Original Communication

Further Evidence That Facial Cues of Dominance Modulate Gaze Cuing in Human Observers

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Abstract. Many studies have demonstrated a gaze-cuing effect in humans, whereby observers are quicker to respond to targets in locations cued by others' gaze direction than they are to respond to uncued targets. Although researchers have generally suggested that this gaze-cuing effect is unaffected by facial cues other than gaze direction, recent work has challenged this view: Both human and macaque observers demonstrate greater gaze cuing when viewing conspecifics' faces that possess physical cues associated with high dominance than when viewing those that possess physical cues associated with low dominance. In the current study, we tested for further evidence of dominance-contingent gaze cuing in women. We conducted a gaze-cuing experiment in which different individual female faces were used as cues and calculated the strength of the gaze-cuing effect for each face. Composite (i.e., average) faces manufactured from images of women who elicited particularly large gaze-cuing effects were perceived as more dominant than composites manufactured from images of women who elicited particularly small gaze-cuing effects. This result supports (1) the existence of dominance-contingent gaze-cuing in human observers and (2) the proposal that the gaze-cuing system is sensitive to facial cues other than gaze direction.

Keywords: gaze, dominance, masculinity, attention

Introduction

Following others' gaze is important for social interaction in many species, playing a critical role in collaboration, social learning, threat assessments, and decoding others' intentions and attitudes (Baron-Cohen, 1995; Emery, 2000; Frischen, Bayliss, & Tipper, 2007; Frith & Frith, 2007; Tomasello, Carpenter, Call, Behne, & Moll, 2005; Zuberbuhler, 2008; Zuberbuhler & Byrne, 2006). Although gaze following has most commonly been researched in humans (see Frischen et al., 2007, for a review), other great apes (e.g., Brauer, Call, & Tomasello, 2005; Tomasello, Hare, & Agnetta, 1999), and macaques (e.g., Deaner & Platt, 2003; Emery, Lorincz, Perrett, Oram, & Baker, 1997; Ferrari, Kohler, Fogassi, & Gallese, 2000; Shepherd, Deaner, & Platt, 2006), it has also been reported in dogs, goats, ravens, bottlenose dolphins, and fur seals (Bugnyar, Stowe, & Heinrich, 2004; Hare, Brown, Williamson, & Tomasello, 2002; Kaminski, Riedel, Call, & Tomasello, 2005; Scheumann & Call, 2004; Schloegl, Kotrschal, & Bugnyar, 2007; Tschudin, Call, Dunbar, Harris, & van der Elst, 2001). The wide range of species in which gaze following has been observed underlines its importance for fundamental aspects of social interaction.

In humans, gaze following is most commonly studied using variations on Posner's spatial cuing paradigm (Posner, 1980; Posner & Cohen, 1984). In this paradigm, the gaze direction of a centrally presented face image can be either congruent or incongruent with the location of a subsequently presented target. Observers are generally faster to respond to targets presented in gaze-congruent locations than to targets presented in gaze-incongruent locations, a phenomenon that is often referred to as the *gaze-cuing effect* (e.g., Deaner & Platt, 2003; Deaner, Shepherd, & Platt, 2007; Driver et al., 1999; Hietanen & Leppanen, 2003; Langton & Bruce, 1999; Shepherd et al., 2006). While the gaze-cuing effect is well-established in human and nonhuman primate observers, the extent to which it is modulated by cues other than gaze direction has been the focus of considerable debate.

A recent review of the literature on gaze cuing in humans concluded that "changing perceptual or semantic properties of the face stimulus does not appear to affect the short-term gaze-cuing effect in the general population" (p. 709, Frischen et al., 2007). This conclusion was based largely on research in which the gaze-cuing effect appeared to be unaffected by familiarity with the individuals presented (e.g., Frischen & Tipper, 2004) or their facial expressions (e.g., Bayliss, Frischen, Fenske, & Tipper, 2007; Hietanen & Leppanen, 2003). Other research suggests that facial cues other than gaze direction can

DOI 10.1024/1421-0185/a000056

modulate the short-term gaze-cuing effect under certain conditions: Greater gaze cuing for faces with fearful expressions has been observed when dynamic changes in gaze direction and facial expression occur simultaneously (Tipples, 2006), when positively and negatively valenced targets are used (Pecchinenda, Pes, Ferlazzo, & Zoccolotti, 2008), and among observers who report particularly high levels of anxiety (Fox, Mathews, Calder, & Yiend, 2007; Mathews, Fox, Yiend, & Calder, 2003; Putman, Hermans, & Van Honk, 2006). Similarly, greater gaze-cuing effects have been observed when observers viewed personally familiar individuals, although the effect of familiarity in this study was only evident in female participants (Deaner et al., 2007). Collectively, these findings suggest that facial cues other than gaze direction can modulate gaze cuing under some circumstances.

