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Gaze leading is associated with liking

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ABSTRACT

Gaze plays a pivotal role in human communication, especially for coordinating attention. The ability to guide the gaze orientation of others forms the backbone of joint attention. Recent research has raised the possibility that gaze following behaviors could induce liking. The present study seeks to investigate this hypothesis. We designed two physically different human avatars that could follow the gaze of users via eye-tracking technology. In a preliminary experiment, 20 participants assessed the baseline appeal of the two avatars and confirmed that the avatars differed in this respect. In the main experiment, we compared how 19 participants rated the two avatars in terms of pleasantness, trustworthiness and closeness when the avatars were following their gaze versus when the avatar generated gaze movements autonomously. Although the same avatar as in the preliminary experiment was rated more favorably, the pleasantness attributed to the two avatars increased when they followed the gaze of the participants. This outcome provides evidence that gaze following fosters liking independently of the baseline appeal of the individual.

1. Introduction

Social interactions involve a diversity of non-verbal behaviors. Gaze, in particular, plays a pivotal role in our daily social experiences. Eyes are commonly regarded as the "window of the soul" (Baron-Cohen, Wheelwright, & Jolliffe, 1997; Hoekstra, Prendinger, Bee, Heylen, & Ishizuka, 2007). Infants start demonstrating visual preference for the eye region as early as 3 months of age (Haith, Bergman, & Moore, 1977). As demonstrated by Kobayashi and Kohshima (2001) who compared the morphology of eyes in half of the known primate species, the human eye holds specific features that are exceptionally well suited for displaying one's orientation of gaze: highly contrasting white sclera and dark iris; large ratio of exposed sclera; outline elongated in the horizontal direction. These specific features are believed to stem from an evolutionary adaptation that optimized the social use of gaze in human communication. The direction of gaze acts as a major indicator of one's focus of attention and thus provides guidance in the interpretation of one's intention (Baron-Cohen, 1997). It is instrumental in our ability to attribute mental states to others. Lacking skills in interpreting the mental significance of the eyes is profoundly disabling and has been linked to the Autism Spectrum Disorder (Baron-Cohen, Campbell, Karmiloff-Smith, Grant, & Walker, 1995).

Social interactions between human beings rely on their ability to coordinate attention. This fundamental human capacity rests on what has been termed "joint attention" (Mundy & Newell, 2007). Joint attention refers to various forms of reciprocal social behaviors involving gaze, pointing gestures, deictic verbal expressions or a combination of those, that are used for the purpose of enabling two or more individuals to focus on a common point of interest. It develops during early infancy and starts appearing when the baby is about six months old (Charman, 2003; Scaife & Bruner, 1975). The ability to follow the gaze direction of others forms the backbone of joint attention (Emery, 2000). This ability has been designated as "gaze leading" or "gaze following" depending on which side is being observed, that is, the person whose gaze is being followed or, respectively, the person following the gaze of another individual. Mundy and Newell (2007) drew a distinction between responding to joint attention and initiating joint attention. Recent brain imaging studies brought support to this distinction by showing that responding to and initiating joint attention recruited different brain networks (Oberwelland et al., 2016; Redcay, Kleiner, & Saxe, 2012; Schilbach et al., 2010). Responding to joint attention has been extensively studied using an adaptation of the classical Posner paradigm (Posner, 1980) where participants, who are shown a human face with eyes moving in a given direction, exhibit an reflexive reaction of orienting their attention in the same direction (Driver, 1999; see reviews in Frischen, Bayliss, & Tipper, 2007; Lachat, Conty, Hugueville, &

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George, 2012). By contrast, initiating joint attention has received lesser attention and is only recently beginning to be approached experimentally (Bayliss et al., 2013; Schilbach et al., 2010). The present study sought to investigate the link between initiating joint attention by leading the gaze of another person in a face-to-face situation and the degree of liking for this person.

To operationalize the study of gaze leading in laboratory settings, experimenters need to expose participants to a human face that follows their gaze. This has been made possible with the advent of virtual avatars and advanced eye-tracking technology. Eye-trackers have been used to create virtual agents that adapt to the user's gaze in real-time (Bailly, Raidt, & Elisei, 2010; Hoekstra, Prendinger, Bee, Heylen, & Ishizuka, 2007; Peters, Asteriadis, & Karpouzis, 2010; Wang, Chignell, & Ishizuka, 2006). Recent research projects have been specifically devoted to the design of virtual avatars that can follow the gaze of users in real-time via eye-tracking technology (Courgeon, Rautureau, Martin, & Grynszpan, 2014; Kim & Mundy, 2012; Wilms et al., 2010). These gaze following avatars enable more controlled and systematic experiments than what a human performer could achieve. They have been instrumental in research on gaze leading. For instance, they were used to identify cortical regions involved in leading the gaze of others (Oberwelland et al., 2016; Schilbach et al., 2010), to examine the influence of gaze leading on memory of faces (Kim & Mundy, 2012), or characterize gaze leading abilities in autism spectrum disorders (Dratsch et al., 2013). Edwards, Stephenson, Dalmaso and Bayliss (2015) recently demonstrated that after leading the gaze of an individual, the leader's attention is drawn towards the eyes of the follower, thus favoring the coordination of joint attention between parties. Closer to the concerns of the present study, Schilbach et al. (2010) demonstrated in a brain imaging study that gaze leading engaged an area of the brain, the ventral striatum, which is involved in hedonic experiences of reward. Furthermore, this increase in neural activity was linked to a feeling of pleasant experience. Pleasantness in this study referred to the experience of having one's gaze followed by another person and was not a judgement expressing liking for this person. Bayliss et al. (2013) addressed this latter issue in a related study on gaze leading. They conducted series of experiments that used eye-tracking to control faces displayed on a screen. Their results suggested that faces which followed the gaze of participants were preferred over faces that looked in the opposite direction. However, the evidence was weak in that this difference was significant in only one of the two experiments that tested the effect. Additionally, the control conditions used in studies by Schilbach et al. (2010) and Bayliss et al. (2013) relied on faces that produced gaze shifts that were contingent to those of the participant but in a different direction. Therefore, the increase in pleasantness that they observed could alternatively be explained by a negative effect yielded by faces that looked away when participants initiated a gaze shift from the face towards an object. Notwithstanding, these two studies drives us to suspect a link between leading the gaze of another person in a joint attention situation and the propensity to find this person pleasant, that is, liking this person. The present study was designed to assess this hypothesis and complement the previous findings of Schilbach et al. (2010) and Bayliss et al. (2013) by using a different control condition where the avatar would not systematically look away each time the participant initiated gaze movements towards an object of interest.

