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Brief article

The dual function of social gaze

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ABSTRACT

Ears cannot speak, lips cannot hear, but eyes can both signal and perceive. For human beings, this dual function makes the eyes a remarkable tool for social interaction. For psychologists trying to understand eye movements, however, their dual function causes a fundamental ambiguity. In order to contrast signaling and perceiving functions of social gaze, we manipulated participants' beliefs about social context as they looked at the same stimuli. Participants watched videos of faces of higher and lower ranked people, while they themselves were filmed. They believed either that the recordings of them would later be seen by the people in the videos or that no-one would see them. This manipulation significantly changed how participants responded to the social rank of the target faces. Specifically, when they believed that the targets would later be looking at them, and so could use gaze to signal information, participants looked proportionally less at the eyes of the higher ranked targets. We conclude that previous claims about eye movements and face perception that are based on a single social context can only be generalized with caution. A complete understanding of face perception needs to address both functions of social gaze.

1. Introduction

You look across the card table, into the eyes of your opponent. Are you searching their eyes for flickers of information, deciding whether to call their bluff? Or by returning their stare are you letting them know that you have nothing to fear? In social interactions, people use their eyes to perceive information and also to signal their intentions. Yet, the dual functions of gaze have been studied by and large separately. While vision psychologists have focused on the information that is present and attended to in a face, social psychologists have focused on how eye contact structures social interaction. But, in any one situation of face-to-face contact, or in any one experiment on face perception, we cannot be certain whether gaze serves to encode information or to signal intentions. We aim to understand when and how gaze is used for either function by varying the social context in which faces are viewed.

Research in vision science shows that there is plenty of useful information to perceive in the eyes of another person. The eyes are linked to many psychological processes, and so are extensively studied by researchers (Buswell, 1935; Just & Carpenter, 1976). They are a remarkably useful source of information during social interaction (Argyle & Cook, 1976; Emery, 2000; Foulsham, Cheng, Tracy, Henrich, & Kingstone, 2010; Kleinke, 1986). Following the gaze of another person, for instance, is an important requirement for social learning (Tomasello, Carpenter, Call, Behne, & Moll, 2005). Gaze attracts attention from very early ages (Batki, Baron-Cohen, Wheelwright, Connellan, & Ahluwalia, 2000), and learning to interpret what another person thinks and feels by looking at the eyes appears to be crucial to many aspects of social cognition (Charman et al., 2001; Senju & Csibra, 2008).

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Because people are looking at the eyes of each other to seek information, gaze is also a powerful tool for signaling information to onlookers. Humans are remarkably sensitive to changes in where others are looking (Gibson & Pick, 1963). Indeed, there is evidence that the bright white human sclera has been selected so that group members can perceive each other's eye movements (Kobayashi & Kohshima, 1997). Intentions, desires, obedience and dominance can all be signaled by the eyes. For example, gaze can be strategically used to cue an observer's attention (Kuhn, Tatler, & Cole, 2009), and prolonged eye contact can indicate the intention to deceive others (Mann et al., 2013), social interest (Staas & Willis, 1967), physical attraction (Mason, Tatkow, & Macrae, 2005), and nonverbal dominance (Dovidio & Ellyson, 1982). Thus, the eyes can both seek and signal information.

Previous research has not yet fully dissociated the dual function of social gaze. For example, while studies conducted in laboratories found that people tend to look predominantly to targets' eyes (e.g., Foulsham et al., 2010; Smith & Mital, 2013; Vo, Smith, Mital, & Henderson, 2012), studies conducted in real life situations found that people tend to avoid direct eye contact with targets (e.g., Gallup et al., 2012; Laidlaw, Foulsham, Kuhn, & Kingstone, 2011). Indeed, gazing behavior in real life is influenced by the potential for social interactions (Laidlaw et al., 2011), joint attention (Gallup et al., 2012), and social norms (Wu, Bischof, & Kingstone, 2013). Such critically relevant social information are often absent when examining eye movements in laboratory settings. In fact, it is possible that presenting still images or video clips activates predominantly the observational function of gazing. In contrast, in real life interactions gazing likely represents a mixture of both observational and signaling functions. Yet, interpreting eye movements from real life observations or comparing between live and prerecorded contexts is difficult. Differences in gazing might, at least partially, be explained by the fact that participants actually see different things across these situations.

