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The eye contact effect: impact of perceived gaze direction on social cognition

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THE EYE CONTACT EFFECT: IMPACT OF PERCEIVED GAZE DIRECTION ON SOCIAL COGNITION

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RESUME

The perception of another's gaze immediately attracts our attention, particularly if focused on us. The present study investigated how social judgments are influenced by eye contact. Specifically, it looked at how direct gaze contact, a highly salient social stimulus, influences the gender categorization process. Participants aged between 17 and 28 viewed facial photographs that varied in the degree of eye gaze deviation from the observer. Their task was to indicate, whether each face was male or female. Response times were measured for each degree of gaze deviation. It was hypothesized that direct gaze contact, given its social importance, would facilitate the categorical knowledge accessibility (gender judgments) compared to gaze that was directed away from the observer. The results only partially confirmed our hypotheses. These findings are discussed regarding potential issues with the experimental paradigm. Above all, the validity of measuring eye contact with photographic stimuli has to be critically considered.

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Content

Chapter 1 – Introduction

1.1   Problem Statement

We are living in a constantly changing social environment. With the rapid advancement of information technology and the emergence of new means of communication, perhaps more than ever. Yet, there remain some fundamental questions about human social behaviour that continue to be the subject of debate among psychologists. One essential question is how people experience their co-existence with others; how they communicate with each other, *what* they communicate to each other and how they interpret the behaviours of others. Such questions are of interest to various branches of psychology including cognitive, social, occupational, and clinical psychology. Although social interaction may appear to be the most natural and automatic behaviour, it depends on a variety of very specific processes and abilities that develop early in life, during the first contact with our caregivers. The study of social cognition is concerned with classic cognitive processes that are required to understand and act within one's social environment (Fiske & Macrae, 2012). It explains how information processing takes place and how ultimately, it guides people's actions and interactions. Thus, one of the insights we gain from social cognition concerns the dynamic ways in which people make sense of their ever-changing social world, and how these processes in turn influence what people anticipate and how they respond. This is relevant as it not only gives us an understanding of human nature in general, but it also allows us to better explain certain social phenomena such as group behaviour, stereotyping, conflicts, or social pathologies.

One fundamental aspect that has been of interest in social cognitive research is the study of face perception and processing. It is rather intuitive that faces are highly meaningful social stimuli, providing us with essential information. They allow us to identify not only people's identities but also several important characteristics, emotions and even intentions. As we will see, the social repercussions for people with conditions that compromise face recognition or the ability to produce facial expressions further illustrate the central role of faces. Not only do our faces allow us to communicate our intentions but they are also an initial point of reference, allowing us to make rapid judgments about others. Being able to make such judgments or categorizations is necessary in order to effectively deal with the vast amount of information that we face constantly. Such categorizations may not always be a perfectly accurate reflection of reality; however, they are a means of organizing what we perceive in meaningful and most

importantly, in efficient ways. For example, looking at a person's face may give us some information about his or her age, sex, or emotional state. Based on our previous experience, this information provides a first indication of the type of behaviour we are more or less likely to expect from this person. We will match, for example, our observation with what we already know about elderly people, women or specific emotions such as anger, and this in turn will allow us to prepare further action. One aspect of social cognitive research is therefore the study of how people link face perception to existing knowledge stored in their long-term memory, how based on this knowledge they draw inferences about others, and how such processes in turn influence behaviour. In addition, social cognition is concerned with other factors that may influence such categorization processes such as facial emotions, social anxiety, or gaze contact.

One factor that is especially meaningful for social interaction and has received much attention are the eyes. Not only do they convey other people's emotional states, but the gaze direction and focus also inform us whether we have somebody's attention and of what nature this attention might be. The fact that we are very sensitive to the detection of other people's eyes, especially when they are looking at us, indicates that social cognition somehow depends specifically on this type of information. It remains unclear, however, exactly how and why the perception of eye gaze affects cognitive processes, such as the activation of stereotypical knowledge. Experimental research in this field remains sparse, with differing paradigms, relying on a limited variety of human faces, or even on virtual avatar faces.

In sum, specific mechanisms involved in the perception of faces and eyes are components of the human ability to make sense of their social world. Consequently, investigating such micro processes is an integral part if we are to understand human social interaction.

1.2   Aim & Scope

Given the current state of affairs, the present study adds to the existing literature by experimentally investigating how social cognitive processes are affected by the visual perception of another person's gaze. Specifically, the aim is to investigate the effect of different gaze directions on the categorical knowledge accessibility of the observer.

1.3 Overview of the study

In order to realize the above aim, chapter 2 first examines the history and theory on the topic of face processing and the specific role of the eyes. It presents current research in the field and further includes a related topic: the construal process in person perception. Based on this link between gaze processing and social cognition this chapter will finally propose our experimental hypotheses. Chapter 3 presents the methods used, describing the stimuli generation, the participants, the experimental procedure, and the questionnaires used. Chapter 4 deals with the statistical analyses and lastly, the results are discussed and conclusions are drawn in chapter 5.

Chapter 2 – Background

2.1 Face Processing

The scientific interest in faces dates back as far as the times of Aristotle and the study of physiognomy. At the time it was considered that human personality was based on physiological characteristics, including the face (McNeill, 2000), an idea that gained more prominence during the 18th century, through the works of Johann Caspar Lavater (1778). Adopting a more scientific approach, Charles Darwin (1873) continued to be interested in faces, particularly emotional expression. He considered facial expression an evolutionary necessity for survival. According to his universality hypothesis, facial emotion expression is biologically innate for humans as well as animals and some basic emotions are universal in the way they are expressed. More recently, it has been argued, that the diversity of human faces, which is much greater than for other body parts and among other animals, has evolved as a result of frequency dependent selection, in order to facilitate identity recognition and thus social interaction (Sheehan & Nachman, 2014).

Indeed, the importance of face recognition in humans becomes apparent in pathological cases where this ability is compromised. Prosopagnosia is a condition following brain damage whereby affected individuals suffer from severe deficits in familiar face recognition (Farah, Levinson, & Klein, 1995). Similarly, an inability to *produce* facial expression, such as it is the case in people with Moebius syndrome, impacts greatly on social functioning (Bogart & Matsumoto, 2010). Such cases illustrate the social importance of human faces and how related

impairments compromise normal everyday functioning. In terms of the neural basis of face perception, several studies have proposed a specialized module dedicated to the visual treatment of faces (Farah, Wilson, Maxwell Drain, & Tanaka, 1995). Support for this view comes from research on monkeys (Perrett, Hietanen, Oram, & Benson, 1992) as well as functional brain imaging studies in humans (Kanwisher & Yovel, 2006), which identified specific cortical regions showing consistent activation in response to faces, particularly the fusiform face area and superior temporal sulcus. In addition, event-related recordings of cortical activity has consistently produced a face selective N170 component (Eimer, 2000).

2.2   The importance of the eyes

More recently, research has focused on the specific role of the eyes, considering them central to face processing (Itier & Batty, 2009). Especially for humans who rely on visual perception more than many other species, the eyes play a crucial role for every day functioning. Our orientation depends largely on visual information and thus our gaze is the first sign of our focus of attention. Humans as well as non-human primates are known to depend on information from the eyes of others during social interaction (Emery, 2000). In addition, we are particularly sensitive to detecting the gaze of others. Baron-Cohen (1995) for example, describes the striking phenomenon of 'sensing' that somebody is looking at us, even when we are initially engaged in a different activity. Studies on visual search have demonstrated a facilitated detection of eyes making contact among averted distractor eyes (von Grünau & Anston, 1995). This effect is also referred to the stare-in the crowd effect.

From an evolutionary perspective, a facilitated detection of gaze directed towards oneself may provide a considerable advantage. Being able to rapidly detect and extract critical information about the nature of somebody's attention towards us may proof essential to survival (S. R. H. Langton, Watt, & Bruce, 2000). Based on his work on autism, Baron-Cohen (1995) proposed a specific mechanism responsible for this ability to detect other people's gaze: the Eye Direction Detector (EDD). It is one of the components of the so-called mindreading system. The EDD detects any eye-like stimulus and determines whether the eye gaze is directed towards oneself or elsewhere. Furthermore, it infers that if someone's eyes are directed at something, it follows that the person sees that object. This mechanism is already present in young infants and is crucial for their early capacity for gaze following and the establishing of joint attention. Eventually, those mechanisms contribute to the development of the ability to attribute mental

states to others, to hypothesize about those mental states and thus to make sense of other people's behaviour. While Baron-Cohen's theory adopts a more nativist view on gaze following, other theories consider this ability to be gradually acquired through social interactions, whereby the infants learns to follow people's gaze as a result of the repeated experience that when doing so, it is likely to encounter interesting visual input (Triesch, Teuscher, Deák, & Carlson, 2006). In this learning process, the infant applies a very basic set of abilities, consisting of perceptual skills and visual preferences for human faces and eyes.

