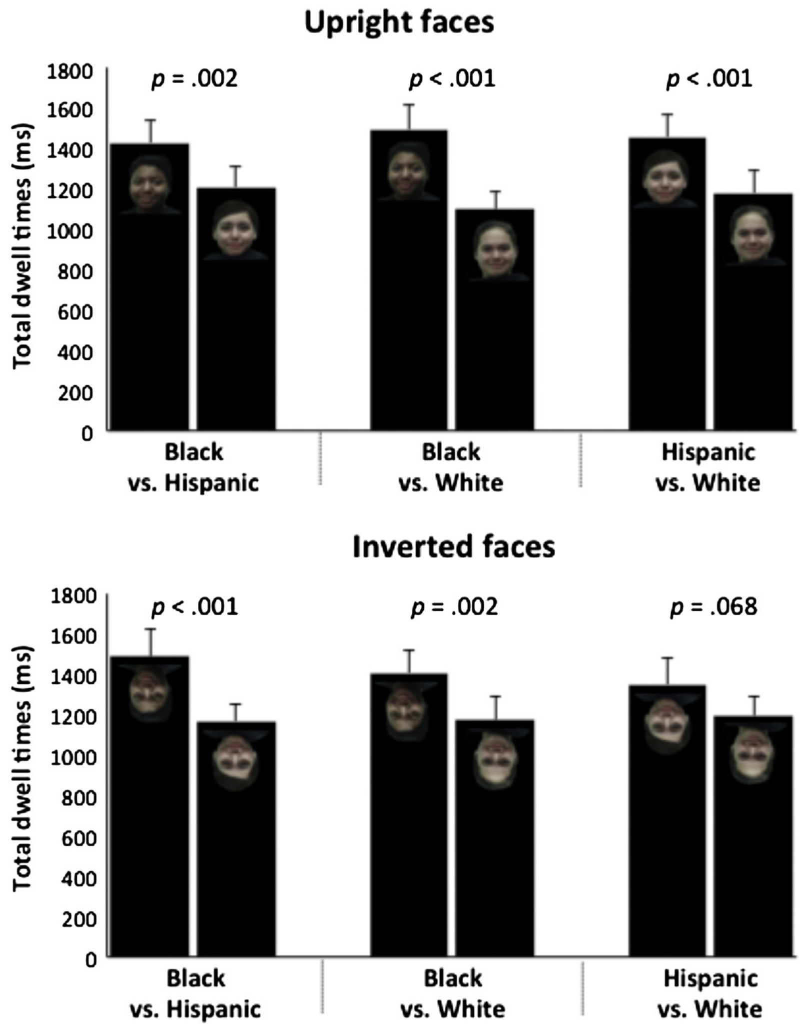

Fig. 3. Mean dwell times for Black vs. Hispanic faces, Black vs. White faces, and Hispanic vs. White faces. The top panel shows data from infants exposed to upright faces, and the bottom panel shows data from infants exposed to inverted faces. Error bars = 95% confidence intervals.

computes a salience map based on relative salience of regions within the image (Walther & Koch, 2006). In Black vs. Hispanic pairs, the Hispanic face was the more salient in 24 of the 36 pairings (two-tailed sign test $p = 0.065$). In Black vs. White pairs, the White face was more salient in 26 of 36 pairings ($p = 0.011$), and in Hispanic vs. White pairs, the White face was more salient in 14 of 36 pairings ($p = 0.243$). Overall, therefore, these comparisons indicate that infants' attention patterns were not likely based on differences in visual salience of the faces.

Finally, we tested the possibility that the Black face stimuli were more physically attractive relative to Hispanic face stimuli, and the Hispanic face stimuli relative to White face stimuli, by presenting upright and inverted face pairs to adult observers. Adults viewed upright ($N = 33$, M age = 21.6 years, 6 males) or inverted ($N = 38$, M age = 20.1 years, 13 males) face pairs and received course credit for participation. Stimulus pairings were structured in the same fashion as those presented to infants and viewed in a web browser. Participants were asked to view each face pair and click on the one that was more attractive. In the upright condition, 27 of the 33 participants clicked on the Hispanic face more frequently in Black-Hispanic pairings (two-tailed sign test $p < 0.001$), 21 clicked on the White face more frequently in Black-White pairings ($p = 0.168$, *ns*), and 17 clicked on the White face more frequently in Hispanic-White pairings ($p = 1.00$, *ns*). In the inverted condition, 33 of the 38 participants clicked on the Hispanic face more frequently in Black-Hispanic pairings ($p < 0.001$), 27 clicked on the White face more frequently in Black-White pairings ($p = 0.014$), and 18 clicked on the White face more frequently in Hispanic-White pairings ($p = 0.871$, *ns*). These results provide little evidence that the Black faces were more attractive overall than the Hispanic or White faces, or that the Hispanic faces were more attractive than the White faces.

