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Gender differences in attentional orienting to infant gaze: Evidence from a modified central cueing paradigm

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Abstract
Attentional orienting in response to infants' gaze is crucial for effective caregiving and interaction with infants, yet it has often been overlooked in previous studies. Using a modified central cueing paradigm, this study measured gaze-cueing effect (GCE) in response to infant versus adult faces ($N = 115$). Results showed that male participants exhibited a negligible GCE to infant faces, significantly smaller than their response to adult faces. In contrast, female participants exhibited significant GCEs to both infant and adult faces. This gender difference disappeared when the infant faces were partially scrambled to obscure facial features, leaving only the eyes visible. These findings highlight distinct processing of infant gaze between males and females, providing new evidence of gender differences in the processing of infant-related stimuli.

Keywords Infant gaze · Gender differences · Eye gaze · Gaze-cueing effect

Introduction

Human infants are considered altricial, characterized by an extended period of immaturity and dependence on parental care. Due to their limited verbal communication abilities, deciphering infants' social cues is vital for effective caregiving and interaction. Among various social cues, eye gaze serves as a pivotal cue conveying one's disposition and intentions (Baron-Cohen, 1995; Birmingham & Kingstone, 2009; Frischen et al., 2007). Gaze perception has been extensively studied, revealing that others' gaze can trigger reflexive attentional orienting to where or what they are looking at (Downing et al., 2004; Driver et al., 1999; Friesen & Kingstone, 1998; Liu et al., 2021; Wang et al., 2024). In these studies, researchers usually employ a modified central cueing paradigm, in which a face with directional gaze cue is presented at the center of the screen, followed by a peripheral target appearing either on the same (congruent) side indicated by the gaze cue or on the opposite (incongruent) side (Driver et al., 1999; Liu, et al., 2021; Wang, et al., 2024). The facilitated response time (RT) in the congruent condition compared to the incongruent condition is identified as the gaze-cueing effect (GCE). The GCE is a stable effect that can occur even when participants are informed that gaze directions do not provide information about target locations, but it can be modulated by various characteristics of the face, such as social status (Dalmaso et al., 2014; Dalmaso et al., 2012) and identity (Collova et al., 2017; Weisbuch et al., 2017; Zhang et al., 2023). However, the extent to which infant faces modulate the GCE remains largely overlooked.

Visual processing of infant faces exhibits distinct characteristics that differ from those associated with adult faces. Infant faces have specific infantile appearance features collectively known as the "baby schema," which refers to a set of physical characteristics such as a large head, big eyes, high and protruding forehead, and chubby cheeks (Lorenz, 1943). These features have been demonstrated to influence facial processing and capture attention (Brosch et al., 2007; Jia et al., 2019). For instance, infant faces elicit a heightened attention bias (Lucion et al., 2017) and enhance viewing motivation (Aradhye at al., 2015). Notably, women and

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men often respond differently to infant faces, with women exhibiting greater sensitivity to infant faces (De Pisapia et al., 2013; Lobmaier et al., 2010; Maestripieri & Pelka, 2002; Zhang et al., 2022), suggesting that gender influences the processing of infant faces. Therefore, it is relevant to compare how infant faces modulate the GCE across genders. While previous studies identified gender differences in the GCE for adult faces, showing that women exhibit a stronger GCE than men (Alwall et al., 2010; Bayliss et al., 2005), these findings have not always been replicated (e.g., Chacón-Candia et al., 2020). The present study specifically focuses on gender differences in the modulation of the GCE by infant and adult faces, rather than on gender differences in the GCE itself.

In this study, we employed a modified central cueing paradigm to investigate the GCE induced by infants' and adults' gaze. In this paradigm, a face is displayed at the center of the screen with the eyes directed to either the left or the right. Subsequently, a target appears on either side of the face, and participants are instructed to promptly and accurately determine its location. In Experiment 1, we used infant and adult faces with averted gaze as cueing stimuli to investigate whether infant faces modulate GCE differently in females and males. In Experiment 2, we introduced a control condition where the top and bottom sections of the faces were scrambled, leaving only the eyes visible. Disparities in the GCE between the two experiments would suggest gender differences in the modulation of the GCE by infant faces.

Method

Participants

In our preliminary experiment involving 35 participants (20 female), we observed a significant interaction between the participants' gender and the GCE of different faces, $F(1,33) = 7.74$, $p = .009$, $\eta^2_p = .190$, with male participants exhibiting a smaller GCE for infant faces (M = -0.003, $SD = 0.017$) compared to female participants ($M = 0.013$, $SD = 0.017$), $t(33) = -2.74$, $p = .010$, Cohen's $d = -0.94$; 95% CI [−1.63, −0.22]. To ascertain the robustness of this gender-related effect, we utilized G*power (Faul et al., 2009) to calculate the required sample size. The analysis indicated that a sample size of 106 participants was required to obtain a medium effect size of 0.25, with an error probability of 0.05 and power of 0.95 for a within-between interaction of a repeated-measures analysis of variance (ANOVA). In this study, we recruited a cohort of 115 college students (57 females), aged between 19 and 28 years (female: $M \pm SD = 21.6 \pm 2.28$ years; male: $M \pm SD = 22.1 \pm 2.43$ years; $t_{113} = 1.03$, $p = .303$, Cohen's $d = 0.193$; 95% CI [−0.17, 0.56]). All male and female participants reported no history of biological parenthood, no siblings younger than 6 years of age, and no prior experience in occupations involving infant care (e.g., nannies). Additionally, all participants possessed normal or corrected-to-normal vision and were naïve to the specific objectives of the study. Before the formal experiment, written informed consent was obtained. Participants received a payment for their time and contribution.