Experimental studies have confirmed an early selectivity for eye-like stimuli in infants. For example, in a classic visual preference paradigm, Farroni, Csibra, Simion, & Johnson, (2002) showed that newborns spent more time looking at photographs of faces with their gaze directed at the viewer compared to faces with their gaze averted. Other authors report an ability to distinguish between direct and averted gaze as early as 4 months of age (Vecera & Johnson, 1995), as well as visual preferences for open compared to closed eyes (Batki, Baron-Cohen, Wheelwright, Connellan, & Ahluwalia, 2000). So, from very early on, humans display an attraction and visual sensitivity towards the eye region.

Besides the evolutionary explanation suggesting an advantage for survival in general, this *early* sensitivity to the eyes may be very useful for a number of other functions. Early on, infants learn that gaze provides important information not only when directed at themselves, but also as a cue to objects that other people might attend or refer to. Several studies using gaze cueing paradigms in children as well as adults were able to demonstrate a reflexive tendency to direct ones attention to the gaze direction of observed faces (Friesen & Kingstone, 1998). In those experiments, participants typically view faces with variations of gaze direction (to the left or to the right) and have to rapidly detect target letters that appear subsequently either to the left or to the right of the face (Frischen, Bayliss, & Tipper, 2007a). The consistent observation of shorter detection times for valid trials (the gaze is directed to the location where the target appears) is interpreted as a premature shift of attention towards the gazed-at location. This gaze following mechanism might exist for a number of reasons. For one, gaze following is necessary to establish joint attention, an early form of communication and important for the development of social cognition (Baron-Cohen, 1995). Furthermore, through the association of words and the attention directed to the corresponding object, gaze following is likely to play a key role in language acquisition (Frischen, Bayliss, & Tipper, 2007b). For example, Brooks and Meltzoff (2008) found that gaze following ability at the age of 10-11 months predicted faster vocabulary

growth at 2 years of age.

Following another person's gaze further contributes to the understanding and predicting of people's actions. Behavioural studies demonstrated the importance of gaze direction in reading people's movement intentions (Castiello, 2003). This is in line with evidence from brain imaging studies suggesting that similar brain regions are activated when observing somebody gazing at an object as compared to grasping the object (Pierno et al., 2006). Furthermore, the eyes have been shown to play a key role in identity recognition. For instance, a case study by (Caldara et al., 2005) demonstrated the difficulty of a prosopagnosic patient in face recognition, resulting from a failure to rely on information from the eyes, as compared to a group of controls. In healthy adults, on the other hand, the eyes are the most frequently looked at region during face learning and face recognition (Henderson, Williams, & Falk, 2005).

Generally, the processing of eyes and specifically eye gaze has been attributed to specific brain regions, notably to activity in the amygdala (Kawashima et al., 1999) as well as the superior temporal sulci (STS) (Hoffman & Haxby, 2000). In line with these findings, it has been argued that the STS is particularly responsible for dynamic properties of the face, such as gaze direction, compared to the fusiform gyrus which treats static facial characteristics such as gender (Cloutier, Turk, & Macrae, 2008). Research on visual adaptation effects further points towards the presence of specific brain cells that are either tuned to gaze directed towards the left or towards the right (Jenkins, Beaver, & Calder, 2006).

Taken together, the literature suggests that eyes and eye gaze, from very early on, are pivotal social cues, a notion that is further supported by brain imaging research, showing specific regions dedicated to processing information relating to eyes and eye gaze. The early sensitivity towards such cues serve the development of a variety of socially adaptive functions, including theory of mind, communication, learning, and identity recognition.

2.2.1 The cone of gaze

Some research has been dedicated specifically to the perception of eye gaze directed toward the observer (eye contact) compared to eye gaze directed away from the observer. Evidence points toward differing neural activations and physiological responses for direct compared to averted gaze (Hietanen, Leppänen, Peltola, Linna-aho, & Ruuhiala, 2008). But *when* exactly do people perceive a gaze as making eye contact? To answer this question, Gamer and Hecht (2007) had participants autonomously moving the eyes of an avatar in a

computerized 'centering-decentering' task. They were instructed to either move the eyes to the side until they felt that the avatar's gaze was directed away from them, or they had to be 'centered' until they felt that the gaze was now directed at them. Interestingly, they found that people not only felt that they were being looked at when this was indeed the case but also when the gaze was slightly (but not massively) deviated. They identified an 8-9° range of gaze deviation within which people still judged a gaze to be making eye contact and therefore suggested that perceived eye contact is best understood in terms of a cone shape. Accordingly, the cone of gaze refers to the range of gaze direction within which people feel that they are being looked at. More recently, the cone of gaze has been studied using gaze categorization tasks: participants view faces with different gaze directions and have to judge whether the eyes are gazing straight, to the left or to the right. For example, Mareschal, Calder, Dadds, & Clifford (2013) used simple avatar faces looking either straight or 1°, 3°, 6°, 9° to the left or right. A selection of their stimuli is shown in Figure 1.
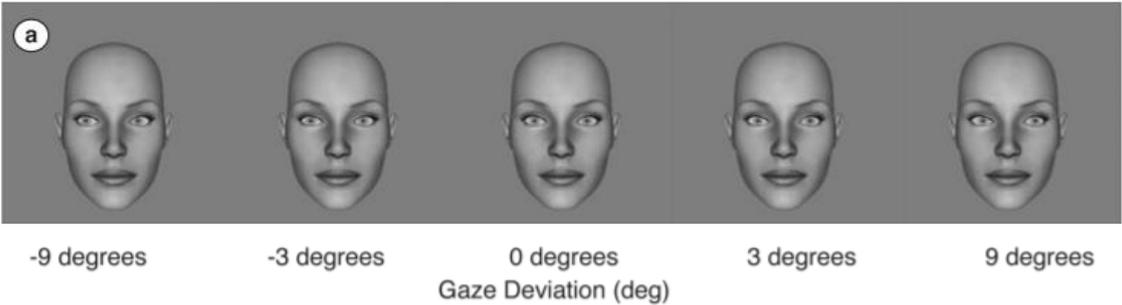

Figure 1: Sample stimuli used by Mareschal et al. 2013

Their method further allowed for the data to be averaged across all trials, obtaining a visual representation of participants' individual cone of gaze, as can be seen in Figure 2. The intersections of responses represent the borders of the participant's cone of gaze.
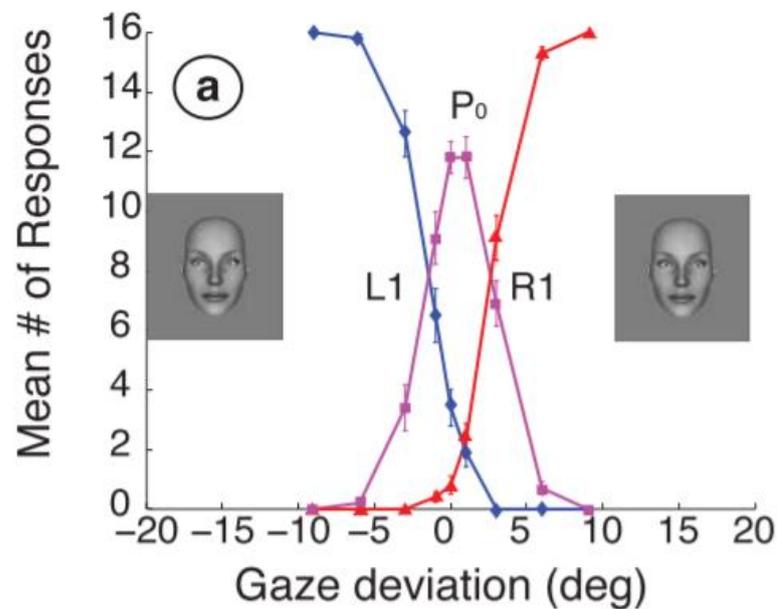
Figure 2: Sample observer's responses to different directions of gaze: averted to the left (blue diamonds), direct (pink squares), or averted to the right (red triangles).

The same concept has been used in an fMRI study by Boyarskaya, Sebastian, Bauermann, Hecht, and Tüscher, (2015), where they found that brain response to gaze at the edge of the gaze cone (at 5°) was similar to that produced by real eye contact and different from that produced by averted gaze. Similarly, Jenkins, Beaver, and Calder, (2006) found that participants were highly accurate at differentiating direct from averted gaze (25° deviation) but had considerably more trouble when the gaze was averted by 5°. Note that they only used photographs of one person and that their definition of the cone of gaze slightly varied from the study by Gamer and Hecht.

