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SOCIAL MODULATORS OF SOCIAL ATTENTION

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ITALIAN ABSTRACT

Con attenzione sociale si intende l'abilità, che generalmente caratterizza gli esseri umani così come altre specie animali, di orientare le proprie risorse attentive in risposta agli indizi spaziali che provengono dagli altri individui. Questi indizi spaziali sono rappresentati, tipicamente, dalla direzione dello sguardo, della testa e dall'orientamento del corpo. La presenti tesi si è focalizzata, principalmente, sul ruolo giocato da alcune variabili di tipo sociale nel modulare tale abilità.

Nel Capitolo 1 è discusso il concetto di attenzione sociale e la sua importanza nella regolazione delle interazioni sociali. Nel Capitolo 2 presento quattro studi nei quali ho utilizzato il paradigma di orientamento attentivo mediato dallo sguardo. Questo paradigma consente di valutare il ruolo della direzione dello sguardo nel modulare l'attenzione sociale. In questi quattro studi, le variabili sociali da me manipolate sono state lo status sociale (Studio 1) e l'affiliazione politica (Studio 2). Inoltre, ho approfondito il ruolo dell'apprendimento implicito di variabili sociali sull'orientamento attentivo mediato dallo sguardo (Studio 3). Lo studio finale (Studio 4), ha indagato l'attenzione sociale in pazienti schizofrenici, nei quali l'abilità di elaborare stimoli sociali risulta generalmente compromessa. Nel Capitolo 3, presento un particolare aspetto legato all'attenzione sociale noto come inibizione di ritorno sociale, un fenomeno per il quale gli individui risultano più lenti nel compiere un movimento verso una posizione spaziale precedentemente raggiunta da un altro individuo. In questo caso, ho manipolato la somiglianza percepita tra i partecipanti (Studio 5). In fine, nel Capitolo 4 presento alcune evidenze che sottolineano come la direzione dello sguardo, in combinazione con l'appartenenza etnica, sia una variabile cruciale implicata non solo nei processi attentivi ma addirittura nei processi di codifica e mantenimento dell'identità di un volto nella memoria visiva a breve termine (Studio 6). Per concludere, nel Capitolo 5, una discussione generale sottolinea l'importanza di considerare le variabili sociali nello studio dell'attenzione sociale e invita l'idea di considerare l'utilizzo paradigmi sperimentali sempre più ecologici, in modo tale da permettere di studiare il fenomeno dell'attenzione sociale durante vere interazioni tra individui che avvengono in contesti sociali reali.

ENGLISH ABSTRACT

Social attention refers to the ability, which generally characterizes human beings as well as other animal species, to orient attentional resources in response to spatial cues provided by other individuals. These spatial cues are typically represented by gaze direction, head direction, and body orientation. This thesis focused mainly on the role that some social variables play in modulating this ability.

In Chapter 1, the concept of social attention and its relevance in regulating social interactions are discussed. After that, in Chapter 2, I present four studies in which I have employed the gaze-cueing paradigm. This allows to investigate the role of gaze direction in modulating social attention. In these four studies, the social variables manipulated have been social status (*Study 1*) and political affiliation (*Study 2*). Moreover, I have also investigated the impact of implicit social learning on gaze cueing (*Study 3*). The final study (*Study 4*), investigated social attention in schizophrenic patients, who are known to be particularly impaired in dealing with social stimuli. In Chapter 3, I present a particular aspect of social attention known as social inhibition of return, a phenomenon whereby an individual is slower to reach a location previously explorer by another individual. Here, I have manipulated the social similarity between participants (*Study 5*). Finally, in Chapter 4, I present some evidence supporting the view that gaze direction, in combination with racial group membership, represents a crucial variable not only for attentional mechanisms but even for the encoding and maintenance of face's visual representations in visual working memory (*Study 6*). To conclude, in Chapter 5, a general discussion highlights the importance of considering social variables in the study of social attention, inviting to embrace a more ecological research approach in order to investigate this phenomenon during real social interactions and in real world settings.

CHAPTER 1

WHAT IS SOCIAL ATTENTION?

Let's try to imagine the following scenario. It is a relaxed Saturday morning and we are heading, as usual, towards our favourite bar to have a coffee with some friends. We are walking slowly, enjoying the last warm sun of September, along a busy city street. Suddenly we notice that a couple of individuals, who were walking some metres ahead of us, have stopped and are gazing upwards. Our first, spontaneous, and instinctive reaction is to orient our own focus towards the same spatial location in order to understand what has captured the attention of the two guys.

Surely this scenario is happened quite often to all of us. Indeed, as humans beings, we are particularly interested in where other individuals are directing their attention, since this can help us to obtain an empathic contact with others and also to discover potentially relevant information in the environment (Emery, 2000). Researchers interested in social cognition started to investigate this phenomenon, referring to it as "social attention" (e.g., Friesen & Kingstone, 1998; Langton & Bruce, 1999; Nummenmaa & Calder, 2008). The importance of social attention has been highlighted by several lines of evidence. For instance, human beings seem to be equipped from birth with a cognitive mechanism specialized in elaborating social cues (e.g., Scaife & Bruner, 1975), and several neuroimaging studies proposed that social attention would be actually regulated by some devoted neural circuits (e.g., Kingstone, Friesen, & Gazzaniga, 2000; Klein, Shepherd, & Platt, 2009; Nummenmaa & Calder, 2008; Perrett el al., 1990). Furthermore, evidence is accumulating reporting a modulation of social cues on our attentional mechanisms even at a behavioural level

(Emery, 2000; for reviews see Langton, Watt, & Bruce, 2000 and Frieschen, Bayliss, & Tipper, 2006).

The direction of another person's attention can be inferred by several social cues but, generally, during a normal social interaction individuals would tend to use gaze, head, and body orientation to reach this goal. In fact, "[…] *from other people's eye gaze, head and body orientation we readily detect their focus of attention, orient our own attention to the same location and draw social-cognitive inferences regarding their goals, intentions and actions* […]" (p. 135, Nummenmaa & Calder, 2008), an evidence also supported by pioneering neurophysiological studies conducted on non-human primates (e.g., Jellema, Baker, Wicker, & Perrett, 2000; Perrett et al., 1990; Perrett, Hietanen, Oram, & Benson, 1992; Wachsmuth, Oram, & Perrett, 1994). In these studies, it has been described the existence of population of cells located in the Superior Temporal Sulcus (STS) of the macaque temporal lobe, a complex area involved in coding biological motion and social processing, which were very sensitive to conjunctions of eye gaze, head and body position. For instance, those cells that were particularly active when presented with eye gaze looking rightwards also responded strongly when the head was directed rightwards and even when the whole body was directed rightwards.

As with macaques, also in humans the STS region seems to be particularly sensitive to social cues (e.g., Allison, Puce, & McCarthy, 2000; Calder et al., 2007) and evidence is accumulating showing that it is part of a wider network devoted to social perception, with particular regards to face processing (e.g., Adolphs, 2001; Hoffman & Haxby, 2000). This neural network would include the parietal cortex, in particular the intraparietal sulcus, which is implicated in orienting of attention (e.g., Rafal, 1996), the lateral fusiform gyrus, involved in the processing of face identity and the amygdala, involved in the processing of the emotional content of the stimuli (i.e., facial expression). Interestingly, lesions of the amygdala can lead to deficits either in judgement of facial expression that in judgement of gaze direction (e.g., Cristinzio, N'Diaye, Seeck, Vuilleumier, & Sander, 2010), and amygdala damages can also impair the ability to use eye gaze direction as a cue to direct attention (e.g., Akiyama, et al., 2007), suggesting that this area could be involved in many processes regarding face and gaze processing. In support of this view there are also some imaging investigations which have found that amygdala activity can be actually modulated by eye gaze direction (e.g., Kawashima et al., 1999; Ochsner, 2004; Richeson et al., 2003) and also the Study 6 can be seen as an attempt to provide further evidence in support of this view.

How would individuals would use spatial signals provided by gaze, head and body orientation of others to shape social attention? A possible answer comes, again, from the studies conducted by Perrett and colleagues (Perrett et al., 1992; Perrett & Emery, 1994). They proposed a model, known as Direction-of-Attention Detector (DAD), in which these three social signals would interact following a hierarchical sequence in which eye gaze would represent the most important cue, followed by head and finally by body. Thus, in the case eye gaze of another individual is visible, we would tend to use information provided by this cue which will override information provided by the head and the body. In turn, in the case eye gaze is occluded we would tend to use information provided by the head which will override information provided by the body. Finally, in the case that neither the head is visible, spatial information regarding others' focus of attention will be inferred by body orientation, which can include also pointing gestures (see Figure 1).

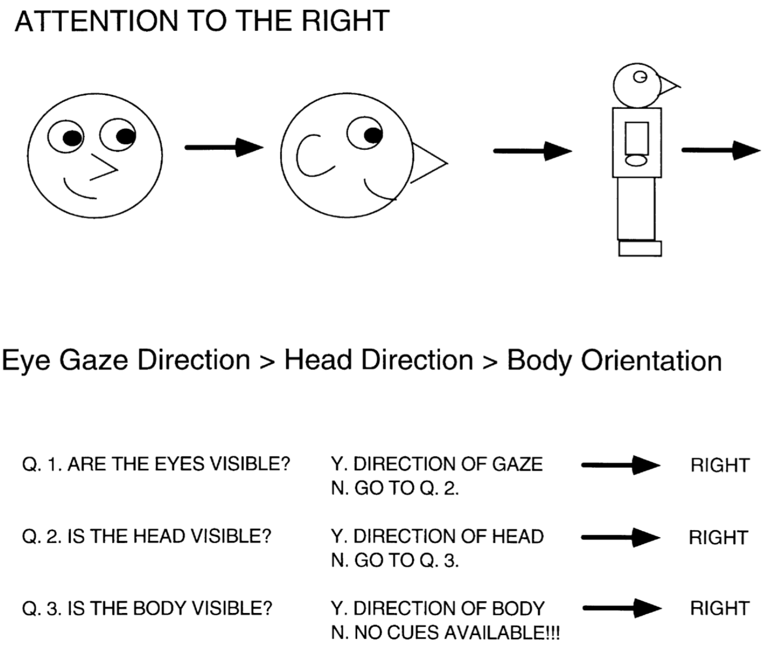

Figure 1. Graphical representation of the cascade model of social attention known as Direction-of-Attention Detector (DAD; e.g., Perrett et al., 1992). In this example, social cues (gaze, head, and body orientation) provided by an individual are all pointing rightwards. According to this model, in the case all these three cues are available for processing, individuals would process them following a hierarchal sequence in which gaze direction would represent the most important and relevant social cue, followed by head direction and, lastly, by body orientation (redrawn from Emery, 2000).

However, this cascade model has been questioned by some studies which reported that these three social cues (i.e., gaze direction, head direction, body orientation) can influence social attention independently (e.g., Hietanen, 1999, 2002; Langton, 2000; Langton & Bruce, 2000). In these studies participants were presented simultaneously with centrally-placed couples of social cues, such gaze and head (Hietanen, 1999; Langton, 2000), head and pointing gestures (Langton & Bruce, 2000), or head and body (Hietanen, 2002), which could point towards the same or a different spatial positions. Participants were asked to perform speeded discriminative responses based on different requests, such as discriminating the direction of one of the cues ignoring the other, or discriminating the position of a lateralized target. In all these cases, the results showed that spatial information was automatically analysed from both cues. This provides evidence in support of a model of social attention in which these three social cues would be processed in a parallel, rather than in a sequential, manner. Therefore, in light of this evidence, it is clear that the DAD model would need to be revised.

Despite others' focus of attention can be inferred by different cues, eye gaze still remains probably the most salient and commonly investigated cue used in social attention processes (Emery, 2000). Gaze-following abilities are common not only among humans but even among other several animal species such as, for instance, non-human primates, birds, dogs and dolphins (e.g., Deaner, Shepherd, & Platt, 2007; for a review see Shepherd, 2010). Moreover, Baron-Cohen (1995) suggested that, in humans, the ability to use gaze direction in social attention is considered to be anticipator to more complex socio-cognitive skills. In fact, in his "Mindreading Model" he proposed (and emphasized) the existence of an Eye-Direction Detector (EDD), namely a functionally specialized module that would be devoted, firstly, to detect the presence of eyes or eye-like stimuli (see also Levy, Foulsham, & Kingstone, 2013), secondly to compute the direction of gaze and, thirdly, to attribute the mental state of "seeing" to an agent with gaze pointed towards something or someone. The EDD module, in combination with other modules that in the present thesis will not be discussed, would contribute to the development of the most sophisticated (and even the most popular) module in the "Mindreading Model", namely the Theory-of-Mind Mechanism (ToMM). Purpose of ToMM would be twofold: on the one hand, it would permit to infer others' mental states (e.g., believing, deceiving, thinking, etc.) directly from their observable behaviour and, on the other hand, it would integrate the knowledge related to these mental states into a theory that individuals would be able to use in order to explain and predict others' behaviour. Interestingly, many neurodevelopmental and mental disorders characterized by deficits in domain of ToMM, showed impairments in gaze following abilities. These mental disorders include, for instance, Autism Spectrum Disorder (ASD; e.g., Dawson et al., 2004; Marotta et al., 2012), Attention Deficit Hyperactivity Disorder (ADHD; Marotta et al., 2013) and schizophrenia (e.g., Akiyama et al., 2008). Despite the indisputable relevance of the model proposed by Baron-Cohen in influencing and inspiring research in social attention, and more generally in social cognition, considering eye gaze as the unique social cue involved in the development of ToMM could be not entirely correct.

The mutual influence which the different social cues play in modulating social attention (e.g., Langton et al., 2000), induced researcher to present eye gaze, head and body stimuli in isolation and many different paradigms have been proposed to reach this goal. Among these, many researchers started to employ some variations of the spatial cueing paradigm made popular by Posner (e.g., Posner, 1980). In a typical Posner's paradigm, participants are instructed to fixate at a central spot that marks the centre of the screen. The central spot is then replaced by a central cue (i.e., an arrow) which typically points rightwards or leftwards. After a certain period of time (Stimulus Onset Asynchrony, SOA), participants are asked to respond to the onset of a target, that can appear to the left or right of the central cue, by making a speeded keypress response. Faster Reaction Times (RTs) and a greater accuracy with targets appearing in the previously cued location (compared to those appearing in the uncued location) are taken as the proof that participants shifted their attention towards the cued location. Researchers interested in social attention replaced the symbolic arrow cues with social cues (e.g., averted gaze, pointing gestures, etc.). In this regards, one of the most commonly used Posner-like paradigm is the gaze-cueing paradigm, that will be discussed in detail in the next chapter, in which pictures depicting faces with averted gaze are used as cueing stimuli (Friesen & Kingstone, 1998). In so doing, Friesen and Kingstone created an elegant and versatile tool, which merges elements belonging both to cognitive (i.e., visual attention) and social (i.e., ecologically valid stimuli such as faces or body parts) psychology, to study social attention. Indeed, since its introduction, evidence is accumulating showing that during social interactions, attentional mechanisms can be modulated by several social variables which characterized individuals, and the experiments illustrated in Chapter 2 will provide further evidence supporting this view.

Despite Posner-like paradigms like the gaze-cueing paradigm are immensely valuable in investigating different aspects of social attention, it is worth to point out that clear differences distinguishes the way attention operates in the presence of real rather than simulated people. To overcome this limit, which strongly affect the ecological validity of the results, some researchers initiated to present participants with social cues provided directly from real individuals. For instance, Lachat and collaborators developed an innovative experimental setup to investigate gaze cueing of attention during a real face-to-face situation (Lachat, Conty, Hugueville, & George, 2012; Lachat, Hugueville, Lemaréchal, Conty, & George, 2012). Another concrete example of how the presence of other individuals can influence the attention of an observer is the phenomenon known as Social Inhibition of Return (SIOR; Welsh et al., 2005), which consists of the observation that participants are slower to initiate a reaching action towards a location previously explored to by another individual. SIOR will be discussed in more detail in Chapter 3. I think that the perspective to move towards a more ecological approach in the study of social attention, employing and developing paradigms inspired by real-world observations or even in which participants are tested in real world setting, represent the frontier towards which researchers should look in next years. This aspect will be discussed in more detail in the final chapter of this thesis.

CHAPTER 2

SOCIAL MODULATORS OF GAZE-CUEING OF ATTENTION

Even if several social cues contribute to communicate social attention (e.g., gaze direction, head direction, body orientation), facial stimuli provide probably the most refined and complex source of information. Indeed, when we are observing others' faces, we are able not only to infer the focus of attention, but even the identities, the intentions, the emotions and the beliefs of the individuals with whom we are interacting (Emery, 2000). For these reasons, it is not surprising that humans seem to be especially sensitive to facial stimuli and in particular to a specific feature of the faces, namely the eye region (Emery, 2000; Ristic & Kingstone, 2005). In fact, it seems that we are already equipped from birth with a cognitive mechanism that promotes the processing of eyes (e.g., Farroni, Csibra, Simion, & Johnson, 2002) and evidence is accumulating showing that this region is the most attended when adults are asked to freely scanning faces (e.g., Birmingham, Bischof, & Kingstone, 2008a, 2008b; Itier, Alain, Sedore, & McIntosh, 1997).

As anticipated in Chapter 1, the effectiveness of eyes in orienting attention towards other parts of the visual field indicated by their gaze direction has been mainly tested through the gaze-cueing paradigm (e.g., Dalmaso, Fuentes, & Galfano, 2012; Friesen & Kingstone, 1998; Galfano et al., 2011; for a review see Frieschen et al., 2007). Specifically, this consists in presenting a central face with direct gaze that moves its eyes towards a specific spatial location. After a Stimulus Onset Asynchrony (SOA) which can be both fixed and variable, a target requiring some kind of response appears in a peripheral location that can be congruent or incongruent to gaze direction (see Figure 2). Generally, this task triggers rapid (e.g., Friesen & Kingstone, 1998;

Brignani, Guzzon, Marzi, & Miniussi, 2009) and reflexive (e.g., Driver et al., 1999; Galfano et al., 2012; Kuhn & Kingstone, 2009) shifts of attention towards the spatial location indicated by gaze, as suggested by the fact that RTs to targets occurring at the cued location (i.e., congruent trials) are typically smaller than those to targets appearing at an uncued location (i.e., incongruent trials). This is known as gaze-cueing effect. Interesting, in the case the duration of SOA is particularly long (i.e., 2400 ms), it is possible to observe an inhibitory after-effect known as Inhibition of Return (IOR; e.g., Frischen & Tipper, 2004). IOR, which has been traditionally observed using peripheral cues, refers to the slowing of responses to targets appearing in previously attended locations. This mechanism would expedite visual search, preventing that attention returns to spatial locations previously inspected (e.g., for reviews see Klein, 2000 and Lupiáñez, Klein, & Bartolomeo, 2006).

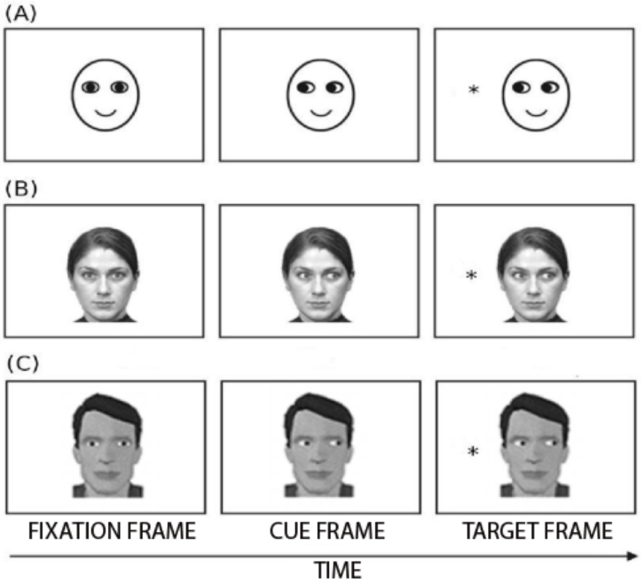

Figure 2. Illustration of stimuli and sequence of events that can be used in a gaze-cueing paradigm. The centrally-placed cueing face is firstly presented with gaze directed to the participants (Fixation frame). After that, the same face can look either leftwards (A) or rightwards (B & C; Cue frame). Finally, a target can either appear in a congruent (A) or in an incongruent (B & C) spatial position with regards to gaze direction (Target frame). Evidence of gaze-cueing effect has been achieved by presenting different types of face stimuli, such as schematic faces (A; e.g., Friesen & Kingstone, 1998), photographs of real individuals (B; e.g., Driver et al., 1999) and computer-generated avatars (C; Bayliss et al., 2005). Redrawn from Frischen et al. (2006).