Stimuli

For Experiment 1, we chose neutral faces from the "Same Face with Multi-Expressions" Image Database for Infants and Adults (Jia et al., 2019) as stimuli. A total of 15 infant faces and 15 adult faces were selected for the main experiment, comprising eight female and seven male faces. One additional infant face and one additional adult face were used in practice. Gaze directions of the faces were manipulated using Adobe Photoshop software.

For Experiment 2, we used the same stimuli as in Experiment 1 with one modification. The upper and lower parts of each face were divided into grids measuring 15 × 15 pixels, which were then scrambled while preserving a central region of 30 × 300 pixels around the eyes (see Fig. 1).

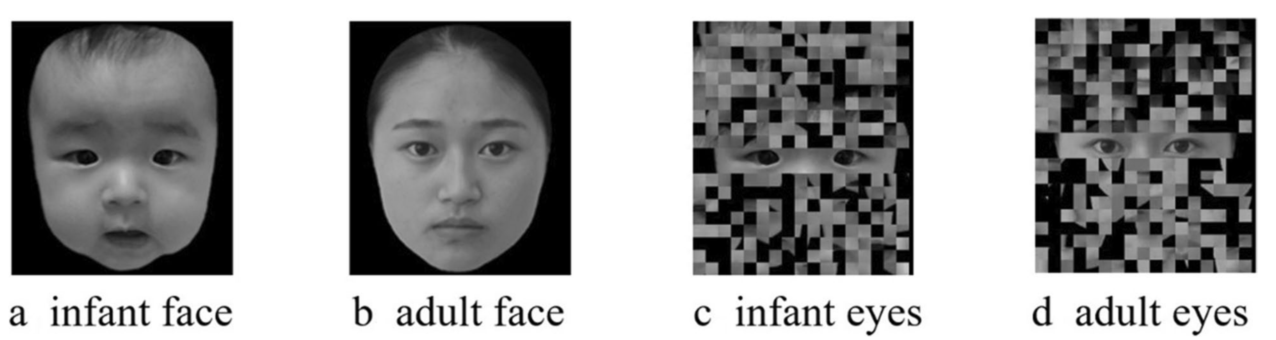

Fig. 1 Examples of stimuli used in Experiment 1 (**a**, **b**) and Experiment 2 (**c**, **d**)

Procedure

All stimuli were presented on a gray background using MATLAB (MathWorks, Natick, MA, USA) together with the Psychophysics Toolbox extensions (Brainard, 1997) on a DELL P2715Q monitor (refresh rate: 60 Hz, spatial resolution: 1,920 × 1,080 pixels). Participants were instructed to maintain fixation on the screen center throughout each trial from an approximate viewing distance of 60 cm, using a chinrest for support.

In Experiment 1, each trial began with a white fixation cross, centrally positioned within a frame (11.77°×11.77°), which extended beyond the outer borders of the stimuli. After an interval ranging from 800 to 1,200 ms, a face (4.15°× 4.76°) with a straight-ahead gaze appeared at the center of the screen for 500 ms. This was followed by a 500-ms averted gaze cue, during which the same face displayed an averted gaze with the iris (the dark central part of the eye) deviating by 0.12° to either the left or the right. The timing of the averted gaze cue was based on previous research indicating that medium intervals (ranging from 401 ms to 600 ms) yield a more pronounced GCE (McKay et al., 2021). Following the gaze cue, a red target dot was presented for 100 ms on either the left or the right side, at a distance of 3.86° from the center (see Fig. 2). Participants were instructed to immediately report the location of the target by pressing one of two arrow keys on a standard keyboard, prioritizing accuracy while minimizing response time. In congruent trials, the target dot aligned with the direction indicated by the gaze cue, while in incongruent trials, the target appeared on the side opposite to the cued location. Participants were explicitly informed before the experiment that the gaze cues did not predict the target's location. Experiment 2 closely mirrored the procedures of Experiment 1, with one difference: instead of presenting intact faces, scrambled faces with the eyes retained were employed, as described above.

All participants completed both experiments. The order of the two experiments was counterbalanced across participants: half began with Experiment 1 followed by Experiment