Important variances in the cone of gaze have been reported across specific populations, notably social phobia patients. Besides displaying an attentional bias towards socially threatening cues such as angry faces (Heeren, Reese, McNally, & Philippot, 2012) or emotional facial expressions in general (Rossignol, Campanella, Bissot, & Philippot, 2013), they also appear to be more sensitive to gaze contact. In another centering-decentering experiment, Gamer, Hecht, Seipp, and Hiller (2011) found that patients diagnosed with social phobia had a wider cone of gaze if a second looker was present compared to a control group. The higher patients scored on social anxiety, the more marked was this observed effect. Similarly, Hecht, Weiland, and Boyarskaya (2011) report a cone of gaze more than twice as wide in social phobics compared to controls.

2.3   Social Cognition & the Eye Contact Effect

As we have seen, there is evidence that – because of its social significance – we are particularly sensitive to eyes, such that they trigger enhanced neural processing. The EDD previously discussed not only rapidly detects eyes, but it also computes the *direction* of the eye gaze (towards oneself or elsewhere). Indeed, recent evidence from brain imaging studies, points towards a specific mechanism that is responsible for processing eye *contact* which is different from the processing of eyes with a deviated gaze. For example, judging the direction was easier for participants for gaze directed at them compared to a gaze moving away from them (Conty, N'Diaye, Tijus, & George, 2007). Combined with higher and longer lasting N170 amplitudes for direct gaze, these authors concluded that eye contact demands more cognitive resources than averted gaze. Another study found a greater activation of the posterior fusiform gyrus for eyes making gaze contact compared to averted gaze; however, this was only the case for conditions where the head orientation was straight as opposed to a deviated (Pageler et al., 2003). Although the study of Mason, Hood, and Macrae, (2004) did not find age-categorization or spatial detection of photographs to be affected by gaze direction, they clearly demonstrated that recognition memory was enhanced for faces making eye contact compared to faces with averted gaze. This indicates, again, that there is something more meaningful about eyes looking straight at the observer which results in enhanced encoding of these faces.

In 2013, Burra and colleagues found that even a cortically blind person with no visual experience, displayed different neural activation when presented with the photograph of a face making eye contact compared to faces with averted gaze. Such phenomena are thought to occur for stimuli of particular importance which can be processed even without a functioning visual cortex, thanks to a more rapid subcortical route (Senju & Johnson, 2009). Correspondingly, research on this topic has led Senju and Johnson (2009) to the term "eye contact effect" which refers to the modulation of cognitive processing following perceived eye contact. For example, Pageler et al. (2003) showed that participants were faster at deciding if a gaze was looking at them or elsewhere, for faces making direct eye contact compared to faces with averted gaze.

Taken together, the evidence points toward a mechanism dedicated specifically to the detection and treatment of gaze contact, which is arguably more meaningful than eyes gazing elsewhere, being a reliable precursor of social interaction (Vuilleumier, George, Lister, Armony, & Driver, 2005). Given then its significance for social encounters and, considering the mechanisms dedicated to make a distinction between direct and averted gaze, the question arises as to how

gaze contact in turn modulates social cognitive processes. One possibility is that we observe different behavioural effects in response to gaze contact.

Eyes are among the first sources of information when encountering a person, allowing us to make rapid judgments about the individual and thus the nature of the situation. Being one of the core processes in social cognition, such judgments are generally referred to as categorizations (Fiske and Macrae, 2012). In social cognition, we talk about categorizations or construal processes when incoming information is grouped into specific, pre-existing categories. In this particular context, a category is considered a highly accessible collection of knowledge about groups of people, for example women, elderly people or different professions (Macrae & Bodenhausen, 2001). On the basis of this initial categorization process, the perceiver can proceed to access relevant knowledge about these categories (i.e. stereotyping) which is stored in long-term memory (Macrae, Hood, Milne, Rowe, & Mason, 2002). Thus, our judgments are based on previous experience whereby we search to match incoming information with existing knowledge. The influential work of Bartlett (1932) provided one of the first demonstrations of how such stereotypic or schematic thinking affected people's cognition. When recalling a story at several points in time, he observed systematic changes to its content such as omissions or adapting information to fit with one's personal knowledge. Thus, cognition is often highly subjective process.

As it was mentioned above, this simplification of the information we receive, guided by what stimuli have in common, is much less costly than analysing each and every incoming information based on their unique properties. This process is of particular usefulness under complex conditions where the perceiver otherwise might struggle to make sense of the information (Macrae & Bodenhausen, 2001). Thus, categorization allows the perceiver to access relevant information with minimal cognitive effort (Hugenberg & Sacco, 2008). The same authors discuss how categorization occurs particularly under conditions where we think of others as social beings, when we make semantic judgments about them, for example regarding their gender or ethnicity. How does gaze contact, a decidedly relevant stimulus, influence such categorization processes?

Some studies have specifically investigated the eye contact effect in relation to such person construal processes. Looking at gender classification, whereby different faces have to be correctly labelled as either male or female, Vuilleumier et al. (2005) reported significantly slower response times for faces with direct compared to averted gaze. Another study (Macrae

et al., 2002) however, found that categorization was faster for photos with direct gaze than those with an averted gaze or eyes closed. They presented participants with photographs of faces making either direct eye contact or with their eyes averted or closed. Using a keyboard they then had to judge whether the face was male or female. In a second experiment involving a visual priming task, the same authors further demonstrated how direct gaze favoured stereotypical knowledge accessibility. They concluded that the perception of direct gaze contact leads to an increase in the accessibility of categorical knowledge, allowing to make more rapid judgments. More recently, these findings have been replicated in children (Pellicano & Macrae, 2009).

Taken together, these studies imply that gaze contact does have an effect on high level social cognitive processes, notably person perception, which is different from the mere perception of eyes or eye gaze directed elsewhere. There is, however, a lack of consistency across studies regarding the precise nature (direction as well as underlying cause) of these effects. Besides existing studies being too few to observe clear patterns emerging, they have considerable differences in their research focus, experimental paradigms, samples as well as data analyses. What these studies do have in common, however, is that they have investigated the effects of eye gaze on cognition using a limited variety of gaze directions face stimuli, in some cases even relying on avatar rather than human faces. Accordingly, the present study aimed to investigate the effect of eye gaze on the efficiency of gender categorization, adapting the experimental paradigm. This included a greater variety of stimuli and taking into account the cone of gaze as an additional subjective measure of perceived gaze contact.

2.4   Hypotheses

In line with the reasoning as well as the study design of Macrae and colleagues (2002) and based on the literature reviewed here, we hypothesized that mutual eye gaze is of higher social relevance, and we therefore expected more rapid gender categorization for direct gaze compared to averted gaze. Within this effect we additionally expected to make the following observations:

1) The facilitating effect on categorization speed would be equally present in conditions where the eyes focus not precisely on the observer but rather on a location within the cone of gaze of the observer. We therefore expected shorter response times for eye

gaze inside the cone compared to eyes looking at a location clearly outside of the cone.

2) Given that socially anxious individuals tend to have a wider cone of gaze, thus being more likely to experience gaze to be directed toward themselves, we expected different levels of social anxiety to influence categorization

It seems worth mentioning that regarding observation 1), by predicting an effect of eye gaze on social cognition we assume the activation of high level cognitive processes. Another possibility, however, would be that observed differences in response times across different degrees of gaze deviation are due to low-level processes consisting merely of visuo-perceptive differences between variations in gaze deviation. In such a case, it would be more likely to observe a linear increase in response times with increased gaze deviation, rather than mere differences of gaze within vs. outside the cone. However, given the high social meaning of eye gaze, we considered this possibility to be less likely.

Chapter 3 – Methods

3.1   Stimuli

A total of 50 Caucasian people (25 male, 25 female) between the ages of 18 and 35 volunteered to have their photographs taken and agreed for them to be used as part of our experiment. In order to obtain photographs of each face with different gaze deviations, we constructed a frame that could be fixed onto a digital camera. Attached to either side of the frame was a bar along which various points could be marked. Those points corresponded to specific degrees of gaze deviation from the camera lens, in other words from the observer. Figure 3 illustrates this construction with some of these deviation points. Photographs of the volunteers were taken while they were fixating each of those different points along both sides of the camera with their eyes. Given that this study was primarily interested in how gaze contact would affect the accessibility of gender categories, we were looking to use faces that were as stereotypical as possible, i.e. faces that were without a doubt either male or female.

Therefore, all faces were initially evaluated in terms of the ambiguousness of their gender. Filling in a Qualtrics online questionnaire, a total of 14 volunteering participants rated 50 different facial photographs. For each face, they indicated whether they thought they were looking at a man or a woman and, on a scale from 0 to 100 they expressed their degree of certainty. As a result of this analysis, a final 12 identities (6 males, 6 females) were retained for the programming of the experiment.

