Psychological Research (2025) 89:67
https://doi.org/10.1007/s00426-025-02098-0

RESEARCH

Not all emotional expressions facilitate recognition of other-race faces in Chinese infants

Shaoying Liu[1] · Shuaike Hu[1] · Jiali Chen[1] · Linlin Yan[1] · Guangxi Liu[2]

Received: 16 April 2024 / Accepted: 24 February 2025 / Published online: 8 March 2025
© The Author(s) 2025

Abstract

Previous research has shown that the addition of happy or angry expressions to other-race faces can assist infants in overcoming the perceptual narrowing of face race and reinstating their recognition of other-race faces. In the present study, we examined how different facial expressions (happy, angry, fearful, and neutral) influence the recognition of African faces among Chinese infants aged 8 to 12 months. We employed a visual familiarization task and measured infants' looking time. The results revealed that infants exhibited above-chance discrimination of African faces in the happy and angry conditions, but not in the neutral or fearful conditions. The findings suggest that not all facial expressions have a uniform effect on infants' ability to recognize faces of other races.

Introduction

Perceptual narrowing is a phenomenon where infants' perceptual systems become more attuned to processing stimuli that they encounter frequently, while ignoring stimuli that they encounter less often. We can observe this phenomenon in how infants process language, music, and faces (Pascalis et al., 2002; Scott et al., 2007). In the case of face race, research has shown that 3-month-old infants are able to recognize faces of all races, but by 9 months old, they may struggle to recognize faces of other races due to limited exposure (Kelly et al., 2007, 2009; Liu et al., 2018). This bias towards own-race face recognition in infancy may contribute to the development of racial biases and prejudices (Bigler & Liben, 2007; Qian et al., 2016).

Many studies have been dedicated to identifying factors that may affect the narrowing of processing faces of different races. Some research has shown that infants aged 6–12 months can benefit from prolonged exposure to faces of different races, as it helps them maintain or restore their ability to recognize those faces (Anzures et al., 2012; Heron-Delaney et al., 2011; Tham et al., 2019). Recent studies have also explored the impact of adding emotional expressions, such as positive or negative emotions, to faces of other races in improving recognition of those faces in 6-9-month-old infants (Quinn et al., 2020b; Zhao et al., 2023). The categorization-individuation model and the perceptual-social linkage hypothesis of face processing (Hugenberg et al., 2010; Lee et al., 2017) serve as the foundation for this idea. Emotional expressions may help infants develop a more individualized approach to processing faces of other races, ultimately leading to improved recognition of other-race faces. For instance, Quinn et al. (2020b) found that 9-month-old Caucasian infants were unable to recognize faces of other races after exposure to neutral faces of that race, but could recognize them when they displayed happy or angry expressions. Similarly, Zhao et al. (2023) found that happy expressions could enhance Chinese infants' recognition of faces of other races. However, it remains unclear whether other facial expressions can have similar effects.

Infants perceive other-race faces as unique individuals due to the motivational dimension of happy or angry facial expressions (Quinn et al., 2020a). Both happy and angry facial expressions are characterized by a high level of motivational intensity, indicating increased arousal compared to neutral faces (Gable & Harmon-Jones, 2010). Research has shown that both types of expressions are related to

✉ Shaoying Liu
syliu@zstu.edu.cn

✉ Linlin Yan
yanlinlin@zstu.edu.cn

1 Department of Psychology, Zhejiang Sci-Tech University, No. 928, 2nd Street, Xiasha Higher Education Park, Hangzhou 310018, China

2 Xiasha Street Community Health Service Center, No. 768, Songqiao Street, Qiantang District, Hangzhou 310018, China

approach-oriented motivation (Carver & Harmon-Jones, 2009; Gable & Dreisbach, 2021). Happy and angry expressions are related to similar neural and visual processing mechanisms, particularly in the left prefrontal lobe associated with approach-oriented motivation (Gable et al., 2015; Poole & Gable, 2014). Infants and young children tend to prefer processing both happy and angry facial expressions over neutral faces, showing increased attention and requiring less cognitive effort (Grossmann et al., 2007; Zsido et al., 2021). The impact of happy and angry expressions on infants' perception of other-race faces can be attributed to their high motivational intensity and approach-oriented direction.