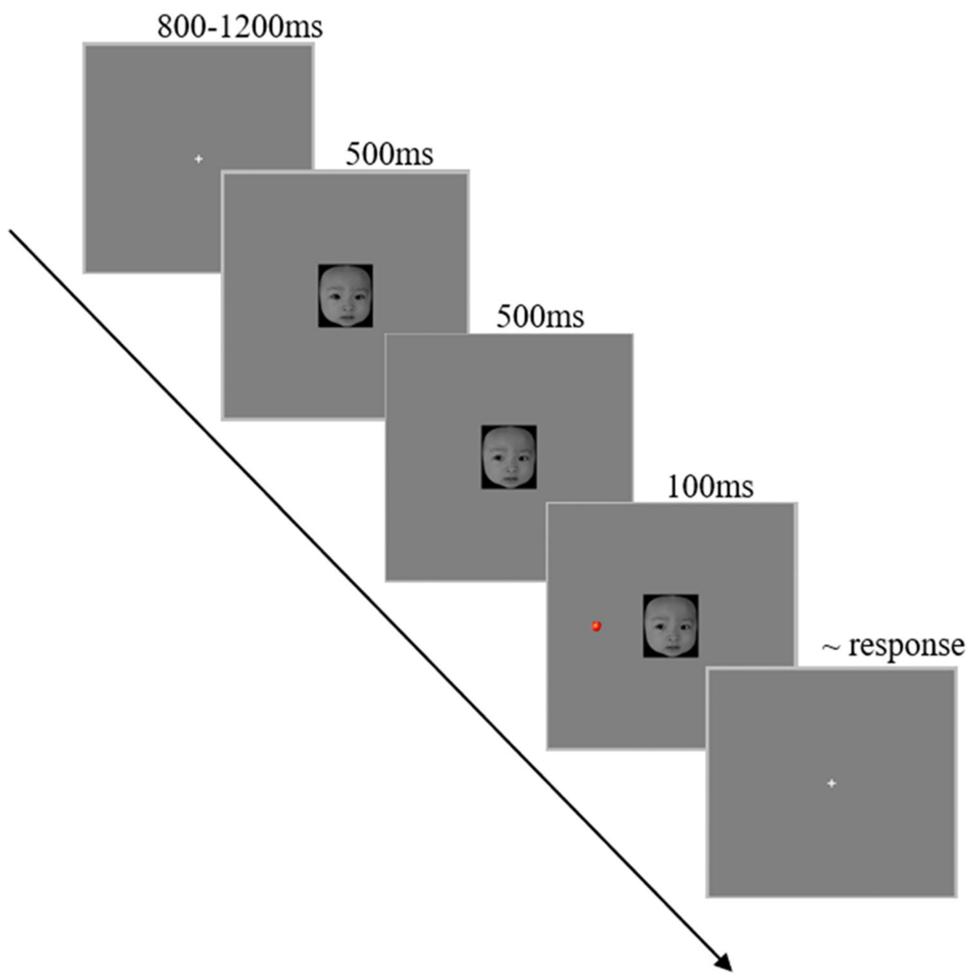

Fig. 2 Experiment procedure

2, and the other half performed the experiments in the reverse sequence. A 15-min break was provided between the two experiments to minimize fatigue. Each experiment consisted of a total of 120 trials, which were presented in a randomized order. Half of the trials utilized infant faces, while the remaining half employed adult faces. Prior to each experiment, participants completed a practice block of eight trials to become familiar with the task procedure. After completing both experiments, a subset of 90 participants (47 females) completed the Autism-Spectrum Quotient (AQ; Zhang et al., 2016).

Data analysis

Response time (RT) was used as an index. Data from participants whose mean RT was more than 3 standard deviations from the mean were excluded. This resulted in the exclusion of one male and one female participant, leaving 56 female and 57 male participants in analysis. Our analysis was limited to trials with correct responses only, and also excluded any trials where RTs exceeded two standard deviations from the mean. The percentage of excluded trials was 4.72% in Experiment 1 and 4.99% in Experiment 2.

To further account for individual differences in response speed and capture the extent to which participants were influenced by gaze cues, we also employed the normalized GCE as an additional index. The normalized GCE was calculated using the formula: (incongruent RT − congruent RT)/(incongruent RT + congruent RT), where congruent RT refers to the mean RT in congruent trials and incongruent RT refers to the mean RT in incongruent trials. This index has been extensively applied in prior research (Gomez et al., 2018; Liu et al., 2021; Wang & Theeuwes, 2020; Yang et al., 2024; Yuan et al., 2023).

In addition, to address potential order effects, we conducted an analysis of variance (ANOVA) with experiment order as a covariate. The results revealed that, for RT, the interaction between experiment order and other variables (Face Type × Gaze Type × Cueing) was not significant, $F(1, 110) = 1.37$, $p = .244$, $\eta^2_p = 0.012$. Similarly, for normalized GCE, the interaction between experiment order and other variables (Face Type × Gaze Type) was not significant, $F(1, 110) = 1.40$, $p = 0.239$, $\eta^2_p = 0.013$. These results indicate that experiment order did not significantly influence the observed effects. Therefore, experimental order was not included in the subsequent analyses.

Results

Using RT as the dependent variable, we conducted a 2 (Face Type: infant vs. adult) × 2 (Gaze Type: intact face [Exp. 1] vs. only eyes [Exp. 2]) × 2 (Cueing: congruent vs. incongruent) × 2 (Participant Gender: female vs. male) mixed-design ANOVA, which revealed a significant four-way interaction, $F(1,111) = 11.66$, $p = .001$, $\eta^2_p = .095$. To further examine this interaction, we first conducted separate within-subjects ANOVAs for the female and male groups to assess their attentional responses to different faces. We then conducted a series of mixed-design ANOVAs to evaluate gender differences in attentional effects across conditions.