For each identity, 10 different black and white facial photographs were created: looking straight into the camera, eyes closed, gaze deviated by 2° from the lens (thus the observer), deviated by 5°, by 8° and by 10°. Any striking facial characteristics, such as moles or excess pimples were removed and face size and shape were normalized to a template using Adobe Photoshop CS5. The stimuli appeared on a computer screen, placed roughly at arm's length from the observer. Each photograph was presented individually on black background in the centre of the screen. Figure 4 shows some examples of male and female photographs with different degrees of gaze deviation that were used as stimuli.
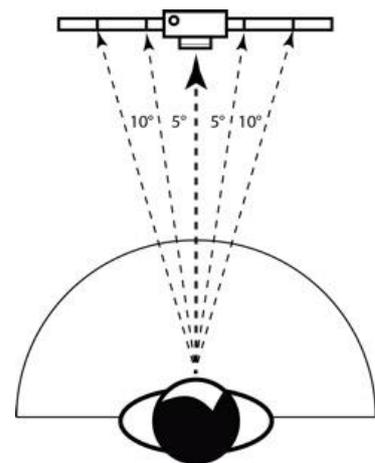
Figure 3: Construction to obtain stimuli with different gaze deviations

Figure 4: *Sample Stimuli with different gaze directions*

3.2   Participants

A total of 42 psychology undergraduate students (26 females and 16 males) from the University of Geneva participated in this study, for which they received course credits. Participants were right-handed and ranged in age between 17-28 years ($M = 20.57$; $SD = 2.15$). Each participant completed his or her entire participation in one single session which lasted around 45 minutes. All experiments took place during the autumn semester 2016 in the EEG lab of the University of Geneva. Participants had normal or corrected-to-normal vision (it was ensured that those who had corrections wore them during their participation). At the beginning of each session, participant's written and informed consent was obtained.

3.3   Experiment 1 – Gender Classification

3.3.1 Aim

The first experiment was designed to evaluate how gaze contact affects the activation of stereotypical, socially relevant knowledge, in other words the accessibility of gender classification scripts. We were thus interested in variations of participants' response times on a gender classification task.

3.3.2 Task

The first experiment was administered with the software E-Prime as depicted in Figure 5. All written and oral information was given in French. Participants were seated in a dimly lit cabin and were instructed to look at the fixation cross in the middle of the computer screen. Their task was to judge as quickly and as accurately as possible whether each subsequently

appearing photograph was showing the face of a man or a woman. Participants indicated their choice by pressing key 1 (for male) or key 2 (for female). Those keys were inversed for the second half of the experiments. Participants saw the facial photographs of the 12 identities described above (presented one at a time) with either their eyes closed, looking straight at the observer, or having their gaze deviated to the right and to the left at various degrees ($2°$, $5°$, $8°$, $10°$). Each photograph remained on the screen until a response was given and the order of stimulus appearance was randomized. The fixation cross was presented for 1000-1500ms and disappeared 30ms before the image appeared. The time between the response and fixation cross onset for the next trial was 1500ms. The experiment consisted of 6 blocks with 48 trials each, lasting about 20 minutes.
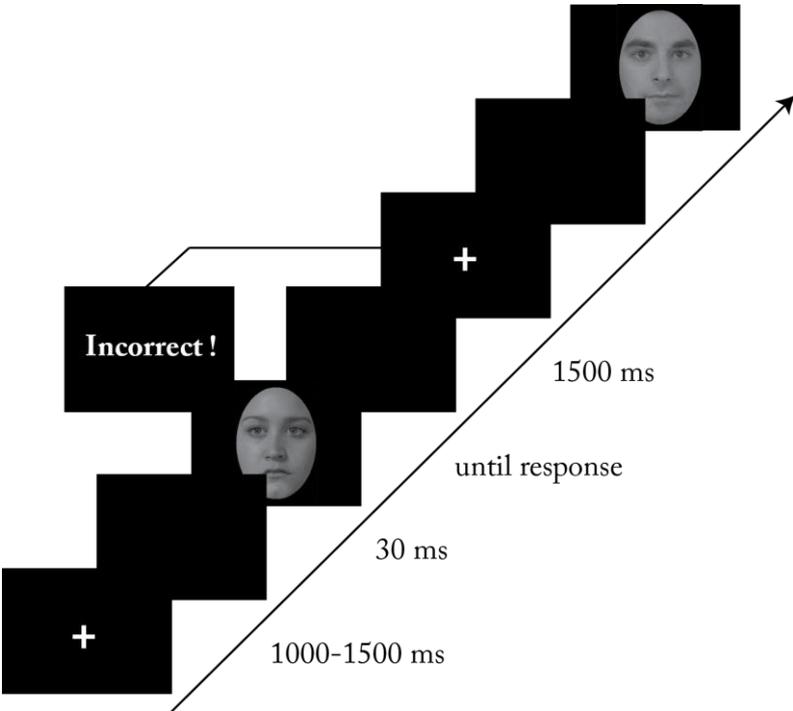
Figure 5: Illustration of two typical consecutive trials

Before the beginning of the trials, participants evaluated 8 faces from a different data base as a prior training for the experimental task. If they gave more than 5 wrong answers, the training session was repeated. In both the training and experimental trials, any response error was indicated to the participant. In addition, at the end of each block, they received a summary of their performance in the form of their average response time. This was intended to keep participants motivated to maintain or even improve their performance. At the end of each block they also had the chance for a short break as they were free to choose when they wished to continue by touching the spacebar.

3.4 Experiment 2 – Gaze Direction Judgments

3.4.1 Aim

Drawing on the concept of the cone of gaze, the second experiment was added to give us more detailed information regarding the subjective and individual perception of different gaze directions.

3.4.2 Task

Again, this experiment was administered with E-Prime, presenting participants with the same photographs as in the first experiment, however, faces that had their eyes closed were excluded this time. This yielded a total of 6 blocks, each consisting of 40 photos. This task took roughly 15 minutes to complete whereby participants no longer received any feedback in the case of a wrong answer (given that we were interested in their subjective perception of the gaze directions), neither was their response time recorded. Participants were instructed to decide for each individual face, whether they felt that the person was looking directly at them, in which case they had to press key 2. If they felt that the person was not quite looking at them, they had to indicate whether the person looked to their left (key 1) or to their right (key 3). They were further instructed to respond as rapidly as possible, to try to focus on the face as a whole and to avoid spending too much time analysing the details. Again, each photograph remained on screen until a response was given and order of appearance was randomized. The fixation cross appeared randomly for 1000-1500ms and disappeared 30ms before the image presentation.

3.5 Social Anxiety Questionnaires

The French adaptations of the two social anxiety questionnaires were administered to the participants on the same computer, once they had completed both experimental tasks. It was made clear that their answers would be treated confidentially and that they had the right to leave questions unanswered.

Liebowitz Social Anxiety Scale (Liebowitz, 1987) – self-report version:
The LSAS-SR consists of 24 items, each describing a hypothetical social situation (e.g. "Speaking up at a meeting" or "telephoning in public"). For each scenario respondents are asked to indicate the degree of fear that they would experience in this situation as well as the frequency with which they would avoid this situation. Half of these scenarios are about social interaction,

and the other half consist of performance situations. Respondents rate both their fear and avoidance on a 4-point Likert scale whereby responses are scored from 0 to 3 (for fear: 0 = none, 3 = severe; for avoidance: 0 = never, 3 = usually). This yields two main scores that range from 0 to 72 for both fear and avoidance which can be added to a global Social Anxiety score. The two main scores additionally contain two sub-scores each, one for social situations and one for performance situations. Higher scores on these scales indicate higher degrees of fear and avoidance in social and performance situations. Furthermore a total score of 60 or higher represents the cut off for social anxiety disorder (Rytwinski et al., 2009). The French version of the LSAS-SR has been shown to have good internal consistency and test-retest reliability (Heeren, Maurage, et al., 2012).

Fear of Negative Evaluation Scale (Watson & Friend, 1969):

According to Watson & Friend, the FNE measures a person's "apprehension about other's evaluations, distress over their negative evaluations, avoidance of evaluative situations, and the expectation that others would evaluate oneself negatively." These cognitions are considered one of the main components of social anxiety. The scale contains 30 items, each of which requires respondents to rate different statements as either true or false in regards to themselves (e.g. "I worry very little about what others may think of me" or "I am afraid that people will find fault with me"). A score of 1 is attributed to positively phrased items if they are considered "true" and for negatively phrased items if they are considered "false." Scores range from 0 to 30, with higher scores representing an increased fear of negative evaluation. Furthermore, scores of 22 and higher are considered to correspond to social anxiety disorder (Nordahl & Wells, 2017). The French version of the FNE has been reported to have good psychometric properties and excellent internal consistency (KR-20 = 0.94) (Musa, Kostogianni, & Lépine, 2004).

