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NOVERBAL FORM OF LANGUAGE OCULEZIKA-EYE LANGUAGE

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Abstract: Social interactions involve complex exchanges of a variety of social signals, such as gaze, facial expressions, speech and gestures. Focusing on the dual function of eye gaze, this review explores how the presence of an audience, communicative purpose and temporal dynamics of gaze allow interacting partners to achieve successful communication. First, we focus on how being watched modulates social cognition and behavior. We then show that the study of interpersonal gaze processing, particularly gaze temporal dynamics, can provide valuable understanding of social behavior in real interactions. We propose that the Interpersonal Gaze Processing model, which combines both sensing and signaling functions of eye gaze, provides a framework to make sense of gaze patterns in live interactions. Finally, we discuss how autistic individuals process the belief in being watched and interpersonal dynamics of gaze, and suggest that systematic manipulation of factors modulating gaze signaling can reveal which aspects of social eye gaze are challenging in autism.

Keywords: eye gaze, audience effect, interpersonal dynamics, social interaction, autism

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Introduction

In any face-to-face interaction between two people, both agents are continuously exchanging a variety of social signals, such as gaze, gestures or facial expressions. This two-way exchange of social information is possible because they are able to see each other, and consequently both agents can gather and communicate information. Although traditional cognitive research has largely ignored this interactive nature of social encounters, an increasing number of studies are looking at how social behavior changes in a live interaction, as well as how eye gaze of two individuals coordinates to achieve successful communication, that is, to accurately process incoming signals and send back meaningful signals at a suitable pace.

In the present paper, we explore gaze as a communicative signal in a two-person interaction, considering both patterns of gaze to/from the other person and the interpersonal dynamics of gaze in relation to other behaviors. To explore these issues, we first introduce the dual function of eye gaze and describe two cognitive theories that explain changes in behavior when being watched. We then consider gaze exchanges during communicative situations, and propose the Interpersonal Gaze Processing model as a framework to study the dynamics of gaze in face-to-face interactions. Finally, we look into the case of autism to discuss how studies on

the audience effect and interpersonal dynamics of gaze can shed light on why autistic people find social communication challenging.

The Dual Function of Eye Gaze

Eye gaze has a dual function in human social interaction – we can both perceive information from others and use our gaze to signal to others (Argyle and Cook, 1976; Gobel et al., 2015; Risko et al., 2016). Simmel (1921) already stated that "the eye cannot take unless at the same time it gives." This contrasts with the auditory modality, where we use our ears to hear, but our mouth to speak. This makes our eyes a powerful tool for social interactions, with a "uniquely sociological function" (Simmel, 1921). For instance, when we see a pair of eyes we can gather information about what other people are looking at (Frischen et al., 2007), and how they feel or think (Baron-Cohen et al., 1997). At the same time, we can use our eyes to strategically cue another's attention (Kuhn et al., 2009). Depending on the duration and direction of our gaze, we are also able to perceive and signal a variety of meanings, such as desire to communicate (Ho et al., 2015), threat and dominance (Ellyson et al., 1981; Emery, 2000), attractiveness (Argyle and Dean, 1965; Georgescu et al., 2013), or seeking for approval (Efran and Broughton, 1966; Efran, 1968).

The dual function of the eyes has often been ignored in cognitive research studying social interactions. In typical lab studies, participants interact with a monitor that displays pictures or videos of other people, while their gaze or other behavior is recorded (see Risko et al., 2012 for a review). In these experimental settings signals are sent only one-way (from the picture to the participant) and the dual function of gaze is completely lost. Although these traditional approaches allow good experimental control, they are not interactive (Schilbach et al., 2013; Gobel et al., 2015; Risko et al., 2016). Recent research has implemented more ecologically valid approaches that can restore the dual function of gaze. The belief that someone can see us, intrinsic to live interactions, is thought to recruit a range of social cognitive processes that are missing when participants interact with videos or pictures (Risko et al., 2012, 2016; Schilbach et al., 2013). Moreover, in face-to-face interactions communication is multimodal (Vigliocco et al., 2014): information is exchanged through eye gaze, but also through gestures, facial expressions or speech, and all these signals need to be integrated over time and across agents (Jack and Schyns, 2015; Hirai and Kanakogi, 2018; Holler et al., 2018).