Two recent experiments have suggested that facial cues of dominance modulate the gaze-cuing effect in primates. Shepherd et al. (2006) found that male macaques demonstrated greater gaze-cuing effects when observing dominant males than when observing subordinate males, potentially reflecting the effects of facial cues associated with dominance (Deaner et al., 2007). More recently, Jones et al. (2010) found that men and women demonstrated greater gaze-cuing effects when observing human faces with shape cues that had been masculinized using computer-graphic transformation (Tiddeman, Burt, & Perrett, 2001) than when observing human faces with feminized shape cues. Since masculinized faces are perceived as more dominant than feminized versions (Jones et al., 2010; Perrett et al., 1998; Watkins, Jones, & DeBruine, 2010) and masculine facial cues are associated with indices of actual dominance (e.g., physical strength, Fink, Neave, & Seydel, 2007; and responses to questionnaires assessing social dominance, Quist, Watkins, Smith, DeBruine, & Jones, 2011), these findings for masculinity and gaze cuing in human observers complement those observed for dominance and gaze cuing in macaques.

While it is well-established that dominance is important for men's social behavior, researchers have often suggested that dominance is considerably less important for social behavior in women (reviewed in Buunk, Park, Zurriaga, Klavina, & Massar, 2008). From this perspective, Jones et al.'s (2010) finding that facial cues of dominance modulate gaze cuing when women view other women's faces is, perhaps, rather surprising. Consequently, in the current study, we tested for dominance-contingent gaze cuing when women completed a gaze-cuing task in which individual women's faces provided the gaze cues. We used a different method than that used by Jones et al. (2010) in order to test for converging evidence for dominance-contingent gaze cuing among women. Women completed a gaze-cuing task in which they viewed unmanipulated women's faces. For each participant, we then manufactured a prototype face with the average shape, color, and texture information for the 15 individuals for whom the largest gaze-cuing effects were observed (the *strong gaze-cuing prototype*) and a prototype face with the average shape, color, and texture information for the 15 individuals for whom the smallest gaze-cuing effects were observed (the *weak gaze-cuing prototype*). A second set of women were then shown these pairs of faces and asked to indicate which face in each pair looked more dominant. Following Jones et al. (2010) and Shepherd et al. (2006), we predicted that these women would choose the strong gaze-cuing prototype as the more dominant significantly more often than would be expected by chance.

Method

Participants

Two groups of participants took part in the study. One group of 20 women (mean age = 21.5 years, *SD* = 1.82 years) completed the gaze-cuing task, generating gaze-cuing data that were used to identify faces that elicited particularly strong and particularly weak gaze-cuing effects. A second group of 48 women (mean age = 21.2 years, *SD* = 3.96 years) judged the dominance of the strong gaze-cuing versus weak gaze-cuing prototypes. All participants were undergraduate student volunteers studying psychology at the University of Aberdeen. None of the women in the second group had taken part in the gaze-cuing part of the study.

Gaze-Cuing Task

The gaze-cuing task we used (Figure 1) is based on those used in Deaner et al. (2007), Driver et al. (1999), and Jones et al. (2010). On each trial, observers initially fixated on an orange square (1.3 ° of visual angle) at the center of the screen for 500 ms. This fixation object was then replaced with a female face image (7.6 °) with left or right averted