Chapter 4 – Results

4.1   Gender Categorization

<u>Response Times Descriptives</u>

Two participants were excluded from further analyses given that they represented outliers with extremely long reaction times (+3 standard deviations of the sample distribution). The remaining sample followed a normal distribution, with respect to the Kolmogorov-Smirnov test for normality ($p > .05$), which is one of the assumptions for a reliable F statistic, and which had not been the case when including the outliers. The response times varied between 412 and 688 milliseconds, with an average of 532 (SD = 63). Figure 6 shows the descriptive statistics for the response times across the different gaze direction conditions. Average response times were highest for the closed eyes condition (M = 576; SD = 81) and lowest for the 2-degree deviation condition (M = 543; SD = 70). The straight gaze condition yielded slightly longer response times than the 2-degree deviation condition (M = 545; SD = 75) and was followed by the 5 degree deviation condition (M = 548; SD = 73), the 8 degree deviation condition (M = 549; SD = 76) and the 10 degree deviation condition (M = 553; SD = 77).
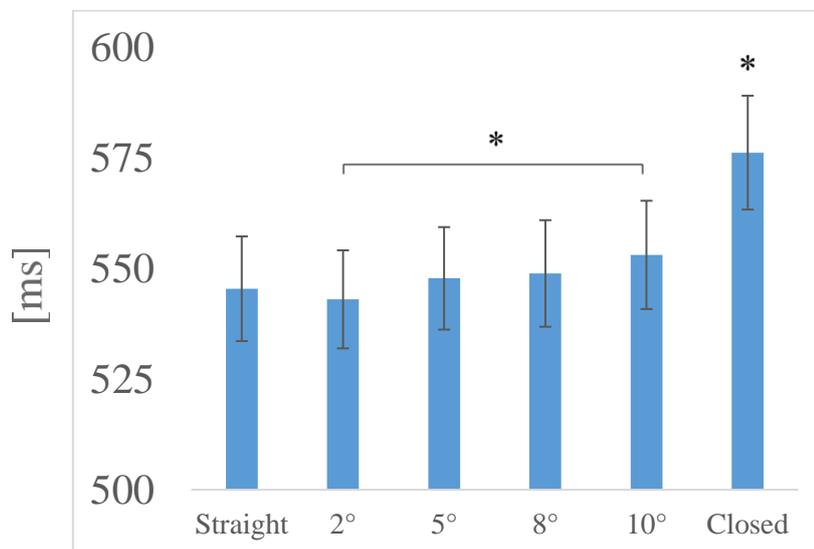
Figure 6: Mean response times (ms) across different conditions

To compare the different response times for the various gaze conditions we performed a repeated measures ANOVA. Assuming sphericity, the mean response times differed statistically significantly between different eye gaze directions ($F (5, 195) = 12.024$, $p < .001$). Contrasts revealed that the longer response times for the closed eyes condition differed

significantly from all other gaze conditions ($p < .001$). In addition, response times for the $10°$ deviated gaze condition were significantly longer compared to the $2°$ deviated gaze condition ($p = .041$).

<u>Accuracy</u>

The response accuracy for the gender categorization, on average, was 97.63% (SD = .01675). Although there was a tendency for higher accuracy in conditions that produced shorter response times, a repeated measures ANOVA revealed no significant effect of eye gaze direction on response accuracy (F $(1, 39) = 2.43$, $p = .13$). Therefore, the task difficulty (categorizing different faces according to gender) was only reflected in longer response times, but not "strictly" in response accuracy.

4.2   Covariates – Social Anxiety & Cone of Gaze

The scores on the FNE scale ranged from 7 to 18 (M = 13.7; SD = 2.64) and from 6 to 85 for the LSAS (M = 50.47; SD = 18.18). The cone of gaze varied between 6 and 17 degrees, with an average of 10.8 degrees (SD = 2.69). Based on the logistic functions used by Mareschal, Calder, Dadds, and Clifford (2013), data from gaze direction judgments (experiment 2) were compiled and logistic functions were fitted to the proportion of "left" and "right" responses. A function for "direct" responses was calculated by subtracting the sum of the left and right responses from 1. These three functions were fitted as Matlab functions.
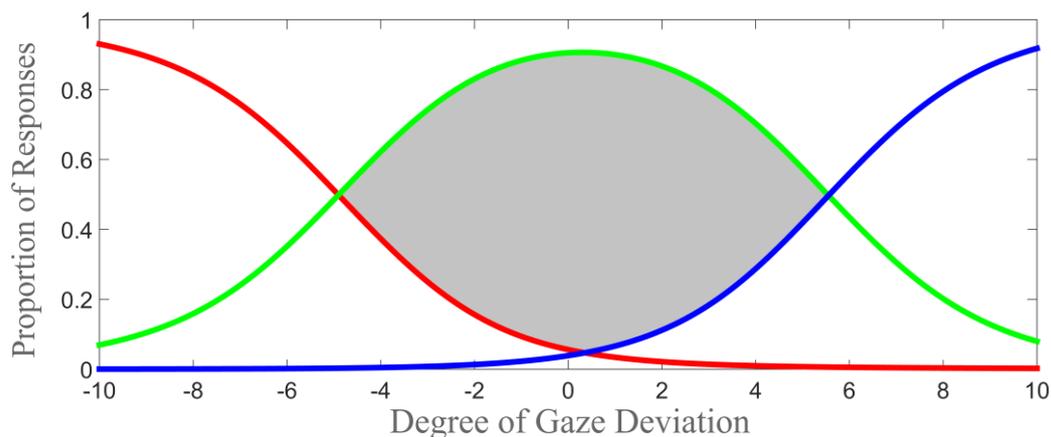
Figure 7: *Gaze Categorization data: mean proportion of "left", "right", or "direct" responses*

Figure 7 illustrates the mean responses to different directions of gaze: averted to the left (red curve), straight gaze (green curve), or averted to the right (blue curve). The grey area

corresponds to the range of gaze directions that participants judged as direct, thus representing the cone of gaze.

Table 1 shows the descriptive statistics as well as the inter-scale correlations between the cone of gaze, the FNE, the LSAS global score as well as the LSAS fear and avoidance ratings. There was a significant positive correlation between the FNE and the LSAS global score. None of the questionnaire scores was correlated with the cone of gaze.

Table 1: *Descriptive statistics and Pearson's r correlations for the questionnaire scores and the cone of gaze*

	(1)	(2)	(3)	(4)	(5)
(1) FNE		.32*	.31	.25	-.24
(2) Liebow_all			.84**	.87**	-.09
(3) Liebow_Fearful				.47**	.19
(4) Liebow_Avoidance					.03
(5) Cone of gaze					
M	13.7	50.47	24.75	25.72	10.81
SD	2.64	18.18	9.94	11.27	2.69

* sig. correlation at .05 level (two-tailed)
** sig. correlation at .01 level (two-tailed)

To determine how social anxiety and the cone of gaze might influence categorization response times, a repeated measures ANCOVA was performed. The covariate, cone of gaze, was not significantly related to the participant's response times across the different gaze conditions (F (5, 190) = 0.76, p = .58). In addition, neither the mean scores on the FNE (F (5, 190) = .288, p = .92) nor on the LSAS (F (5, 190) = .30, p = .91) were related to categorization response times.

Additionally, the three variables were used as covariates for the analysis of categorization accuracy. The response accuracy across different gaze conditions remained insignificant when controlling for LSAS scores (F (5, 190) = 0.34, p = .89), FNE scores (F (5, 190) = 1.42, p = .22) and the cone of gaze (F (5, 190) = 0.9, p = .48).

4.3   Gender Categorization Inside vs. Outside the Cone of Gaze

To test our hypothesis that subjectively *perceived* direct gaze would have similar effects on response times as real gaze contact, which would differ from perceived averted gaze, we compared two different categories of gaze deviations: those that are clearly *inside* the cone of gaze (direct gaze and 2° deviation) and those that are *outside* the cone of gaze (8° and 10°). The differences between those two categories are illustrated in Figure 8. Mean response time was 544 ms for gaze inside the cone (SD = 70.78) and 551 ms for gaze outside the cone (SD = 75.14). A paired t-test revealed a significant difference between the two gaze categories (t = - 2.08, p = .044).
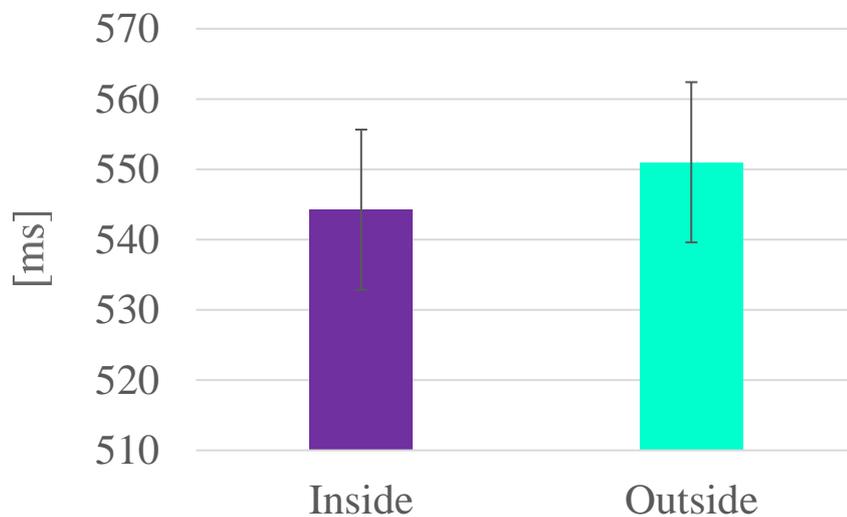