In the following, we first describe two cognitive theories that explain changes in behavior when being watched. Then, we discuss why interpersonal dynamics are relevant when studying social eye gaze.

Social Functions of Eye Gaze During Conversation

During communicative encounters, such as conversations, the eyes of both agents are generally very active. In a seminal study on gaze direction during conversation, Kendon identified asymmetrical gaze behavior between speakers and listeners (Kendon, 1967): while listeners gazed at speakers most of the time, speakers shifted their gaze toward and away from listeners. More recently, Rogers et al. (2018) found that during a 4 min conversation participants spent on average 60% of the time directing their gaze toward the face of the other person (only 10% of the time it was directed specifically to the eyes), and that these events were approximately 2.2 s long (for direct eye contact events were 0.36 s long). The brief duration of these events supports Kendon's original findings, because it indicates that participants are constantly alternating their gaze between face or eyes of their partner and other regions. There has been much debate about the meaning of these rapid and subtle changes in eye gaze direction and duration. Kendon (1967) originally suggested that they give rise to three main social functions of gaze. Note that, although the gaze patterns described below allow us to send signals to another person, these signals are sent implicitly and without awareness.

First, he proposed that eye gaze has a regulatory function during conversation, because it allows individuals to modulate transitions between speaker and listener states (i.e., turn-taking). In line with this, it has been found that speakers use averted gaze when they begin to talk and during hesitation (probably to indicate that they want to retain their role as speakers), but they use direct gaze to the listener when they are about to end an utterance (probably to signal that their turn is ending and that the listener can take the floor) (Kendon, 1967; Duncan and Fiske, 1977;Cummins, 2012; Sandgren et al., 2012; Ho et al., 2015). However, as noted by Ho et al. (2015) conversation is a two-way process and this means that the listener is also responsible to regulate in turn-taking. For instance, it has been shown that listeners make more gestures, head shifts and gaze shifts before speaking, probably to indicate to the speaker that they want to take the turn (Harrigan, 1985).

Second, Kendon suggested that eye gaze has a monitoring function: it allows each participant to track attentional states and facial displays of the partner to ensure mutual understanding and seek social approval from others (Efran and Broughton, 1966; Efran, 1968; Kleinke, 1986). Indeed, speakers try to gain more information about what listeners think by engaging in brief periods of mutual eye gaze, which elicit back-channeling (i.e., listener's brief responses showing comprehension of what the speaker is saying) (Bavelas et al., 2002). Rogers et al. (2018) have also proposed that brief and rapid gaze shifting between gaze directed to the eyes and to other facial regions (e.g., mouth, eyebrows) may serve to scan facial features and pick subtle cues that help interpreting the meaning of what is being said. The monitoring function of gaze can also have high cognitive costs. For

instance, when participants are asked to look at the face of the experimenter, they perform worse than participants who can avert their gaze naturally (Beattie, 1981), or who are asked to fixate on other static or dynamic stimuli (Markson and Paterson, 2009). Thus, Kendon also claimed that speakers avert their gaze partly to reduce the costs associated with monitoring a face.

It is important to bear in mind that the social functions of gaze are only meaningful during face-to-face interactions, where both partners can see each other. It is only in this context that eye gaze has a dual function and both agents can perceive and signal information (Gobel et al., 2015; Risko et al., 2016). Moreover, gaze signals are not isolated: speakers need to shift their gaze toward or away from the listener at specific time points during speech, listeners need to coordinate gaze direction with facial expressions to indicate preference or reduce arousal, and speakers and listeners need to engage in brief mutual gaze periods to exchange turns or elicit back-channeling. Thus, to succeed in communicative encounters social signals need to be coordinated within and across conversation partners over time.