3.2. Attention to facial features

We next examined attention to internal facial features (eyes, nose, and mouth) for Black vs. Hispanic, Black vs. White, and Hispanic vs. White face pairs in upright and inverted orientations with a series of mixed ANOVAs. Within-subjects factors were Face (Black vs. Hispanic, Black vs. White, or Hispanic vs. White) and Feature (eyes, nose, and mouth), and the between-subjects factor was Ethnicity of the infant (Hispanic vs. White).

3.2.1. Upright orientation

The Face × Feature × Ethnicity ANOVA for the Black vs. Hispanic upright comparison revealed a main effect of Face, $F(1,38) = 20.54$, $p < 0.001$, partial $\eta^2 = 0.35$, the result of longer dwell times in Black feature AOIs, a main effect of AOI, $F(1,38) = 118.89$, $p < 0.001$, partial $\eta^2 = 76$, due to greater attention to the eye region vs. the nose and mouth (Fig. 4, top), and a Face × Feature interaction, $F(1,38) = 13.43$, $p = 0.001$, partial $\eta^2 = 0.26$, the result of attention to the eyes in the Black face in particular. There were no other significant effects. The Face × Feature × Ethnicity ANOVA for the Black vs. White upright comparison likewise revealed a main effect of Face, $F(1,38) = 21.28$, $p < 0.001$, partial $\eta^2 = 0.36$, the result of longer dwell times in Black feature AOIs, a main effect of AOI, $F(1,38) = 136.90$, $p < 0.001$, partial $\eta^2 = 0.78$, again due to greater attention to the eye region vs. the nose and mouth, and no other significant effects. Finally, the Face × Feature × Ethnicity ANOVA for the Hispanic vs. White upright comparison yielded a main effect of Face, $F(1,38) = 17.01$, $p < 0.001$, partial $\eta^2 = 0.31$, the result of longer dwell times in Hispanic feature AOIs, a main effect of AOI, $F(1,38) = 113.09$, $p < 0.001$, partial $\eta^2 = 0.75$, due to greater attention to the eye region vs. the nose and mouth, and a Face × Feature interaction, $F(1,38) = 17.63$, $p < 0.001$, partial $\eta^2 = 0.32$, the result of attention to the eyes in the Hispanic face in particular. There were no other significant effects.

3.2.2. Inverted orientation

Results were again similar to those from the upright orientation. The Face × Feature × Ethnicity ANOVA for the Black vs. Hispanic inverted comparison revealed a main effect of Face, $F(1,35) = 20.70$, $p < 0.001$, partial $\eta^2 = 0.37$, the result of longer dwell times in Black feature AOIs, a main effect of AOI, $F(1,35) = 89.42$, $p < 0.001$, partial $\eta^2 = 0.72$, due to greater attention to the eye region vs. the nose and mouth (Fig. 4, bottom), and a Face × Feature interaction, $F(1,35) = 13.22$, $p = 0.001$, partial $\eta^2 = 0.27$, again the result of attention to the eyes in the Black face in particular. There were no other significant effects. The Face × Feature × Ethnicity ANOVA for the Black vs. White inverted comparison yielded a marginally significant main effect of Face, $F(1,35) = 4.05$, $p = 0.052$, partial $\eta^2 = 0.10$, the result of somewhat longer dwell times in Black feature AOIs, a main effect of AOI, $F(1,35) = 80.99$, $p < 0.001$, partial $\eta^2 = 0.70$, again due to greater attention to the eye region vs. the nose and mouth, and a Face × Feature × Ethnicity interaction, $F(1,35) = 5.20$, $p = 0.029$, partial $\eta^2 = 0.13$, the result of somewhat longer looking toward the eye and nose region of Black faces by Hispanic infants (the reasons for this effect are unclear). There were no other statistically reliable effects. Finally, the Face × Feature × Ethnicity ANOVA for the Hispanic vs. White upright comparison yielded a main effect of Face, $F(1,35) = 5.28$, $p = 0.028$, partial $\eta^2 = 0.13$, the result of longer dwell times in Hispanic feature AOIs, and a main effect of AOI, $F(1,35) = 85.90$, $p < 0.001$, partial $\eta^2 = 0.71$, again due to greater attention to the eye region vs. the nose and mouth. There were no other significant effects.