It is important to note that, generally, the strong automaticity that seems to characterize the gaze-cueing effect has been observed using schematic faces (e.g., Akiyama et al., 2007; Friesen & Kingstone, 1998; Galfano et al., 2012; Kuhn et al., 2011). This means that participants were presented with some extremely impoverished social stimuli that did not convey any kind of social information, except for gaze direction. However, faces that we meet in real life interaction vary along several social dimensions and gaze is a key factor in the regulation of social interactions. For this reason, it is not surprisingly that when in a gaze-cueing task real rather than schematic faces are used, it is possible to observe a modulation of gaze-cueing effect due to the social factors that characterized face stimuli. Indeed, it is well known that the specific type of relationship between the perceiver and the observed person can impact onto the attention devoted to gaze. In fact, on the one hand, features of the cuing face can alter the magnitude of gaze cuing. For instance, a greater gaze-cueing effect has been observed in response to faces characterized by signals of physical dominance (Jones et al., 2010; Jones, Main, Little, & DeBruine, 2011; Ohlsen, van Zoest, & van Vugt, 2013) or in response to fearful rather than happy faces (e.g., Kuhn & Tipples, 2011; Tipples, 2006). On the other hand, participants' individual differences have also been shown to play a critical role. Indeed, a greater gaze-cuing effect has been observed in females with respect to males (Bayliss, di Pellegrino, & Tipper, 2005), and people with higher need for belongingness (Wilkowski, Robinson, & Friesen, 2009) and higher levels of anxiety (Fox, Mathews, Calder, & Yiend, 2007).

The next set of experiments have been carried out to explore in more detail the potential impact of some social factors in modulating the gaze-cueing effect. In particular, in Study 1, I have investigated the impact of social status, which represents one of the most important indexes used by humans (and many other animal species) to modulate their behaviour (e.g., Ridgeway & Walker, 1995). In Study 2, I have addressed the role played by political affiliation in moderating the gaze-cueing effect. A previous study reported a reduced gaze-cueing effect in conservatives but not in liberals (Dodd, Hibbing, & Smith, 2011). Study 3 has been carried out to explore the potential impact of implicitly-learned social information on the gaze cueing effect. Finally, Study 4 has been conducted in schizophrenic patients, a clinical population characterized by serious impairments in processing social stimuli, with particular regards to eye gaze (e.g., Tso, Mui, Taylor, & Deldin, 2012).

2.1. Study 1

Social status gates social attention in humans

Dalmaso, M., Pavan, G., Castelli, L., & Galfano, G. (2012). Social status gates social attention in humans. Biology Letters, 8, 450-452.

Dalmaso, M., Galfano, G., Coricelli, C., & Castelli, L. (Submitted). Temporal dynamics underlying the modulation of social status on social attention.

Social status deeply shapes our social interactions. According to sociologists, social status can be described as "[…] *the prestige accorded to individuals because of the abstract positions they occupy rather than because of immediately observable behaviour* […]" (p. 1147, Gould, 2002). Generally, high-status individuals tend to use their prestige in order to establish and maintain a set of social norms that define which behavior is permitted, obligated or prohibited within a determined social group (e.g., Cummins, 2000), leading to hierarchically organized societies (e.g., Henrich & Gil-White, 2001). Social status is highly relevant since infancy (e.g., Boyce, 2004; Dunham, Baron, & Banaji, 2006; Pellegrini et al., 2011) and becomes even more important during adolescence (e.g., Bowker, Rubin, Buskirk-Cohen, Rose-Krasnor, & Booth-LaForce, 2010; Lansu, Cillessen, & Karremans, 2013). Under an evolutionary perspective, differences in status are also associated to an asymmetric distribution of resources (e.g., Clutton-Brock & Harvey, 1976; Fiske, 1992). Therefore, the ability to readily and accurately infer the social status of others represents an essential skill for both humans and nonhuman species to successfully navigate and, in some circumstances, also to survive within social groups characterized by different degrees of complexity (e.g., Cummins, 2000). Social status can be inferred from physical traits signalling physical dominance (e.g., facial features, body size, body postures, etc.), especially among nonhuman species such as bees and ants (e.g., Wilson, 2000), fishes (e.g., Grosenick, Celement, & Fernald, 2007), rats (e.g., Davis, 1992) and primates (e.g., Maestripieri, 1996). In the case of humans, social status is mainly inferred from specific knowledge about personal characteristics such as educational qualification, job, and material wealth. This implies that, especially in human communities, inferences about social hierarchies are mainly a function of the perceived intellectual capacities and skills of the individuals rather than their perceived physical strength.

Because of the importance of social status in regulating social interactions among humans, several studies have explored the effects of this social variable on human cognitive processes. For instance, it has recently been shown that high-status faces are recognized significantly better than low-status faces, likely because they are coded more accurately (see Ratcliff, Hugenberg, Shriver, & Bernstein, 2011, Experiment 1). In addition, high-status faces are better attended to and processed more holistically than low-status faces (see Ratcliff et al., 2011, Experiments 2 and 3). Furthermore, social status affects the perception of facially-expressed emotions, so that anger is perceived to appear sooner and to last longer on the faces of high-status individuals compared to low-status targets (Ratcliff, Franklin, Nelson, & Vescio, 2012).

More relevant for the present study, social status seems to be also involved in regulating social attention. A pioneer animal study reported that submissive macaque monkeys (*macaca mulatta*) showed a generalized gaze-cuing effect independently of whether the face stimulus depicted a high- or a low-status individual, whereas dominant macaque monkeys selectively followed the gaze of high-status individuals (Shepherd, Deaner & Platt, 2006; but see Teufel, Gutmann, Pirow, & Fischer, 2010c, for a non-significant effect of social ranking on gaze following). Dominant-like exemplars, who are likely to have elevated testosterone levels, are more closely attended to and trigger stronger gaze-cuing effects. A related modulation has recently been demonstrated also in humans, who show greater gaze-cuing effects for artificially masculinized than for feminized faces (Jones et al., 2010, 2011; Ohlsen et al., 2013). Indeed, many studies have reported a positive relationships between masculine facial features and the perceived dominance (e.g., Perrett et al. 1998). As already pointed out, although physical shapes and hormonal levels can deeply influence individual ranking within the group (Mazur & Booth, 1998), especially in human communities social hierarchies are to a large extent determined by intellectual capacities and skills, so that power positions are not necessarily occupied by the physically strongest individuals. In this case, there might be no reliable perceptual cues that allow the perceivers to infer the relative social status of other individuals but one has to rely on episodic learning.

In the present research, I have addressed the impact of social status information on social attention in humans, independently of the physiognomic traits of the cuing face. To this end, I have conducted three experiments in which I have employed a standard gaze-cuing paradigm (e.g., Friesen & Kingstone, 1998) and manipulated the status of the cuing faces via a preliminary learning phase. Specifically, I used different face stimuli and two versions of fictive curriculum vitae (CV) conveying opposite social status information. Participants were asked to read CVs in which half of the face stimuli were associated to a high social status and the other half to a low social status. The association between status and faces was counterbalanced between participants (Experiment 1) or randomly established (Experiments 2/A and 2/B). I thus manipulated social status so as to associate each stimulus face to both high and low status. In so doing, there was no correlation between social status and the perceptual features of the faces used as stimuli in the gaze-cuing task. In all the three experiments, my expectation was to observe greater gaze-cuing effects for the faces that in each condition were presented as high-status individuals. Furthermore, in Experiments 2/A and 2/B I have explored in more detail the temporal dynamics underlying this modulation.

Experiment 1

In Experiment 1 I aimed to address whether the social status of the cuing face can modulate the gaze-cueing effect. Participants were asked to look at the faces of 16 individuals and read fictive CV associated with each of them that could describe the person as having a high or low social status. The association between each specific face and either high or low social status was counterbalanced between participants. The same faces were then used as stimuli in a gaze-cuing task. I expected to observe a greater gaze-cueing effect in response to high- than to low-status faces.

Methods

Participants

Forty-six undergraduates (Mean age = 23 years, *SD* = 2.71, 30 females) from the University of Padova participated as volunteers. All had normal or corrected-to-normal vision. The study was conducted in accordance with the Declaration of Helsinki. The local ethic committee approved the study.

Stimuli, apparatus, and procedure

Sixteen full-colour photos of adult males bearing a neutral expression were used as stimuli. In particular eight older adults aged between 50 and 60 years (00082_931230_fa, 00172_931230_fa, 00474_940519_fa, 00714_941201_fa, 00739_941201_fb, 00919_960620_fa, 00950_960627_fa, 00955_960627_fb) and six 20 years old younger adults (00129_931230_fb, 00253_940128_fa, 00591_940928_fa, 00658_941121_fa, 00659_941121_fa, 00695_941121_fa) were selected from "The Color FERET Database" (Phillips, Wechsler, Huang, & Rauss, 1998), while two younger adults apparently aged around 20 years (00272012, 00811015) were selected from "The PUT Face Database" (Kasiński, Florek, & Schmidt, 2008). Any element of asymmetry (e.g., moles, birthmark, earrings) was removed using The Gimp 2.6 (The Gimp Team, http://www.gimp.org). In order to induce an association between faces and social status, participants were asked to read fictive CVs associated with each face. Participants were randomly assigned to one of two conditions. In condition 1, the CVs of older adults emphasized that they had a relative high social status (e.g. 'Dean of a Faculty of Architecture. President of the European Eco-Sustainable Constructions Society'), while younger adults had a relative low social status (e.g. 'After the compulsory education he started to work as a workman in a textile industry.'). In condition 2, the same faces of condition 1 were used, but in this case different CVs were administered to participants, in which social status information related to older and younger adults was reversed (e.g. younger adults: ‘Graduated with honours in physics. He is currently working as researcher in a famous European laboratory’; older adults: ‘Retired factory worker. He did not complete primary school’; see Appendix A). In this manner, in two conditions, the same faces were associated with opposite social status information. Status was mainly related to educational/academic information that was highly relevant for the participants recruited in the study (i.e. undergraduate students). A perfect correlation between age and status within each condition was created so, as to facilitate the retrieval of the information about the status of the face stimuli during the gaze-cuing task. CVs were pretested with a sample of ten students (9 females) from the same population who took part in the experiment. Participants were shown the eight CVs of the individuals belonging to one specific group (e.g., high-status younger adults) and asked to report the perceived status of this group of people. Status was defined as the capacity of having an active role within the society so that to gain power and hold leading positions. Responses were provided along a 7-point Likert scale (1 = very low, 7 = very high). Each participant evaluated all four groups of individuals (i.e., high-status older adults, low-status younger adults, high-status younger adults, low-status older adults). A 2 × 2 repeated-measures ANOVA with Social status (high vs. low) and Age (older vs. younger adults) as within-participants factors showed a strong effect of status, $F(1,9) = 67.5$, $p < 0.001$, $\eta^2_p = 0.88$. High-status groups ($M = 6.2$, $SE = 0.15$) were indeed perceived as having a higher status as compared to low-status groups ($M = 3.2$, $SE = 0.29$). No age effect was found, but the interaction was significant, $F(1,9) = 17.03$, $p < 0.005$, $\eta^2_p = 0.65$. This was due to the fact that the evaluations toward older adults tended to be more polarized as compared to those toward younger adults. Importantly, however, the difference between the high- and low-status group was significant both when the older adults, $t(9) = 6.33$, $p < 0.001$, and the younger adults, $t(9) = 7.68$, $p < 0.001$, represented the high-status group. Overall, these data indicate that the CVs were effective in inducing differences in perceived status. Immediately after having read the CVs, participants took part in a gaze-cuing task in which the same 16 faces were used as cuing faces.

Stimulus presentation and data collection were controlled by a PC running E-Prime 1.1. Participants sat approximately 57 cm from a 17-inch monitor (1024 × 768 pixel, 60 Hz). Stimuli were presented on a black background. Each trial began with the presentation of a white fixation cross (0.82°) in the centre of the screen for 900 ms (Fixation frame, Figure 3), followed by a central face (21.2° height × 14° width) with direct gaze (Face frame). After 900 ms, the same face appeared with averted gaze (Cue frame). This photograph was obtained by moving the irises 0.25° to the right or to the left from the original central position using The Gimp v. 2.6. After 200 ms, a white target letter (L or T, 0.82°) appeared 11° to the left or right of the centre of the screen in one of two possible locations: spatially congruent or incongruent with gaze direction. The target frame remained visible until a response was provided. Gaze direction was uninformative as regards target location and participants were instructed to maintain fixation at the centre of the screen. Instructions emphasized both response speed and accuracy. Participants responded using their right and left index fingers. Half of the participants were instructed to press the ‘K’ key of a standard keyboard if the target was an ‘L’, and the ‘D’ key if the target was a ‘T’. The remaining participants responded using the opposite map- ping. In the case of a wrong response, the text ‘ERROR’ appeared in white centred on the screen for 500 ms. There were 64 trials for each condition defined by congruency between gaze direction and target location (congruent vs. incongruent) and social status (high vs. low), for a total of 256 trials presented in a random order.

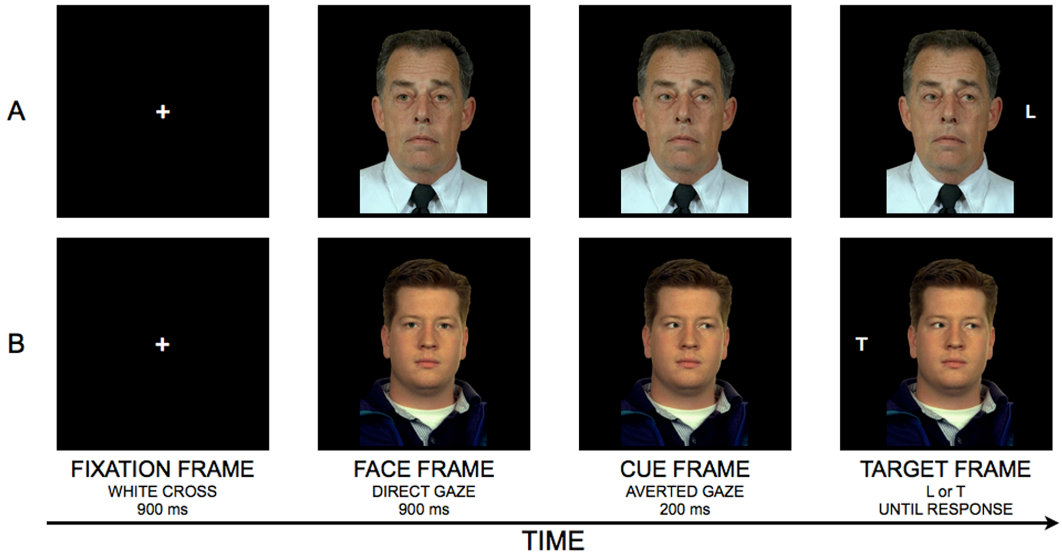

Figure 3. Illustration of stimuli (not drawn to scale) and sequence of events for (A) a spatially congruent trial with an older adult and letter 'L' target and (B) a spatially incongruent trial with a younger adult and letter 'T' target.

Results

All trials in which participants committed an error (3.62%) were removed. Preliminary analyses of RTs showed that participant's gender had no effect, and therefore, this factor was not considered. A 2 × 2 × 2 mixed-design repeated-measures ANOVA was conducted with Cue-target spatial congruency (congruent vs. incongruent) and Social status (high vs. low) as within-participants factors, and Condition (condition 1 vs. condition 2) as between-participant factor. The main effect of Cue-target congruency was significant, $F(1,44) = 13.071$, $p = 0.001$, $\eta^2_p = .229$, owing to faster RTs on congruent ($M = 520$ ms, $SE = 9.56$) than on incongruent ($M = 530$ ms, $SE = 8.62$) trials. Critically, the Cue-target congruency × Social status interaction was also significant, $F(1,44) = 6.141$, $p = 0.017$, $\eta^2_p = .122$. Two-tailed paired-samples t-tests indicated that participants shifted their attention in response to the averted gaze of high-status faces, *t*(45) = 3.808, $p = 0.01$, but not in response to the averted gaze of low-status faces, *t*(45) = 1.381, $p = 0.174$ (Figure 4). No other significant effect emerged (*p*s > .163). This overall pattern is inconsistent with the possibility that the physiognomic traits of the specific faces used in the present study played a relevant role in the gaze-cuing effects that I found. A second mixed-design repeated-measures ANOVA conducted on the percentage of errors with the same factors as earlier revealed a main effect of cue-target spatial congruency, *F*(1,44= 7.036, $p = .011$, $\eta^2_p = .138$, reflecting more errors on incongruent (*M* = 3.89 %, *SE* = 0.53) than on congruent (*M* = 2.93 %, *SE* = 0.54) trials. No other significant effect emerged (*p*s > .113). Thus, speed-accuracy trade-off cannot account for the present findings.

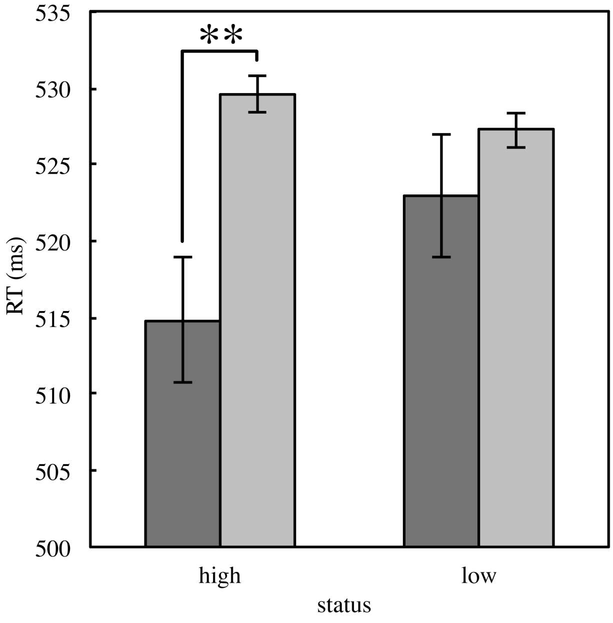

Figure 4. Mean RTs collapsed across conditions for spatially congruent (dark grey) and incongruent (light grey) trials as a function of the social status of the cuing face. Error bars represent standard error of the mean. Double asterisks denote t-test $p < 0.01$.

Discussion

It is well-known that social status deeply shapes social interactions, and that humans are particularly sensitive to social hierarchies (e.g., Chiao, Bordeaux, & Ambady, 2004; Freeman, Penner, Saperstein, Scheutz, & Ambady, 2011; for a review see Dalmaso, submitted). Indeed, people preferentially allocate attentional resources to high-status individuals. In this regard, it has recently been demonstrated that people tend to gaze at high-status individuals more often and for longer than at low-status individuals (e.g., Foulsham, Cheng, Tracy, Henrich, & Kingstone, 2010) and that high-status faces are better encoded in memory and processed more holistically (Ratcliff et al., 2011). Based on the idea that high-status individuals could be considered as more relevant sources of information when compared with low-status individuals, it has been hypothesized that gaze cuing could be influenced by perceived social status (e.g., Shepherd et al., 2006).

The present results demonstrate that information regarding social status acquired through episodic learning is sufficient to moderate gaze cuing in humans. Indeed, participants consistently shifted attention only in response to the averted gaze of a face that was described as depicting a high-status individual. This suggests that gaze cuing is not immune to top-down influences, so that it can be conceived as a conditionally automatic process, which is modulated by contextually relevant social information (e.g., Foulsham et al., 2010; see also Teufel et al., 2009; Teufel, Alexis, Clayton, & Davis, 2010a; Teufel, Fletcher, & Davis, 2010b).

The perception of social status can be derived from at least two different sources of information. One is related to the physiognomic traits of the face, and previous research showed that gaze cuing is significantly reduced (if not totally abolished) for apparently less dominant faces (e.g., ones et al., 2010). Moreover, a recent study observed a reduced gaze-cueing effect also for white than for black faces (Pavan, Dalmaso, Galfano, & Castelli, 2011). Indeed, at least in most Western societies, White people can be considered as the majority group, in that they are more likely associated to higher positions within the society as compared to Black people (Castelli, Zogmaister, & Tomelleri, 2009). Alternatively, the perception of social status can rely on verbal social information concerning the specific roles one has within the group. This latter source of information is especially relevant among humans, for whom achievements based on intellectual capacities more heavily shape social hierarchies. My findings show that, even when the impact of physiognomic traits is controlled for by counter- balancing the face-status association, social status influences gaze cuing, so that this phenomenon is magnified when participants view faces of high-status individuals, irrespective of their facial characteristics. On the basis of the verbal information received, people build up exemplar-based representations that are then retrieved when performing the gaze-cuing task. This mechanism appears to be highly adaptive for regulating social life. Indeed, it implies that we rapidly encode the relative social status of the individuals populating our environment and we shape our social attention processes accordingly. The fact that humans selectively attend to the locations gazed by high-status individuals might be interpreted as further evidence of the possible existence of a cognitive process that boosts the identification and monitoring of high-status individuals (e.g., DeWall & Maner, 2008; Foulsham et al., 2010; Henrich & Gil-White, 2001). This mechanism is likely to be particularly relevant for low-status individuals who more heavily depend on high-status individuals (Shepherd et al., 2006). Supportive evidence in favour of this hypothesis comes also from studies using neuroimaging techniques. Recent research provided the first evidence that some neural circuits can be modulated by social status, both in humans (e.g., Beasley, Sabatinelli & Obasi, 2012; Chiao et al., 2008; Hogeveen, Inzlicht, & Obhi, 2013; Kumaran, Melo, & Duzel, 2012; Ly, Haynes, Barter, Weinberger, & Zink, 2011; Muscatell et al., 2012) and in nonhuman primates (for a review see Chiao, 2010). These pioneering results strengthen the notion that individuals from several species are equipped with a neural network devoted to the elaboration of social status information.