Watching Eyes Model

A pair of eyes watching us is an ostensive communicative cue (Csibra and Gergely, 2009) that rapidly captures our attention (Senju and Hasegawa, 2005). Early work on gaze processing proposed various mechanisms how direct gaze modulates our attention and behavior. For instance, Baron-Cohen (1995) suggested that there is a specialized Eye Direction Detector module in the brain. This module rapidly identifies whether we are the target of someone else's attention by processing the direction of other people's eyes relative to us. The detection of direct gaze will in turn trigger mentalising processes that allow us to interpret the other person's mental states (Baron-Cohen and Cross, 1992; Baron-Cohen et al., 1997). Later, Senju and Johnson (2009) coined the term "eye contact effect" to describe changes in cognitive processing following perception of direct gaze, and introduced the Fast-track Modulator model of gaze processing. This model suggests that detection of direct gaze is implemented by a fast subcortical route involving the pulvinar and amygdala, and is modulated by higher cortical regions that depend on social context and task demands. The recently proposed Watching Eyes model (Conty et al., 2016) builds up on these models and suggests that audience effects are due to the "self-referential power of direct gaze.".

Yet, it is important to consider that different tasks measure different forms of self-reference and self-awareness. This means that different tasks are likely to engage different self-related cognitive processes, which might have different sensitivity to the belief in being watched. For instance, the pronoun-selection task used by Hietanen and Hietanen (2017) is rather intuitive and has been shown to be

sensitive to manipulations of self-awareness (Davis and Brock, 1975). However, it could be that other tasks which elicit more complex self-referential cognitive processes (e.g., self-referential effect memory task; Craik and Tulving, 1975; Lombardo et al., 2007) are not as sensitive to this top-down modulation. It is equally important to distinguish between different forms of self-awareness, such as bodily self-awareness (accuracy in reporting physiological signals; Cameron, 2001) and metacognitive self-awareness (accuracy in judging performance in a task; Fleming and Dolan, 2012). Thus, it remains to be seen whether direct gaze and the belief in being watched modulate all forms of self-referential processing and self-awareness or not.

Cognitive Theories of the Audience Effect

The audience effect and the dual function of gaze are closely linked in that both require someone who can see us. In line with this, recent evidence suggests that being watched modulates gaze patterns directed at the face of the observer, because in this context direct gaze acquires a social meaning that an individual may or may not wish to signal to someone else. These studies show that in a live interaction people look less to the other person than in a pre-recorded interaction (Laidlaw et al., 2011; Gobel et al., 2015). This change in gaze patterns is further modulated by several factors, such as the observer's social status (high rank or low rank; Gobel et al., 2015) or role in the interaction (speaker or listener; Freeth et al., 2013; Ho et al., 2015). Thus, when being watched eye gaze is adjusted to send appropriate signals to the observer, rather than to only gather information from the environment.

We behave differently when we are alone or in the presence of others. For instance, when we are with other people our actions become more prosocial (Izuma et al., 2009; Izuma et al., 2011), our memory improves (Fullwood and Doherty-Sneddon, 2006), and we smile more (Fridlund, 1991). Triplett first introduced this idea 120 years ago, when he showed that cyclists were faster when competing against each other than against a clock (Triplett, 1898). To explain this effect, he suggested that the "bodily presence of another" causes changes in the behavior of participants, which makes them more competitive when racing against others. However, previous research has shown that there is more than one way in which the presence of another person can change our behavior.

On the other hand, the audience effect is a change in behavior specifically caused by the belief that someone else is watching me. It builds on mechanisms which process the perceptual state of the other, known as perceptual mentalising (Teufel et al., 2010b). Perceptual mentalising modulates the processing of social information from the eyes in a variety of ways. For example, seeing a live-feed of a person with transparent glasses (who can see) leads to a larger gaze cuing effect

than a matched stimulus of a person with opaque glasses (who cannot see) (Nuku and Bekkering, 2008; Teufel et al., 2010a), and similar results are seen in tests of visual perspective taking (Furlanetto et al., 2016). This demonstrates that even basic social processing is influenced by the knowledge that another person can see something. The audience effect takes this one step further, considering how our social cognition is affected by the knowledge that another person can see us.