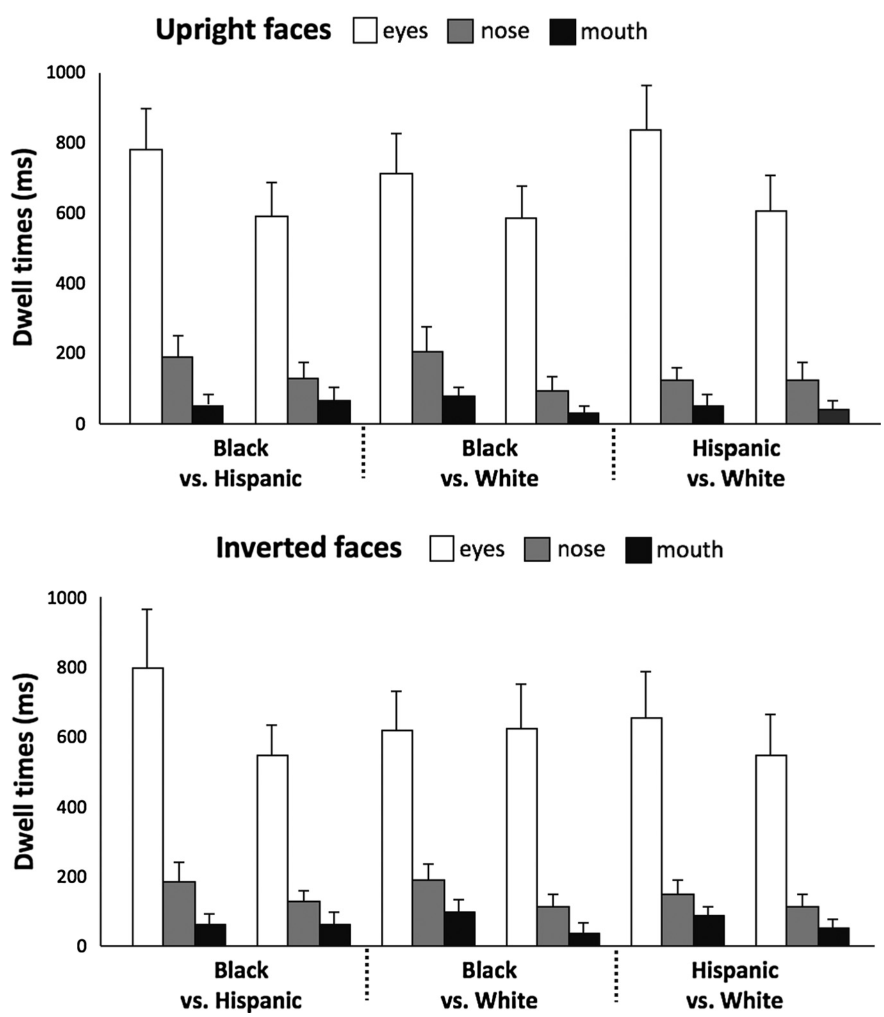

Fig. 4. Mean dwell times for eyes, nose, and mouth in Black vs. Hispanic faces, Black vs. White faces, and Hispanic vs. White faces. The top panel shows data from infants exposed to upright faces, and the bottom panel shows data from infants exposed to inverted faces. Error bars = 95% confidence intervals.