The next two experiments have been carried out to address in more detail this issue, as well as the time-course of the interaction between social processing and gaze cuing, in order to clarify whether the observed modulation reflects early-rising reflexive mechanisms.

Experiment 2/A

Experiment 1 provided evidence that social status information acquired through episodic learning can shape social attention processes. However, it is unknown whether very fast exposure to a face is sufficient to extract social status information which in turn affects allocation of spatial attention. In Experiment 2/A, I have addressed this issue by keeping the SOA constant at 200 ms, and manipulating the duration of the direct-gaze face frame, that could be either 50 or 900 ms. For the long duration, I expected to replicate the results reported in Experiment 1. As for the brief duration, different hypotheses could be put forward. On the one hand, one may hypothesize that retrieving this episodic information may require a substantial amount of time. Because in Experiment 1 I used fixed temporal parameters and left the face with direct gaze available to participants for a considerable time (900 ms), one cannot rule out the possibility that the observed modulation would disappear when shorter exposure times are used. Alternatively, since social status is a critical feature in the regulation of social interaction, one may predict a modulation of social attention processes, as indexed by gaze-cuing, also when faces are presented only briefly. This latter possibility would be supported by evidence showing that the valence associated with person-based representations is automatically retrieved (Castelli, Zogmaister, Smith, & Arcuri, 2004).

Methods

Participants

Sixty-nine undergraduates (Mean age = 21.5 years, *SD* = 2.7, 18 males) took part in the experiment on a voluntary basis. All were naive as to the purpose of the study and reported normal or corrected- to-normal vision. The local ethic committee approved the study.

Stimuli, apparatus, and procedure

Six photos of older adult males were extracted from the same set of stimuli as that used in Experiment 1 (00474_940519_fa, 00714_941201_fa, 00739_941201_fb, 00919_960620_fa, 00950_960627_fa, 00955_960627_fb).

For each face there were three different versions: one with direct gaze (i.e., the original photograph), one with gaze averted rightwards and one with gaze averted leftwards. The averted-gaze photographs were obtained by moving the irises 0.25° to the right or to the left from the original central position using The Gimp v. 2.6. Participants sat approximately 57 cm from a 17-inch monitor (1024 × 768 pixel, 60 Hz). A PC running E-Prime v. 1.1 handled timing and stimuli presentation. A standard keyboard collected manual responses.

The whole experiment was composed of three computer-based phases: a learning phase, in which participants were asked to learn the social status of the face stimuli; an experimental phase, in which the same faces were employed in the gaze-cuing task; a manipulation check, aimed to verify whether participants remembered the association between each face and the corresponding social status studied during the learning phase. In all phases, each face was presented alone, with constant size (21.2° × 14°), in a central position and against a black background.

The learning phase consisted of presenting each face singularly, accompanied with a fictive CV that appeared in white letters (18-point Courier New) above the face. Three faces were paired to a high-status profile (e.g., ‘Dean of a Faculty of Architecture. President of the European Eco-Sustainable Constructions Society’), whereas the other three faces were paired to a low-status profile (e.g., ‘Retired factory worker. He did not complete primary school’; see Appendix A). The association between faces and profiles was randomly determined for each participant. In so doing, I minimized the eventual influence of the physiognomic traits of the stimulus faces. Status was mainly related to educational/academic information that was highly relevant for the participants recruited in the study (i.e., undergraduate students; see also Experiment 1). Participants were asked to memorize each face identity and the corresponding CV, with no time limits. To move from a face to another one, participants were asked to press the spacebar. When participants had visualized all the 6 faces, a categorization task was administered in order to verify learning. This task consisted of presenting each face for 900 ms without CV. Within that time, participants were required to categorize each face as depicting a high- or a low-status individual by pressing the ‘Y’ and the ‘B’ keys, respectively. Each face appeared twice for a total of 12 trials. The green text ‘CORRECT’ or the red texts ‘ERROR’ or ‘FASTER’ appeared centrally for 2000 ms in case of a correct, an incorrect or a missing response, respectively. In the case participants committed at least one error in these 12 trials, the categorization task was administered again. Moreover, in case participants were unable to complete successfully the categorization task after 8 cycles, they were presented again with both faces and their associated CVs.

After the learning phase was successfully completed, the experimental phase started. This consisted of a gaze-cuing task in which the same faces used in the learning phase were employed. Each trial began with the presentation of a white fixation cross (0.82°) in the centre of the screen for 900 ms (see Figure 5), followed by a central face with direct gaze. After either 50 or 900 ms, the same face appeared with averted gaze rightwards or leftwards. After a fixed SOA of 200 ms, a white target letter (L or T, 0.82°) appeared 11° rightwards or leftwards from the centre of the screen with the same probability. The averted-gaze face and the target letter remained visible until a response was provided or 1500 ms had elapsed, whichever came first. Participants were informed that gaze direction was uninformative with regard to the target location, they were instructed to maintain fixation at the centre of the screen, to ignore gaze direction, and to respond as fast and accurately as possible. Half of the participants responded by pressing the ‘K’ key with their right index finger in case the target was a ‘L’, and the ‘D’ key with their left finger in case the target was a ‘T’. The remaining participants responded using the opposite mapping. In the case of a wrong or a missing response, the central red text ‘ERROR’ or ‘NO

RESPONSE' appeared on the screen for 1500 ms. There was a practice block composed by 10 trials followed by 3 experimental blocks each composed of 96 trials, for a total of 288 experimental trials presented in a random order.

After the experimental phase, participants were asked to take part in the manipulation check task. This was identical to the categorization task of the learning phase, the only exceptions being that a single cycle was presented and that there was no time limit for responding. This latter change had the purpose of maximizing accuracy in the responses. At the end of the experiment the participants were thanked and debriefed. The whole procedure took about 1 hour.

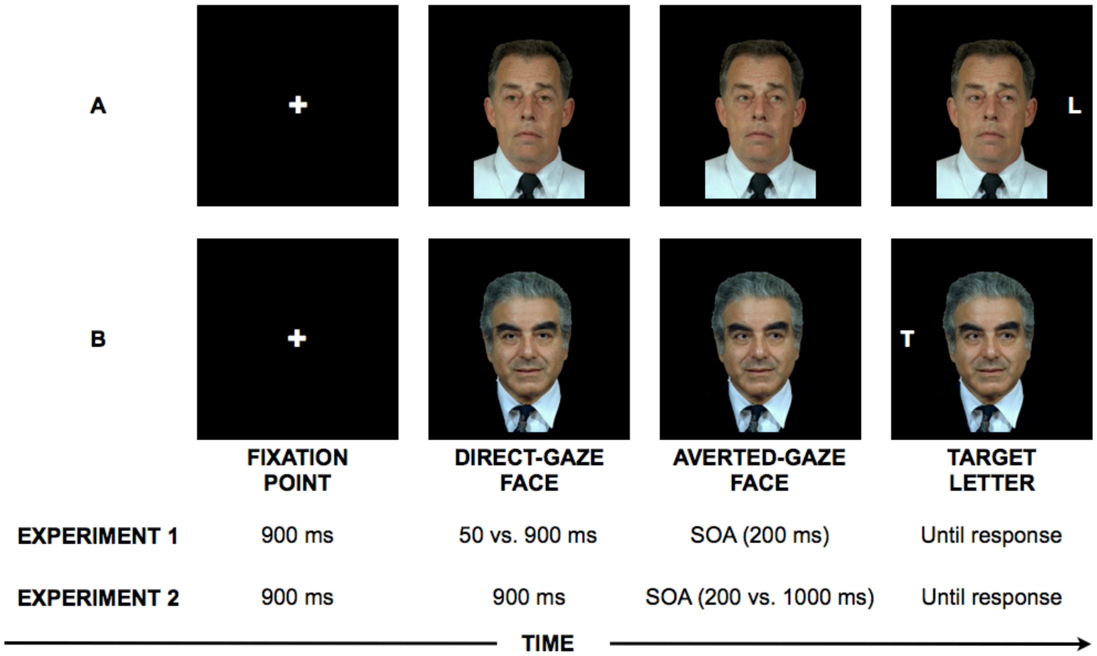

Figure 5. Example of stimuli (not drawn to scale) and sequence of events presented during a congruent (A) and an incongruent (B) trial in Experiment 1 and in Experiment 2.

Results

Participants who committed at least one error during the manipulation check (N = 13) and with a percentage of errors during the experimental phase that fell 2 SD above the mean (N = 1) were excluded from the analyses. Then, incorrect responses were removed and analysed separately (2.68% of total trials). A repeated-measures ANOVA was performed on median RTs with Cue-target spatial congruency (congruent vs. incongruent), Direct-gaze face duration (50 ms vs. 900 ms) and Status (high vs. low) as within-participant factors. The main effect of Cue-target spatial congruency was significant, $F(1,54) = 37.120$, $p <. 001$, $\eta^2_p = .407$, owing to smaller RT on congruent (M = 520 ms, SE = 7.4) than on incongruent (M = 530 ms, SE = 7.3) trials, as well as the Cue-target spatial congruency × Status interaction, $F(1,54) = 6.388$, $p = .014$, $\eta^2_p = .106$. Paired comparisons between congruent and incongruent trials divided by status revealed that participants oriented their attention in response to the averted gaze of high, $t(54) = 6.440$, $p < .001$, and low, $t(54) = 2.527$, $p = .014$, status faces, but the effect was greater in the former case (15 ms vs. 6 ms; see Figure 6). Critically, the three-way Cue-target spatial congruency × Direct-gaze face duration × Status interaction was not significant ($p = .829$), confirming a comparable effect of social status on gaze-cuing irrespective of direct-gaze face duration (see Table 1). No other main effects or interactions emerged (ps > .23).

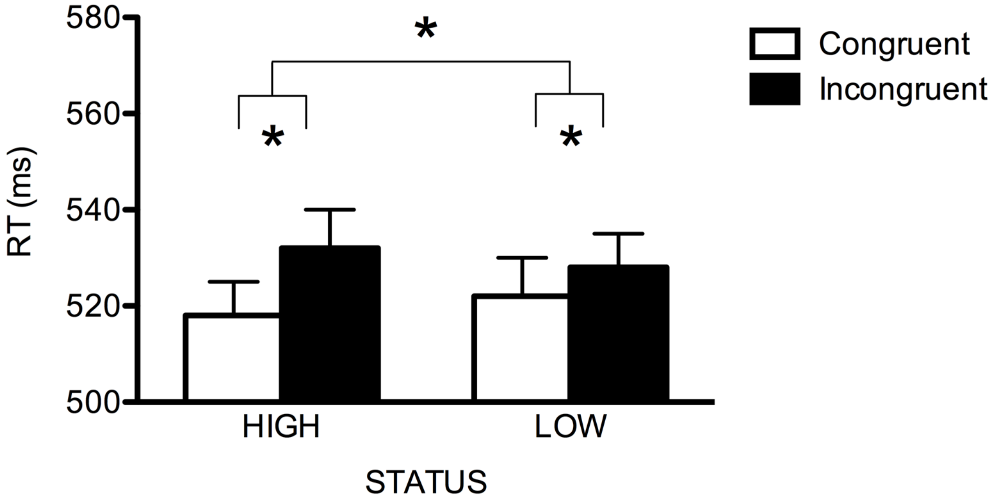

Figure 6. Median RTs (ms) as a function of Cue-Target Spatial Congruency and Status in Experiment 1. Error bars represent standard errors. Asterisk denotes t-test $p < .05$.

A second repeated-measure ANOVA was conducted on the percentage of errors with Cue-target spatial congruency (congruent vs. incongruent), Direct-gaze face duration (50 ms vs. 900 ms) and Status (high vs. low) as within-participant factors. The main effect of Direct-gaze face duration approached significance, $F(1,54) = 3.472$, $p = .068$, $\eta^2_p = .06$, reflecting the tendency to commit more errors at the longer (M = 2.4 %, SE = .25) than at the shorter (M = 2 %, SE = .17) duration. Moreover, also the Cue-target spatial congruency × Direct-gaze face duration × Status interaction approached significance, $F(1,54)= 3.88$, $p = .054$, $\eta^2_p = .067$. However, the critical paired comparisons between congruent and incongruent trials divided by duration and status revealed no differences among the critical conditions (ps > .13; see Table 1). No other main effects or interactions emerged (ps > .253). Thus, the data were unlikely to be affected by any speed-accuracy trade-off.

Discussion

The results from Experiment 2/A are interesting mainly for three reasons. First, they are in line with those reported in Experiment 1, namely that the tendency to attend to the spatial location indicated by other’s gaze direction is more pronounced in response to high- rather than to low-status faces. Second, in Experiment 1 faces from different age levels were used and, in each experimental condition, status co-varied with age to help building episodic knowledge. In contrast, here I used faces from a single age level (older adults). Hence, the present findings cast stronger evidence that gaze cuing is influenced by social status, in that participants could not rely upon any categorical cue to retrieve episodic knowledge about status. Finally, and more importantly, the observed gaze cuing modulation seems to emerge even when the time to extract social status information is particularly brief (i.e., 50 ms). This result is in line with previous evidence. Indeed, as for the temporal dynamics underlying the modulation of attentional processes elicited by social information conveyed by faces, there is evidence of significant effects even very brief exposures (50 ms or even less, see e.g. Holmes, Green, & Vuilleumier, 2005; Stone & Valentine, 2005; Trawalter, Todd, Baird, & Richeson, 2008). However, it is worth noting that, unlike all these previous studies in which the manipulation was based on changes in the physical features of the faces used as stimuli, in Experiment 2/A I observed a modulation due to non-visual information associated with faces. This finding suggests the possibility that even a top-down modulation can readily impact onto our social attention mechanism, at least in the case of social status. Overall, this confirms that individuals are extremely sensitive to signals of social status and process them efficiently.

Experiment 2/B was aimed to further explore the temporal dynamics underlying the modulation of social status on social attention.

Experiment 2/B

In Experiment 1, another important aspect that had not been addressed is related to the temporal persistence of the modulation of social attention as a function of social status. In Experiment 2/B, I addressed this issue by keeping the duration of the direct-gaze face frame constant at 900 ms, and manipulating the duration of SOA, that could be either 200 or 1000 ms. In so doing, the former case was a replication of Experiment 1 temporal parameters. As for the latter case, on the one hand, one may predict social status to exert its influence upon gaze cuing only at the short SOA, in that social status information is not relevant for performing the gaze-cuing task, and hence modulations related to differences in social status may disappear. On the other hand, finding a modulation of social attention processes at both the short and the long SOA would cast evidence about the persistent nature of the effects of social status even when this variable is not directly relevant for the task at hand.

Methods

Participants

Seventy-six undergraduates (Mean age = 23.8 years, *SD* = 4.9, 26 males) took part in the experiment on a voluntary basis. None of them had taken part in the previous experiment. All were naive as to the purpose of the study and reported normal or corrected-to-normal vision. The local ethic committee approved the study.

Stimuli, apparatus, and procedure

Apparatus, stimuli and procedure were the same as in Experiment 2/A, with the following exceptions: the duration of the direct-gaze face frame was held constant at 900 ms (see Figure 5), and two SOAs of 200 ms and 1000 ms were used.

Results

I used the same data reduction rationale as in Experiment 1. Participants who committed at least 1 error during the manipulation check ($N = 19$) and with a percentage of errors during the experimental phase that fell 2 SD above the mean ($N = 4$) were excluded from the analyses. Then, incorrect responses were removed and analysed separately (2.09% of the total trials). A repeated-measures ANOVA was performed on median RTs with Cue-target spatial congruency (congruent vs. incongruent), SOA (200 ms vs. 1000 ms) and Status (high vs. low) as within-participants factors. The main effect of Cue-target spatial congruency was significant, $F(1,52) = 24.777$, $p < .001$, $\eta^2_p = .323$, owing to smaller RTs on congruent ($M = 533$ ms, $SE = 9.1$) than on incongruent trials ($M = 544$ ms, $SE = 9.5$), as well as the main effect of SOA, $F(1,52) = 35.192$, $p < .001$, $\eta^2_p = .404$, owing to smaller RTs at the longer ($M = 529$ ms, $SE = 9.3$) than at the shorter ($M = 547$ ms, $SE = 9.4$) SOA. The Cue-target spatial congruency × SOA interaction was also significant, $F(1,52) = 8.343$, $p = .006$, $\eta^2_p = .138$. Paired comparisons between congruent and incongruent trials divided by SOA revealed that the cuing effect was significant both at the shorter, *t*(52) = 2.327, *p* = .024, and at the longer, *t*(52) = 4.669, *p* < .001, SOA, but the effect was larger in the latter case (5 ms vs. 18 ms). The two-way Cue-target spatial congruency × Status interaction did not yield a significant effect (*p* = .209), whereas the three-way Cue-target spatial congruency × SOA × Status interaction was statistically significant, *F*(1,52) = 4.551, *p* = .038, η^2_p = .080. Paired comparisons between congruent and incongruent trials divided by SOA and status revealed that the cuing effect was significant for high-status faces both at the shorter, *t*(52) = 2.5309, *p* = .01444, and at the longer SOA, *t*(52) = 2.5314, *p* = .01442, and also for the low-status faces but only at the longer SOA, *t*(52) = 5.72, *p* < .001. At the shorter SOA, the cuing effect for low status faces was not significant, *t*(52) = .921, *p* = .361 (see Table 1). No other main effects or interactions emerged (*p*s >.331).

A second repeated-measures ANOVA was conducted on the percentage of errors with the same factors as above. The main effect of Cue-target spatial congruency was significant, *F*(1,52) = 7.083, *p* = .010, η^2_p = .12, owing to more errors on incongruent (*M* = 2.4 %, *SE* = .26) than on congruent (*M* = 1.8 %, *SE* = .2) trials. The main effect of SOA approached significance, *F*(1,52) = 3.943, *p* = .052, η^2_p = .07, reflecting more errors at the shorter (*M* = 2.4 %, *SE* = .26) than at the longer (*M* = 1.8 %, *SE* = .24) SOA, as well the main effect of Status, *F*(1,52) = 3.487, *p* = .067, η^2_p = .063, reflecting more errors in response to high- (*M* = 2.3 %, *SE* = .25) than to low-status (*M* = 1.8 %, *SE* = .23) faces. No other main effects or interactions emerged (*p*s > .538). Thus, no speed-accuracy trade-off affected the data.

Table 1. Median RTs (ms) and percentage of errors (%) for each condition in Experiment 1 and 2. Values in brackets are SEM.

C = congruent trials; I = incongruent trials.

	EXPERIMENT 1								EXPERIMENT 2							
	Direct-gaze face duration 50-ms				Direct-gaze face duration 900-ms				Averted-gaze face duration 200-ms SOA				Averted-gaze face duration 1000-ms SOA			
	High Status		Low Status		High Status		Low Status		High Status		Low Status		High Status		Low Status	
	C	I	C	I	C	I	C	I	C	I	C	I	C	I	C	I
RTs	520	534	523	528	515	531	520	527	543	550	546	550	523	535	518	542
	(7)	(8)	(8)	(7)	(8)	(8)	(8)	(8)	(10)	(10)	(10)	(9)	(9)	(10)	(9)	(10)
% E	2.4	1.7	1.9	2	2.1	2.4	3	2.3	2.3	2.8	1.9	2.5	1.9	2.4	1.1	1.9
	(.38)	(.29)	(.34)	(.27)	(.36)	(.48)	(.4)	(.37)	(.4)	(.4)	(.37)	(.41)	(.3)	(.47)	(.24)	(.39)

Discussion

In line with Experiment 1 and Experiment 2/A, in Experiment 2/B a reliable gaze-cuing effect emerged in response to the averted gaze of high- but not low-status individuals at the shorter SOA, whereas at the longer SOA a reliable gaze-cuing effect emerged irrespective of the social status of the faces. This pattern of results suggests that the tendency to selectively attend to the locations gazed by high-status individuals decays with time.

In sum, the results of Experiment 2/A and 2/B show that social status information can rapidly be extracted from faces on the basis of previous episodic learning and that differences in gaze cuing as a function of social status disappear with time.

Future studies may provide further insight about the temporal dynamics underlying the modulation of social attention as a function of social status by combining behavioural and high-temporal resolution electrophysiological measures. This may also help understanding how the neural bases of the interplay between social status and social attention processes.

2.2. Study 2

The politics of attention (contextualized)

Carraro, L., Dalmaso*, M., Castelli, L., & Galfano, G. (Submitted). The politics of attention contextualized: Gaze but not arrow cuing of attention is moderated by political temperament.*

* The first two authors contributed equally, with first authorship being determined by a coin toss.