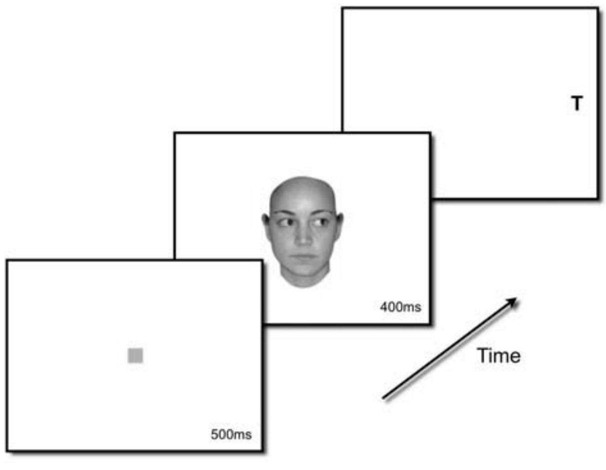

Figure 1. Example of a trial in the gaze-cuing task in which gaze direction and target location are congruent.

gaze. We used 45 different female identities in total. The face image disappeared after 400 ms of viewing time and a peripherally located target (either an uppercase L or an uppercase T approximately 1.3 ° in size) was immediately presented on either the left or right of the screen. Left and right targets were symmetrically located 12.5 ° from the center of the screen and could be either congruent or incongruent with the gaze cue (i.e., could appear on the side of the screen cued by the gaze direction of the preceding image or on the opposite side). The faces presented were masked so that hairstyle and clothing were not visible.

On each trial, the 20 female observers were instructed to indicate as quickly and accurately as possible whether the target was an L or a T. Following Langton and Bruce (1999) and Jones et al. (2010), participants were told to ignore the face and that gaze cues did not usefully predict the likely location of the target. Responses were made by pressing the 1 or the 7 key on a number pad with the index finger on the dominant hand. Note that the manual responses, up and down, were dissociated from the possible target locations, left and right (following, e.g., Deaner et al., 2007; Driver et al., 1999; Jones et al., 2010). Half of the participants used the 1 key to indicate that the target was an L and the 7 key to indicate that the target was a T. The other half of the participants used the 1 key to indicate that the target was a T and the 7 key to indicate that the target was an L. The target remained onscreen until a response was made or 1200 ms had elapsed. Each observer completed 360 trials in which *target location* (left, right), *gaze direction* (left, right), *type of target* (T or L), and face identity were fully counterbalanced. Trial order was fully randomized, with four short breaks randomly distributed during the test. The eight blocks of experimental trials were preceded by 40 practice trials.

Following Deaner et al. (2007) and Jones et al. (2010), we excluded trials in which incorrect responses were given, responses preceded the target presentation, the response time was greater than three standard deviations above or below each observer's overall mean, or no response was made within 1200 ms of the target appearing (see also Driver et al., 1999). This process excluded ~7% of the trials. For each participant, we calculated the gaze-cuing effect separately for each individual identity shown by subtracting the mean response time when the target location and gaze direction were congruent from the mean response time when the target location and gaze direction were incongruent.

Manufacturing Strong and Weak Gaze-Cuing Prototypes

We used the gaze-cuing data for each observer to identify the 15 individuals for whom each one showed the biggest gaze-cuing effect and the 15 for whom each showed the smallest gaze-cuing effect. Then, again for each observer, we manufactured a prototype face with the average shape, color, and texture information for the 15 individuals for whom the largest gaze-cuing effects were observed (the strong gaze-cuing prototype) and a prototype face with the average shape, color, and texture information for the 15 individuals for whom the smallest gaze-cuing effects were observed (the weak gaze-cuing prototype). These prototypes were manufactured from face images, with direct gaze, using specialist software specifically designed for manufacturing prototype faces and that is widely used to manufacture stimuli for face perception research (see Tiddeman et al., 2001). Using this process, we created 20 pairs of prototype faces (each pair manufactured from one observer's data), each pair consisting of a strong gaze-cuing prototype and a weak gaze-cuing prototype.

Assessing Perceptions of Strong Versus Weak Gaze-Cuing Prototypes

The 20 pairs of prototypes were then presented to 48 women (none of whom had taken part in the gaze-cuing task) who were asked to indicate which face in each pair looked more dominant. The order in which pairs of faces were presented was fully randomized, as was the side of the screen on which any particular image was presented.