In the present research, we developed an experimental paradigm to dissociate the dual function of social gaze. We combined the socially relevant information present in real life interactions with the experimental control of the laboratory. Unlike previous experiments that contrasted eye movements during real life situations to recorded stimuli (e.g., Laidlaw et al., 2011), in our experiment, participants viewed exactly the same stimuli across conditions. We presented the same faces throughout, but varied across blocks participants' beliefs about the social context.

We decided to test this paradigm in the domain of social hierarchy, because as with most of the cognitive literature on social gaze, it remains unclear why and when eye movements between people of different social ranks change. In many ways, people actively communicate their social rank through dress and demeanor, so that observers can easily perceive it and adjust their behavior accordingly (e.g., Gobel & Kim, 2014; Kraus & Keltner, 2009). Indeed, staring into other's eyes can be used as warning signal (Nichols & Champness, 1971), since prolonged eye contact is perceived as a sign of power (Dovidio & Ellyson, 1982). Yet, people also increase attention to higher ranked individuals to monitor their behaviors and learn from them. For example, the eyes of higher ranked individuals are looked at more when watching video recordings (Foulsham et al., 2010), and gaze cueing effects are greater for higher than lower ranked faces (Dalmaso, Pavan, Castelli, & Galfano, 2012). Therefore, it is possible that eye movements related to social rank could reflect the function of either signaling or perceiving social information, and previous studies have not distinguished these possibilities.

In the present study, we presented participants with faces of higher and lower ranked targets in different viewing contexts. Sometimes participants thought that they were merely observing targets' faces on the computer screen (one-way viewing), whereas other times participants thought that targets would later watch a video of them looking at targets' faces (two-way viewing). If the primary function of gaze is to perceive information about a target's social rank, then the viewing condition would not change eye movements, as the same stimuli would display the same visual information across conditions. Alternatively, if at least part of the function of gaze is to signal information about one's own social rank, then viewing condition will interact with the social rank of faces, even when people are looking at faces that are video-recorded.

We predicted that when looking at higher ranked targets, participants would look longer to their eyes when being unobserved compared to when targets could also see them, as to gain additional information without challenging targets' superior rank (Emery, 2000). In contrast, when looking at lower ranked targets, following literature on rank communication in primates (e.g., De Waal, 1989), we expected that participants would look longer into their eyes when targets could also see them compared to when being unobserved, presumably to signal their own superior rank.

2. Method

2.1. Participants

Sixty students (45 females, M_{age} = 23.03, SD_{age} = 3.12) took part in this study for €5 pay. Participants were French undergraduate and postgraduate students from Parisian universities. All participants had normal or corrected-to-normal vision.

2.2. Design

We employed a 2 (target rank: high or low) × 3 (viewing condition: baseline or one-way or two-way) mixed factor design, with the viewing condition as within-subjects factor.

2.3. Apparatus

Participants sat approximately 65 cm in front of a 24″ LCD. A SMI 250 remote eye tracker was positioned at the base of the monitor and sampled gaze position 250 times a second, with an accuracy of approximately 0.5 degrees.

2.4. Stimuli

We used eight 5 s long video-clips of Caucasian members of the general public (4 males, 4 females, M_{age} = 34.50, SD_{age} = 12.12) as they looked directly into the camera with neutral facial expressions (selected from Richardson, Street, Clark, Lotto, & Rice, 2014). We overlaid video-clips with white masks so that only the inner parts of the face were visible. The video-clip resolution was 640 × 480 pixels, which when presented on screen subtended 34 × 26 degrees of visual angle.