3.3. Social environments

We compared Hispanic and White infants' social environments in terms of exposure to own- and other-race and other-ethnicity individuals (Table 1). For both Hispanic and White infants, parents were usually the same ethnicity as infant. (Data were also collected about other family members. No parent reported other family members from a race or ethnicity different than the infant.) Exposure to other-race or other-ethnicity individuals in child care was likewise minimal. We also analyzed the racial and ethnic compositions of each infant's larger social community from US Census zip code data (Table 2). A mixed ANOVA with within-subjects factor Race/Ethnicity (% Black, Hispanic, and White population) and between-subjects factor Ethnicity of the infant (Hispanic vs. White) yielded a main effect of Race/Ethnicity, $F(1,71) = p < 0.001$, partial $\eta^2 = 0.19$. Comparisons of the three race/ethnicity categories via *t*-test revealed greater exposure to both Blacks and Hispanics in the community for Hispanic infants, $t(71) = 2.63$, $p = 0.011$ and $t(71) = 3.68$, $p < 0.001$, respectively, but less exposure to Whites, $t(71) = 4.14$, $p < 0.001$.

A final set of analyses examined individual differences in attention to race/ethnicity in face pairs and the racial/ethnic composition of infants' social environments. We computed correlations between proportions of race/ethnicity in each infant's zip code (i.e., % Black, % Hispanic, and % White populations from census data) and each infant's proportion of looking to the Black face in Black-White and Black-Hispanic face pairs, and to the Hispanic face in Hispanic-White face pairs (i.e., the differences in visual attention to race/ethnicity in face pairs reported previously). There were no statistically significant correlations across the entire sample of 77 infants, Pearson $rs < 0.13$, $ps > 0.28$. These analyses were repeated for infants exposed to upright or inverted faces (collapsed across infant ethnicity), for Hispanic and White infants separately (collapsed across upright vs. inverted orientation), and for the four ethnicity/orientation combinations separately. No statistically significant correlations were revealed, $rs < 0.36$, $ps > 0.11$. We did, however, find a marginally significant correlation ($r(16) = -0.453$, $p = 078$) between % Black zip code composition and looking at Hispanic faces in Hispanic-White face pairs by White infants viewing inverted face pairs—likely a spurious (not to mention nonsignificant) correlation. In summary, we obtained no evidence that 11-month-old infants' attention to same-and other-race faces was influenced by the racial and ethnic makeup of their immediate social environments.

Table 1
Exposure to own- and other-race and -ethnicity individuals (*M* hours/day, *SDs* in parentheses).

	Mother's race/ ethnicity		Father's race/ ethnicity		Child care race/ ethnicity	
	Own	Other	Own	Other	Own	Other
Hispanic infants	15.89 (7.92)	0.34 (1.48)	6.68 (6.52)	2.68 (5.61)	3.22 (4.85)	0.11 (0.65)
White infants	13.31 (8.95)	1.00 (3.13)	7.40 (4.39)	0.00 (0.00)	1.76 (2.32)	1.53 (2.33)

Table 2
Racial and ethnic composition of infants' communities.

	Zip code race/ethnicity (*M* %, *SDs* in parentheses)		
	Black	Hispanic	White
Hispanic infants	13.32 (17.03)	32.80 (18.46)	37.53 (27.04)
White infants	5.71 (3.59)	19.34 (12.04)	59.04 (15.79)

Source: http://www.census.gov/quickfacts/table/PST045215/00.

4. Discussion

We examined the possibility that relatively greater attention to same-race faces would be observed in 11-month-old infants, following a time of presumed perceptual tuning toward characteristics of own-race faces that yields an own-race recognition bias thought to be stable into adulthood (Anzures, Quinn, Pascalis, Slater, & Lee, 2013). We tested two ethnic groups, Hispanics and Whites, providing an opportunity as well to examine the possibility of greater attention to own-ethnicity faces. We discovered that infants showed clear and strong attentional biases for Black over Hispanic and White faces, and Hispanic over White faces. There were no consistent differences in these patterns of race- and ethnicity-based attention, or in eye movement scanning patterns, between Hispanic and White infants. Inversion of the face stimuli, their low-level visual properties, and attractiveness differences had negligible effects on performance. Yet the social environments of the Hispanic and White infants we observed are markedly different: Hispanic infants are almost exclusively exposed to Hispanic individuals within the family, and White infants are almost exclusively exposed to White family members. The larger social communities are also distinct, with Hispanic infants living in communities that are relatively more racially and ethnically heterogeneous. Despite these considerable differences in social environments, however, patterns of visual attention to Black, Hispanic, and White faces exhibited by Hispanic and White infants were remarkably similar.