Figure 8: Mean categorization times for gaze inside (0°, 2°) and outside (8°, 10°) the cone of gaze

Chapter 5 – Synthesis

5.1   Discussion

Overall, our data only partially support the hypotheses. Comparing the different gaze deviations individually failed to show a clear effect on gender categorization. Neither was there an effect of social anxiety (in the case of the FNE this could however be due to the lack of variability of scores) nor the cone of gaze on gender categorization speed. However, when regrouping the different gaze deviations such that it allowed for the comparison of gaze inside vs. outside the cone of gaze, our predictions were confirmed: gender categorization was facilitated for gaze that is generally perceived as being directed at the observer. Thus, when taking the cone of gaze into account, the data confirmed our hypotheses as well as previous results reported by Macrae et al. (2002). The implications for research in the field may be important, as the present results suggest that when analysing how people process eye gaze, the subjective aspect of gaze direction analysis can add valuable information. Simply presenting a slightly deviated gaze without further analysis runs the risk of missing individual differences as well as global tendencies in how this gaze direction is really perceived. These findings notwithstanding, the difference between gaze inside and outside the cone of gaze was only marginally significant. While Macrae and colleagues report differences of around 100ms, we found differences of less than 10ms. Therefore, it remains unclear why, in the present study, looking at response times for independent gaze deviations did not show a clear-cut facilitation effect and why comparing gaze inside vs. outside the cone of gaze resulted in much smaller differences. There are a variety of possible explanations that will be discussed in this chapter.

First, our stimuli may simply have been too similar in terms of the variations of gaze deviations, which made it impossible for any significant patterns to emerge. Indeed, it is hard to tell whether the subtle differences between a gaze deviation of say 2° and 5° can be accurately perceived. In that sense, the addition of a greater variety of gaze deviation (as compared to earlier studies) may have proved to be a disadvantage. It is possible that the previously reported effects are only observable when the differences between these conditions are bigger. This would explain why there was no significant difference from one gaze deviation to the next, but only when grouping more similar ones together (inside vs. outside the cone of gaze). Interestingly, the eyes-closed condition produced considerably longer response times than any other condition. There is little available research that has worked specifically with closed-eye

stimuli, hence we can only make assumptions when interpreting these observations. One possible explanation is that there is something more unusual about faces with closed eyes, leading to effects of confusion or surprise and thus, longer response times. Another possibility is that the absence of eye gaze, one of the most important cues for gender recognition (Latinus, 2008) makes the decision task considerably more difficult. Furthermore, the eyes closed condition was included to control for potential shifts of attention as a result of gaze-cueing. The finding that this control condition differed statistically significantly from all other gaze-averted conditions could imply the involvement of gaze cueing effects, a point to which we shall return later in this chapter.

A second aspect to bear in mind is that we did not explicitly demand our participants to treat the eye region. Thus, the absence of any clear effect of different gaze deviations on categorization times could be due to a failure of participants to engage in specific treatment of the gaze direction, resulting in a more holistic face processing. Boyarskaya and colleagues (2015) controlled for this by adding an irrelevant task whereby participants had to indicate the person's eye colour, thus forcing them to treat the eyes in particular. It remains to be investigated, whether there are systematic differences between conditions that ensure the treatment of the eye region compared to paradigms that do not specifically control for this. Given the important role of the eyes in face processing and identity recognition, however, it seems more likely that the eyes receive preferential treatment in both cases.

A further point to consider is the highly standardised way in which we presented the facial stimuli. As can be seen in Figure 4, we scaled each face to fit the same template, to control for any unwanted effects resulting from variables such as head-shape, hair styles, etc. Again, one major drawback is the resulting difficulty to generalize such findings to social cognitive processes as they occur under normal conditions. There is evidence that face processing generally depends on a holistic perception, including head shape and motion (Sinha, Balas, Ostrovsky, & Russell, 2006). Similarly, Langton (2000) demonstrated how the judgment of the direction of attention not only depends on gaze alone, but other information such as head orientation is also taken into consideration. This phenomenon, termed the Wollaston effect, has been demonstrated in young infants (Otsuka, Ichikawa, Clifford, Kanazawa, & Yamaguchi, 2016) as well as adults (Pageler et al., 2003). Thus, there is evidence that judgments hardly ever depend on isolated information from the eyes, but equally on related information.

On the other hand, when showing participants different combinations of head position and gaze deviation, Carlin, Calder, Kriegeskorte, Nili, and Rowe, (2011) found that the anterior STS coded for gaze direction independently of facial features (i.e. head position). It therefore appears possible, at least under certain conditions, that gaze direction can be discriminated irrespective of head position. Nonetheless, studies that have included different head positions in addition to gaze deviations, such as that of Vuilleumier et al. (2005), have reported decidedly different results from studies that have not done so (Macrae et al., 2002). Whether this is truly due to the interaction of head position – gaze direction, or whether other variables are responsible, is not entirely clear. Future studies should further investigate this relationship as it may potentially account for the conflicting results across studies.

Another possibility is that our stimuli were too stereotypical, making the categorization task too simple to produce observable reaction time differences. As was described above, one of the criteria for the choice of identities was that they could easily and correctly be categorized. The question therefore remains as to what would happen if we had used more androgynous faces. In any case, the absence of the expected effects is less likely due to any issues with the gaze directions of our stimuli. The cone of gaze was generally of a similar shape across participants. In addition, we observed the typical range of "direct" responses reported in other studies, with a cone spectrum around 10° on average. This suggests that our stimuli as such, particularly the variations in gaze deviation are working well.

Nevertheless, an important issue is the more global question as to whether such stimuli are the right choice to study social cognitive processes. Given that our participants were merely looking at photographs as opposed to having a real person in front of them, can we really speak of gaze contact? The possibility that what we have measured is in fact something different from a response to gaze contact must be taken into consideration. In order to perceive gaze *contact*, the observer needs to take the intentional stance. That is, one must attribute a mind to a person (or in this case a photograph) which comes with the awareness that, if our gazes meet, the other is looking at me in the same way that I am looking at him or her, that I am the focus of his attention. Indeed, it has been shown, that the intentional stance is necessary if we are to measure gaze related, automatic responses (Wykowska, Wiese, Prosser, & Müller, 2014). A study by Gobel, Kim, & Richardson, (2015) demonstrated how gazing behaviour is highly dependent on social context. Specifically, believing that the target will see participants gazing reduces the time spent looking at the target's eyes. Similarly, in the previously mentioned study by Hietanen

et al. (2008) the reported effects (comparing direct vs. averted gaze) were only observed in the presence of a real person and not on photographs, while the facilitation of gaze judgments reported by Conty et al. (2007) emerged when comparing eyes *moving* towards the viewer and eyes moving away from the viewer. Such variables might have provided more realistic conditions compared simply to static photographs as it was the case in our study.

More recent research on the eye contact effect has increasingly recognized the difficulty of using photographic stimuli and has sought to adopt more meaningful paradigms. For example, (Hietanen, Myllyneva, Helminen, & Lyyra, 2016) had a real person sitting behind a computer screen on which participants engaged in different cognitive tasks, allowing for the establishment of genuine eye contact. Although testing performance on different cognitive tasks, they report an increased arousal resulting from direct gaze contact and conclude that, there is a fundamental difference between social cognition studies using photographic compared to real-life stimuli. A similar argument can be made for the absence of any effect of the cone of gaze and social anxiety. In the above-mentioned study of Gamer et al. (2011) social anxiety patients only had a wider cone of gaze than controls if a second looker was present. If there was only one pair of eyes making eye contact (as in the present study) their cone of gaze was no different from that of a healthy control group. In addition, Mareschal et al. (2013) showed that gaze categorization judgments change under different conditions of (un)certainty. This suggests that the cone of gaze might in fact not be a fix individual construct, but highly context dependent.