Dodd et al. (2011) have recently reported that even political temperament, like social status, can modulate gaze cuing of attention. In their study, they first measured political orientation by asking participants to indicate their standing in relation to a series of sensitive social issues. Next, they administered a standard gaze-cuing task with three SOA between cue and target onset and found a reliable gaze-cuing effect among liberals but not among conservatives. According to Dodd et al. (2011), this may be consistent with the idea that conservatives, as compared to liberals, assign greater value to personal autonomy and therefore might be less likely to be influenced by others. However, the pattern reported by Dodd et al. (2011) might not be confined to gaze cues and, instead, reflect a reduced attentional response to any central cue that "pushes" spatial attention. In other words, conservatives might prove to be less sensitive to any cue that is interpreted as an external drive. In order to explore this latter hypothesis, I conducted a first experiment (Experiment 1) in which I used the procedure employed by Dodd et al. (2011), and examined attention shifting in both conservatives and liberals by comparing gaze and arrow cues. Similar to gaze, arrow cues have been shown to elicit reflexive shifts of attention and are often used as a useful term of comparison for assessing the relative impact of social and symbolic cues (e.g., Bayliss et al., 2005; Bayliss & Tipper, 2005; Galfano et al., 2012; Kuhn & Benson, 2007; Kuhn & Kingstone, 2009; Kuhn et al., 2011; Tipples, 2002, 2008). Subsequently, I carried out a second experiment (Experiment 2) in order to increase to ecological validity of the present research by using photographs of real individuals as face stimuli.

Experiment 1

The first goal of the present study was to provide further empirical evidence supporting the results reported by Dodd et al. (2011), namely, the presence of a reliable gaze-cuing effect among liberals but not among conservatives. Importantly, because the current study was conducted in a different country, consistent evidence would speak in favour of the generalizability of the findings in different social contexts. The second goal of this study was assessing the extent to which the absence of cuing effect exhibited by conservatives is specific to gaze cues, or extends to symbolic cues such as arrows. Because I used an additional cue, unlike Dodd et al. (2011), I only included two SOAs in order to simplify the experimental design.

Methods

Participants

Sixty-eight undergraduate students (Mean age = 20.1 years, *SD* = 5.32, 13 males) at the University of Padova took part in the study in exchange for course credits. All reported normal or corrected-to-normal vision and were naïve to the purpose of the experiment. The local ethic committee approved the study.

Stimuli, apparatus, and procedure

Questionnaire on political ideology

Political ideology was assessed separately from the main study through an online survey (www.surveymonkey.com), as part of a mass testing at the beginning of the semester. Participants were asked to express their level of agreement (from 1 = "not at all" to 7 = "very much") towards 8 social issues (i.e., reduction of immigration, abortion, medically assisted procreation, homosexual marriage, legalization of soft drugs, euthanasia, use of stem cells, adoption by homosexual couples; $\alpha = .74$). This scale has been already widely used in previous research (e.g., Carraro, Castelli, & Macchiella, 2011; Castelli & Carraro, 2011).

Spatial cueing task

Gaze and arrow stimuli were used as cues in two distinct blocks that were selected in a random order. I have chosen to present the different cues in separate blocks because it has been shown that gaze cuing can be sensitive to contextual factors such as the presence of other cuing stimuli within the same block of trials (Pavan et al., 2011). In the gaze-cue block, the cue was very similar to that used by Dodd et al. (2011), namely a schematic face (6° of diameter) with gaze pointing either rightwards or leftwards. In the arrow-cue block, the cue was an arrow (3.8° × 1.6°)

pointing either rightwards or leftwards. The arrow appeared with a symmetric head and tale in order to be comparable to the two eyes conveying directional information (see also Galfano et al., 2012). A PC running E-prime 1.1 handled stimulus presentation and data collection. Participants sat approximately 57 cm from a 17-inch monitor (1024 × 768 pixel, 60 Hz) on which stimuli were presented in white against a black background.

The procedure was similar to that used by Dodd et al. (2011). Each trial began with a fixation cross (1°) presented in the centre of the screen for 250 ms. In the face-cue block, a face without pupils was shown for 750 ms and then replaced with the same face with gaze pointing rightwards or leftwards. After either 200 or 700 ms, depending on SOA, a white-dot target (1°) appeared 2.5° to the right or to the left of the cue. In the arrow-cue block, fixation was followed by the arrow-cue without head and tale (i.e., a horizontal line segment). Afterwards the same arrow with head and tale both pointing rightwards or leftwards appeared. Timing parameters were the same in the face-cue and arrow-cue blocks. Participants were instructed to maintain fixation at the centre of the screen and to press the space bar as fast as possible when the target appeared (target present trial), and to refrain from responding if the target did not appear (catch trial). They were explicitly instructed that cue direction was uninformative with respect to target location. Catch trials were used in order to avoid anticipations. The red words “NO RESPONSE” or “ERROR” were presented when participants failed to respond within 2000 ms (i.e., omissions) or responded on catch trials (i.e., false alarms), respectively. Finally, a blank screen appeared for 500 ms (see Figure 7). Then, the next trial began. Each experimental block was composed of 160 target present trials and 40 catch trials and it was preceded by a practice block composed of 8 target present trials and 2 catch trials. Target present trials and catch trials were presented in a random order. There were potentially 40 data points for each condition defined by cue-target spatial congruency, cue type and SOA.

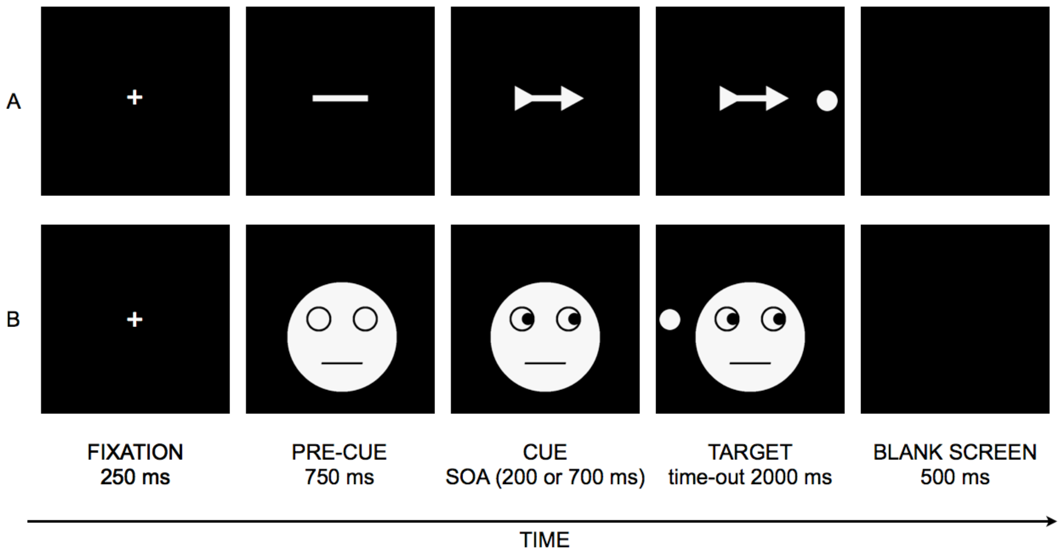

Figure 7. Examples of an arrow-cue congruent trial (A) and a gaze-cue incongruent trial (B).

Results

False alarms were extremely low (.08% of trials) and were removed. Missed responses (.02% of trials) and outliers, defined as trials for which RTs were 2 SDs above or below the mean of each participant divided by condition (3.8% of trials), were also removed. Due to the low rate of errors, these were not analysed further.

First, we classified participants as either conservatives or liberals on the basis of their responses to the questionnaire. Responses to the questionnaire were rescaled so that higher scores corresponded to more conservative views (Mean of the experimental sample = 3.52, *SD* = 1.18; range from 1.14 to 6.00). The median value was 3.57, a score reported by three participants. The split half thus resulted in groups with different size (35 liberals and 33 conservatives; 7 and 6 males, respectively).

Mean RTs for correct responses were submitted to a mixed-design repeated-measures ANOVA with Cue-target spatial congruency (congruent vs. incongruent), Cue type (arrow vs. gaze) and SOA (200 vs. 700 ms) as within-participants factors, and with Political ideology (liberal vs. conservative) as between-participants factor. The main effect of Cue-target spatial congruency was significant, $F(1,66) = 90.301$, $p < .001$, $\eta^2_p = .578$, owing to shorter RTs on congruent ($M = 321$ ms, $SE = 5.30$) than on incongruent ($M = 329$ ms, $SE = 5.55$) trials. The main effect of SOA was also significant, $F(1,66) = 150.315$, $p < .001$, $\eta^2_p = .695$, owing to shorter RTs on longer ($M = 312$ ms, $SE = 5.51$) than on shorter ($M = 338$ ms, $SE = 5.53$) SOA. In addition, the Cue-target spatial congruency × Cue type interaction was significant, $F(1,66) = 7.342$, $p = .009$, $\eta^2_p = .100$, a pattern that was further qualified by the four-way cue-target spatial Congruency × Cue type × SOA × Political ideology interaction, $F(1,66) = 4.087$, $p = .047$, $\eta^2_p = .058$.

In order to clarify this interaction, RT data of conservatives and liberals were submitted to two separate mixed-design repeated-measures ANOVAs with the same within-participants factors as earlier.

As for liberals, the main effect of cue-target spatial congruency was significant, $F(1,34) = 41.135$, $p < .001$, $\eta^2_p = .547$, owing to shorter RTs on congruent ($M = 323$ ms, $SE = 7.05$) than on incongruent ($M = 331$ ms, $SE = 7.20$) trials. The main effect of SOA was also significant, $F(1,34) = 70.363$, $p < .001$, $\eta^2_p = .674$, owing to shorter RTs on longer ($M = 312$ ms, $SE = 6.99$) than on shorter ($M = 342$ ms, $SE = 7.61$) SOA. No other main effect or interaction emerged. For the sake of completeness, two-tailed paired-samples t-tests confirmed that, regardless of SOA, liberals shifted their attention in response to both arrow and gaze (all *p*s $< .007$; Figure 8).

As for conservatives, the main effect of Cue-target spatial congruency was significant, $F(1,32) = 50.531$, $p < .001$, $\eta^2_p = .612$, owing to shorter RTs on congruent (M = 320 ms, SE = 7.97) than on incongruent (M = 328 ms, SE = 8.52) trials. The main effect of SOA was also significant, $F(1,32) = 94.961$, $p < .001$, $\eta^2_p = .748$, owing to shorter RTs on longer (M = 312 ms, SE = 8.59) than on shorter (M = 335 ms, SE = 8.03) SOA. Crucially, the two-way Cue-target spatial congruency × Cue type interaction was also significant, $F(1,32) = 11.448$, $p = .002$, $\eta^2_p = .263$, reflecting the fact that conservatives were much more sensitive to arrow cues (congruent trials: M = 316 ms, SE = 7.85; incongruent trials: M = 327 ms, SE = 8.47) than to gaze cues (congruent trials: M = 322 ms, SE = 8.50; incongruent trials: M = 328 ms, SE = 8.87). The three-way Cue-target spatial congruency × Cue type × SOA interaction was also significant, $F(1,32) = 7.025$, $p = .012$, $\eta^2_p = .180$. Two-tailed paired-samples t-tests comparing congruent and incongruent trials at each SOA divided by cue indicated that at the shorter SOA conservatives shifted their attention in response to both arrow, $t(32) = 4.974$ $p < .001$, and gaze, $t(32) = 4.547$, $p < .001$, whereas at the longer SOA they shifted their attention in response to arrow, $t(32) = 5.652$, $p < .001$, but not in response to gaze, $t(32) = .947$, $p = .351$.

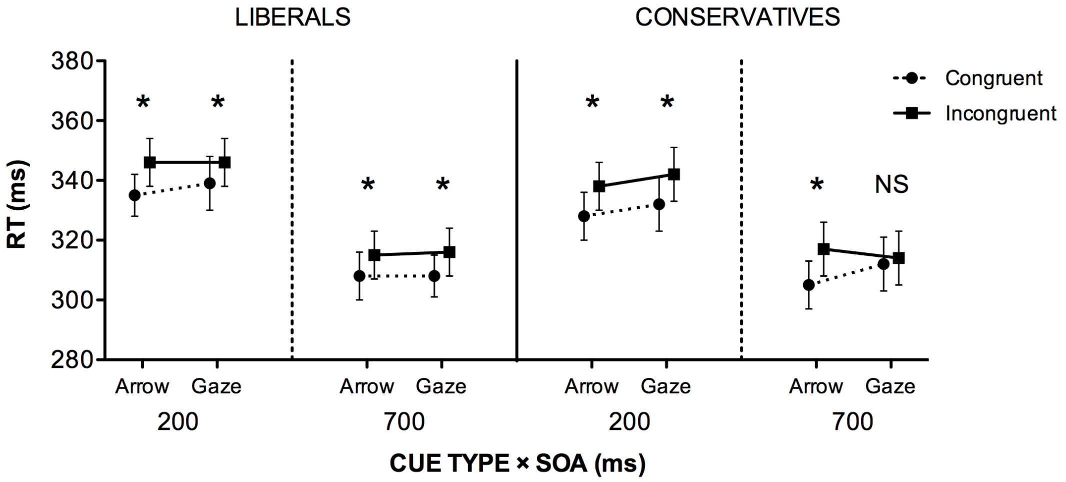

Figure 8. Mean RTs for congruent and incongruent trials as a function of cue type and SOA divided for liberals and conservatives. Error bars represent standard error of the mean. Asterisks denote t-test $p < 0.05$. NS = not significant.

Furthermore, because the two groups of liberals and conservatives differed in size, I tried to test whether the assignment of the three respondents with the median score to the ideology questionnaire to the group of liberals might have somehow affected the results. To this aim, a further mixed-design repeated-measures ANOVA with Cue-target spatial congruency (congruent vs. incongruent), Cue type (arrow vs. gaze), SOA (200 vs. 700 ms), and Political ideology (liberal vs. conservative) was conducted on mean RTs after classifying the three respondents as conservatives. Importantly, the four-way Cue-target spatial congruency × cue type × SOA × Political ideology interaction was still significant, $F(1,66) = 5.008$, $p = .029$, $\eta^2_p = .071$. This pattern suggests that assigning respondents scoring around the median value to one group rather than the other did not affect the results.

In addition, in order to clarify the robustness of the observed pattern, I also adopted a different strategy by considering ideology as a continuous variable. To this end, mean RTs were submitted to an ANCOVA with Cue-target spatial congruency, Cue, and SOA as within-participants factors, and political ideology as covariate. Critically, the four-way Cue-target spatial congruency × Cue type × SOA × Political ideology interaction was statistically significant, $F(1,66) = 4.364$, $p = .041$, $\eta^2_p = .062$.

Discussion

During the last decade, research has shown important differences between people who support different political opinions. Indeed, conservatives and liberals not only have divergent ideas about social and economical issues but, interestingly, they display more profound cognitive differences (e.g., Carraro et al., 2011; Castelli & Carraro, 2011; Dodd et al., 2012; Jost & Amodio, 2012; Oxley et al., 2008). For instance, as compared to liberals, conservatives show increased alertness responses to sudden events (Oxley et al., 2008) and their attention is more strongly grabbed by negative stimuli (Carraro et al., 2011). Dodd et al. (2011) showed that conservatives and liberals seem to differ also with regard to another important aspect, namely, their attentional response to gaze. In particular, a consistent gaze-cuing effect was observed in liberals but not in conservatives.

The present findings add to an increasing literature suggesting that political temperament and affiliation can modulate attention towards social stimuli. The goal of Experiment 1 was twofold. Firstly, I wanted to address whether the pattern reported by Dodd et al. (2011) extended to a different social context. The second aim was to determine whether the lack of gaze cuing reported by Dodd et al. (2011) was suggestive of a general reduced response towards central cues or a gaze-specific phenomenon. To this purpose I included also arrows, that is central cues that are known to be very effective in pushing attention and are often used as a term of comparison for eye gaze (e.g., Bayliss et al., 2005; Galfano et al., 2012; Kuhn & Kingstone, 2009; Tipples, 2002).

As for liberals, I found a generalized cuing effect for both gaze and arrow cues. In sharp contrast, conservatives showed a stronger cuing effect for arrows than for gaze cues. This pattern is important in that it shows that the reduced attentional response exhibited by conservatives is specific for gaze stimuli. In addition, the present results suggest that the pattern reported by Dodd et al. (2011) extends to a different social context. Unlike Dodd et al. (2011), however, the magnitude of gaze cuing for conservatives was further modulated by SOA. Indeed, gaze cuing was absent at the 700-ms SOA only. This discrepancy with respect to Dodd et al. (2011)'s results was unexpected. If any, this finding seems to suggest that individual differences took some time to exert their influence, at least in my sample. Future research will have to include a more dense and broader range of SOAs aimed at clarifying the temporal dynamics underlying the impact of political temperament on gaze cuing.

The observed dissociation between gaze cuing and arrow cuing in conservative people is theoretically relevant in that it allows to disentangle between different potential explanations. Indeed, the present findings do not support the view that conservatives have a generalized diminished tendency to follow central cues that "push" attention. In contrast my results are more in line with the idea that conservatives are specifically less responsive to stimuli acting as *social* external drives. This interpretation is consistent with the theoretical frame provided by Dodd et al. (2011), who suggested that conservatives are typically more individualistic and, therefore, they may be less prone to being influenced by others.

To conclude, results of Experiment 1 confirmed the presence of a reduced cuing effect in response to gaze but not in response to arrow cues among conservatives, whereas liberals showed a reliable cuing effect regardless of cue type. This is in line with and extends what observed by Dodd et al. (2011). Experiment 2 was carried out to replicate these findings by using stimuli more ecologically valid.

Experiment 2

In Study 1 we replicated the main result reported by Dodd et al. (2011), namely a reduced gaze-cueing effect, in the face of a spared arrow-cueing effect, among conservatives but not among liberals. Aim of the Study 2 was to replicate this pattern of results by presenting participants only with photographs of real individuals, in order to increase the ecological validity of the results. In fact, both in Dodd et al. (2011) and in Experiment 1, participants were presented with a schematic face, namely a particularly impoverished social cue which did not reflects the complexity of a stimulus such as of human face.

Methods

Participants

Thirty-three undergraduate students (Mean age = 20.06 years, *SD* = 5.402, 7 males) at the University of Padova took part in the study in exchange for course credits. All reported normal or corrected-to-normal vision and were naïve to the purpose of the experiment. The local ethic committee approved the study.

Stimuli, apparatus, and procedure

Questionnaire on political ideology

The questionnaire used to assess the political ideology of participants was the same used in Study 1.

Gaze-cueing task

The apparatus was the same as that used in Experiment 1. Two faces depicting older adults were extracted from the same set of stimuli as that used in Study 1 (00739_941201_fb, 00950_960627_fa). Stimuli were presented on a black background. Each trial began with the presentation of a white fixation cross (0.82°) in the centre of the screen for 900 ms (Fixation frame, Figure 9), followed by a central face (21.2° height × 14° width) with direct gaze (Face frame). After 900 ms, the same face appeared with averted gaze (cue frame). After 200 ms, a white target letter (L or T, 0.828) appeared 11° to the left or right of the centre of the screen in one of two possible locations: spatially congruent or incongruent with gaze direction. The target frame remained visible until a response was provided. Gaze direction was uninformative as regards target location and participants were instructed to maintain fixation at the centre of the screen. Instructions emphasized both response speed and accuracy. Participants responded using their right and left index fingers. Half of the participants were instructed to press the ‘K’ key of a standard keyboard if the target was an ‘L’, and the ‘D’ key if the target was a ‘T’. The remaining participants responded using the opposite map- ping. In the case of a wrong response, the text

'ERROR' appeared in white centred on the screen for 500 ms. There was a practice block composed by 10 trials followed by and experimental block composed by 192 trials. The whole procedure took about 20 minutes.

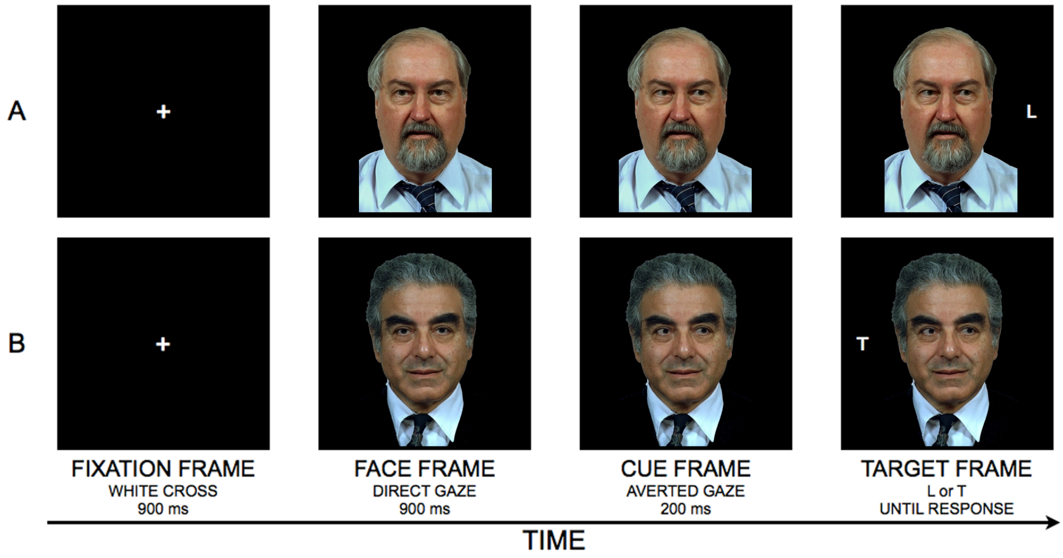

Figure 9. Illustration of stimuli (not drawn to scale) and sequence of events for a spatially congruent trial (A) and a spatially incongruent trial (B).