A complete theory of social cognition must account for the development of biases toward in- and out-group members, and race-based visual attention in infancy is particularly important to understand for this reason. As noted previously, some theories have proposed that race-based face processing has its developmental origins in the social environment: Exposure to individuals from distinct social categories facilitates extraction of various types of visual cues or invoking of processing strategies that support recognition of in-group members, perhaps through enhanced configural processing or a more detailed "feature space" of relevant characteristics (Hugenberg et al., 2010; Sporer, 2001). This "expertise-through-contact" hypothesis has received support from studies of face recognition in infants and children (Anzures et al., 2010, 2012, 2013; de Haan, Johnson, Maurer, & Perrett, 2001; Macchi Cassia, Luo, Pisacane, Li, & Lee, 2014) but somewhat less support from studies of adults (Meissner & Brigham, 2001; Young, Hugenberg, Bernstein, & Sacco, 2012). Our results suggest that development of race-based visual attention is not entirely compatible with such theories, for two reasons. First, the patterns of attention to faces of distinct races we found were independent of the racial and ethnic composition of infants' families and communities. Second, no special visual processing mode is implicated in the patterns of attention we observed. There is no evidence, for example, that own- and other-race faces recruited distinct oculomotor scanning patterns. Inversion of the stimuli presumably precluded configural face processing, yet this manipulation had little apparent effect on infant visual attention. (Our findings, however, do not necessarily discount the possibility that processing fluency plays a role in other face processing tasks (e.g., face recognition, Anzures et al., 2010), or other kinds of visual attention, at 11 months.)

Instead, our results seem more compatible with theories of social cognition such as Developmental Intergroup Theory (DIT) that stress identification of psychological salience of features that distinguish individuals (Bigler & Liben, 2006, 2007). The developmental process initially establishes feature salience from perceptual discriminability of social groups and proportional group sizes. DIT predicts that minority group attributes should be distinctive and therefore psychologically salient, and proposes a flexible cognitive system that motivates and equips children to infer which bases of classification are important within a given context. Our results imply that these processes are apparent by 11 months, as the differences in visual attention we observed (greatest for Black faces, next for Hispanic faces, least for White faces) reflect proportional minority group sizes in the greater US population: Blacks at <15% of the population, Hispanics at <20%, and Whites at >60% (United States Census Bureau, 2015). By 11 months, infants may have received sufficient exposure outside their immediate social environment to majority and minority faces that explain the behaviors we observed, if infants are exposed more to Whites than other Hispanics, and Black faces are least commonly seen. This shift from greater attention toward members of the majority (or in-group) to members of the minority (or out-group) may be similar to the developmental shift from a bias to look at familiar to novel stimuli that is found in other areas of perceptual development (cf. Aslin, 2007). However, these results should not be taken to indicate true social preferences, prejudice, or stereotyping, as these would presumably require direct knowledge of group characteristics (Shutts, 2015).

In conclusion, our findings suggest that as early as 11 months, well before children express race-based preferences verbally (e.g., Shutts, Banaji, & Spelke, 2010) infants may be sensitive to the racial and ethnic composition of a broad population, broader than close relatives and local communities. This proposal can be readily tested with studies of early race-based visual attention in societies with different ratios of majority-minority racial and ethnic categories (cf. Shutts, Kinzler, Katz, Tredoux, & Spelke, 2011), by testing infants from monoracial communities, and by testing infants from different racial groups. Studies of the day-to-day visual experiences of infants, likewise, can illuminate exposure to specific social categories during the first year after birth (e.g., Aslin, 2009; Jayaraman, Fausey, & Smith, 2015).

Author contributions

A. Singarajah, J. Chanley, and S. P. Johnson developed the study concept. All authors contributed to the study design. Data collection was performed by A. Singarajah, J. Chanley, Y. Gutierrez, Y. Cordon, and B. Nguyen. A. Singarajah, J. Chanley, Y. Gutierrez, Y. Cordon performed the data analysis and interpretation under the supervision of L. Burakowski and S. P. Johnson. A. Singarajah, J. Chanley, Y. Gutierrez, Y. Cordon, and L. Burakowski drafted the manuscript, and S. P. Johnson prepared the final version. All authors approved the final version of the manuscript for submission.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.cognition.2016.11.006.

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