Fear and anger both have negative valence, high arousal, and signal threat (Russell, 1980). Fear is seen as an avoidance emotion distinct from anger (Adams et al., 2006). Fearful expressions do not activate the same left frontal cortical activity associated with approach-oriented motivation as angry expressions (Bayet et al., 2021; Gable & Dreisbach, 2021; Poole & Gable, 2014; Zhao et al., 2017). Additionally, studies have shown that both adults and infants process fear expressions differently from anger expressions. Adults can recognize other-race faces with happy or angry expressions, but not with fearful expressions (Ackerman et al., 2006; Johnson & Fredrickson, 2005; Kaufmann & Schweinberger, 2004; Lahera et al., 2014). Infants aged 5–12 months tend to pay more attention to fearful expressions compared to other expressions such as happy or angry, and this looking bias is associated with a decrease in heart rate (Miguel et al., 2019; Peltola et al., 2013). Therefore, fear expressions were chosen to examine whether all facial expressions can promote infant recognition of other-race faces.

The current study aimed to determine if fearful expressions can help infants recognize faces of other races. Infants aged 8–12 months were tested on their ability to recognize other-race faces in different facial expression conditions: happy, angry, fearful, and neutral. The visual task, similar to the research by Kobayashi et al. (2018), was carried out in three phases: a pre-familiarization test phase with two 10-second trials, a familiarization phase with six 20-second trials, and a post-familiarization test phase with two 10-second trials. If fearful expressions help with recognizing other-race faces, as well as happy and angry expressions, then infants should be able to identify other-race faces in all emotion conditions except neutral. If not, infants may not be able to recognize other-race faces in the fearful condition, similar to the neutral condition, but could still do so in happy or angry conditions.

Methods

Participants

The study involved a total of 64 healthy, full-term infants aged between 8 and 12 months, comprising 30 females and 34 males ($M=267$ days, $SD=38$ days, range: 238–372 days). These infants were randomly assigned to four groups, each containing 16 infants. The groups were as follows: the neutral facial expressions group (8 girls and 8 boys; $M=263$ days, $SD=35$ days, range: 238–370 days), the happy facial expressions group (8 girls and 8 boys; $M=278$ days, $SD=43$ days, range: 242–372 days), the angry facial expressions group (8 girls and 8 boys; $M=261$ days, $SD=35$ days, range: 240–361 days), and the fearful facial expressions group (6 girls and 10 boys; $M=267$ days, $SD=39$ days, range: 242–369 days). We recruited infants of Chinese descent participating in this experiment from a community hospital in Hangzhou, China, where they attended regular checkups. Their parents confirmed that the infants did not have regular exposure to African faces. Thirteen additional infants participated in the experiment but were excluded from the analysis due to either fussiness ($n=9$) or side bias ($n=4$). All parents of infants gave informed consent before the experiment. The study was approved by the Institutional Review Board of Zhejiang Sci-Tech University and conducted in accordance with the Declaration of Helsinki.

For this study, we used a power analysis with G*Power 3.1 to determine the number of participants in each group. Previous research (Quinn et al., 2020b) showed effect sizes between 1.05 and 1.27, which were considered in the analysis. With a significance level of 0.05 and a power value of 0.95, we utilized a two-tailed one-sample t-test to calculate the estimated sample size for each group. The results showed that the estimated sample size ranged from 11 to 14, which closely aligns with the actual sample size of 16 participants per group in our study.

Materials

The current study involved using colored photographs of African women's faces displaying neutral, happy, angry, and fearful expressions. We chose the images from the NimStim face set (Tottenham et al., 2009) and included four faces for each emotion category, with each face showing a neutral, happy, angry, or fearful expression. Since most caregivers of infants in China are women, we used only female adult faces as stimuli. These faces were aged between 21 and 30, and all expressions were depicted with closed mouths. To ensure consistency, we edited each photograph using Adobe Photoshop to minimize hairstyle differences while maintaining the external contour. Finally, we placed the images on a uniform white background measuring 377 × 484 pixels. Previous research using the same facial stimuli demonstrated that there were no significant disparities in basic visual features such as brightness, hue, and saturation among the faces in each emotion group (Quinn et al., 2020b). Furthermore, we ensured that the attractiveness and intensity of the paired expressions remained consistent by matching the four faces within each emotion condition.

A group of 17 adults rated the pleasantness and arousal levels of different facial expressions on a 9-point scale, as shown in Table 1. The results showed significant differences in both pleasantness and arousal levels among happy, angry, fearful, and neutral expressions, $F\ (3, 268) = 72.21$, $p < 0.001$, $\eta_p^2 = 0.45$; $F\ (3, 268) = 21.77$, $p < 0.001$, $\eta_p^2 = 0.20$. Post hoc analysis revealed that happy expressions were rated as the most pleasant, followed by neutral, fearful, and angry expressions (*ps* < 0.002). Additionally, happy, angry, and fearful expressions were all rated as more arousing than neutral expressions (*ps* < 0.001). However, there were no significant differences in arousal levels among happy, angry, and fearful expressions.