Results

I discarded from analysis 2 participants because they did not respond to the questionnaire and other 2 participants because they committed more than 15 % of errors, leaving my sample composed by 29 individuals. Trials in which participants committed an error (4.63 % of total trials) and outliers, defined as trials for which RTs were 3 SDs above or below the mean of each participant divided by condition (1.65 % of total trials) were removed. Errors were analysed separately.

First, I classified participants as either conservatives or liberals on the basis of their responses to the questionnaire. Responses to the questionnaire were rescaled so that higher scores corresponded to more conservative views (Mean of the experimental sample = 3.5, *SD* = .97; range from 1.88 to 5.50). The median value was 3.5. The split half resulted in 15 (4 males) liberals and 14 (2 males) conservatives. Mean RTs for correct responses were submitted to a mixed-design repeated-measures ANOVA with Cue-target spatial congruency (congruent vs. incongruent) as within-participants factors, and with Political ideology (liberal vs. conservative) as between-participants factor. The main effect of Cue-target spatial congruency was significant, $F(1,27) = 11.356$, $p = .002$, $\eta^2_p = .296$, owing to shorter RTs on Congruent ($M = 566$ ms, $SE = 14.13$) than on Incongruent ($M = 575$ ms, $SE = 14.27$) trials. Critically, the interaction Cue-target spatial congruency × Political ideology was also significant, $F(1,27) = 11.356$, $p = .002$, $\eta^2_p = .296$. Two-tailed paired-samples t-tests comparing congruent and incongruent trials divided by political ideology revealed that liberals, $t(14) = 5.428$, $p < .001$, but not conservatives, $t(13) = .7671$, $p = .514$, oriented their attention in response to gaze cues (Figure 10).

A second mixed-design repeated-measures ANOVA conducted on the percentage of errors with the same factors as earlier excluded the presence of speed-accuracy trade-off (Fs < 1).

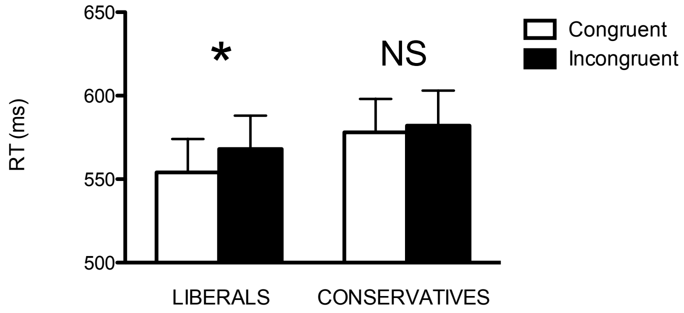

Figure 10. Mean RTs for congruent and incongruent trials divided for liberals and conservatives. Error bars represent standard error of the mean. Asterisk denote t-test $p < 0.01$. NS = not significant.

Discussion

Here I replicated the main result observed in the previous experiment, namely reduced gaze-cueing effect in conservatives but not in liberals. It is worth to notice that here I presented participants with photographs of real individuals, approaching closer what really happens during social interactions. Interestingly, recent evidence shown that when faces of real politicians are used as cues, conservatives and liberals are less influenced by gaze direction of their respective outgroup leaders (Liuzza et al., 2011, 2013). Taken together, all these evidence strongly emphasize the importance of political variables in shaping social attention. Future work is planned to address the question of whether conservatives still show an impaired cuing effect also when other social cues (e.g., pointing gestures, head turns, etc.), that are known to produce robust attention shifts (e.g., Cazzato, Macaluso, Crostella, & Aglioti, 2012; Langton & Bruce, 2000), are used. Any additional evidence in this regard would further clarify how the different views about the world hold by conservatives and liberals also reflect into different social attention mechanisms.

2.3. Study 3

I know that gaze! Effects of implicit social learning on gaze cueing

Dalmaso, M., Edwards, S. G., & Bayliss, A. P. (In preparation). I know that gaze! Effects of implicit social learning on gaze cueing.

In literature, the vast of the majority of the studies that investigated gaze-mediated orienting participants were presented with faces that they had never seen before. This means that the critical modulation was achieved by varying the physical features of the facial stimuli. For instance, as discussed also in the introductory part of this chapter, an enhanced gaze-cueing effect has been observed in response to faces that depicted fearful expressions (e.g., Kuhn & Tipples, 2011; Tipples, 2006) or faces that were characterized by signs of physical dominance (e.g., Jones et al., 2010), whereas a decreased gaze-cueing effect emerged for faces that depicted individuals of low social status manipulated through racial membership (Pavan et al., 2011). However, in every day we tend to re-encounter people we have previously interacted with or which we could know aspects related to their identity. Only a few studies assessed the role of this non-visual information associated with faces in modulating the gaze-cueing effect. For instance, in some studies participants were presented with faces of which they already possess a prior knowledge with respect to their identity. In this regard, it has been observed that faces of famous (Frischen & Tipper, 2006) or familiar (Deaner et al., 2007) individuals produced a grater gaze-cueing effect. On the other hand, in other studies the social knowledge related to faces was acquired by participants through episodic learning that preceded the gaze-cueing task. In this regard, a greater gaze-cueing effect has been observed for high than for low social status faces, when participants were asked to read some fictive CVs associated with them (see Study 1).

In the present study I conducted two experiments to further assess the impact of episodic learning on gaze-cueing effect. Unlike previous studies, here I was interested in investigate the possible impact on gaze-cueing effect of implicit learning of social information regarding gaze behavior. In fact, it is well know that eye gaze direction can produce not only shift of attention in an observer, but it also has profound influences on basic aspects of person perception. For instance, we judge other individuals as more trustworthy and more attractive and we tend to produce a stronger memory trace of them, when they make direct eye contact with us (e.g., Mason, Hood, & Macrae, 2004; Mason, Tatkow, & Macrae, 2005). Moreover, direct-gaze faces facilitate some categorical responses such as gender discrimination (Macrae, Hood, Milne, Rowe, & Mason, 2002). However, it is interestingly to note that a prolonged exposure to direct gaze can be perceived by an observer as a threatening signal which is even able to increase arousal (Argyle & Cook, 1976; Nichols & Champness, 1971). More relevant for the present study, it has been demonstrated that we tend to evaluate as more trustworthy even faces that consistently look towards an object than faces that consistently look towards the opposite direction (e.g., Bayliss, Griffiths, & Tipper, 2009; Bayliss & Tipper, 2006). This is because, embracing an evolutionary prospective, we can become aware of the presence of interesting objects in our environment (e.g., a food source, a sex mate, a danger, etc.) by using others' gaze direction. Therefore, we would tend to assign more positive traits to a face that always suggests to us the correct location of one of these objects rather than to a face that use its gaze to deceive (Bayliss & Tipper, 2006).

On this basis, I employed a novel paradigm to assess whether faces that, in a preliminary oculomotor task, showed a cooperative gaze behavior with participants instead of a non-cooperative gaze behaviour, could modulate attentional orienting in a subsequent gaze-cueing task. Cooperative or not cooperative gaze behaviour has been operationalized in term of Joint Attention (JA). JA is the most commonly used term employed to indicate a specific aspect of social attention. In fact, while gaze-cueing of attention represents a dyadic interaction involving two individuals, JA refers to a triadic interaction involving a kind of abstract triangle formed by two individuals whose share their focus of attention on a third element, such as another individual, an object or, more simply, a spatial location (e.g., Emery, 2000; Pfeiffer, Vogeley, & Schilbach, 2013; Schilbach et al., 2010). More specifically, the whole procedure was so composed. Firstly, participants were asked to take part in an implicit episodic learning phase. This consisted in a gaze-contingent eye-tracking task in which centrally-placed faces could continuously lead, or not, to a state of JA with the participant. More specifically, a peripheral instruction cue onset informed participants towards which of two spatial positions make an eye movement. This eye movement could be directed towards the instruction cue itself (i.e., a saccade) or towards the opposite spatial position (i.e., an antisaccade). After that the required eye movement was performed, participants and faces eyes could find themselves in a condition in which they were fixating towards the same position (i.e., JA) or towards the opposite position (i.e., Dis-Joint Attention; D-JA). In Experiment 1, the instruction cue was presented after that the central face moved its eyes. In other words, participant's response was subsequent to face's behaviour, a condition of gaze following. In Experiment 2 this relationship was reversed, with the instruction cue that was presented before that the central face moved its eyes. So, in this case, face's behaviour was subsequent to participant’s response, a condition of gaze leading. This second condition, in which participant is the initiating member of the JA triad, so far has been scarcely investigated. However, some recent studies have highlighted the great importance of initiating JA episodes (e.g., Bayliss et al., 2012; Schilbach, 2010). In particular, Schilbach et al. (2010) asked participants to move their eyes towards a specific part of the screen. After that, a computer-generated avatar could either look towards the same spatial location, achieving a state of JA, or towards a different spatial location, achieving a state of D-JA. Schilbach and colleagues found that the ventral striatum preferentially activated during JA episodes relative to episodes of D-JA. The ventral striatum has been shown to activate to a wide variety of reward scenarios, supporting the idea gaze leading can be considered as a form of social reinforcement. Interestingly, Schilbach and colleagues tested also the condition in which JA episodes were achieved through gaze following. In this second case, they observed an activation of different areas with respect to the gaze leading condition, with particular regards to the anterior portion of the medial prefrontal cortex which seems to be involved in stimulus oriented attending.

Critically, in both experiments of the present study, a group of faces always led to a state of JA with the participant whereas the other group of faces never led to a state of JA with the participant. Secondly, the same faces were employed in a standard gaze-cueing task, identical in both experiments, in which a peripheral target to be discriminated could be congruent or incongruent to gaze direction of the central face. Importantly, in the gaze-cueing task gaze direction was equally non-predictive of target location independently by face’s identity.

In both experiments, I expected to observe a greater gaze-cueing effect for faces that, in the first task, led to a state of JA (i.e., cooperative faces) than in a state of D-JA (i.e., non-cooperative faces) with participants. Furthermore, this question was tested using two different SOA (i.e., 200 ms and 1200 ms), in order to explore the time course of attention shifting elicited by the two groups of faces, if any. In particular, the 200-ms SOA was choose in order to tap into reflexive processes (e.g., Müller & Rabbitt, 1989), whereas the 1200-ms SOA should be more suitable to observe volitional processes (e.g., Friesen, Ristic, & Kingstone, 2004; Tipples, 2008).

Experiment 1

In the episodic learning phase of the present experiment, participants were asked to make a saccade or an antisaccade after that the central face moved its eyes. Faces looked always towards the position of the upcoming onset of the instruction cue. In this manner, participant's response was subsequent to face's behaviour, a condition of gaze following. After the learning phase, participants were asked to complete a standard gaze-cueing task in which same faces as previous task was employed. In this second task, faces were not predictive with regards to target position.

Methods

Participants

Nineteen students at the University of East Anglia (Mean age = 21 years; *SD* = 4.1; 8 males) participated in return for payment (£7) or course credits. All had correct or correct to normal vision, were naïve to the purpose of the experiment and gave a written consent approved by the local ethics committee.

Stimuli, apparatus, and procedure

A PC running E-Prime 2.0 (Psychology Software Tools, Pittsburgh, USA) handled timing and stimulus presentation. A video-based (infrared) eye tracker (Eyelink 1000, SR Research, Ontario, Canada) recorded right eye position (spatial resolution of 0.1°, 500 Hz). Participants placed their head on a chinrest in front of a 19-inch monitor (1024 × 768 px, 75 Hz). Viewing distance was 65 cm. A standard keyboard collected manual response.

Four smiling faces of white individuals were taken from the NimStim face set (Tottenham et al., 2009). Smiling faces were choses because the positive context they create appears to encourage learning processes (Bayliss, Frischen, Fenske, & Tipper, 2007; Bayliss et al., 2009; Bayliss, Schuch, & Tipper, 2010). Photos depicted two adult males and two of adult females. Each pair of same gender was matched for age and attractiveness (see Bayliss et al., 2009; Bayliss et al., 2012). Then, one male and one female were allocated to Face Group A whereas the others to Face Group B and used in the experimental blocks. An additional smiling face of a white adult male was used in the practice blocks.

Task 1: Saccade/antisaccade task

Each trial began with a central black fixation cross (0.8° of side) on a dark grey background flanked by two white squared placeholders (1° of side) with black contours (0.2° width) placed 9.8° rightwards and leftwards from the cross. Participants were asked to fixate on the cross and press the space bar once they had achieved fixation. This procedure ensured that participants fixated the centre of the screen and allowed us to perform a drift correction. 600 ms after the key press, the fixation cross was replaced by a central face with direct gaze (11° height × 8° width) for 1500 ms, followed by the same face with averted gaze rightwards or leftwards. After 200 or 1200 ms, depending on SOA, the white area of the gazed placeholder turned green or red (instruction cue). Participants were instructed to move their eyes towards the placeholder if it turned green (i.e., a saccade), or to move their eyes towards the opposite placeholder if it turned red (i.e., an antisaccade). A trial ended after that participants maintained their eyes on the correct placeholder for 500 ms, assessed by a gaze-contingent trigger (see Figure 11, Panel A).

The instruction cue was always appeared at the location to which the face looked – in other words it was spatially congruent to the gaze direction of the central face. For half of the participants, faces belonging to Face Group A always appeared on ‘saccade’ trials. So, they always looked towards the same placeholder (green) that participant was required to look at, whereas faces belonging to Face Group B always appeared on ‘antisaccade’ trials. So, they always looked towards the opposite placeholder (red) that participant was asked to look at. In this way, one set of faces always led to a state of JA with the participants, while the other faces never engaged in JA with the participant. For the other half of the participants, the type of trial associated with each face was reversed.

Participants were instructed to move their eyes as quickly and as accurately as possible and to ignore faces and gaze direction. There were 16 practice trials followed by 240 experimental trials divided in three blocks of 80 trials each in which all the experimental conditions, each of them composed by an equal number of trials, were chosen randomly. A 5-point calibration was conducted at the beginning of each block. At the end of the task a brief break was granted.

Task 2: Gaze-cueing task

Each trial began with a central black fixation cross (0.8° of side) on a dark grey background flanked by two white squared placeholders (1° of side) with black contours (0.2° width) placed 9.8° rightwards and leftwards from the cross. 600 ms after, the fixation cross was replaced by a central face with direct gaze for 1500 ms, followed by the same face with averted gaze rightwards or leftwards. The faces were the same as those in Task 1. After 200 or 1200 ms, depending on SOA, a black target line (1° height × 0.2° width) appeared centrally-placed inside one of the placeholders (see Figure 11, Panel C). The inclination of the target line could be vertical or horizontal. Half of the participants were instructed to press the 'H' key with the middle finder of their dominant hand in case the line was vertical, and the space bar with the index finger of their dominant hand in case the line was horizontal. The other half of the participants responded using the opposite mapping between key and target latter. Either face and target line remained visible until the participant responded or 3000 ms were elapsed, whichever came first. The centrally-placed red words 'ERROR' or 'NO RESPONSE' replaced the central face for 500 ms in the case of a wrong or a missing response, respectively.

Contrary to Task 1, now the participants were instructed to maintain their eyes at the centre of the screen. Moreover, although in the Task 1 there was a clear mapping between face identity and trial type, there was no such mapping here. In fact, all faces could be valid or invalid equally often with respect to target position – in other words the target line, independently by its inclination, was spatially congruent or incongruent to gaze direction of the central face with the same probability.

Participants were asked to respond as quickly and as accurately as possible and to ignore the faces and their gaze direction. There were 10 practice trials followed by 256 experimental trials in which the all the experimental conditions, each of them composed by an equal number of trials, were chosen randomly. A 5-point calibration was conducted at the beginning of the practice block. The whole Experiment (Task 1 and Task 2) lasted about 1 hour.

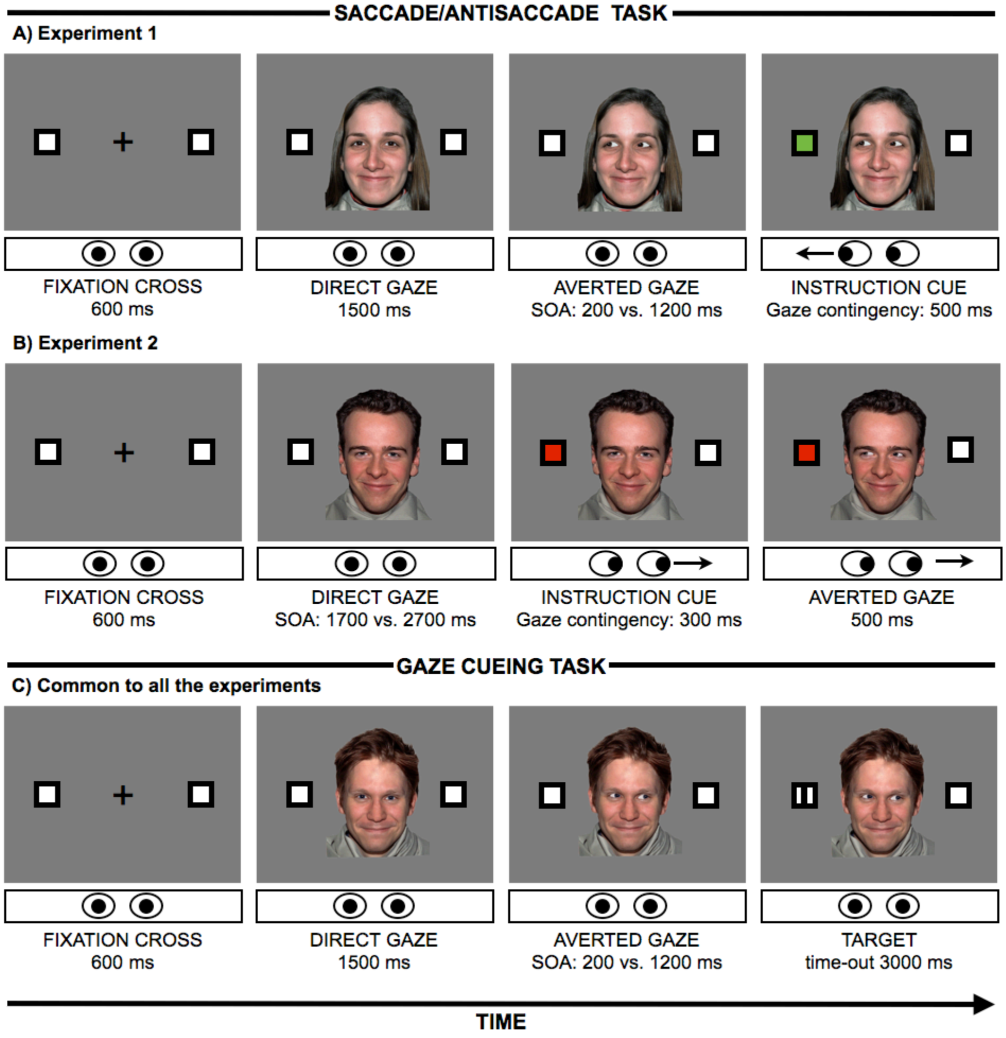

Figure 11. Panel A: Stimuli, trial sequence and timing of the saccade/antisaccade task (Task 1) used in Experiment 1. An example of JA is depicted, in which participant, who is asked to make a saccade (green instruction cue), and the central face look towards the same placeholder. Panel B: Stimuli, trial sequence and timing of the saccade/antisaccade task (Task 1) used in Experiment 2. An example of D-JA is depicted, in which participant, who is asked to make an antisaccade (red instruction cue), and the central face look towards different placeholders. Panel C: Stimuli, trial sequence and timing of the gaze-cueing task (Task 2) common to all the experiments. An example of an incongruent trial is depicted, in which a vertical target line appears in the opposite placeholder with respect to the placeholder gazed by the central face. Schematic eyes below each picture frame represent the correct eye movement requested to participants during the saccade/antisaccade task (Panel A and B) whereas in the gaze-cueing task participants were asked to maintain their eyes at the centre of the screen (Panel C). Stimuli are not drawn to scale.

Results

Task 1: Saccade/antisaccade task

Data from the first two participants were lost due to technical problems, leaving a sample of 17 participants (Mean age = 21 years; *SD* = 4.3; 7 males). Eye movement onset latency was defined as the time that elapsed from the instruction cue (colour change of the placeholder) to the initiation of the first saccade. The first saccade was defined as the first eye movement with a velocity exceeding 35°/sec and an acceleration exceeding $9500°/\text{sec}^2$. Only saccades with a minimum amplitude of 1° were analysed (for a similar procedure, see Kuhn & Tipples, 2011).