2.5. Procedure

Before the experiment started, all participants completed a brief questionnaire about their personality and demographic background. We told them that we were studying how people form first impressions of each other, and that they would watch a series of video-clips of other participants who had taken part in the experiment previously. We informed participants that an eye tracker was measuring their pupil size, and that sometimes we would be video-recording their face.

Participants watched three blocks of the same eight video-clips (Fig. 1). Video-clips were presented in a random order. Each trial started with a 1500 ms message announcing that the camera pointing at the participant's face would soon start recording. There was a 3000 ms countdown to the start of the trial. Next, a fixation cross appeared for 1000 ms. The video-clip was presented for 5000 ms followed by a message for 1500 ms announcing that the recording was completed.

The first block was a baseline condition in which participants watched the video-clips without explicit information about the targets. The experimenter switched the video camera on and told participants that he needed to make sure that all equipment was operating properly, but that their recordings would not be looked at. After the first block, participants were given information about the social rank of the targets.

The second and third blocks were the one-way and two-way viewing conditions, with the order counterbalanced between participants. The only difference between the blocks was that participants received different explanations regarding the video-recording of their faces. In the two-way condition, the experimenter told participants that the targets being displayed on screen were scheduled to return to the lab in two weeks' time, when they would watch the videos that we were filming of the participant. For the one-way condition, the experimenter told participants that their recordings would be archived in a drawer, and only watched if he needed to verify the pupil measurement given by the eye tracker.

2.6. Target rank manipulation

We experimentally controlled the social rank of the target faces between subjects. After the first block, we informed participants how the past participants had described themselves in the same questionnaire that the

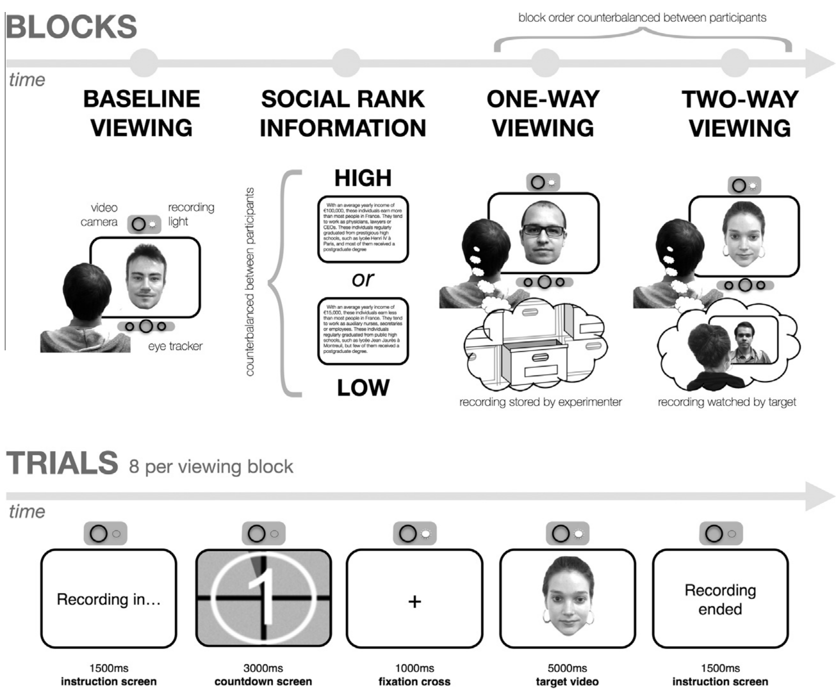

Fig. 1. Schema of the experiment. Participants watched three blocks of the same eight video-clips while themselves being filmed. The first block was a baseline condition. After the first block, we informed participants how the past participants had described themselves. The second and third block were the one-way and two-way viewing conditions. The experimenter told the participants that targets being displayed would later watch their recordings (two-way viewing) or that their recordings would be stored in a drawer (one-way viewing).

participants had filled in at the beginning of the experiment. Half of the participants read a description on screen suggesting that all targets occupied higher social ranks, for example, that they obtained postgraduate university degrees and occupied prestigious jobs. The other half of the participants read a description on screen suggesting that all targets occupied lower social ranks, for instance, that they failed to obtain postgraduate university degrees and occupied less prestigious jobs.