Procedure

The study used Tobii Studio software (version 1.7.3) to control and present stimuli on a 17-inch monitor with a resolution of 1024 × 768 pixels. Parents brought the infants to the laboratory and seated them on their laps in front of a Tobii 1750 eye tracker, positioned at a distance of 60 cm. The eye tracker had a data sampling rate of 50 Hz. The researcher instructed parents to remain silent and wear a black sleeping mask during the testing to ensure they were not influenced by the study's hypothesis or predicted looking preferences.

To accurately record eye movements, each infant underwent a calibration procedure at the beginning of the session using Tobii's default infant eye-tracking calibration method. This involved fixating on five different screen locations, including the four corners and the center. If the initial calibration was unsuccessful, the procedure was repeated up to three times until a successful calibration was achieved. During the session, we displayed a cartoon character on the screen with accompanying sound, prompting infants to focus on it for at least one second before it moved to a different position.

We randomly assigned the infants to one of four expression conditions: neutral, happy, angry, or fearful. In each condition, the infants went through a testing procedure that included three phases. During the first phase, the infants were shown two different neutral faces in a pre-familiarization test, with one of those faces used in the familiarization phase. Next, the infants were familiarized with six 20-second trials of the two identical emotional faces based on their assigned condition, with the familiarized face randomly selected from four faces. In the final phase, the infants underwent a post-familiarization test that was the same as the pre-familiarization test. For example, in the angry expression condition, we initially showed the infants a familiar neutral face alongside a novel neutral face. Then, the infants were familiarized with six trials of the two identical angry faces, and finally, we presented the same faces as in the first phase.

In order to attract infants' attention to the screen, we displayed a pair of face-sized cartoon ducks before each trial. The experimenter would begin the experiment by pressing a button when the infant looked at the screen.

Table 1 Mean and standard deviation of subjective pleasantness and arousal ratings of four facial expressions

	Neutral M (SD)	Happy M (SD)	Angry M (SD)	Fearful M (SD)
Pleasantness	4.53 (1.04)	5.96 (1.44)	2.90 (1.04)	3.68 (1.49)
Arousal level	4.06 (1.35)	5.51 (1.47)	5.87 (1.67)	5.76 (1.45)

Data analysis

In the current study, we calculated the total looking time of all fixations inside each face (excluding hair and ear areas) recorded by the Tobii 1750 eye tracker for every trial of each individual. A fixation was defined as a continuous period where the gaze remains on an area with a minimum radius of 30 pixels for at least 100 milliseconds.

We calculated the total looking time for each familiarization trial by summing the time the infants spent on the two faces presented in pairs. To determine successful habituation during the familiarization phase, the sum of the looking time in the last three trials had to be significantly lower than that of the first three trials, which was done in accordance with the standard in previous studies (Xiao et al., 2014). In the pre- or post-familiarization test phase, we calculated novelty preference scores by dividing the time spent looking at the novel face by the total time spent looking at both the novel face and the familiar face with neutral expressions, and then multiplying by 100%.

Results

The preliminary analysis revealed no significant differences in gender or face stimuli across the pre-familiarization test phase, familiarization phase, and post-familiarization test phase. Therefore, we merged the data from infants of both genders and in different face stimuli conditions for the subsequent analyses.

Pre-familiarization test trials

In order to examine infants' preference for familiar versus novel faces, the study used identical face pairs in both the pre-familiarization and post-familiarization test trials. We analyzed the mean looking bias scores using one-sample t-tests to determine if they were significantly different from a random level of 50% in each expression condition. The results showed no significant differences across all conditions (*ps* > 0.05), indicating that infants did not show a bias towards paired other-race faces of different identities in the pre-familiarization test phase.

Familiarization trials

We summed the individual looking time for the left and right copies of the faces presented on each trial. The mean looking time for the sum of the first three trials and the last three trials for each condition is presented in Table 2. We conducted a two-way analysis of variance (ANOVA) on the individual looking time, with factors of Facial Expressions (neutral, happy, angry, and fearful) and Trials (trial 1–3 vs. trial 4–6). The analysis showed a significant effect of Trials, F (1, 60) = 13.06, p = 0.001, η_p^2 = 0.18. The total looking time for the last three trials (M = 30.68 s, SD = 12.03 s) was significantly lower than that of the first three trials (M = 34.72 s, SD = 12.07 s). However, there was no significant effect of Expressions, F (3, 60) = 0.57, p = 0.64, or interaction between Trials and Facial Expressions, F (3, 60) = 0.87, p = 0.46.