Trials containing blinks (0.7 %) were removed. Errors, namely trials in which the first saccade was in the opposite direction according to the instruction cue (8.56%), were excluded from calculation of *saccadic Reaction Times* (sRTs) and analysed separately. Outliers, defined as trials in which sRTs exceeded 3SD above and below participant's mean (1.14 %) were also discarded.

The percentages of errors for each participant in each condition were submitted to a 2 × 2 repeated-measures ANOVA with Task (antisaccade vs. saccade) and SOA (200 ms vs. 1200 ms) as within-subjects factors. The main effect of Task was significant, $F(1,16) = 11.060$, $p = .004$, $\eta^2_p = .409$, owing to less errors for the saccade ($M = 5.4$ %, $SD = 4.1$) than for the antisaccade ($M = 11.6$ %, $SD = 9.5$) movements, whereas the main effect of SOA approached statistical significance, $F(1,16) = 4.130$, $p = .059$, $\eta^2_p = .205$, reflecting fewer errors at the longer ($M = 7.5$ %, $SD = 6.5$) than at the shorter ($M = 9.5$ %, $SD = 6.4$) SOA. The interaction Task × SOA was also significant, $F(1,16) = 10.333$, $p = .005$, $\eta^2_p = .329$. Paired comparison between antisaccade and saccade movements for each SOA revealed that the percentage of errors was smaller for the saccade than for the antisaccade movements at the shorter, *t*(16)= 3.846, *p* = .001, but not at the longer, *t*(16)= .070, *p* = .945, SOA.

A second ANOVA was conducted on mean sRTs with the same factors considered for the analysis of the errors. The main effect of Task was significant, *F*(1,16) = 4.941, *p* = .041, η^2_p= .236, owing to smaller sRTs for the saccade (*M* = 267 ms, *SD* = 36.2) than for the antisaccade (*M* = 282 ms, *SD* = 45.8) movements, whereas the main effect of SOA did not reach statistical significance (*p* = .135). The Task × SOA interaction was significant, *F*(1,16) = 6. 484, *p* = .022, η^2_p= .288. Paired comparison between antisaccade and saccade movements for each SOA revealed that sRTs were smaller for the saccade than for the antisaccade movements at the shorter, *t*(16)= 3.142, *p* = .006, (25 ms), but not at the longer, t(16)= .660, *p* = .519, (5 ms), SOA.

Taken together, these results showed that the oculomotor task required to participants varied in the degree of difficulty. In particular, perform a saccade movement was easier than perform an antisaccade movement, as reported also in previously studies (e.g., Wolohan & Crawford, 2012). This is what exactly I expected to happen, since that a saccade is an eye movement towards the same location occupied by a target, whereas an antisaccade movement requires more cognitive effort in order to localize the position of the target and to program the consequent eye movement towards the opposite spatial location. More interestingly, in the present task saccade and antisaccade movements were always associated with two distinct sets of faces. So, in case participants learned this association, this could be reflected in the subsequent gaze cueing task, in which same faces were used.

Task 2: Gaze-cueing task

Errors (5.24 % of trials) and outliers, defined as trials in which RTs were 3 SD above or below participant's mean (1.79 % of trials), were discarded from manual RT analysis.

The mean error percentages for each participant in each condition were submitted to a 2 × 2 × 2 repeated-measures ANOVA with Cue-target spatial congruency (congruent vs. incongruent), SOA (200 ms vs. 1200 ms) and Type of face (D-JA face vs. JA face) as within-subjects factors. No main effects or interactions emerged (*p*s > .185).

A second ANOVA was conducted on mean RT with the same factors considered for the analysis of the errors. The main effect of Cue-target spatial congruency was significant, $F(1,18) = 18.498$, $p < .001$, $\eta^2_p = .507$, owing to smaller RTs on congruent ($M = 651$ ms; $SD = 101.7$) than on incongruent ($M = 670$ ms; $SD = 109$) trials, as well as the main effect of SOA, $F(1,18) = 5.884$, $p = .026$, $\eta^2_p = .246$, owing to smaller RTs on longer ($M = 651$ ms; $SD = 103.6$) than on shorter ($M = 670$ ms; $SD = 109.1$) SOA. Neither the main effect of Type of face nor any two-ways interactions were significant (*p*s > .355). Critically, also the triple interaction Cue-target congruency × SOA × Type of face was significant, $F(1,18) = 9.112$, $p = .007$, $\eta^2_p = .336$. Paired comparison between congruent and incongruent trials for each type of face and SOA revealed that participants shifted their attention in response to D-JA faces at the longer, $t(18) = 4.031$, $p < .001$, but not at the shorter, $t(18) = .351$, $p = .73$, SOA. On trials in which they viewed a face that had – in Task 1 – engaged them in JA, the reverse pattern emerged. These faces produced reliable gaze cueing at the shorter, *t*(18) = 3.657, *p* = .002, but not at the longer, *t*(18) = .669, *p* = .512, SOA (see Figure 2).

Data of all participants were considered for this analysis. However, since the first two participants completed the saccade/antisaccade task but I lost their data from this task due to technical problems, for completeness I further analysed gaze-cueing data excluding these two participants. Results remained unchanged. Errors analysis showed that neither main effects nor interactions approached statistical significance (all *p*s > .213). With regards to RT analysis, the main effects of cue-target spatial congruency ($F(1,16) = 15.882$, $p = .001$, $\eta^2_p = .498$) and SOA ($F(1,16) = 5.126$, $p = .038$, $\eta^2_p = .243$) were significant, as well as the triple interactions cue-target spatial congruency × SOA × type of face ($F(1,16) = 14.826$, $p = .001$, $\eta^2_p = .481$). Paired comparisons confirmed that participants oriented their attention in response to D-JA faces at the longer, *t*(16) = 4.585, *p* < .001, but not at the shorter, *t*(16) = .283, *p* = .781, SOA, and in response to JA faces at the shorter, *t*(16) = 3.613, *p* = .002, but not at the longer, *t*(16) = .326, *p* = .749, SOA.

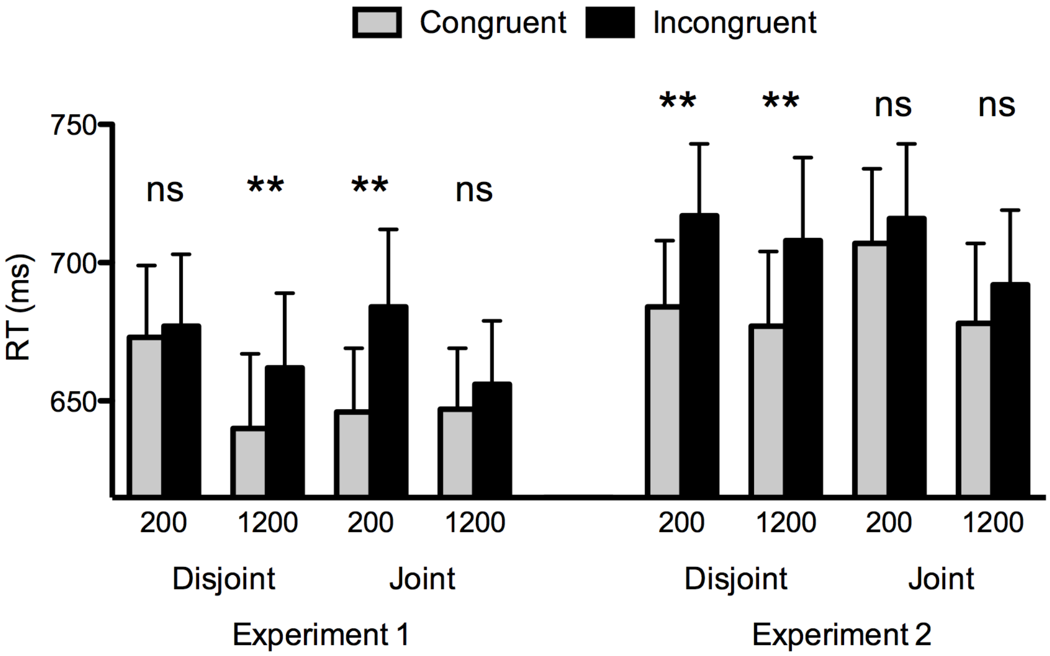

Figure 12. Mean RTs for the gaze-cueing task (Task 2) divided by type of face and SOA in Experiment 1 and 2. Error bars represent standard error of the mean. Double asterisk denote $p < .01$. NS = not significant.

Discussion

Recent evidence showed that faces that show a "cooperative" gaze behaviour are judged as more trustworthy than faces that act in a non-cooperative way (e.g., Bayliss & Tipper, 2006). Based on this evidence, here I have investigated whether faces that, in an oculomotor task, continuously led to a state of JA (i.e., cooperative faces) with participants, could even produce a greater orienting with respect to faces that continuously led to a state of D-JA (i.e., non-cooperative faces), when employed in a subsequent gaze-cueing task. At the 200-ms SOA, this hypothesis has been clearly confirmed, since a reliable gaze-cueing effect emerged in response to JA faces but not in response to D-JA faces. Interestingly, an inverted pattern emerged at the

1200-ms SOA, with a reliable gaze-cueing effect that emerged in response to D-JA faces but not in response to JA faces. This latter result was unexpected. A possible explanation could be found considering the different levels of expectations which participants have associated with each group of faces. In the case of JA faces, the expectation that these cues might gazed towards the upcoming target should be particularly high, promoting the tendency to reflexive follow their gaze as confirmed at the 200-ms SOA. However, in the case the onset of the target is delayed, as for the 1200-ms SOA, these faces would lose their reliability, and the volitional processes that should emerge at this longer SOA would favour the tendency to ignore their gaze direction. Analogously, in the case of D-JA faces, the expectation that these cues might gazed towards the upcoming target should be particularly low and participant would automatically tend to ignore their gaze, as confirmed by lack of gaze-cueing effect observed at the 200-ms SOA. Nevertheless, after a certain period of time, these faces would acquire reliability, as confirmed by the gaze-cueing effect observed at the 1200-ms.

Taken together, these results confirmed that gaze behaviour represents an important social cue that has profound impacts on our behaviour. In fact, the intentions to cooperate (or not) of other individuals, such as in the case they are willing to reach a state of JA with us, can be implicitly learned on the basis of a previous social encounter and go on to affect our subsequent responses to that individuals. However, another explanation based on the different degree of difficulty of the task associated with each group of faces could explain the results emerged in Experiment 1. For this reason, I decided to conduct Experiment 1/B as a control task.

Experiment 1/B

This second experiment has been carried out in order to rule out a potential alternative hypothesis which could explain results observe in Experiment 1. In fact, it is worth to point out that the group of faces which lead to a state of JA was always associated with a saccade, whereas the group of faces associated with a state of D-JA was always associated with an antisaccade. Due to the fact that perform a saccade is easier than perform an antisaccade (e.g., Wolohan & Crawford, 2012), one could argue that what participants actually learned during the learning phase was not related with faces' gaze behavior but simply with the difficulty associated with each group of faces. In order to test this alternative hypothesis, I decided to conduct a control experiment in which, in the episodic learning phase, a two group of faces were associated with an easier and a more difficult task, respectively. Subsequently, same faces were employed in a standard gaze-cueing task. In the case the different degree of difficulty was responsible of the results emerged in Experiment 1, here I expected to observe a similar pattern of results. Otherwise, I expected to observe no effect of this variable on gaze-cueing effect.

Methods

Participants

Nineteen students at the University of East Anglia (Mean age = 23 years; *SD* = 4; 4 males) participated in return for payment (£7) or credits course. All had correct or correct to normal vision, were naïve to the purpose of the experiment and gave a written consent approved by the local ethics committee.

Stimuli, apparatus, and procedure

Apparatus and stimuli were the same as those in Experiment 1.

Task 1: Easy vs. difficult task

The procedure was the same as that in Experiment 1 (Task 1) with the following exceptions: participants were instructed to maintain their eyes always at the centre of the screen, placeholders were absent and after the averted gaze face onset a black target line (1.3° height × 0.4° width) appeared 9.8° rightwards or leftwards from fixation. The target line could be vertically inclined of ±5° or ±45°. Participants were instructed to press the ‘Z’ key with their left index finger in case the line was inclined leftwards (i.e., −5° or −45°), and the ‘M’ key with their right index finger in case the line was inclined rightwards (i.e., +5° or +45°). In this manner, a different degree of difficulty was associated to the task required to participants.

The target line was always congruent to gaze direction of the central face. For half of the participants, faces belonging to Face Group A looked always towards a target line inclined ±5°, so they were associated with a more difficult response, whereas faces belonging to Face Group B looked always towards a target line inclined ±45°, so they were associated with an easier response. For the other half of the participants, this association was inverted.

Task 2: Gaze-cueing task

The procedure was the same as that in Experiment 1 (Task 2). The whole Experiment (Task 1 and Task 2) lasted about 1 hour.

Results

Task 1: Easy vs. difficult task

Errors (3.66 % of trials) and outliers, defined as trials in which RTs were 3 SD above and below participant's mean (1.4 % of trials), were discarded RTs from analysis.

The percentages of errors for each participant in each condition were submitted to a 2 × 2 repeated-measures ANOVA with Target inclination (±5° vs. ±45°) and SOA (200 ms vs. 1200 ms) as within-subjects factors. Only the main effect of the inclination of the target was significant, $F(1,18) = 5.052$, $p = .037$, $\eta^2_p = .219$, owing to fewer errors in response to targets inclined ±45° ($M = 2.8$ %, $SD = 6.16$) than ±5° ($M = 4.5$ %, $SD = 5.26$). Neither the main effect of SOA nor the interaction Target inclination × SOA approached statistical significance (all ps > .517).

A second ANOVA was conducted on mean RT with the same factors considered for the analysis of the errors. The main effect of Target inclination was significant, $F(1,18) = 128.482$, $p < .001$, $\eta^2_p = .877$, owing to smaller RTs in response to targets inclined ±45° ($M = 541$ ms, $SD = 100.5$) than ±5° ($M = 625$ ms, $SD = 120.7$) whereas the main effect of SOA did not reach statistical significance ($p = .726$). The interaction Target inclination × SOA was significant, $F(1,18) = 7.011$, $p = .016$, $\eta^2_p =$

.28. Paired comparison between targets inclined ±5° and ±45° divided by SOA revealed that RTs were smaller in response to the ±45° target inclination both at the shorter, $t(18) = 8.340$, $p <.001$, and at the longer, $t(18) = 10.873$, $p < .001$, SOA, but the difference between target inclination was greater in the former case (100 ms vs. 68 ms).

Taken together, these results confirmed that a different degree of difficulty was associated with the task required to participants. In particular, identify the direction of a target line was easier when it was inclined ±45° rather than ±5°, reflecting the performance associated with saccade and antisaccade movements emerged in the oculomotor task of Experiment 1.

Task 2: Gaze-cueing task

Errors (4.15 % of trials) and outliers, defined as trials in which RTs were 3 SD above and below participant's mean (2.08 % of trials), were discarded RTs from analysis.

The percentages of errors for each participant in each condition were submitted to a 2 × 2 repeated-measures ANOVA with Cue-target spatial congruency (congruent vs. incongruent), SOA (200 ms vs. 1200 ms) and Difficulty associated to face identity (easy vs. difficult) as within-subjects factors. No main effects or interactions emerged (*p*s > .12).

A second ANOVA was conducted on mean RT with the same factors considered for the analysis of the errors. The main effect of Cue-target spatial congruency was significant, $F(1,18) = 8.340$, $p = .01$, $\eta^2_p = .317$, owing to smaller RTs on congruent ($M = 656$ ms, $SD = 87.37$) than on incongruent ($M = 671$ ms, $SD =$

95.66) trials. No other main effects or interactions approached statistical significance (*p*s > .37).

Discussion

Taken together, these results confirm that in Experiment 1 the different degree of difficulty associated with the oculomotor task cannot explain the pattern of the results observed in the subsequent gaze-cueing task. On this basis, I decided to deal with Experiment 2.

Experiment 2

In Experiment 2, the relationship between the participant and the central face that occurred in the episodic learning phase was inversed with respect to Experiment 1. Namely, participants were asked to make a saccade or an antisaccade before that the central face moved its eyes. In this manner, participant's response was subsequent to face's behaviour, a condition of gaze leading (Bayliss et al., 2012; see also Schilbach et al., 2010). Also in this case, faces looked always towards the position in which the instruction cue appeared. After the learning phase, participants were asked to complete a standard gaze-cueing task in which same faces as previous task was employed. In this second task, faces were not predictive with regards to target position.

Methods

Participants

Twenty-three students at the University of East Anglia (Mean age = 24 years; SD = 4.3; 3 males) participated in return for payment (7 pounds) or credit course. All had correct or correct to normal vision, were naïve to the purpose of the experiment and gave a written consent approved by the local ethics committee.

Stimuli, apparatus, and procedure

Apparatus and stimuli were the same as those in Experiment 1.

Task 1: Saccade/antisaccade task

The procedure was the same as that Experiment 1 (Task 1) with the following exceptions: after the fixation cross, a central face with direct gaze appeared for 1700 or 2700 ms, depending on SOA. These two SOA were chosen in order to present faces for a temporal duration comparable to that in Experiment 1. After that, the instruction cue appeared and participants were asked to move their eyes towards the correct placeholder (i.e., on saccade trials, towards the placeholder that turned green and, on antisaccade trials, towards the opposite placeholder with respect to the one that turned red). After 300 ms of fixating the placeholder the eyes of the central face moved to either look at, or away from the placeholder at which the participant was looking.

Like in Experiment 1, the gaze direction of the central face was always spatially congruent to the instruction cue position. For half of the participants, faces belonging to Face Group A looked always towards the same placeholder (green) that participant was looking at (JA faces), whereas faces belonging to Face Group B looked always towards the opposite placeholder (red) that participant was looking at (D-JA faces). For the other half of the participants, this association was reversed. After 500 ms, with participant still looking at the placeholder and face's eyes still averted, a trial ended (see Figure 11, panel B).

Task 2: Gaze-cueing task

The procedure was the same as that in Task 2 of Experiment 1 (see Figure 11, Panel C). The whole Experiment (Task 1 and Task 2) lasted about 1 hour.

Results

Task 1: Saccade/antisaccade task

Saccades were extracted using the same procedure as that in Experiment 1 (Task 1).

Trials containing blinks (3.1 %) were removed. Errors, namely trials in which the first saccade was in the opposite direction according to the instruction cue (4.5 %), were excluded from RTs and analysed separately. Outliers, defined as trials in which sRTs were 3 standard deviations above and below participant's mean (1.09 %), were discarded from analysis.

The percentages of errors for each participant in each condition were submitted to a 2 × 2 repeated-measures ANOVA with Task (antisaccade vs. saccade) and SOA (200 ms vs. 1200 ms) as within-subjects factors. The main effect of Task was significant, $F(1,22) = 5.910$, $p = .024$, $\eta^2_p = .212$, owing to less errors for the saccade ($M = 2.7$ %, $SD = 3.4$) than for the antisaccade ($M = 5.8$ %, $SD = 6.8$) movements. Neither the main effect of SOA nor the interaction Task × SOA approached statistical significance (*p*s > .399).

A second ANOVA was conducted on mean sRTs with the same factors considered for the analysis of the errors. The main effect of Task was significant, $F(1,22) = 11.197$, $p = .003$, $\eta^2_p = .337$, owing to smaller RTs for the saccade ($M =$ 330 ms, $SE = 59.7$) than for the antisaccade ($M = 354$ ms, $SD = 65.6$) movements, as well as the main effect of SOA, $F(1,22) = 31.578$, $p < .001$, $\eta^2_p = .589$, owing to smaller RTs at the longer ($M = 327$ ms, $SD = 63.1$) than at the shorter ($M = 356$ ms, $SD = 59.7$) SOA. The interaction Task × SOA was not significant (F < 1).

Taken together, these results confirmed that saccades were easier to perform than antisaccades, in line with Experiment 1.

Task 2: Gaze-cueing task

Errors (3.45 % of trials) and outliers, defined as trials in which RTs were 3 SD above and below participant's mean (1.9 % of trials), were discarded from RTs analysis.

The percentages of errors for each participant in each condition were submitted to a repeated-measures ANOVA with Cue-target spatial congruency (congruent vs. incongruent), SOA (200 ms vs. 1200 ms) and Type of face (D-JA face vs. JA face) as within-subjects factors The main effect of Cue-target spatial congruency approached statistical significance, *F*(1,22) = 3.048, $p = .095$, $\eta^2_p = .122$, reflecting more errors on incongruent (*M* = 3.8 %, *SD* = 3.3) than on congruent (*M* = 3.1 %, *SD* = 2.7) trials. The interaction Cue-target spatial congruency × SOA was significant, *F*(1,22) = 9.469, $p = .006$, $\eta^2_p = .301$. Paired comparisons between congruent and incongruent trials for each SOA showed that at the shorter SOA participants committed more errors on incongruent than on congruent trials, *t*(22) = 3.087, $p = .005$, whereas no differences emerged at the longer SOA, *t*(22) = .755, $p = .458$. No other main effects or interactions approached significance (*p*s > .45).