2.7. Manipulation check

After the second block, participants reported their impressions of targets to verify our manipulation. Participants rated targets' social rank characteristics along five 8-point items (anchored: uneducated vs. educated, low status vs. high status, lower class vs. upper class, not prestigious occupation vs. prestigious occupation, inferior social status than the participant vs. superior social status than the participant).

3. Results

3.1. Perceived social rank

Our social rank manipulation was successful. Since the five manipulation check items were highly correlated ($\alpha = .92$), we averaged their scores creating a perceived social status scale ($M = 5.24$, $SD = 1.24$). We submitted this scale to an independent samples t-test. Lower ranked targets were perceived as having significantly less status than higher ranked targets ($M = 4.26$, $SD = 0.87$, and $M = 6.04$, $SD = 0.86$ respectively), $t(58) = -7.92$, $p < .001$, $d = 2.06$.

3.2. Eye movements

Fixation durations were detected by BeGaze 3.3 (SensoMotoric Instruments, Teltow, Germany). Overall, fixations to facial features did not differ between baseline ($M = 3739$ ms, $SEM = 142$ ms), one-way viewing ($M = 3868$ ms, $SEM = 127$ ms), and two-way viewing ($M = 3827$ ms, $SEM = 133$ ms) conditions, $F(1.81, 106.93) = 2.45$, $p = .096$, $\eta_p^2 = .04$ (Greenhouse-Geisser corrections applied). Therefore we calculated the ratio of total fixation duration to the eye and mouth regions, following one of the most common measures used in the literature (e.g., Klin, Jones, Schultz, Volkmar, & Cohen, 2002). These two features are looked at most frequently (Kingstone, 2009; Yarbus, 1965), and differences in these ratios have been observed under different experimental conditions and between different participant populations (e.g., Fox, Mathews, Calder, & Yiend, 2007).

We found that how participants looked at lower versus higher ranked targets depended on whether participants believed that targets would be looking back at them (Fig. 2). A 2 (target rank) $\times$ 2 (viewing condition) $\times$ 2 (block order) mixed-design ANOVA yielded a significant interaction between target rank and viewing condition, $F(1, 56) = 5.21$, $p = .026$, $\eta_p^2 = .085$. Thus, we administered paired samples t-tests to compare gazing between one-way and two-way viewing conditions for each target rank separately. Results indicated that when viewing higher ranked targets, participants looked more into targets' eyes during the one-way viewing ($M = .93$, $SEM = .02$) than the two-way viewing condition ($M = .88$, $SEM = 0.02$), $t(32) = 2.13$, $p = .041$. In contrast, when viewing lower ranked targets, participants looked somewhat more into targets' eyes during the two-way viewing ($M = .93$, $SEM = 0.02$) than the one-way viewing condition ($M = .90$, $SEM = 0.02$), albeit this difference did not reach levels of statistical significance, $t(26) = -1.26$, $p = .218$. The effect of block order was marginally significant, $F(1, 56) = 3.39$, $p = .071$, $\eta_p^2 = .057$, but did not interact with any other variables, $p_s > .28$.

Further analyses took account of any baseline differences in face perception between our participants. We computed the differences between one-way viewing and baseline conditions as well as two-way viewing and baseline conditions. Analyzing these difference scores also yielded significant results. Differences equated to approximately 324 ms increase in looking time on the eyes of lower ranked targets comparing the two-way viewing to baseline condition, and about 367 ms increase in looking time on the eyes of the higher ranked targets comparing the one-way viewing to baseline condition. Thus, participants increased direct gaze to the eyes by roughly one or two fixations. Finally, we found that neither participants' gender nor subjective status affected the outcome variables.

4. Discussion

The way viewers look at faces of different rank changes with the belief that they too are being viewed. By manipulating this belief alone, we showed that gaze performs a dual function. It extracts information from the world and signals information back into the world. In our experiment, the social rank of the target face had different consequences for these two functions.