We further conducted t-tests for each expression condition on the individual looking time. The results revealed significant differences between the first half and the second half of the trials in the neutral condition, t(15) = 1.80, p = 0.046, Cohen's d = 0.45, the happy condition, t(15) = 2.13, p = 0.025, Cohen's d = 0.53, and the angry condition, t(15) = 3.17, p = 0.003, Cohen's d = 0.79. However, there was no difference in the fearful condition, t(15) = 0.59, p = 0.28, Cohen's d = 0.15. The decrease in looking time from the first to the second half of the trials in the neutral, happy, and angry conditions indicated habituation to the stimuli for these three groups, while the fearful group did not exhibit habituation.

Post-familiarization test trials

The mean novelty preference scores for each facial expression condition are displayed in Table 2 and illustrated in Fig. 1. To examine infants' performance on the test trials after being familiarized with neutral, happy, angry, or fearful African faces, we conducted an ANOVA on the individual novelty preference scores, with Expression as a between-subject factor. The results showed a significant effect of Expression on novelty preference, F (3, 60) = 6.45, p = 0.001, η_p^2 = 0.24. Post hoc analyses using Fisher's Least Significant Difference (LSD) showed that infants exhibited higher novelty preference scores in the happy condition (M = 65.58%, SD = 9.90) and the angry condition (M = 64.08%, SD = 8.43) compared to the neutral condition (M = 52.59%, SD = 11.63), with all p-values less than 0.05. However, there was no significant difference in novelty preference scores between the fearful condition (M = 52.21%, SD = 14.50) and the neutral condition, with p-values greater than 0.05.

To examine whether infants can discriminate between African neutral expression faces after being exposed to those faces displaying four different expressions, we conducted one-sample t-tests to compare the mean novelty preference scores from each facial expression condition to chance level (50%). The findings revealed that infants showed significantly higher novelty preferences in the happy and angry conditions compared to chance [happy: t (15) = 6.29, p < 0.001, Cohen's d = 1.57; angry: t (15) = 6.68, p < 0.001, Cohen's d = 1.67]. However, there was no significant difference in novelty preferences in the neutral and fearful conditions compared to chance [neutral: t (15) = 0.89, p = 0.39, Cohen's d = 0.22; fearful: t (15) = 0.61, p = 0.55, Cohen's d = 0.15].

Further analysis revealed that the novelty preference scores in the post-test were significantly higher than those in

Table 2 Mean fixation time (s) and novelty preference scores (%) in familiarization and test phases

Conditions	Pre-familiarization (%)		Familiarization(*s*)		Post-familiarization (%)	
			Trial 1–3	Trial 4–6		
	M (SD)	*t/ p*	*M (SD)*	*M (SD)*	*M (SD)*	*t/ p*
Neutral	50.87	0.51/0.62	33.95	30.67	52.59	0.89/0.39
(n = 16)	(6.79)		(15.45)	(14.59)	(11.63)	
Happy	46.74	-1.25/0.23	33.48	27.70	65.58	6.29/0.001
(n = 16)	(10.44)		(10.93)	(12.12)	(9.90)	
Angry	50.11	0.06/0.95	38.48	32.85	64.08	6.68/0.001
(n = 16)	(7.37)		(11.08)	(13.63)	(8.43)	
Fearful	53.80	1.45/0.17	32.95	31.53	52.21	0.61/0.55
(n = 16)	(10.52)		(10.48)	(6.86)	(14.50)	

Note: t vs. chance level (50%)