Results for female participants

For female participants, we employed RT as the dependent measure and conducted a Face Type × Gaze Type × Cueing within-subjects ANOVA. The main effect of Face Type was not significant, $F(1, 55) = 0.07$, $p = .789$, $\eta^2_p < .001$. In contrast, the main effect of Gaze Type was significant, $F(1, 55) = 4.27$, $p = .043$, $\eta^2_p = .072$. Specifically, female participants showed longer RTs in the intact-face condition compared to the only-eyes condition (mean difference = 4.75 ms, SE = 2.30). This suggests that gaze type influenced performance, with intact faces slowing responses relative to isolated eyes. The main effect of Cueing was also significant, $F(1, 55) = 54.58$, $p < .001$, $\eta^2_p = .498$. Participants responded significantly faster on congruent trials than on incongruent trials (mean difference = -12.8 ms, $SE = 1.74$), indicating a robust attentional cueing effect. None of the interaction effects reached significance: the three-way interaction of Face Type × Gaze Type × Cueing, $F(1, 55) = 3.86$, $p = .054$, $\eta^2_p = .065$; the two-way interaction of Face Type × Gaze Type, $F(1, 55) = 0.27$, $p = .608$, $\eta^2_p = .005$; the interaction of Gaze Type × Cueing, $F(1, 55) = 3.21$, $p = .079$, $\eta^2_p = .055$; and the interaction of Face Type × Cueing, $F(1, 55) = 0.78$, $p = .381$, $\eta^2_p = .014$.

We also employed normalized GCE as the dependent measure and conducted a Face Type × Gaze Type within-subjects ANOVA. Neither the main effects nor the interaction reached statistical significance: Face Type, $F(1, 55) = 1.59$, $p = .213$, $\eta^2_p = .028$; Gaze Type, $F(1, 55) = 2.89$, $p = .095$, $\eta^2_p = .049$; Interaction, $F(1, 55) = 3.81$, $p = .056$, $\eta^2_p = .064$ (see Fig. 3).

Results for male participants

For male participants, the ANOVA on RTs revealed a significant three-way interaction of Face Type × Gaze Type × Cueing for RTs, $F(1, 56) = 8.07$, $p = .006$, $\eta^2_p = .126$. To decompose the significant three-way interaction, follow-up two-way ANOVAs were conducted separately at each level of one factor.

Under the intact-face condition of Gaze Type, a significant interaction was observed between Face Type × Cueing, $F(1, 56) = 11.17$, $p = .001$, $\eta^2_p = .166$. Simple-effects analysis revealed no significant difference in RTs between

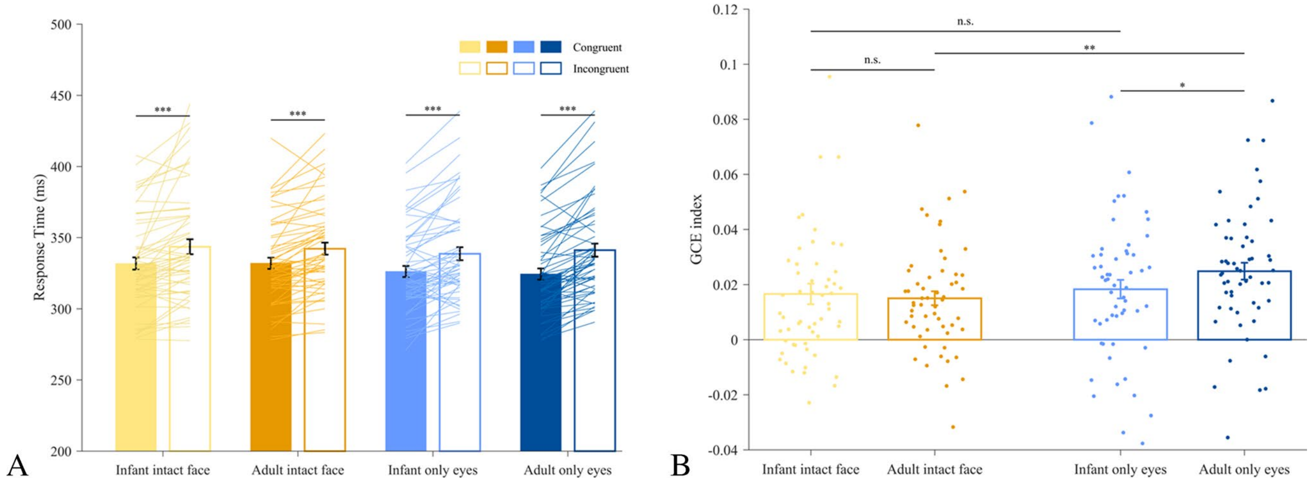

Fig. 3 Results for female participants. (**A**) Mean and individual response times across experimental conditions. (**B**) Mean and individual normalized gaze-cueing effect (GCE) values across experimental conditions. Error bars indicate standard errors