Our central claim, that social context modulates viewers' responses to social rank, rests upon the significant interaction between target rank and viewing condition. Additionally, we found that when looking at higher ranked targets, participants looked longer to the eyes in the one-way than two-way viewing condition. The opposite trend emerged when looking at lower ranked targets, although this difference was not significant.

Our findings suggest that how social context impacts viewers' responses to faces differs depending on whether the target holds a higher or lower rank. The results are consistent with previous research suggesting that monkeys (Shepherd, Deaner, & Platt, 2006) and humans (Dalmaso et al., 2012) are more attentive and responsive to higher than lower ranked individuals. Perhaps because higher ranked targets have a greater potential to influence others, and thus their actions and reactions matter more, participants in our study might have shown greater responsiveness to situational cues, when they were viewing higher ranked rather than lower ranked targets. Of course, in other situations, such as direct competition over resources,

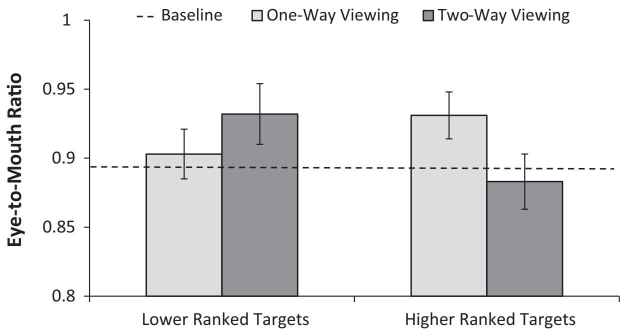

Fig. 2. Participants' gazing behavior. Depicted are eye-to-mouth ratios when looking at lower and higher ranked targets under one-way or two-way viewing conditions. Larger eye-to-mouth ratios indicate greater looks to the eyes compared to the mouth. Error bars denote standard error.

it might be advantageous to signal superior rank to lower ranked targets. Future studies should test how such social contexts impact gazing behavior in relation to social rank.

Our findings advance a growing literature illustrating that the way we observe the world depends on the beliefs about our ability to interact with it (e.g., Faber & Jonas, 2013; Risko, Laidlaw, Freeth, Foulsham, & Kingstone, 2012). For example, people avoid engaging in eye contact when sitting in a waiting room with a live person, but not when viewing that person's video recording (Laidlaw et al., 2011), and they avoid following the gaze of another person, when that person can see them (Gallup et al., 2012). Contrarily, social norms increase gaze contact in other social contexts such as sharing meals, so that when eating salad with another person compared to when eating salad alone, people look more up from their plate (Wu et al., 2013). In these previous studies, it cannot be ruled out that the differences in eye movements were, at least to some extent, due to differences in stimuli. But in our novel experimental paradigm, visual stimuli were identical across viewing conditions. By manipulating beliefs alone, we showed that social context can modulate gazing behavior.

In order to dissociate the signaling and encoding function of social gaze, we chose to depict all target faces with direct gaze and manipulated participants' beliefs about the viewing condition. In real life, people tend to shift their gaze. Indeed, previous research has found that gazing behavior to faces depends on degrees to which stimuli are both social and dynamic (e.g., Speer, Cook, McMahon, & Clark, 2007). Future studies therefore could complement our findings by manipulating targets' rank in more naturalistic videos, where targets move gaze within different viewing contexts.

5. Conclusion

We found that eye movements systematically changed when looking at higher and lower ranked targets depending on whether gaze was being used to perceive or to signal. In many other situations, however, we still do not know which function is driving gaze. Do people with autism spectrum condition look away from the eyes of others (Klin et al., 2002), because they do not seek any information from the eyes, or because they do not wish to signal social engagement? Do highly anxious people look more into the eyes of angry faces (Fox et al., 2007), so that they can scan for potentially negative feedback, or because they wish to signal that they are being attentive? Our findings highlight that a full understanding of face perception in different contexts needs to consider the dual function of social gaze.

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