A second ANOVA was conducted on mean RTs with the same factors considered for the analysis of the errors. The main effect of Cue-target spatial congruency was significant, *F*(1,22) = 22.758, $p < .001$, $\eta^2_p = .508$, owing to smaller RTs on congruent (*M* = 687 ms, *SD* = 126) than on incongruent (*M* = 708 ms, *SD* = 128) trials, as well as the main effect of SOA, *F*(1,22) = 5.298, $p = .031$, $\eta^2_p = .194$, owing to smaller RTs at the longer (*M* = 689 ms, *SD* = 132.9) than at the longer (*M* = 706 ms, *SD* = 122.6) SOA. The interaction SOA × Type of face was significant, *F*(1,22) = 7.075, $p = .014$, $\eta^2_p = .243$ (see Figure 12). Also the interaction Cue-target spatial congruency × Type of face was significant, *F*(1,22) = 4.972, $p = .036$, $\eta^2_p = .184$. I further analysed only the latter interaction; paired comparison between congruent and incongruent trials for each type of face revealed that participants oriented their attention in response both to D-JA, *t*(22) = 4.409, $p < .001$, and to JA, *t*(22) = 2.182, $p = .04$, faces. However, the magnitude of the gaze cueing was bigger in the former case (31 ms vs. 12 ms). The triple interaction Cue-target spatial congruency × SOA × Type was not significant (F < 1). Nevertheless, for completeness and because this interaction had been significant in Experiment 1, paired comparison between congruent and incongruent trials divided by type of face and SOA revealed that participants shifted their attention in response to D-JA faces at both SOA (*p*s < .01) but not in response to JA faces at either SOA (*p*s > .135).

Discussion

Experiment 2 was aimed to replicate the pattern of the results observed in Experiment 1 by varying the initiating member of the triadic interactions during the learning phase. In fact, while in Experiment 1 participant's response was subsequent to face's behavior, here face behavior was subsequent to participant's response. This condition of gaze leading has been largely neglected, but a few recent studies suggested that it is be of great interest indeed (e.g., Bayliss et al., 2012; Schilbach, 2010).

Results provided by Experiment 2 overlap only partially with those observed in Experiment 1. Indeed, similarly to Experiment 1, at the 1200-ms SOA participants showed a reliable gaze-cueing effect in response to faces that led to a state of D-JA but not in response to faces that led to a state of JA. Hence, it seems that even in a condition of gaze leading, when the level of the SOA allows the emergence of volitional processes, such as in the case of the 1200-ms SOA, JA faces would lose their reliability favouring the tendency to ignore their gaze direction whereas an opposite strategy would be implemented in response to D-JA faces. However, contrarily to Experiment 1, an identical pattern of results emerged even at the 200-ms SOA, namely, JA faces still failed to elicit gaze-cueing effect in the face of a reliable gaze-cueing effect in response to D-JA faces. This surprisingly, yet unexpected, result, would mean that even when reflexive orienting mechanisms are likely to occur, as in the case of the 200-ms SOA, JA faces would considered as less reliable with respect to D-JA faces. The discrepancy of these results with that observed in Experiment 1 should be mainly sought in the different conditions implemented during the learning phase. In fact, while in the learning phase of Experiment 1 participant's eye movement was subsequent to that of the central face, here in Experiment 2 the central face move its eyes after that participant's eye movement. Schilbach et al. (2010) found that this two different type behaviour (i.e., gaze following and gaze leading) recruit different neural circuits when participants where asked to reach a state of JA or D-JA with a computer-generated avatar. Hence, it is possible that this differences at a neural level could even impact at a behavioural level for a particularly long time interval, thus influencing the subsequent gaze-cueing task. To my knowledge, the present study represents finalized in understanding in the normal population the potential impact of social information, acquired through an implicit learning, on gaze cueing of attention. For this reason, it is objectively hard try to draw other potential explanations that could be reasonably explain the results observed here, in particular that emerged in Experiment 2. Future work is planned to examine in depth the potential impact of social variables that here have been neglected, such as autistic traits, gender differences, and individual variables such as trustworthiness and attractiveness associated with each face stimulus. In so doing, a more holistic view concerning implicit social learning and its effects on social attention could, hopefully, emerge.

Overall, these two experiments that compose Study 3 highlights the potential to employ social stimuli in gaze-contingent eye-tracking tasks in order to create innovative and stimulating interactive paradigms. A large implementation of that paradigms may provide to researchers the opportunity to enlarge and expand the investigation of social attention. In fact, I believe that, due to the reciprocal nature of social interaction in which, generally, two individuals act and react also on the basis of other's behaviour, gaze-contingent eye-tracking tasks could help to address the differential contribution many social processes, both implicit and explicit, under ecologically valid conditions. Furthermore, due to relatively novelty of these interactive paradigms, many different future directions can be currently followed in order to expand knowledge of some mechanisms which rule social cognition.

To conclude, taken together these two studies provide further evidence of the importance of others' gaze behaviour in modulating our own behaviour, supporting to the idea that would see the person perception system playing a key role in shaping social attention mechanisms. Future work is currently planned to persecute along this line of research.

2.4. Study 4

Is social attention impaired in schizophrenia?

Dalmaso, M., Galfano, G., Tarqui, L., Forti, B., & Castelli, L. (2013). Is social attention impaired in schizophrenia? Gaze but not pointing gestures is associated with spatial attention deficits. Neuropsychology, 27, 608-613.

The notion that attentional processing may be impaired in schizophrenia has been the focus of extensive research, especially with spatial cuing paradigms (Luck & Gold, 2008). These consist of the presentation of a spatial cue providing information concerning the location of a subsequent peripheral target stimulus requiring a response (e.g., Posner, 1980). The vast majority of studies involving schizophrenic patients have focused on reflexive attentional orienting elicited by uninformative peripheral abrupt onsets, reporting that, relative to controls, the magnitude of spatial orienting in schizophrenics seems to be even enhanced, at least under some circumstances (e.g., Fuentes, Boucart, Alvarez, Vivas, & Zimmerman, 1999). Much less is known about reflexive orienting elicited by social cues. More generally, evidence is accumulating showing that schizophrenic patients are impaired in dealing with social stimuli, in particular in processing information conveyed by eye gaze (e.g., Hooker & Park, 2005; Tso et al., 2012). As reported in the intoductive section, looking at gaze is an essential ability to create an empathic contact among individuals and gaze is a key factor in the regulation of social interactions (e.g., Emery, 2000). Moreover, in healthy participants, the gaze-cuing paradigm typically triggers reflexive shifts of attention towards the spatial location indicated by gaze (e.g., Friesen & Kingstone, 1998) followed by IOR (e.g., Frischen & Tipper, 2004). The few existing studies addressing gaze cuing in schizophrenic patients reported a different trend. Indeed, schizophrenics exhibit IOR for peripheral onset but not for gaze cues (Nestor, Klein, Pomplun, Niznikiewicz, & McCarley, 2010) while the immediate attentional response to gaze cues is more controversial. In this regard, Langdon, Corner, McLaren, Coltheart, & Ward (2006) reported that, compared to healthy controls, schizophrenic patients showed an early-rising reflexive shift of attention. At short SOA, that is when the time in between cue onset and target onset was set to 100 milliseconds (ms), a gaze-cuing effect emerged only among schizophrenic patients. At longer SOAs (i.e., 300 and 800 ms), gaze cuing was reliable and undistinguished in both schizophrenics and healthy controls. A very different pattern has recently been reported by Akiyama et al. (2008). They hypothesized that abnormal gaze cuing might specifically be observed in long-term, unremitted patients, given that hyposensitivity to social stimuli is prominent in chronic schizophrenia (e.g., Hooker & Park, 2005; Tso et al., 2012). In comparing gaze cues with central arrows, Akiyama et al. (2008) observed no differences in performance between chronic schizophrenics and healthy controls with regards to arrow-driven orienting of attention. However, in line with predictions, a decreased attentional response to gaze was observed among schizophrenics but not among healthy controls. Importantly, experimental manipulations employed by Langdon et al. (2006) and Akiyama et al. (2008) to create gaze cues were extremely polarized. On the one hand, Langdon et al. (2006) cued participants' attention by means of a turn of the head and eyes, namely they presented two simultaneous social cues (i.e., gaze and head direction). On the other hand, Akiyama et al. (2008) used a particularly impoverished social cue (i.e., a pair of rectangular vs. elliptic eyes).

The first goal of the present study was to further explore gaze-cuing response in schizophrenic patients using a gaze cue in isolation (i.e., the spatial cue only included gaze direction) but presenting the eyes embedded in a face, in order to provide a more ecological stimulus. Secondly, I aimed to explore the extent to which the altered social cuing response, if any, is specific to gaze stimuli or extends to other socially relevant cues instead. In this regard, pointing gestures elicit consistent attention shifts in healthy participants and are indeed powerful social cues for communicating information and intentions among humans (e.g., Cazzato et al., 2012; Langton, O'Malley, Bruce, 1996;). Previous studies addressing social cuing in schizophrenia only focused on gaze. For this reason, including pointing gestures in a modified spatial-cuing paradigm is particularly relevant for understanding whether any eventual impairment involves social cues overall or whether abnormal processing is confined to eye gaze. Thus, my second goal was testing whether the altered attentional response demostrated by schizophrenic patients reported in previous studies reflects gaze-specific impairments or rather it is the consequence of a more general impaired mechanism in processing social stimuli. In addition to gaze and pointing cues, arrow cues were also included in my study, in order to obtain a direct comparison between social and symbolic stimuli (see also Akiyama et al., 2008; Spencer et al., 2011). I predicted that healthy controls would shift attention to the cued location irrespective of cue type. In contrast, previous work might lead one to predict either a similar (Langdon et al., 2006) or a decreased (Akiyama et al., 2008) gaze-cuing effect for schizophrenic patients compared to healthy controls. Any altered attentional response for both gaze and pointing gestures would support the view that schizophrenia is associated with a general deficit in social cognition processes. On the other hand, any eventual pattern of findings showing an altered attentional response only for gaze cues would be consistent with the view that gaze is a special social signal characterized by unique ontogenetic and phylogenetic roots (e.g., Farroni et al., 2002). Finally, no altered attentional response was expected in schizophrenics for arrow cues, due to their symbolic nature.

Experiment

Methods

Participants

Eighteen outpatient clinical participants were recruited from two psychiatric clinics located in northern Italy. Fifteen patients had a diagnosis of schizophrenia and three were diagnosed with schizoaffective disorder. Diagnoses were made by a board-certified attending research team of psychiatrists using the International Classification of Diseases (ICD-10, World Health Organization, 1992). Eighteen healthy participants, selected carefully to be perfectly matched by gender, age and education with schizophrenic patients, participated as controls. They were interviewed and reported neither personal nor family history of psychiatric/neurological illness. Demographic and clinical information are summarized in Table 2. All participants had a normal or corrected-to-normal vision, were naïve about the purposes of the experiment, and took part on a voluntary basis. The experiment was approved by the local ethics committee.

Table 2. Demographic and clinical information of participants.

	Schizophrenic patients (N=18)	Healthy controls (N=18)
Mean age (years)	49 (7.12)	49 (7.04)
Gender	M 9, F 9	M 9, F 9
Handedness	R 18	R 18
Mean education (years)	9.33 (2.83)	9.67 (2.63)
Mean age of illness onset (years)	28.5 (5.18)	
Mean duration of illness (years)	21 (7.24)	
Typical antipsychotic medication (%)	45.9	
Atypical antipsychotic medication (%)	54.1	

Note. Values in brackets are SD. The most frequently used typical antipsychotic medication was Bromperidol, used in conjunction with Aripiprazole and Fluphenazine (N=1), Clozapine (N=2), Clozapine and Clotiapine (N=1), Clozapine and Olanzapine (N=1), Levomepromazine (N=1), Levomepromazine and Clotiapine (N=1). The most frequently used atypical antipsychotic medication was Clozapine, used in conjunction with Haloperidol (N=3), followed by Quetiapine used in conjunction with Haloperidol (N=1), Olanzapine (N=1), Paliperidone (N=1), and Perphenazine (N=1). Olanzapine was also used in conjunction with Haloperidol (N=1), and Levomepromazine (N=1). Two schizophrenic patients were also prescribed Olanzapine (N=1) and Risperidon (N=1) alone. The mean chlorpromazine (CPZ) equivalent daily dose of antipsychotic was 286.11 gr (SD= 303.8). Pharmacological therapy included also anxiolytics (benzodiazepines).

Stimuli, apparatus, and procedure

Three different stimuli were used as cues and presented in three distinct blocks of trials. In the arrow-cue block, the cue was an arrow (3.8° × 1.6°) oriented leftwards or rightwards; in the pointing finger-cue block, the cue was a schematic pointing finger (3.8° × 2.7°) oriented leftwards or rightwards; in the gaze-cue block, the cue was a schematic face (6° of diameter) with gaze averted leftwards or rightwards. The regions that in each cue provided spatial information were identical in size (3.8° × 1.6°). The arrow cue was drawn with a symmetric tale and head in order to be comparable to the two eyes of the face cue conveying directional information (also see Galfano et al., 2012). Participants sat approximately 57 cm from a 15-inch laptop monitor (1024 × 768 pixel, 60 Hz) on which stimuli were presented, using E-prime 1.1, in white against a black background.

Each trial began with a fixation cross (1°) visible for 675 ms at the centre of the screen, followed by a central cue. After either a 200-ms or 700-ms SOA, a target stimulus represented by a filled circle (1.5°) appeared 9° rightwards or leftwards with respect to the centre of the screen. Two different SOAs were used in order to investigate the time course of attention shifting elicited by the different cues. Both cue and target remained visible until the participant responded or 3000 ms were elapsed, whichever came first. The target was spatially congruent or incongruent to cue direction with the same probability. Participants were told that cue direction was uninformative with regards to target location and they were instructed to maintain fixation at the centre of the screen throughout each trial. They were asked to detect the target by pressing the space bar with their dominant hand as fast as possible, and to refrain from responding and wait for the next trial when a catch trial was displayed, namely when no target was shown. Catch trials were included to prevent anticipatory responses. The red words “ERROR” and “NO RESPONSE” were presented when participants responded on catch trials (i.e., false alarms) and when they failed to respond (i.e., missed responses), respectively. Finally, a blank screen appeared for 1000 ms (see Figure 13). Order of blocks was randomized separately for each participant, and cue type was constant within each block. Each experimental block included 96 target present trials and 24 catch trials and was preceded by a practice block containing 8 target present trials and 2 catch trials. In total, each participant went through 360 experimental trials. The entire session required about 40 minutes.

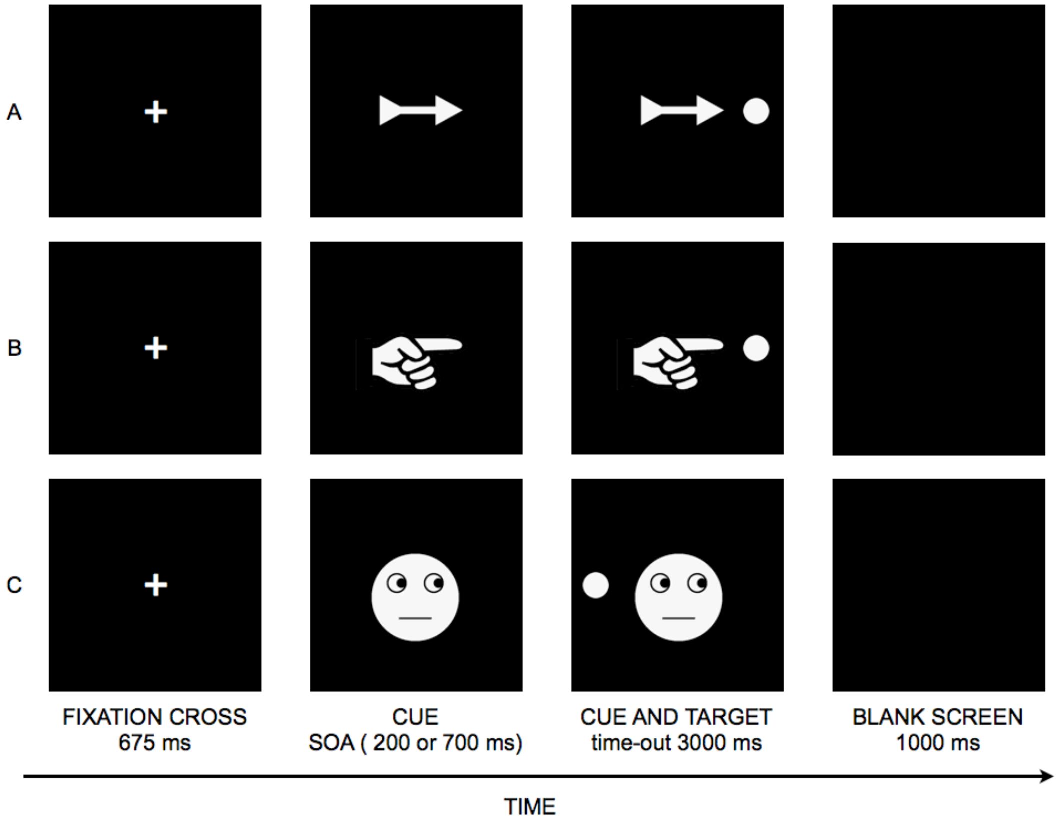

Figure 13. Illustration of stimuli (not drawn to scale) and sequence of events for a spatially congruent trial with arrow (A) and pointing finger (B) cues, and for a spatially incongruent trial with gaze cue (C).

Results

False alarms (0.4 %), missed responses (1.17 %) and anticipations defined as RTs less than 100 ms (0.17 %) were removed. Due to the low rate of errors, they were not analysed further. Raw data of each participant were then transformed to reciprocals in order to reduce the influence of extreme RTs and to obtain a more normal distribution of values (Howell, 2010, pp. 340-341; also see Slessor, Phillips, & Bull, 2008). Although analyses were carried out on reciprocal scores, for easy of interpretation, descriptive statistics are reported also as untransformed mean RTs (see Table 3).

A mixed-design repeated-measures ANOVA was performed on mean reciprocal scores, with Cue-target spatial congruency (congruent vs. incongruent), Cue type (arrow vs. pointing finger vs. gaze) and SOA (200 vs. 700 ms) as within-participants factors, and Group (schizophrenic patients vs. healthy controls) as between-participants factor. Cue-target spatial congruency was significant, $F(1,34) = 30.685$, $p < .001$, $\eta^2_p = .474$, indicating lower RTs for congruent relative to incongruent trials. Group was also significant, $F(1,34) = 5.392$, $p = .026$, $\eta^2_p =. 137$, indicating slower RTs for schizophrenics. Both the Cue-target spatial congruency × Cue type interaction, $F(2,68) = 4.453$, $p = .015$, $\eta^2_p = .116$, and the Cue-target spatial congruency × SOA interaction, $F(1,34) = 22.727$, $p = .012$, $\eta^2_p = .171$, were significant. More interestingly, the four-way Cue-target spatial congruency × Cue type × SOA × Group interaction approached statistical significance, $F(2,68) = 2.501$, $p = .09$, $\eta^2_p = .069$. No other main effects or interactions were significant. Although the four-way interaction did not reach conventional levels of significance, two separate 2 (Cue-target spatial congruency) × 3 (Cue type) × 2 (SOA) repeated measures ANOVAs were performed for the two groups, as within-participants designs provide better control of individual differences. For healthy controls, there was only a significant main effect of Cue-target spatial congruency, $F(1,17) = 18.069$, $p = .001$, $\eta^2_p = .515$, indicating lower RTs for congruent relative to incongruent trials. The Cue-target spatial congruency × Cue type interaction was not significant, $F(2,34) = 1.669$, $p = .203$, $\eta^2_p = .089$. Two-tailed paired-samples t-tests comparing congruent and incongruent trials confirmed that healthy controls oriented their attention in response to arrow, $t(17) = 2.347$, $p = .031$, pointing finger, $t(17) = 4.975$, $p < .001$, and gaze, $t(17) = 2.343$, $p = .032$, indistinguishably. For schizophrenic patients, there was a significant main effect of cue-target spatial congruency, $F(1,17) = 13.584$, $p = .002$, $\eta^2_p = .444$, indicating lower RTs for congruent relative to incongruent trials, as well as a significant Cue-target spatial congruency × SOA interaction, $F(1,17) = 7.498$, $p = .014$, $\eta^2_p = .306$. Two-tailed paired-samples t-tests indicated that schizophrenics shifted their attention to the cued location both at the shorter, $t(17) = 1.829$, $p = .043$, and at the longer, $t(17) = 4.147$, $p < .001$, SOA, although the effect was stronger in the latter case, suggesting an increased orienting response at longer intervals. Critically, the Cue-target spatial congruency × Cue type interaction was also significant, $F(2,34) = 3.643$, $p = .037$, $\eta^2_p = .176$. All the key findings for the purpose of the study remained significant also when additional ANOVAs collapsing across levels of SOA, were performed. Two-tailed paired-samples t-tests comparing congruent and incongruent trials confirmed that schizophrenics shifted their attention in response to arrows, $t(17) = 2.499$, $p = .022$, and pointing fingers, $t(17) = 4.298$, $p < .001$, but not in response to gaze, $t(17) = .664$, $p = .52$ (see Figure 14). In the attempt to obtain further evidence about the lack of gaze cuing among schizophrenic patients, data were also submitted to Bayesian analyses. This approach helps in trying to disentangle which model (null vs. alternative hypothesis) is more strongly supported by the available data and is particularly helpful for dealing with the null hypothesis appropriately. The Bayesian Information Criterion (BIC) was computed following the procedure proposed by Masson (2011). This analysis showed that the posterior probability favouring the hypothesis that gaze cuing was absent in schizophrenic patients was $p\text{BIC}(\text{H0} \mid \text{D}) = 0.771$. In contrast, the posterior probability favouring the hypothesis that gaze cuing was absent in healthy controls was $p\text{BIC}(\text{H0} \mid \text{D}) = 0.255$. Within this framing, BIC values lower than 0.50 indicate that there is more evidence for the alternative than for the null hypothesis, whereas values higher than 0.50 indicate the opposite. According to the conventional categorization of degrees of evidence (see Masson, 2011), the obtained posterior probabilities for the null hypothesis constitute “positive” evidence for the conclusion that no gaze-cuing effect is present in schizophrenics, whereas a real cuing effect is present in the control group.