the infant-intact-congruent ($M \pm SD$ = 330.93 ± 29.6 ms) and infant-intact-incongruent conditions ($M \pm SD$ = 333.46 ± 32.0 ms, mean difference = - 2.53 ms, SE = 1.82), $t(56) = -1.26$, p =.212, Cohen's d = - 0.17; 95% CI [-0.43, 0.09], indicating an absence of gaze-cueing effect when male participants viewed intact infant faces. In contrast, a significant gaze-cueing effect emerged for adult faces: RTs were significantly shorter in the adult-intact-congruent condition ($M \pm SD$ = 327.93 ± 30.1 ms) compared to the adult-intact-incongruent condition ($M \pm SD$ = 337.10 ± 34.2 ms, mean difference = - 9.16 ms, SE = 2.05), $t(56)$ = - 4.32, p <.001, Cohen's d = - 0.57; 95% CI [-0.85, -0.29]. Furthermore, pairwise comparisons showed that RTs in the infant-intact-congruent condition were significantly longer than those in the adult-intact-congruent condition (mean difference = 3.00 ms, SE = 1.30), $t(56) = 2.26$, p =.028, Cohen's d = 0.299; 95% CI [0.03, 0.56], while RTs in the infant-intact-incongruent condition were significantly shorter than in the adult-intact-incongruent condition (mean difference = -3.63 ms, SE = 1.29), $t(56)$ = -2.83, p =.006, Cohen's d = -0.375; 95% CI [-0.64, -0.11]. However, under the only-eyes condition, male participants did not exhibit a significant interaction effect between Face Type × Cueing, $F(1, 56) = 0.44$, p =.511, η^2_p =.008.

Under the infant face condition of Face Type, male participants exhibited a significant interaction between Gaze Type × Cueing, $F(1, 56) = 9.04$, p =.004, η^2_p =.139. Simple-effects analysis revealed no significant difference between the infant-intact-congruent and infant-intact-incongruent conditions, consistent with prior observations. However, a significant difference emerged between the infant-only eyes-congruent ($M \pm SD$ = 330.93 ± 31.8 ms) and infant-only eyes-incongruent conditions ($M \pm SD$ = 338.98 ± 32.9 ms, mean difference = -8.05 ms, SE = 1.69), $t(56) = -4.90$, p <.001, Cohen's d = -0.65; 95% CI [-0.93, -0.36]. Furthermore, there was no significant difference in RTs between the infant-intact-congruent and infant-only eyes-congruent conditions (mean difference = 0.16 ms, SE = 2.93), $t(56)$ = 0.05, p =.957, Cohen's d = 0.007; 95% CI [-0.25, 0.27], whereas the RTs in the infant-intact-incongruent condition was significantly shorter than that in the infant-only eyes-incongruent condition (mean difference of -5.84, SE = 2.46), $t(56)$ = -2.38, p = 0.021, Cohen's d = -0.315, and 95% CI [-0.58, -0.05]. In contrast, under the adult face condition, no significant interaction between Gaze Type and Cueing was observed for male participants, $F(1, 56) = 0.70$, p =.406, η^2_p =.012.

Under the congruent cueing condition, no significant interaction was found between Face Type × Gaze Type for male participants, $F(1, 56) = 2.57$, p =.114, η^2_p =.044. In contrast, under the incongruent cueing condition, a significant interaction emerged between Face Type × Gaze Type, $F(1, 56) = 6.38$, p =.014, η^2_p =.102. Simple-effects analysis revealed that RTs in the infant-intact-incongruent condition were significantly shorter than those in the infant-only eyes-incongruent condition, as well as compared to the adult-intact-incongruent condition, consistent with prior observations. However, no significant differences were observed between the other conditions (all ps >.116).

Using normalized GCE as the dependent measure, a Face Type × Gaze Type within-subjects ANOVA was conducted on male participants. The interaction was significant, $F(1, 56) = 8.14$, p =.006, η^2_p =.127. Simple-effects analysis showed that GCE was significantly lower for infant-intact faces ($M \pm SD$ = 0.004 ± 0.021) than for adult-intact faces ($M \pm SD$ = 0.013 ± 0.024, mean difference = −0.010, SE = 0.003), $t(56) = -3.17$, p =.002, Cohen's d = -0.420; 95% CI [-0.69, -0.15], and also significantly lower than for the infant-only-eyes condition ($M \pm SD = 0.012 \pm 0.020$), mean difference = -0.009, SE = 0.003, $t(56)$ = -2.89, p =.005, Cohen's d = -0.383; 95% CI [-0.65, -0.11]. No significant differences were found between infant-only eyes and adult-only eyes ($M \pm SD = 0.010 \pm 0.023$), mean difference = 0.002, SE = 0.003, $t(56)$ = 0.85, p =.398, Cohen's d = 0.113; 95% CI [-0.15, 0.37], or between adult-intact faces and adult-only eyes, mean difference = 0.003, SE = 0.004, $t(56)$ = 0.79, p =.433, Cohen's d = 0.105; 95% CI [-0.16, 0.37] (see Fig. 4).

Gender differences

To investigate gender differences in attentional effects, a Participant Gender ×Cueing two-way ANOVA was conducted for each of the four experimental conditions. Significant interaction effects were observed in the infant-intact-face condition, $F(1, 111) = 8.59$, p =.004, η^2_p =.072, and the adult-only-eyes condition, $F(1, 111) = 11.00$, p =.001, η^2_p =.090. In contrast, no significant interactions were found in the adult-intact face, $F(1, 111) = 0.31$, p =.577, η^2_p =.003, and infant-only-eyes conditions, $F(1, 111) = 1.83$, p =.179, η^2_p = 0.016. These findings suggest that gender modulates attentional cueing effects specifically in the infant-intact face and adult-only-eyes conditions.