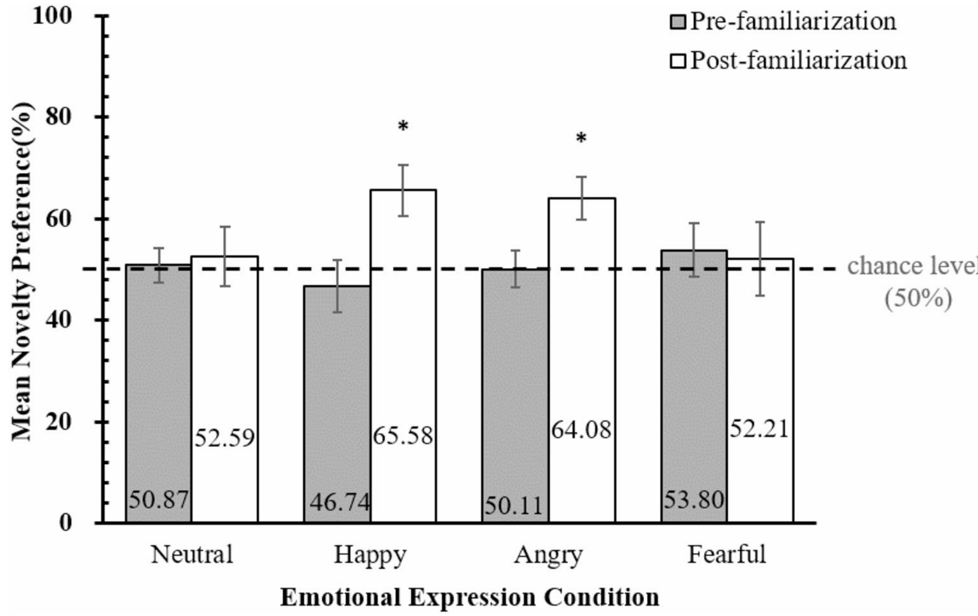

Fig. 1 The mean novelty preference scores (%) were calculated based on the emotional expression condition (neutral, happy, angry, or fearful) in both the pre-familiarization phase and the post-familiarization phase. Error bars represent the standard errors of the mean. Scores that differed from chance (50%) were marked with an asterisk

the pre-test for both the happy and angry conditions [happy: $t(15)=5.51$, $p<0.001$, Cohen's $d=1.38$; angry: $t(15)=5.44$, $p<0.001$, Cohen's $d=1.36$]. However, there was no significant difference in novelty preference scores between the pre-test and post-test for the neutral and fear conditions [neutral: $t(15)=0.55$, $p=0.59$, Cohen's $d=0.14$; fearful: $t(15) = -0.39$, $p=0.70$, Cohen's $d = -0.10$]. These findings indicate that infants could distinguish between African faces with neutral expressions after being exposed to happy or angry expressions, but not after being exposed to neutral or fearful expressions.

Traditional null-hypothesis significance tests have limitations as they do not allow researchers to provide evidence supporting the null hypothesis and to avoid overstating evidence against it (Rouder et al., 2009). To address this, we integrated Bayes factors into frequentist statistical analysis to assess support for both accepting and rejecting null hypotheses. A Bayes factor greater than 3 or less than 1/3 indicates substantial evidence for the alternative or null hypothesis, respectively, while values close to 1 suggest weak or anecdotal evidence (Dienes, 2014).

In current study, we used JASP software Version 0.18.3.0 to calculate Bayes factors for each pairwise comparison with a default prior width (Cauchy scale = 0.71). Our results show strong evidence that the mean novelty preference scores in the happy and angry conditions were different from those in the neutral condition (happy vs. neutral, $BF_{10}=18.29$; angry vs. neutral, $BF_{10}=12.11$). This suggests that the data are more than 18 and 12 times more likely to support the alternative hypothesis than under the null hypothesis. When comparing the fearful and neutral conditions, the Bayes factor ($BF_{10}=0.34$) indicates that our data are more in line with the null hypothesis, showing approximately three times more support for no distinction between the two groups. Furthermore, Bayes factors were utilized alongside t-tests with default prior width. The results provide strong evidence that the mean novelty preference scores were different from chance in the happy and angry conditions ($BF_{10}=1589.03$ and $BF_{10}=2928.45$, respectively), while indicating that the fearful condition's scores are equivalent to chance ($BF_{10}=0.30$). There was also moderate evidence suggesting that the mean novelty preference scores in the neutral condition were equivalent to chance ($BF_{10}=0.36$).

Discussion

In the current study, we used a visual familiarization task to examine whether 8 ~ 12-month-old infants could differentiate between African faces in different emotional expression familiarization conditions, including happy, angry, fearful, and neutral. Our aim was to determine if infants' narrowing of face race perception could be impacted by varying facial expressions. The findings revealed that infants could distinguish African faces in the happy and angry conditions, but not in the fearful or neutral condition.

This study found that infants could recognize other-race faces after being familiarized with either happy or angry facial expressions, aligning with previous research by Quinn et al. (2020b) and Zhao et al. (2023). The findings suggest that both happy and angry facial expressions can alter infants' perceptual narrowing of face race. However, the results showed that fear expressions did not have the same effect on infants, consistent with previous studies on adults (Johnson & Fredrickson, 2005). The lack of effect of fearful expressions is explained in terms of emotional valence, arousal level, and motivational direction. Happy faces of other races were perceived as more pleasant than neutral faces, while both fearful and angry faces were rated as less pleasant. Interestingly, fearful faces were rated as more pleasant than angry faces. In terms of arousal levels, happy, angry, and fearful facial expressions were all found to be highly arousing compared to neutral expressions, with no significant differences among them. Therefore, the lack of effect of fearful expressions cannot be attributed to emotional valence or arousal level. In terms of motivational direction, such as approach motivation or avoidance motivation, emotions like happiness and anger, which are approach-motivational, were found to help infants distinguish between faces of different races according to Quinn et al. (2020b). However, the study found that fearful expressions did not aid infants in recognizing faces of other races, suggesting a potential link to avoidance motivation.