Interpersonal Dynamics of Eye Gaze

Original studies about the role of eye gaze during communicative encounters date back to the 60 s, when Argyle and colleagues (Argyle and Cook, 1976; Argyle and Dean, 1965) put forward the intimacy equilibrium model, which is the first account on the relationship between "looking and liking:" they showed that gaze directed at other people serves to control the level of intimacy or affiliation with the partner, and that it compensates with other behaviors (e.g., physical proximity) to achieve an equilibrium level of intimacy (see also Loeb, 1972). Furthermore, Watzlawick et al. (1967) proposed the idea that "one cannot not communicate," since the lack of response is a response in itself (e.g., not looking at someone signals lack of interest in the interaction; Goffman, 1963).

Recent studies show that direct gaze can act as an ostensive communicative signal (Csibra and Gergely, 2009). During face-to-face interactions, where individuals exchange information with communicative purpose through a variety of channels (e.g., gaze, gestures, facial expressions, speech), direct gaze helps to integrate and coordinate auditory and visual signals (Bavelas et al., 2002). Moreover, it has been shown that to successfully produce and detect gestures with communicative purpose, information conveyed by gaze signals (e.g., direct gaze) is preferentially used over information conveyed by kinematics of the gesture (Trujillo et al., 2018). Thus, eye gaze has a core function in leading social interactions up to successful communicative exchanges, where there is efficient transmission of information between sender and receiver.

In the following, we first describe the main social functions that eye gaze has during communicative interactions. Then, we focus on the temporal dynamics of gaze as a key mechanism that enables meaningful interpersonal exchanges during communication, as well as successful progression of the interaction.

Active Sensing in Eye Gaze

Active sensing is a key process in our interaction with the world, since it allows our sensors to be directed to the environment in order to extract relevant information (Yang et al., 2016). Gaze behavior (i.e., deciding where to look) can be considered a form of active sensing in that we choose to move our eyes to specific locations to sample useful information from a visual scene. Since our visual system only gains high-resolution information for items falling in the fovea, the motor

system needs to move our eyes to orient the fovea to different locations of interest. Thus, our motor actions shape the quality of the sensory information we sample (Yang et al., 2016).

The active sensing framework provides a mathematical account of how we can sample the world with our eyes to get useful information. Because we can only direct our eyes at one location at a time, each eye movement (i.e., saccade) comes at some opportunity cost. For instance, in Figure 1A, looking at the woman and child on the bottom means we might lose the chance to get information about the house in the center or the woman and child on the left. Similarly, in Figure 1B, looking at the landscape on the right means we will lose information about the blue car on the left or the speedometer. Active sensing suggests that saccades are planned to maximize the information we sample depending on the goal of the task at hand.

Conclusion

Natural social interactions are characterized by complex exchanges of social signals, so achieving successful communication can be challenging. This paper aimed to review research manipulating three key factors that modulate eye gaze processing during social interactions: the presence of an interacting partner who can perceive me, the existence of communicative purpose, and the development of interpersonal and temporal dynamics.

Current findings indicate that the belief in being watched has a strong impact on other-focused social cognition (both on prosocial behavior and social norms of eye gaze), but evidence is less clear for self-focused cognition: future studies should clarify to what extent being watched affects different forms of self-related processes. We also find that, to achieve successful communication, eye gaze needs to coordinate with verbal and non-verbal social signals, both within and between interacting partners. We propose the Interpersonal Gaze Processing model as a framework where gaze sensing and signaling are combined to determine where the eyes will look next in a live interaction. In this model, the belief in being watched and the communicative purpose of the interaction are key to define the gaze signaling map, while the contingencies between different signaling modalities (e.g., gaze, speech) are critical in changing this map on a moment-by-moment basis. Systematic manipulation of these factors could help elucidate how they relate to each other to enable successful communicative encounters, as well as how signaling maps are computed in the brain.

Finally, research on autistic individuals reveals that they are less sensitive to the belief in being watched, but more studies are needed to clarify how the presence of an audience impacts self-related processing in autism. Although evidence on interpersonal dynamics is mixed, it is agreed that autistic individuals have difficulties with social dynamics of eye gaze during real interactions. We

argue that the Interpersonal Gaze Processing model provides a framework for future studies to systematically characterize which aspects of gaze communication are most challenging for autistic people.

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