When normalized GCE was used as the dependent measure, male participants showed significantly smaller GCEs than female participants in the infant-intact-face condition, mean difference = −0.013, SE = 0.005, $t(111)$ = −2.96, p =.004, Cohen's d = -0.557; 95% CI [-0.93, -0.18]. In contrast, no significant gender difference was observed for GCE under the adult-intact-face condition, mean difference = -0.002, SE = 0.004, $t(111)$ = −0.58, p =.557, Cohen's d = -0.111; 95% CI [-0.48, 0.26]. Similarly, no significant gender difference was found under the infant-only-eyes condition, mean difference = −0.005, SE = 0.004, $t(111)$ = -1.26, p =.212, Cohen's

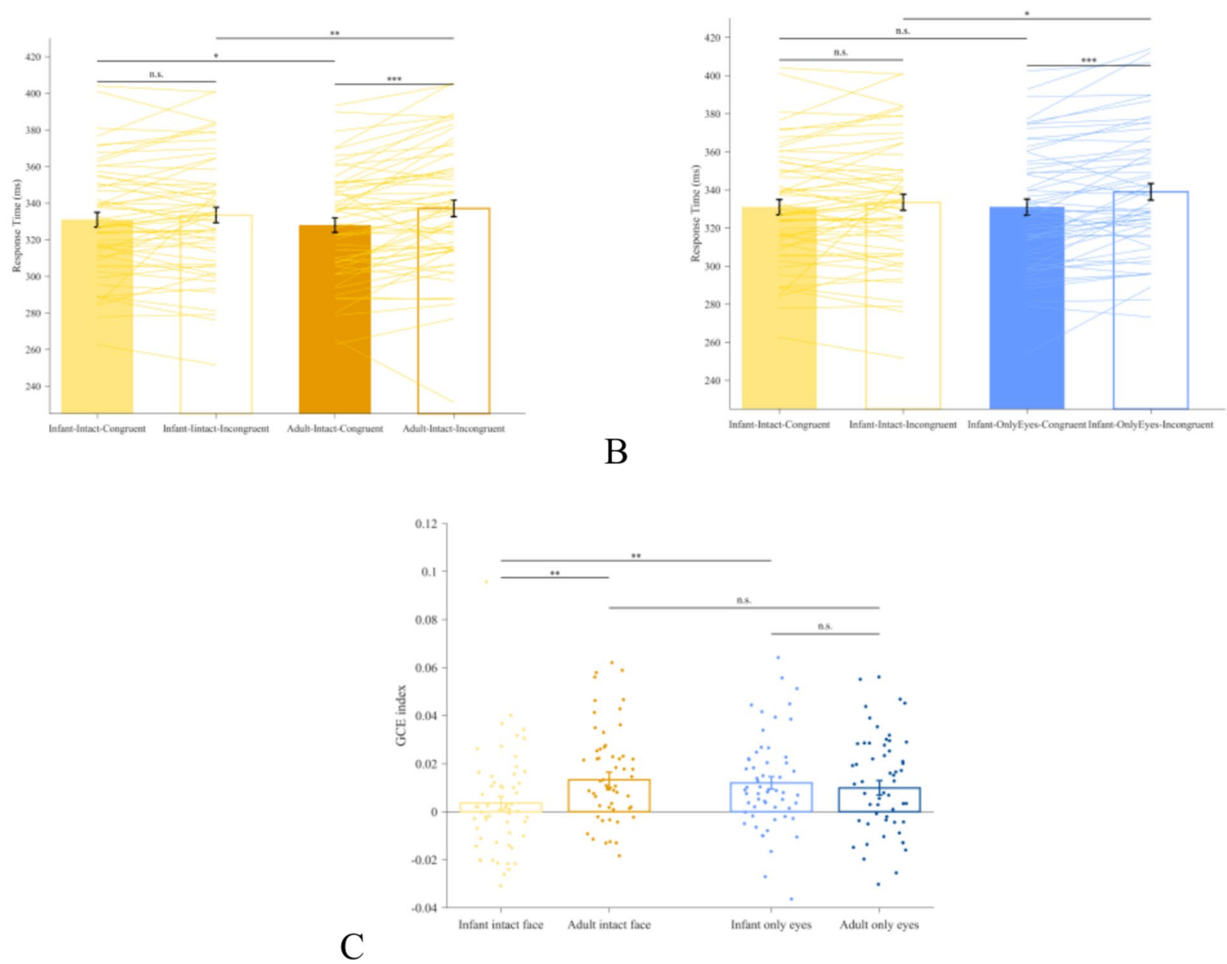

Fig. 4 Results for male participants. (**A**) Face Type × Cueing interaction under the intact-face condition of Gaze Type. (**B**) Gaze Type × Cueing interaction under the infant face condition of Face Type. (**C**) Mean and individual normalized gaze-cueing effect (GCE) values across experimental conditions. Error bars indicate standard errors