The shared signal hypothesis posits that the perception of approach-oriented emotions like happiness and anger is enhanced when paired with a direct gaze. Conversely, the perception of avoidance-oriented emotions like fear and sadness is improved when accompanied by an averted gaze (Adams & Kleck, 2005; Rigato et al., 2013). In our study, all facial stimuli presented had direct gazes during the familiarization phase. This might have posed a challenge for infants in perceiving fearful faces. The analysis of variance showed a significant difference in infants' looking time between the first and second halves of the familiarization phase. However, further analysis indicated that infants did not habituate to the fearful face. We are unsure if increasing the number of familiarization trials with fearful faces would enable infants to habituate and recognize faces of other races. This is because studies with adults have shown that individuals struggle to recognize other-race faces with fearful expressions (Ackerman et al., 2006; Johnson & Fredrickson, 2005). Even if an increase in the number of trials leads to habituation in the data, it is possible that this could be attributed to infants becoming fatigued rather than attaining sufficient perceptual familiarity.

There are a few limitations to this study. Firstly, the familiarization task used in this study was fixed, and infants under the fear condition did not habituate within the standard time frame, except for other expression conditions. It is unclear whether infants need more time to habituate to fear expressions compared to other expressions. Future research could use an infant-controlled habituation program to ensure habituation to other-race faces with fear expressions. Secondly, more supporting evidence is required to support the idea that the lack of improvement in infant recognition of other-race faces under the fear condition may be attributed to the avoidance motivation aspect of fear expressions. Further research could use neurophysiological evidence to investigate brain activation patterns in infants when recognizing other-race faces under different expression conditions. Lastly, both the previous and current studies only focused on high arousal expressions. Future research could explore the effects of low arousal expressions like humor and sadness on infant recognition of other-race faces.

Conclusion

The current study revealed that happy and angry facial expressions can help 8~12-month-old infants recognize faces of other races. In contrast, fearful expressions did not exhibit a similar facilitative effect. The findings suggest that not all emotional expressions are conductive to infants' recognition of other-race faces.

Acknowledgements The authors gratefully acknowledge the contribution of the participating infants and their parents. We also appreciate the support of the doctors and nurses at the community hospital in helping us recruit our subjects.

Author contributions SL contributed to the study conception and design. Material preparation and data collection were performed by JC. and GL. Data analysis was performed by SH. and JC. The first draft of the manuscript was written by SH, SL, JC. and LY. All authors read and approved the final manuscript.

Data availability The data supporting the findings of this study are available from the corresponding author upon request.

Declarations

Ethical approval The study reported in this manuscript were conducted in compliance with the ethical standards of the 1964 Declaration of Helsinki and its subsequent amendments and approved by the University's ethics committee.

Informed consent All caregivers of infants provided informed consent before participating.

Competing interests The authors declare no competing interests.

Open Access This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by-nc-nd/4.0/.

References

Ackerman, J. M., Shapiro, J. R., Neuberg, S. L., Kenrick, D. T., Becker, D. V., Griskevicius, V., Maner, J. K., & Schaller, M. (2006). They all look the same to me (Unless they're Angry): From Out-Group Homogeneity to Out- Group Heterogeneity. *Psychological Science*, *17*(10), 836–840.

Adams, R. B., & Kleck, R. E. (2005). Effects of direct and averted gaze on the perception of facially communicated emotion. *Emotion*, *5*(1), 3–11. https://doi.org/10.1037/1528-3542.5.1.3

Adams, R. B., Ambady, N., Macrae, C. N., & Kleck, R. E. (2006). Emotional expressions forecast approach-avoidance behavior. *Motivation and Emotion*, *30*(2), 177–186. https://doi.org/10.1007/s11031-006-9020-2

Anzures, G., Wheeler, A., Quinn, P. C., Pascalis, O., Slater, A. M., Heron-Delaney, M., Tanaka, J. W., & Lee, K. (2012). Brief daily exposures to Asian females reverses perceptual narrowing for Asian faces in Caucasian infants. *Journal of Experimental Child Psychology*, *112*(4), 484–495. https://doi.org/10.1016/j.jecp.2012.04.005

Bayet, L., Perdue, K. L., Behrendt, H. F., Richards, J. E., Westerlund, A., Cataldo, J. K., & Nelson, C. A. (2021). Neural responses to happy, fearful and angry faces of varying identities in 5- and 7-month-old infants. *Developmental Cognitive Neuroscience*, *47*, 100882. https://doi.org/10.1016/j.dcn.2020.100882

Bigler, R. S., & Liben, L. S. (2007). Developmental intergroup theory: Explaining and reducing children's social stereotyping and prejudice. *Current Directions in Psychological Science*, *16*(3), 162–166. https://doi.org/10.1111/j.1467-8721.2007.00496.x

Carver, C. S., & Harmon-Jones, E. (2009). Anger is an approach-related affect: Evidence and implications. *Psychological Bulletin*, *135*(2), 183–204. https://doi.org/10.1037/a0013965

Dienes, Z. (2014). Using Bayes to get the most out of non-significant results. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2014.00781. 5.