Finally, as it has been briefly mentioned at the beginning of this chapter, there is another way in which we can look at the effects observed in response to direct and averted gaze. So far, we have mainly considered those effects in terms of whether or not they facilitate social cognition and, as we have seen, the results are mixed. But there is another point that needs to be raised, one that has been previously addressed in the influential work of Jerry Fodor (1983): if we have an experimental paradigm, and in one condition we find that response times are faster than in the other and if we then, under different circumstances, find the inverse, can we assume one single underlying process? Or rather, do we have to presume multiple processes (or modules) involved? Accordingly, rather than being the result of a *facilitation* resulting from the social significance of eye contact, the difference in response times could be due to a *delay* in reaction time resulting from a gaze cueing effect for faces that look elsewhere. In other words, there might be at least two different processes involved simultaneously. Indeed, there is robust

evidence from gaze cueing studies showing that people's attention is automatically attracted to the location of the gaze of others (Wykowska et al., 2014). Driver IV et al. (1999) demonstrated how participants were unable to avoid looking into the direction in which the eyes on a photo look, even under conditions where it would have been more effective not to do so. Drawing on the previously mentioned issue regarding the absence of mind attribution to photographic stimuli, these effects might be explained differently. Rather than representing a social gaze following mechanism, they might result from visual learning: our experience with screen displays (animated films, video games etc.) might have simply taught us to follow the screen character's gaze, as there might be relevant information in that location. This would explain why spatial cueing effects are consistently observed, despite taking an intentional stance.

While one interpretation (social cognitive processes) is based on observing faster categorization times, the latter stems from gaze cueing effects, reflected by faster detection of targets appearing at the gazed-at location. In both cases, interpretations rely on measuring behavioural responses and inferring to mental processes. The problems of such inferences have been much debated and are frequently considered one of the major limitations of cognitive research. As Fiske and Macrae (2012) put it: "By moving away from meaningful behaviour, social-cognitive research creates an explanatory gap between the measuring instruments it employs (e.g. questionnaires, reaction times) and the phenomena it strives to explain (e.g. stereotyping)" (pp. 2). We therefore need to interpret such findings very carefully, particularly when it comes to generalizing to social behaviour outside of the laboratory. Conclusive evidence can only emerge from future research that employs meticulously designed paradigms and includes brain imaging techniques providing more direct measures of these mechanisms.

5.2   Conclusion

The purpose of the present study was to investigate the influence of gaze perception on social cognitive processes, specifically gender categorization. We compared response times on a gender categorization task for different gaze conditions. Using the same identities, experiment 1 required participants to decide whether individual faces were either male or female while experiment 2 demanded the categorization of gaze direction (straight, left or right) allowing the individual computation of the cone of gaze. We hypothesized that, given its social importance, direct gaze would produce shorter gender categorization times compared to averted

gaze. Such a benefit to performance would be taken as an indicator of the higher accessibility of categorical knowledge in response to gaze contact.

As has been discussed in the previous chapter, our results did not clearly demonstrate a higher categorical knowledge accessibility for direct compared to averted gaze, although a trend into this direction could be observed. There are several possible explanations to account for the absence of the expected effects, among which the very similar gaze conditions and the use of highly gender stereotypical as well as standardized stimuli. In addition, there is the more fundamental issue regarding the validity of our experimental paradigm, particularly concerning the use of static photographs.

Despite these limitations, our findings point towards new possibilities in this area of research. Especially the inclusion of the cone of gaze which allows us to consider variations of subjective gaze perception might bring useful information to social cognitive research. There are many challenges in designing appropriate experimental paradigms that yield useful information and which can account for the various processes underlying eye gaze perception. Above all, research should not lose sight of what it strives to explain, and thus aim for the applicability of their findings to a wider social context that goes well beyond the laboratory.

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Appendices

Appendix A – Fear of Negative Evaluation Scale

Age   Homme/Femme :

FNE

Ci-dessous vous trouverez des phrases concernant des attitudes personnelles. Lisez chaque phrase, décidez si elle est vraie ou fausse, selon qu'elle vous concerne personnellement ou pas.

		VRAI	FAUX
1	Je m'inquiète rarement de paraître ridicule.		
2	Je m'inquiète de l'opinion des autres même quand je sais que cela n'a aucune importance.		
3	Je deviens tendu(e) et agité(e) si je sais qu'on est en train de me juger.		
4	Je suis imperturbable même si je sais qu'on est en train de se faire une opinion défavorable sur moi.		
5	Je suis bouleversé(e) quand je commets une erreur en société.		
6	Les opinions que les gens importants ont de moi ne me soucient guère.		
7	J'ai souvent peur de paraître ridicule ou de me comporter d'une façon absurde.		
8	Je réagis très peu quand les gens me désapprouvent.		
9	J'ai souvent peur que les gens s'aperçoivent de mes défauts.		
10	La désapprobation des autres a peu d'effet sur moi.		
11	Si quelqu'un est en train de m'évaluer, je m'attends au pire.		
12	Je m'inquiète rarement de l'impression que je donne aux autres.		
13	J'ai peur d'être désapprouvé(e).		
14	J'ai peur que les autres me trouvent des défauts.		
15	Ce que les autres pensent de moi m'est égal.		
16	Je ne suis pas peiné(e) si je ne plais pas à quelqu'un.		
17	Lorsque je suis en train de parler à quelqu'un je m'inquiète de ce qu'il est en train de penser de moi.		
18	Je pense que parfois on ne peut pas éviter de faire des erreurs en société, alors je ne m'inquiète pas.		
19	Je m'inquiète de l'impression que je donne aux autres.		
20	Je m'inquiète beaucoup de l'impression que je donne à mes supérieurs.		

		VRAI	FAUX
21	Si je sais que quelqu'un est en train de me juger, cela ne me perturbe pas.		
22	Je m'inquiète en imaginant que les autres pensent que je ne vaux rien.		
23	Je m'inquiète très peu de ce que les autres vont penser de moi.		
24	Parfois, je pense que je m'inquiète trop de ce que les autres vont penser de moi.		
25	Je m'inquiète souvent en m'imaginant que je vais faire ou dire ce qu'il ne faut pas.		
26	Je suis souvent indifférent(e) à ce que les autres pensent de moi.		
27	En général, je suis confiant(e) de l'impression favorable que je donne aux autres.		
28	Je m'inquiète souvent en m'imaginant que les gens que je considère importants, ne pensent pas grand-chose de moi.		
29	Je me pose souvent des questions sur les opinions de mes amis à mon sujet.		
30	Je deviens tendu(e) et agité(e) si je sais que je suis en train d'être jugé(e) par mes supérieurs.		

Appendix B – Liebowitz Social Anxiety Scale

	Intensité de la peur 0 = Aucun 1 = Légère 2 = Moyenne 3 = Sévère	Fréquence des évitements 0= Jamais 1= Occasionnel (0-33%) 2= Fréquent (33-66%) 3= Habituel (67-100%)
1. Téléphoner en public	---	
2. Participer au sein d'un petit groupe	---	---
3. Manger dans un lieu public	---	---
4. Boire en compagnie dans un lieu public	---	---
5. Parler à des gens qui détiennent une autorité	---	---
6. Jouer, donner une représentation ou une conférence	---	---
7. Aller à une soirée	---	---
8. Travailler en étant observé	---	---
9. Ecrire en étant observé	---	---
10. Contacter par téléphone quelqu'un que vous ne connaissez pas très bien	---	---
11. Parler à des gens que vous ne connaissez pas très bien	---	---
12. Rencontrer des inconnus	---	---
13. Uriner dans les toilettes publiques	---	---
14. Entrer dans une pièce alors que tout le monde est déjà assis	---	---
15. Etre le centre d'attention	---	---
16. Prendre la parole à une réunion	---	---
17. Passer un examen	---	---
18. Exprimer son désaccord ou sa désapprobation à des gens que vous ne connaissez pas très bien	---	---
19. Regarder dans les yeux des gens que vous ne connaissez pas très bien	---	---
20. Faire un compte-rendu à un groupe	---	---
21. Essayer de "draguer" quelqu'un	---	---
22. Rapporter des marchandises dans un magasin	---	---
23. Donner une soirée	---	---
24. Résister aux pressions d'un vendeur insistant	---	---
TOTAL	A = -----	E = ----

Appendix C – Descriptive statistics for mean response times

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
All_RT	40	412.00	688.00	532.5000	62.64716
RT_2	40	429	713	543.05	70.108
RT_5	40	421	730	547.80	73.289
RT_8	40	408	780	548.90	76.225
RT_10	40	436	752	553.10	77.418
RT_close	40	427	775	576.23	81.393
RT_straight	40	415	733	545.45	74.826
Valid N (listwise)	40				

```
GLM RT_straight RT_2 RT_5 RT_8 RT_10 RT_close
  /WSFACTOR=RT 6 Polynomial
  /METHOD=SSTYPE(3)
  /CRITERIA=ALPHA(.05)
  /WSDESIGN=RT.
```

Appendix D – Repeated Measures ANOVA comparing RTs across different gaze conditions

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
RT	Sphericity Assumed	29490.121	5	5898.024	12.024	.000
	Greenhouse-Geisser	29490.121	4.369	6750.098	12.024	.000
	Huynh-Feldt	29490.121	4.988	5911.750	12.024	.000
	Lower-bound	29490.121	1.000	29490.121	12.024	.001
Error(RT)	Sphericity Assumed	95654.713	195	490.537		
	Greenhouse-Geisser	95654.713	170.385	561.404		
	Huynh-Feldt	95654.713	194.547	491.679		
	Lower-bound	95654.713	39.000	2452.685		