In addition to pleasantness, gaze behaviors involved in joint attention seem to also influence trustworthiness. Faces that provided predictive gaze cues towards an in-coming target were shown to be judged as more trustworthy than faces looking away from the target (Bayliss, Griffiths, & Tipper, 2009; Bayliss & Tipper, 2006). A similar trend has been reported for gaze leading. In a series of experiment conducted by Dalmaso, Edwards and Bayliss (2016), participants rated as more trustworthy faces that followed their gaze compared to faces that looked in the opposite direction. However, as before, the observed difference in trustworthiness could be due to a negative effect of looking away rather than to a positive influence of having one's gaze followed. To investigate this issue, our study evaluated trustworthiness in addition to pleasantness. Finally, we also tentatively sought to explore the possible influence of gaze leading on closeness. Closeness is considered to characterize the amount of time and activities shared with another person and the impact one can have on this person's plans (Berscheid, Snyder, & Omoto, 1989). We put forward the tentative hypothesis that leading the gaze of another individual could promote the impression of sharing an activity with this individual and having an impact on her/his choices. In the present study, pleasantness, trustworthiness and closeness were considered as separate constructs. As emphasized by Schilbach et al. (2010), pleasantness is associated with hedonic feelings and involves reward-related cortical networks. By contrast, trustworthiness has been linked to the appraisal of potential threat with brain imaging studies showing increased activity in the amygdala in response to untrustworthy faces (Winston, Strange, O'Doherty, & Dolan, 2002). Finally, closeness qualifies the interpersonal relationship someone has with another individual and not the individual per se.

As stated above, previous studies have shown that individuals who follow one's gaze are found more pleasant and trustworthy than individuals who look away (Bayliss et al., 2013; Dalmaso, Edwards, & Bayliss, 2016). In these studies, the faces that followed gaze were always different from the faces that did not. Our goal was to extend these experiments by testing whether the same individual could be judged more favorably when s/he engaged in gaze following. The present study thus aimed at measuring changes in how individuals were appraised due to them switching to a gaze following behavior. Moreover, we sought to test whether such changes would occur to the same extent in individuals who were initially judged relatively less favorably compared to individuals initially judged more favorably. The experiment was thus performed with two avatars that were physically different, one being more appealing than the other. In previous experiments on gaze leading, participants were instructed to follow a predefined sequence of gaze fixations and gaze shifts. Although these procedures guaranteed experimental controllability, they came at the cost of ecological validity and realism. We opted for an experimental setup that enabled participants to have more freedom of movement, thus enhancing ecological validity.

To achieve our goal, we designed advanced versions of avatars endowed with the ability to follow the user's gaze. In previous attempts to draw a connection between gaze leading and pleasantness or trustworthiness (Bayliss et al., 2013; Dalmaso et al., 2016; Schilbach et al., 2010), researchers relied on static human faces that could only move their eyes in pre-defined directions. We developed a system that enabled avatars to simulate naturalistic gaze movements using their eyes and head in a 3D environment. The avatars could follow the gaze of the user in every direction so long as the user was looking at the screen. To further enhance the ecological aspect of the experimental setup, the avatars were based on 3D models of real individuals. Additionally, contrasting with Bayliss et al. (2013) and Dalmaso et al. (2016), we did not limit the comparison of gaze following movements to gaze movements in the opposite direction. In our control condition, gaze movements were independent of the user, that is, they were based on prerecorded real gaze movements generated by a naïve individual.

Participants were administered a task where they had to look at objects displayed in front of them and decide which one they preferred. While doing so, a human avatar facing them was also attending to the same objects, thus creating a joint attention situation involving the participants. The avatar would either follow the gaze of the participants or explore the objects independently from the participants in the control condition. To extend the validity of our study so that it would not be too contingent on the physical appearance of a single human avatar, the experimental manipulation was applied to two distinct avatars with different degrees of appeal. We report two experiments in the following sections. First, a preliminary experiment is described where the degree of appeal of the two avatars was assessed. Second, we present the main experiment where the avatars were compared between two