Gable, P. A., & Dreisbach, G. (2021). Approach motivation and positive affect. *Current Opinion in Behavioral Sciences*, *39*, 203–208. https://doi.org/10.1016/j.cobeha.2021.03.030

Gable, P., & Harmon-Jones, E. (2010). The motivational dimensional model of affect: Implications for breadth of attention, memory, and cognitive categorisation. *Cognition & Emotion*, *24*(2), 322–337. https://doi.org/10.1080/02699930903378305

Gable, P. A., Poole, B. D., & Harmon-Jones, E. (2015). Anger perceptually and conceptually narrows cognitive scope. *Journal of Personality and Social Psychology*, *109*(1), 163–174. https://doi.org/10.1037/a0039226

Grossmann, T., Striano, T., & Friederici, A. D. (2007). Developmental changes in infants' processing of happy and angry facial expressions: A neurobehavioral study. *Brain and Cognition*, *64*(1), 30–41. https://doi.org/10.1016/j.bandc.2006.10.002

Heron-Delaney, M., Anzures, G., Herbert, J. S., Quinn, P. C., Slater, A. M., Tanaka, J. W., Lee, K., & Pascalis, O. (2011). Perceptual training prevents the emergence of the other race effect during infancy. *Plos One*, *6*(5), e19858. https://doi.org/10.1371/journal.pone.0019858

Hugenberg, K., Young, S. G., Bernstein, M. J., & Sacco, D. F. (2010). The categorization-individuation model: An integrative account of the other-race recognition deficit. *Psychological Review*, *117*(4), 1168–1187. https://doi.org/10.1037/a0020463

Johnson, K. J., & Fredrickson, B. L. (2005). We all look the same to me: Positive emotions eliminate the Own-Race Bias in face recognition. *Psychological Science*, *16*(11), 875–881. https://doi.org/10.1111/j.1467-9280.2005.01631.x

Kaufmann, J. M., & Schweinberger, S. R. (2004). Expression influences the recognition of familiar faces. *Perception*, *33*(4), 399–408. https://doi.org/10.1068/p5083

Kelly, D. J., Quinn, P. C., Slater, A. M., Lee, K., Ge, L., & Pascalis, O. (2007). The Other-Race effect develops during infancy: Evidence of perceptual narrowing. *Psychological Science*, *18*(12), 1084–1089. https://doi.org/10.1111/j.1467-9280.2007.02029.x

Kelly, D. J., Liu, S., Lee, K., Quinn, P. C., Pascalis, O., Slater, A. M., & Ge, L. (2009). Development of the other-race effect during infancy: Evidence toward universality? *Journal of Experimental Child Psychology*, *104*(1), 105–114. https://doi.org/10.1016/j.jecp.2009.01.006

Kobayashi, M., Macchi Cassia, V., Kanazawa, S., Yamaguchi, M. K., & Kakigi, R. (2018). Perceptual narrowing towards adult faces is a cross-cultural phenomenon in infancy: A behavioral and near-infrared spectroscopy study with Japanese infants. *Developmental Science*, *21*(1), e12498. https://doi.org/10.1111/desc.12498

Lahera, G., Herrera, S., Fernández, C., Bardón, M., De Los Ángeles, V., & Fernández-Liria, A. (2014). Familiarity and face emotion recognition in patients with schizophrenia. *Comprehensive Psychiatry*, *55*(1), 199–205. https://doi.org/10.1016/j.comppsych.2013.06.006

Lee, K., Quinn, P. C., & Pascalis, O. (2017). Face race processing and Racial Bias in early development: A Perceptual-Social linkage. *Current Directions in Psychological Science*, *26*(3), 256–262. https://doi.org/10.1177/0963721417690276

Liu, S., Quinn, P. C., Xiao, N. G., Wu, Z., Liu, G., & Lee, K. (2018). Relations between scanning and recognition of own- and other-race faces in 6- and 9-month-old infants. *PsyCh Journal*, *7*(2), 92–102. https://doi.org/10.1002/pchj.211

Miguel, H. O., McCormick, S. A., Westerlund, A., & Nelson, C. A. (2019). Rapid face processing for positive and negative emotions in 5-, 7-, and 12-month-old infants: An exploratory study. *British Journal of Developmental Psychology*, *37*(4), 486–504. https://doi.org/10.1111/bjdp.12288

Pascalis, O., de Haan, M., & Nelson, C. A. (2002). Is face processing Species-Specific during the first year of life?? Science. *New Series*, *296*(5571), 1321–1323.