Appendix E – Contrasts for the different gaze conditions

Pairwise Comparisons

Measure: MEASURE_1

(I) RT	(J) RT	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	2.400	4.976	.632	-7.665	12.465
	3	-2.350	5.166	.652	-12.799	8.099
	4	-3.450	4.580	.456	-12.713	5.813
	5	-7.650	5.304	.157	-18.379	3.079
	6	-30.775[*]	4.887	.000	-40.659	-20.891
2	1	-2.400	4.976	.632	-12.465	7.665
	3	-4.750	4.361	.283	-13.571	4.071
	4	-5.850	4.540	.205	-15.033	3.333
	5	-10.050[*]	4.749	.041	-19.656	-.444
	6	-33.175[*]	5.661	.000	-44.625	-21.725
3	1	2.350	5.166	.652	-8.099	12.799
	2	4.750	4.361	.283	-4.071	13.571
	4	-1.100	3.741	.770	-8.667	6.467
	5	-5.300	5.008	.296	-15.430	4.830
	6	-28.425[*]	5.332	.000	-39.210	-17.640
4	1	3.450	4.580	.456	-5.813	12.713
	2	5.850	4.540	.205	-3.333	15.033
	3	1.100	3.741	.770	-6.467	8.667
	5	-4.200	5.052	.411	-14.419	6.019
	6	-27.325[*]	5.582	.000	-38.616	-16.034
5	1	7.650	5.304	.157	-3.079	18.379

	2	10.050*	4.749	.041	.444	19.656
	3	5.300	5.008	.296	-4.830	15.430
	4	4.200	5.052	.411	-6.019	14.419
	6	-23.125*	5.005	.000	-33.248	-13.002
6	1	30.775*	4.887	.000	20.891	40.659
	2	33.175*	5.661	.000	21.725	44.625
	3	28.425*	5.332	.000	17.640	39.210
	4	27.325*	5.582	.000	16.034	38.616
	5	23.125*	5.005	.000	13.002	33.248

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix F – Descriptive Statistics for response accuracy

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
All_ACC	40	.93	1.00	.9763	.01675
ACC_straight	40	.88	1.00	.9775	.02648
ACC_2	40	.90	1.00	.9790	.02437
ACC_5	40	.85	1.00	.9773	.02909
ACC_8	40	.92	1.00	.9770	.02289
ACC_10	40	.90	1.00	.9765	.02637
ACC_close	40	.90	1.00	.9705	.02717
Valid N (listwise)	40				

```
GRAPH
  /LINE(SIMPLE)=MEAN(ACC_straight) MEAN(ACC_2) MEAN(ACC_5) MEAN(ACC_8) MEAN(ACC_10) MEAN(ACC_close)
  /MISSING=LISTWISE.
```

Appendix G – Descriptive Statistics for the cone of gaze and social anxiety

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Cone	40	6.28	16.86	10.8068	2.69374
Leiwb_all	40	6.00	85.00	50.4750	18.17717
FNE	40	7.00	18.00	13.7000	2.64284
Valid N (listwise)	40				

Appendix H – Effect of Gaze condition on RT controlling for cone of gaze

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
factor1	Sphericity Assumed	29492.054	5	5898.411	11.950	.000
	Greenhouse-Geisser	29492.054	4.306	6849.037	11.950	.000
	Huynh-Feldt	29492.054	5.000	5898.411	11.950	.000
	Lower-bound	29492.054	1.000	29492.054	11.950	.001
factor1 * Cone_centré	Sphericity Assumed	1873.161	5	374.632	.759	.580
	Greenhouse-Geisser	1873.161	4.306	435.010	.759	.562
	Huynh-Feldt	1873.161	5.000	374.632	.759	.580
	Lower-bound	1873.161	1.000	1873.161	.759	.389
Error(factor1)	Sphericity Assumed	93781.551	190	493.587		
	Greenhouse-Geisser	93781.551	163.629	573.137		
	Huynh-Feldt	93781.551	190.000	493.587		
	Lower-bound	93781.551	38.000	2467.936		

Appendix I – Effect of Gaze condition on RT controlling for social anxiety

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
factor1	Sphericity Assumed	29490.121	5	5898.024	11.804	.000
	Greenhouse-Geisser	29490.121	4.363	6759.403	11.804	.000
	Huynh-Feldt	29490.121	5.000	5898.024	11.804	.000
	Lower-bound	29490.121	1.000	29490.121	11.804	.001
factor1 * FNE_centré	Sphericity Assumed	720.661	5	144.132	.288	.919
	Greenhouse-Geisser	720.661	4.363	165.182	.288	.899
	Huynh-Feldt	720.661	5.000	144.132	.288	.919
	Lower-bound	720.661	1.000	720.661	.288	.594
Error(factor1)	Sphericity Assumed	94934.052	190	499.653		
	Greenhouse-Geisser	94934.052	165.788	572.625		
	Huynh-Feldt	94934.052	190.000	499.653		
	Lower-bound	94934.052	38.000	2498.265		

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
factor1	Sphericity Assumed	29491.002	5	5898.200	11.808	.000
	Greenhouse-Geisser	29491.002	4.365	6756.887	11.808	.000
	Huynh-Feldt	29491.002	5.000	5898.200	11.808	.000
	Lower-bound	29491.002	1.000	29491.002	11.808	.001
factor1 * Liebow_centré	Sphericity Assumed	749.901	5	149.980	.300	.912
	Greenhouse-Geisser	749.901	4.365	171.815	.300	.892
	Huynh-Feldt	749.901	5.000	149.980	.300	.912
	Lower-bound	749.901	1.000	749.901	.300	.587
Error(factor1)	Sphericity Assumed	94904.812	190	499.499		
	Greenhouse-Geisser	94904.812	165.854	572.218		
	Huynh-Feldt	94904.812	190.000	499.499		
	Lower-bound	94904.812	38.000	2497.495		

Appendix J – Effect of gaze condition on Accuracy controlling for social anxiety

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Accuracy	Sphericity Assumed	.002	5	.000	.713	.614
	Greenhouse-Geisser	.002	4.181	.000	.713	.590
	Huynh-Feldt	.002	4.886	.000	.713	.611
	Lower-bound	.002	1.000	.002	.713	.404
Accuracy * Liebow_centré	Sphericity Assumed	.001	5	.000	.339	.889
	Greenhouse-Geisser	.001	4.181	.000	.339	.859
	Huynh-Feldt	.001	4.886	.000	.339	.885
	Lower-bound	.001	1.000	.001	.339	.564
Error(Accuracy)	Sphericity Assumed	.093	190	.000		
	Greenhouse-Geisser	.093	158.867	.001		
	Huynh-Feldt	.093	185.654	.001		
	Lower-bound	.093	38.000	.002		

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Accuracy	Sphericity Assumed	.002	5	.000	.733	.599
	Greenhouse-Geisser	.002	4.200	.000	.733	.577
	Huynh-Feldt	.002	4.911	.000	.733	.597
	Lower-bound	.002	1.000	.002	.733	.397
Accuracy * FNE_centré	Sphericity Assumed	.003	5	.001	1.419	.219
	Greenhouse-Geisser	.003	4.200	.001	1.419	.228
	Huynh-Feldt	.003	4.911	.001	1.419	.220
	Lower-bound	.003	1.000	.003	1.419	.241
Error(Accuracy)	Sphericity Assumed	.091	190	.000		
	Greenhouse-Geisser	.091	159.589	.001		
	Huynh-Feldt	.091	186.613	.000		
	Lower-bound	.091	38.000	.002		

Appendix K – Effect of gaze condition on Accuracy controlling for the cone of gaze

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Accuracy	Sphericity Assumed	.002	5	.000	.724	.606
	Greenhouse-Geisser	.002	4.204	.000	.724	.583
	Huynh-Feldt	.002	4.917	.000	.724	.604
	Lower-bound	.002	1.000	.002	.724	.400
Accuracy * Cone_centré	Sphericity Assumed	.002	5	.000	.897	.484
	Greenhouse-Geisser	.002	4.204	.001	.897	.471
	Huynh-Feldt	.002	4.917	.000	.897	.483
	Lower-bound	.002	1.000	.002	.897	.350
Error(Accuracy)	Sphericity Assumed	.092	190	.000		
	Greenhouse-Geisser	.092	159.759	.001		
	Huynh-Feldt	.092	186.838	.000		
	Lower-bound	.092	38.000	.002		

Appendix L – Descriptive statistics for gaze "inside" and "outside" the cone of gaze

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	inside_cg	544.2500	40	70.77701	11.19083
	outside_cog	551.0000	40	75.14371	11.88126

Appendix M – Comparing RTs for gaze inside vs. outside the cone of gaze

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	inside_cg - outside_cog	-6.75000	20.49171	3.24002	-13.30357	-.19643	-2.083	39	.044