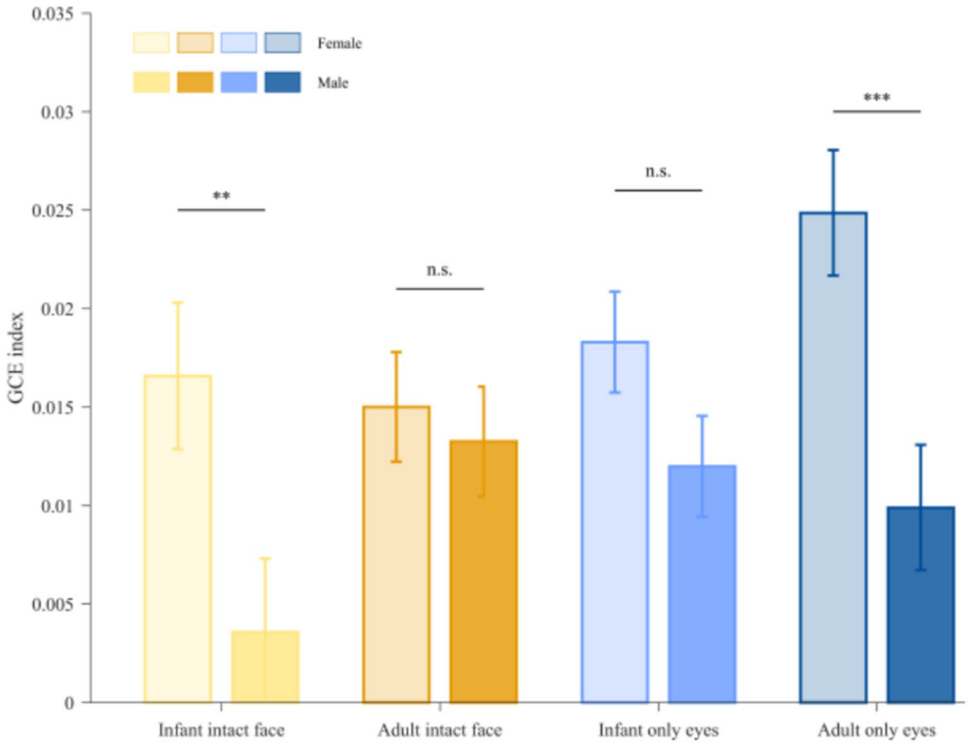

Fig. 5 Results of gender differences. Mean normalized gaze-cueing effect (GCE) values across experimental conditions. Error bars indicate standard errors

d = -0.24; 95% CI [-0.61, 0.13]. However, a significant gender difference emerged under the adult-only-eyes condition, where female participants exhibited a larger GCE than male participants, mean difference = -0.015, SE = 0.004, $t(111)$ = -3.43, p <.001, Cohen's d = -0.646; 95% CI [-1.02, -0.27]. These findings suggest that female participants demonstrated greater sensitivity to gaze cue embedded in infant face and adult eyes compared to male participants (see Fig. 5).

Correlations between AQ scores, RTs, and normalized GCE index

A subset of 90 participants (47 females) completed the AQ. No significant associations were found between total AQ score or any of its subscale scores and either RT or normalized GCE values. The smallest p-value was 0.061.

Discussion

Attentional orienting according to others' gaze plays a pivotal role in social interaction (Birmingham & Kingstone, 2009; Frischen et al., 2007). By promptly attending to infant gaze cues, adults can provide effective care and impart social learning information to infants. In the current study, we incorporated infant faces alongside adult faces into a modified central cueing paradigm, leading to an intriguing finding: gender modulation of the attention cueing effect for infant faces. Female participants exhibited robust GCE in response to infant-intact faces, with response patterns similar to those elicited by adult-intact faces and infant-only eyes. In contrast, male participants showed no significant difference between congruent and incongruent RTs for infant-intact faces, and exhibited reduced normalized GCE values compared to their responses to adult-intact face and infant-only-eyes condition. Moreover, the normalized GCE values for infant-intact faces were significantly lower in male participants compared to female participants. In contrast, in the control condition where only eyes were presented, this gender difference disappeared, and male participants exhibited significant GCE for infant-only eyes, comparable to that for adult-only eyes. These results suggest that presenting an intact face, which allowed participants to clearly distinguish between infants and adults, appeared to reduce the GCE of infant face in male participants. These findings collectively suggest that reflexive attentional orienting to infant gaze may be more pronounced among females than males. This represents an initial exploration of how adults process infant gaze, contributing to the understanding of gender differences in processing infant information.

When processing gaze cues from intact infant faces, male participants exhibited slower responses to congruent cues and faster responses to incongruent cues compared to their responses to adult-intact face, suggesting reduced sensitivity to gaze direction in infant faces. Previous studies have found that various factors related to the face influence the GCE, including social status, familiarity, and age (Bailey et al., 2014; Ciardo et al., 2014; Dalmaso et al., 2014; Dalmaso et al., 2012; Deaner et al., 2007). Research has shown that high-status faces induce larger GCEs than low-status faces (Dalmaso et al., 2014; Dalmaso et al., 2012; Weisbuch et al., 2017). In comparison to adults, infants have lower social status as they neither control social resources and power nor provide useful environmental information. Moreover, infant faces are rarely encountered in adults' everyday lives and share few relevant characteristics with adult faces (Macchi Cassia, 2011). Additionally, previous studies have identified an own-age bias in GCE, where young adults (e.g., those aged 18–25 years and 35–45 years, Ciardo et al., 2014; and those aged 17–41 years, Slessor et al., 2010) tend to follow gaze cues more readily from individuals within their own age group rather than from older adults. These factors may help explain why male participants in our study exhibited a smaller GCE response to infant faces compared to adult faces. Furthermore, when the rest of the face was masked and only the eyes were visible, male participants exhibited a similar GCE for both infant and adult eyes. This suggests that the presence of the infant face contributed to the reduced GCE observed in males. While someone may argue that the absence of GCE is related to the inherent attractiveness of infant faces, as previous research has shown slower responses to infant target stimuli (Thompson-Booth et al., 2014), our current study did not reveal any such difference in RTs between infant faces (M = 0.664, SD = 0.061) and adult faces (M = 0.665, SD = 0.063) [t_{56} = 0.381, p =.705, Cohen's d =.050] among male participants, thereby refuting this explanation.