Peltola, M. J., Hietanen, J. K., Forssman, L., & Leppänen, J. M. (2013). The emergence and stability of the attentional Bias to fearful faces in infancy. *Infancy*, *18*(6), 905–926. https://doi.org/10.1111/infa.12013

Poole, B. D., & Gable, P. A. (2014). Affective motivational direction drives asymmetric frontal hemisphere activation. *Experimental Brain Research*, *232*(7), 2121–2130. https://doi.org/10.1007/s00221-014-3902-4

Qian, M. K., Heyman, G. D., Quinn, P. C., Messi, F. A., Fu, G., & Lee, K. (2016). Implicit Racial biases in preschool children and adults from Asia and Africa. *Child Development*, *87*(1), 285–296. https://doi.org/10.1111/cdev.12442

Quinn, P. C., Lee, K., & Pascalis, O. (2020a). Beyond perceptual development: Infant responding to social categories. In Advances in Child Development and Behavior (Vol. 58, pp. 35–61). Elsevier. https://doi.org/10.1016/bs.acdb.2020.01.002

Quinn, P. C., Lee, K., Pascalis, O., & Xiao, N. G. (2020b). Emotional expressions reinstate recognition of other-race faces in infants following perceptual narrowing. *Developmental Psychology*, *56*(1), 15–27. https://doi.org/10.1037/dev0000858

Rigato, S., Menon, E., Farroni, T., & Johnson, M. H. (2013). The shared signal hypothesis: Effects of emotion-gaze congruency in infant and adult visual preferences. *British Journal of Developmental Psychology*, *31*(1), 15–29. https://doi.org/10.1111/j.2044-835X.2011.02069.x

Rouder, J. N., Speckman, P. L., Sun, D., Morey, R. D., & Iverson, G. (2009). Bayesian t tests for accepting and rejecting the null hypothesis. *Psychonomic Bulletin & Review*, *16*(2), 225–237. https://doi.org/10.3758/PBR.16.2.225

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*(6), 1161–1178. https://doi.org/10.1037/h0077714

Scott, L. S., Pascalis, O., & Nelson, C. A. (2007). A Domain-General theory of the development of perceptual discrimination. *Current Directions in Psychological Science*, *16*(4), 197–201.

Tham, D. S. Y., Woo, P. J., & Bremner, J. G. (2019). Development of the other-race effect in Malaysian-Chinese infants. *Developmental Psychobiology*, *61*(1), 107–115. https://doi.org/10.1002/dev.21783

Tottenham, N., Tanaka, J. W., Leon, A. C., McCarry, T., Nurse, M., Hare, T. A., Marcus, D. J., Westerlund, A., Casey, B., & Nelson, C. (2009). The nimstim set of facial expressions: Judgments from untrained research participants. *Psychiatry Research*, *168*(3), 242–249. https://doi.org/10.1016/j.psychres.2008.05.006

Xiao, W. S., Quinn, P. C., Pascalis, O., & Lee, K. (2014). Own- and other-race face scanning in infants: Implications for perceptual narrowing. *Developmental Psychobiology*, *56*(2), 262–273. https://doi.org/10.1002/dev.21196

Zhao, K., Zhao, J., Zhang, M., Cui, Q., & Fu, X. (2017). Neural responses to rapid facial expressions of fear and surprise. *Frontiers in Psychology*, *8*, 761. https://doi.org/10.3389/fpsyg.2017.00761

Zhao, B., Wang, A., Liu, S., Yan, L., & Liu, G. (2023). The effect of happy expression on infants' face Racial perceptual narrowing: Eye-tracking evidence. *Chinese Journal of Applied Psychology*, *29*(4), 326–333. https://doi.org/10.20058/j.cnki.cjap.022089

Zsido, A. N., Arato, N., Ihasz, V., Basler, J., Matuz-Budai, T., Inhof, O., Schacht, A., Labadi, B., & Coelho, C. M. (2021). Finding an emotional face revisited: Differences in Own-Age Bias and the happiness superiority effect in children and young adults. *Frontiers in Psychology*, *12*, 580565. https://doi.org/10.3389/fpsyg.2021.580565

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.