Results

Analysis of Responses on the Gaze-Cuing Task

The average gaze-cuing effect for each observer was compared with what would be expected by chance alone (i.e., 0) using a one-sample *t*-test. This analysis demonstrated that the gaze-cuing effect was significantly greater than chance, $t(19) = 3.12$, $p = .006$, $M = 8.75$ ms, $SEM = 2.80$ ms, replicating previous research suggesting that observers are faster to respond correctly to targets in locations that were congruent with a preceding gaze cue than targets in locations that were incongruent with a preceding gaze cue.

Analysis of Dominance Judgments

For each of the 20 pairs of strong gaze-cuing and weak gaze-cuing prototypes presented, we calculated the proportion of participants who indicated that the strong gaze-cuing prototype appeared more dominant than the weak gaze-cuing prototype. A one-sample *t*-test comparing these scores with the chance value of 0.5 indicated that participants chose the strong gaze-cuing prototype as the more dominant significantly more often than the weak gaze-cuing prototype, $t(19) = 2.28$, $p = .034$, $M = 0.60$, $SEM = 0.04$.

Discussion

Consistent with previous research (e.g., Deaner & Platt, 2003; Deaner et al., 2007; Driver et al., 1999; Hietanen & Leppanen, 2003; Jones et al., 2010; Langton & Bruce, 1999), participants were significantly faster to respond to targets presented in cued locations than they were to respond to targets presented in uncued locations. Additionally, the prototype faces with the average shape, color, and texture of the individual faces that elicited the largest gaze-cuing effects were perceived as being more dominant than those that elicited the smallest gaze-cuing effects. This latter finding demonstrates that cues of dominance were correlated with variation in the magnitude of the gaze-cuing effect in this sample of female faces. This finding complements previous work by Shepherd et al. (2006) and Jones et al. (2010), which reported similar dominance-contingent gaze cuing in male macaques and human observers, respectively. Here we confirm the role of perceived dominance in a naturalistic experiment on human observers, showing that prototypes of faces that elicited strong gaze-cuing effects are perceived as more dominant than those that elicited relatively weak gaze-cuing effects.

Following a review of the gaze-cuing literature, Frischen et al. (2007) concluded that there was little evidence that gaze cuing in the general population was affected by facial cues other than gaze direction. The findings of the current study add to a growing body of evidence against this claim by demonstrating that gaze cuing in humans may be sensitive to facial cues such as dominance (see also Jones et al., 2010) and, under some circumstances, emotional expressions (Pecchinenda et al., 2008; Tipples, 2006). That gaze cuing is affected by cues other than gaze direction is consistent with models of face processing that emphasize interdependent processing of different facial cues (e.g., Haxby, Hoffman, & Gobbini, 2000) and evidence for interactions among the effects of gaze direction and face shape in perceptions of attractiveness, dominance, and emotion (reviewed in Main, DeBruine, Little, & Jones, 2010; Main, Jones, DeBruine, & Little, 2009; see also Dovidio & Ellyson, 1982; and Dovidio, Ellyson, Keating, Heltman, & Brown, 1988, for further discussion of the importance of gaze cues for dominance judgments).

While our findings present further evidence that gaze cuing is modulated by facial cues of dominance (see also Jones et al., 2010; and Shepherd et al., 2006), an issue that remains to be investigated is the extent to which this effect of cues of dominance may be further qualified by the dominance of the perceiver. Recent research by Watkins and colleagues has reported that men's and women's sensitivity to cues of dominance in same-sex faces is negatively correlated with their own height and scores on a dominance questionnaire (e.g., Watkins, Fraccaro et al., 2010; Watkins, Jones et al., 2010). These findings raise the possibility that effects of the type observed in the present study may be particularly pronounced among low-dominance observers.

Although it would appear that gaze cuing in both macaque and human observers is sensitive to cues of dominance, the ultimate function of dominance-contingent gaze cuing remains unclear. One engaging possibility is that, given the important role of gaze following for fluent social interaction, dominance-contingent gaze cuing may have evolved because it promoted alliances with dominant individuals (Jones et al., 2010). Alternatively, dominance-contingent gaze cuing may reflect a filter for threat assessment whereby dominant individuals provide the most reliable cues to the locations of nearby threats. We suggest that investigating these and other possibilities are likely to prove fruitful avenues for future research into the evolution of the gaze-cuing system.

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