The situation markedly differed for female participants. Despite being matched with male participants in social identity, baby-care experience, and age, females exhibited significantly different GCEs for infants compared to males in the current study, displaying similar levels of GCEs for both infants and adults. This finding aligns with previous studies indicating that women respond more strongly to infant faces than men. Women tend to exhibit stronger preferences for infants (Charles et al., 2013), provide more favorable ratings related to adoption, happiness, cuteness, and health (Franklin et al., 2018), and display a more robust and enduring attentional bias (Hahn et al., 2013) towards infants compared to men. Additionally, it has been found that the N1 response to infant faces was much larger in women than in men across the left hemisphere (Proverbio et al., 2011), and when viewing infant faces, the connectivity of the default-mode network-related regions increased in women compared to men (Zhang et al., 2022). These heightened responses to infant faces among females potentially compensate for the influence of facial identity in GCE, resulting in a similar GCE for infant faces to that observed for adult faces. It is plausible that the millions of years of evolved nurturing instincts counteracted the infants' inherent lack of power and the ability to convey survival-related information. Furthermore, female participants exhibited longer RTs in the intact-face condition compared to the only-eyes condition. This may indicate that female participants are more sensitive to facial stimuli, requiring a greater cognitive effort to disengage attention from whole faces than from stimuli containing only eyes.

Previous research has suggested a link between autistic traits and the GCE, with higher AQ scores generally associated with reduced GCE (Bayliss et al., 2005; de Araújo et al., 2021; McCrackin & Itier, 2019). However, other studies have reported no significant correlation between AQ and GCE (Chacón-Candia et al., 2020). In the present study, no significant relationship was found between AQ scores and GCE for either infant or adult stimuli. These results suggest that AQ may not be a critical factor influencing the processing of gaze cues in male participants.

Note that female participants exhibited a significantly greater GCE in response to adult eyes compared to infant eyes, and their GCE for adult eyes was also larger compared to their male counterparts. This might be attributed to women's heightened sensitivity to subtle differences in eye movement. To ensure uniformity in eye-movement manipulations, we used Photoshop to systematically move the iris (the darker portion of the eye) of each eye a physically consistent distance, while erasing any excess to maintain a natural appearance. However, due to differences in appearance and physiology between the two types of eyes, infant eyes appear to exhibit less movement compared to adult eyes, despite both being manipulated to the same extent. Compared to adults' eyes, infants' eyes generally exhibit wider inter-ocular spacing and more rounded inner canthal angles. Infants, particularly those of Asian descent, often display epicanthal folds near the inner corners of their eyes. The iris is also positioned closer to the inner corner of the eye in infants. When we displaced the iris towards the inner canthus by a specific distance and removed the excess portions that extended beyond the inner corner, it created the illusion that the iris of infant eyes had moved a shorter distance. In contrast, adult eyes may offer clearer cues for movement detection. The exact mechanisms underlying this gender difference necessitate further investigation in subsequent research endeavors.

We used faces with only the eyes visible as control stimuli in the current study, differing from previous studies that have commonly utilized inverted faces. Our choice of controlled stimuli is based on several reasons: first, inverted faces can still be rapidly identified as either infants or adults; secondly, inverted faces change the position of the eyes, as in upright conditions, infant eyes are situated lower on the face compared to adult eyes (Kawaguchi et al., 2023), but the opposite occurs in the inverted condition. In our study, the utilization of carefully controlled stimuli ensures consistency in physical attributes such as eye position and image brightness, while effectively obscuring the distinctive facial features of infants, thereby preventing participants from readily distinguishing between infants and adults.

In conclusion, our study reveals that gender plays a significant role in modulating the GCE for infant faces. Female participants demonstrated significant GCE responses to infant faces, while male participants did not. This difference may be attributed to factors such as familiarity and social status affecting men's GCE responses to infant faces, while women's responses are influenced by nurturing instincts. Our research highlights the differentiated processing of infant-related stimuli based on gender.

Open practices statement The stimuli and data for all experiments are available at: https://doi.org/10.57760/sciencedb.31143. None of the experiments were preregistered.

Authors' contributions C. L. and Y. J. conceptualized the study. C. L. designed the experiments, and conducted data collection and analysis. B. Z. and X. L. contributed to the interpretation of results. C. L wrote the original draft. All authors reviewed and approved the final version of the manuscript for submission.

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Declarations

Conflicts of interest/Competing interests The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Ethics approval This study was approved by the Institutional Review Board of the Institute of Psychology, Chinese Academy of Sciences.

Consent to participate Written informed consent was obtained from all participants.

Consent for publication All the authors approved the final manuscript and agreed to publication.

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