To control for effects due to medication, if any, three additional Analyses of Covariance were performed with CPZ equivalent dosage as a covariate. Cuing effects were observed for both arrows and pointing gestures whereas no gaze cuing emerged ($F = .13$). This further supports the conclusion that gaze cuing is impaired among schizophrenics.

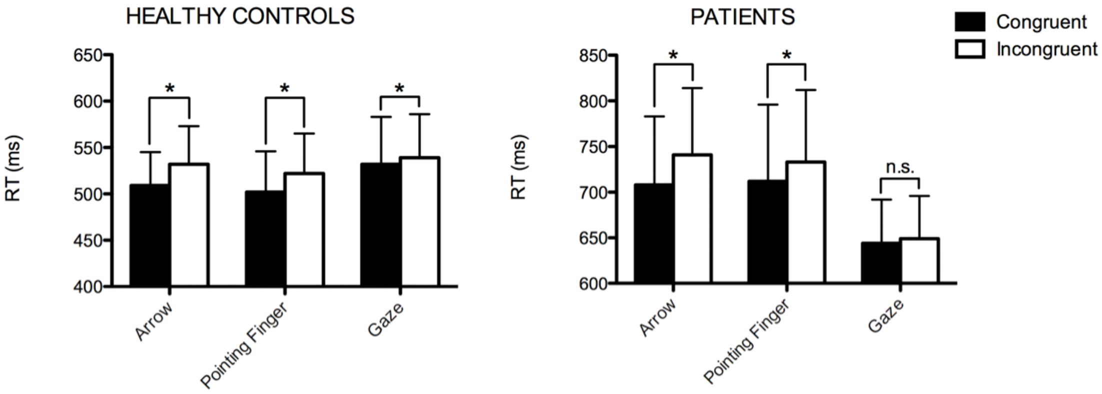

Figure 14. Mean RTs of schizophrenic patients and healthy controls for spatially congruent and incongruent trials as a function of the cue. Error bars represent standard error of the mean. Asterisks denote t-test $p < 0.05$. NS = not significant.

Table 3. Mean RTs (in ms) and Reciprocal Scores (RS) computed from raw RTs data for spatially congruent and incongruent trials as a function of both cue type and SOA, for schizophrenic patients and healthy controls. Values in brackets are SD. C = congruent trials; I = incongruent trials.

	Arrows								Pointing Finger								Gaze							
	200				700				200				700				200				700			
	C		I		C		I		C		I		C		I		C		I		C		I	
	RT	RS	RT	RS	RT	RS	RT	RS	RT	RS	RT	RS	RT	RS	RT	RS	RT	RS	RT	RS	RT	RS	RT	RS
Schizophrenic	706	0.001781	749	0.001698	710	0.001807	732	0.001703	711	0.001826	719	0.001805	713	0.001881	748	0.001684	654	0.001841	657	0.001832	635	0.001889	641	0.001868
Patients	(328)	(0.000579)	(319)	(0.000511)	(318)	(0.000565)	(305)	(0.000491)	(350)	(0.000625)	(358)	(0.000602)	(372)	(0.000627)	(322)	(0.000528)	(216)	(0.000517)	(208)	(0.000443)	(198)	(0.000498)	(202)	(0.000494)
Healthy	501	0.002219	536	0.002154	518	0.002197	528	0.002155	505	0.002284	522	0.002198	500	0.002293	522	0.002189	533	0.002186	532	0.002175	531	0.002235	545	0.002139
Controls	(146)	(0.000528)	(181)	(0.000563)	(164)	(0.000569)	(165)	(0.000559)	(195)	(0.000551)	(184)	(0.000521)	(183)	(0.000583)	(183)	(0.000553)	(205)	(0.000552)	(209)	(0.000535)	(229)	(0.000625)	(194)	(0.000539)

Discussion

The purpose of the present study was twofold. First, I aimed to clarify the presence, if any, of abnormal gaze-cuing effects in schizophrenia. In this regard, the available studies in the literature have reported mixed evidence. Langdon et al. (2006) reported consistent gaze-cuing effects for schizophrenic patients using a 100-ms SOA, with performance becoming similar to that of healthy controls at longer SOAs. In contrast, Akiyama et al. (2008) have recently reported overall decreased gaze-cuing effects in schizophrenic patients with respect to controls, in the presence of undifferentiated and reliable cuing effects for both groups when arrow cues were used. Results confirmed the pattern reported by Akiyama et al. (2008), and showed that schizophrenic patients' and healthy controls' performance could be dissociated when considering gaze but not arrow cues. In addition, abnormal processing for gaze stimuli was identified by a reduced gaze-cuing effect in schizophrenic but not in control participants. Critical factors for accounting for the discrepant results emerging from the current study and those reported by Langdon et al. (2006) may include the use of different types of gaze cues, as well as the duration of illness of the clinical samples that were tested. In this latter regard, hyposensitivity to gaze stimuli seems to become a typical schizophrenic trait only as the course of illness becomes chronic. Whereas the clinical samples included in both the present study and Akiyama et al. (2008) consisted of chronic schizophrenic patients, duration of illness in schizophrenic patients tested by Langdon et al. (2006) was shorter.

The second goal of the present study was addressing whether abnormal attentional processing of social stimuli was specific to gaze or not. This was tested using a pointing gesture, a social cue other than gaze, that has been shown to elicit robust attention shifting effects (e.g., Cazzato et al., 2012). In this regard, the present results showed that, similar to healthy controls, schizophrenic patients exhibited a reliable attentional orienting effect moderated by pointing gestures. This finding seems to suggest that the attentional deficit in processing social stimuli among schizophrenic patients is selective for gaze cues.

The latter pattern of results could be explained in terms of the special status of eye gaze, among other social and non-social cues, suggested by previous studies. Indeed, there is abundant evidence that prioritized gaze processing can be observed very early in childhood (Farroni et al., 2002) and gaze-cuing effects are even detectable in several animal species other than humans (e.g., Deaner & Platt, 2003; for a review see Shepherd, 2010), highlighting the importance of eye gaze at both an ontogenetic and phylogenetic level. Importantly, evidence concerning a prioritized response for other social signals such as pointing gestures is more scarce and less unequivocal (Shepherd, 2010).

The presence of impaired gaze cuing in schizophrenia could be linked to a dysfunction in the complex neural network regulating social processing that critically involves the Superior Temporal Sulcus (STS) region. There is abundant neuroimaging evidence showing that STS region is critically activated during gaze processing in healthy humans (Allison et al., 2000). Although some studies have reported that STS would also be engaged in processing directional information from other symbolic (Tipper, Handy, Giesbrecht, & Kingstone, 2008), and social (Sato, Kochiyama, Uono, & Yoshikawa, 2009) signals, some studies seem to suggest that involvement of STS region would be specific for eye gaze (e.g., Kingstone, Tipper, Ristic, & Ngan, 2004). Moreover, Akiyama et al. (2006) have reported a single-case study of a brain damaged patient with a lesion involving the right STS, who showed no gaze-cuing effect, in the face of spared arrow-driven orienting. Crucially, there is evidence of decreased activity of the STS region in schizophrenic patients (e.g., Rajarethinam, Venkatesh, Peethala, Luan Phan, & Keshavan, 2011). Hence, the observation that schizophrenics exhibit a reduced gaze-cuing response may be related to abnormal functioning in the STS region. Although symbolic (e.g., an arrow) or social signals other than gaze (e.g., a pointing gesture) can call STS into play to some extent, it has been shown that STS activity is much more pronounced for gaze than for these other signals (e.g., Greene et al., 2011; Sato et al., 2009). Therefore, the results of the present study seem overall consistent with the available neuropsychological data.

In sum, the present findings support the notion that schizophrenics show impaired gaze-cuing effects and are consistent with the observation of altered gaze-driven IOR for schizophrenic patients (Nestor et al., 2010). In addition, it appears that the observed deficit does not extend to other important social cues such as a pointing gesture. However, future work is needed to establish whether other types of social cuing that were not tested here are impaired in schizophrenia.

One limitation of the study is that I was unable to administer standardized measures of neuropsychological tests. Hence, the possibility of examining the contributions of neuropsychological functioning in schizophrenic patients and its relationship with symptom variables, with regards to attentional response to social vs. non-social cues, was precluded. Although these issues have been addressed in previous work (e.g., Akiyama et al., 2008; Nestor et al., 2010) further research is needed to fully understand the extent to which abnormal response to gaze stimuli is related to neuropsychological measures and affective symptoms in schizophrenic patients.

CHAPTER 3

SOCIAL MODULATORS OF SOCIAL INHIBITION OF RETURN

The phenomenon of Inhibition of Return (IOR), partially introduced in Chapter 2, is an attentional mechanism that consists in the tendency to avoid orienting attention towards spatial positions already explored. Experimentally, IOR has been reported for the first time in a spatial cueing task using peripheral cues (Posner & Cohen, 1984). In this task, participants were asked to maintain fixation on a central spot. Two squared placeholders were placed to the right and to the left of the central spot. After a certain period of time, one of the two placeholders flashed for 150 ms and, after a variable SOA, a target appeared inside one of them. This target could randomly appear inside the placeholder which get flash (i.e., a valid trial) or inside the opposite one (i.e., invalid trial). Results showed that, on the one hand, when the level of SOA was smaller than 300 ms RTs were smaller for the valid than for the invalid trials. This because attention, captured by the onset of the peripheral cue, was already positioned on the spatial position on which the target would have appeared. Instead, on the other hand, when the level of SOA was equal or greater than 300 ms, RTs were smaller for the invalid than for the valid trials. Authors explained this "bizarre" pattern of results proposing that the attention, initially positioned on the cue, then would have moved on the other location, favouring in this manner the elaboration of the target on the invalid trial. For this reason, IOR can be considered as a kind of bridge between memory and attention that would allow to "remember", for then inhibit, the spatial positions that have been already explored. Under an adaptive prospective, avoiding that our focus of attention moves back towards a spatial recently explored would help individuals in exploring the surrounding environment in a particularly efficient manner (e.g., Galfano, Betta, & Turatto, 2004; for reviews see Klein, 2000 and Lupiáñez et al., 2006).

IOR has been widely investigated by using different paradigms other than the one proposed by Posner and Cohen (1984). For instance, IOR has been observed also adopting a modified version of the standard gaze-cueing task (Frischen & Tipper, 2004). This modified version consists of presenting participants with faces with averted gaze to the left or right. After that, the gaze is reoriented back to the center. Such reorienting is aimed to encourage the disengagement of attention from the cued location, in order to facilitate the emergence of IOR. After a SOA particularly long, which is typically set to 2400 ms, a peripheral target appears in congruent or in an incongruent spatial position with respect to gaze direction. In so doing, it is possible to observe IOR in response to gaze cues (see also Frischen, Smilek, Eastwood, & Tipper, 2007; Marotta et al., 2012). More relevant for the present study, IOR has been recently observed even in a joint action task (Welsh et al., 2005). More specifically, pairs of naïve participants were asked to sit opposite each other and complete a series of rapid aiming movements to visual targets that could appear on the right or on the left. Participants responded alternatively, so that one made two successive aiming movements then the other made two successive movements, and so on. Results showed that participants were slower when repeating their own responses to a location. More interesting, however, was the observation that responses were also slower when directed to locations to which their partner had just responded. Welsh et al. (2005) concluded that IOR could emerge not only in response to own actions but even in response to actions performed by others, a phenomenon subsequently called social IOR (SIOR; Skarratt, Cole, & Kingstone, 2010).

So far, both IOR and SIOR has been reported in numerous studies which adopted the experimental apparatus developed by Welsh and collaborators (Cole, Skarratt, & Billing, 2011; Hayes, Hansen, & Elliott, 2010; Skarratt et al., 2010; Welsh, McDougall, & Weeks, 2009; Welsh et al., 2007). However, the potential impact of social variables in regulating this phenomenon has been scarcely considered. In fact, to my knoledge, only one study took into account individual differences, testing normal individuals versus individuals with Autism Spectrum Disorder (ASD) who generally show significant deficits in social interactions (Welsh, Ray, Weeks, Dewey, & Elliott, 2009). In line with the hypothesis, result coming from that study showed that participants with ASD did not demonstrate SIOR in the face of a spared IOR.

The present study represented an attempt to investigate wheteher a direct manipulation of some social variables, which charachterized people, can modulated SIOR. In particular, I manipulated the perceived similarity between individuals. In fact, recent studies reported that perceived similarity would deeply shape our perceptual (e.g., Serino, Giovagnoli, & Ladavas, 2009) and cognitive (e.g., Liew, Han, & Aziz-Zadeh, 2010) mechanisms, in particularly those involved in social attention. In fact, linking up to Chapter 2, it has been observed that the higher the perceived similarity, the stronger the gaze-cueing effect (Hungr & Hunt, 2012; Liuzza et al., 2011) and a similar pattern of results was expected even in the present study.

2.5. Study 5

I follow you if you are similar to me (but even if you are not)

This study was composed by two experiments. Experiment 1 was carried out to replicate the main findings reported by Welsh et al. (2005), namely the presence of both IOR and SIOR in a joint action task. In Experiment 2, I manipulated perceived similarity between participants. In more detail, a naïve participant was asked to read fictive information regarding a confederate who could be described as very similar or very dissimilar to him/her. After that, both individuals took part in the joint action task. I expected that the SIOR of naïve participants was greater in the case of higher perceived similarity with respect lower perceived similarity.

Experiment 1

This study was aimed to replicate the main results observed by Welsh et al. (2005), in order to validate the correct functioning of both the experimental apparatus, created *ad hoc* for this study, and the experimental paradigm. In particular, I expected to observe both IOR and SIOR, of comparable magnitude.

Methods

Participants

Twenty students (Mean age = 23 years, *SD* = 1.11, 16 females, all right-handed) of the University of Padova took part in this study on a voluntary basis. All participants were naïve to the purpose of the experiment. The local ethic committee approved the study.

Stimuli, apparatus, and procedure

Procedure was the same as that used in Welsh et al. (2005). Participants were divided in couples of same gender, in order to reduce any potential confounds due to this factor. Members of each couple, for instance A and B, sit opposite each other. In between them there was the experimental apparatus. This was composed by a metallic board connected to a PC running a custom program created with E-Prime 1.1. Four buttons were collocated on the surface of the board. Two of them, the "home" buttons, were collocated in front of each participant. The remaining two buttons, which contained a lamp, represented the "target" buttons and were collocated one on the right and one on the left of participants (see Figure 15).

Initially, participants were askes to maintain pressed, with the index finger of the dominant hand, their "home" buttons. Subsequently, one of the two "target" buttons, selected randomly by the program, flashed for 100 ms. Then, one of the participants, for instance A, were asked to a) release his "home" button as fast as possible, recording thus a RT and b) perform a rapid aiming movement in order to press the "target" button which get flashed, recording thus a Movement Time (MT). After that, 1000 ms were granted in order to go back to press the "home" button. The sequence of movements was completed in an AABBAABBAA…(etc.) pattern. This design allowed to obtain both a condition in which the "target" button that get flashed in trial *n* was the same as that in trial *n-1* (i.e., same target position), and a condition in which the "target" button that get flashed in trial *n* was different with respect to that in trial *n-1* (i.e., different target position). At the same time, this design allowed to examine both within-person (e.g., AA) and between-person (e.g., BB) IOR effects.

There were 4 practice block, each composed by 16 trials, followed by 20 experimental blocks, each composed by 33 trials in which both "target" buttons get flashed for an equal number of times. Overall, each participant responded to 660 experimental trials. The whole procedure took about 30 minutes.

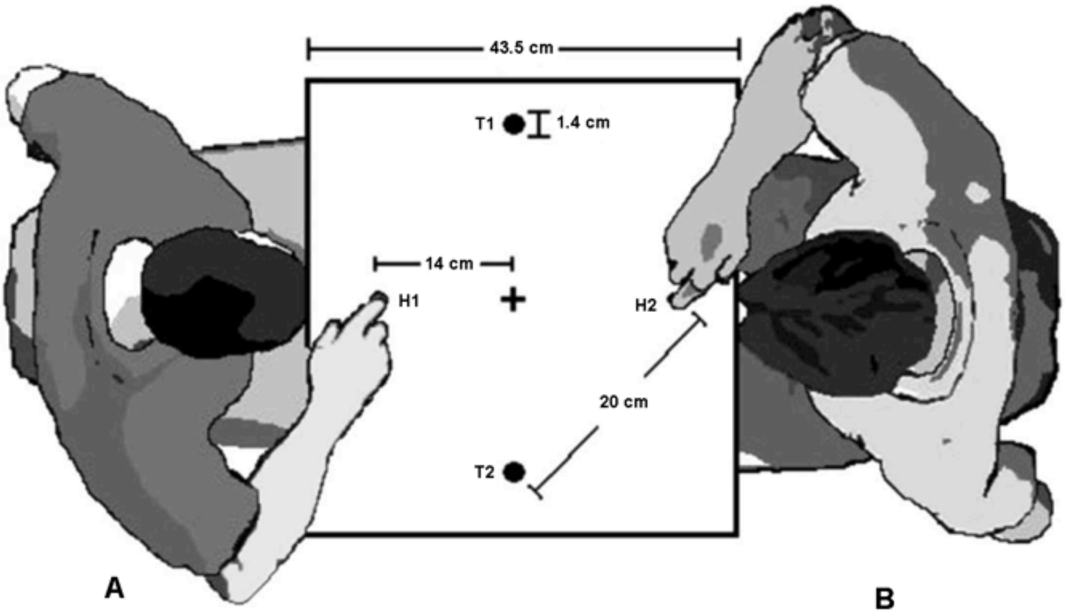

Figure 15. Illustration (not drawn to scale) of the experimental apparatus, and its size, and of the participants' placement (A and B). H1 and H2 represent the "home" buttons which participants maintained pressed during the "resting" phase, while T1 and T2 represent "target" buttons which participants were asked to press during the "movement" phase. The central black cross represent the fixation point on which participants were asked to maintain their gaze for the whole duration of the experiment (redrawn from Welsh et al., 2005).

Results

The very first trial of each block was eliminated because, for its nature, it was not preceded by a response (3% of total trials), as well as trials on which participants broke the alternation pattern or went to the incorrect location (2.4% of total trials). Moreover, adopting the same criterion used by Welsh et al. (2005), trials in which RTs were smaller than 100 ms or greater than 1000 ms were removed, as judged as anticipations and outliers, respectively (0.3% of total trials).

After data reduction, mean RTs and MTs were submitted to two distinct repeated measures ANOVAs with Target position (same vs. different) and Person (same vs. different) as within-participants factors. With regards to RTs, the main effect of Target position was significant, $F(1,9) = 53.96$, $p < .001$, $\eta^2_p = .857$, owing to greater RTs in response to the same (M = 309 ms, SE = 10.07) rather then to a different (M = 287 ms, SE = 9.18) target position. The interaction Target position × Person, crucial to the purpose of this study, did not reach the statistical level of significance ($p = .166$). Nevertheless, for completeness, two-tailed paired-samples t-test confirmed that RTs were greater in response to the same rather than to a different target position both for the within-person, $t(9) = 5.402$, $p < .001$, and for the between-person, $t(9) = 5.984$, $p = .001$, trials (see Figure 16).

With regards to MTs, of lesser importance with respect to RTs to the purpose of the present study, the main effect of Person approached statistical significance, $F(1,9) = 4.454$, $p = .064$, $\eta^2_p = .331$, reflecting greater MTs for between-person (M = 259 ms, SE = 13.5) than for the within-person (M = 252 ms, SE = 11.5) trials. No other results were significant (ps > .1). Nevertheless, for completeness, two-tailed paired-samples t-test confirmed that MTs were not different in response to the same rather than to a different target position both for the within-person, *t*(9) = 1.265, *p* = .238, and for the between-person, *t*(9) = 1.472, *p* = .175, trials.

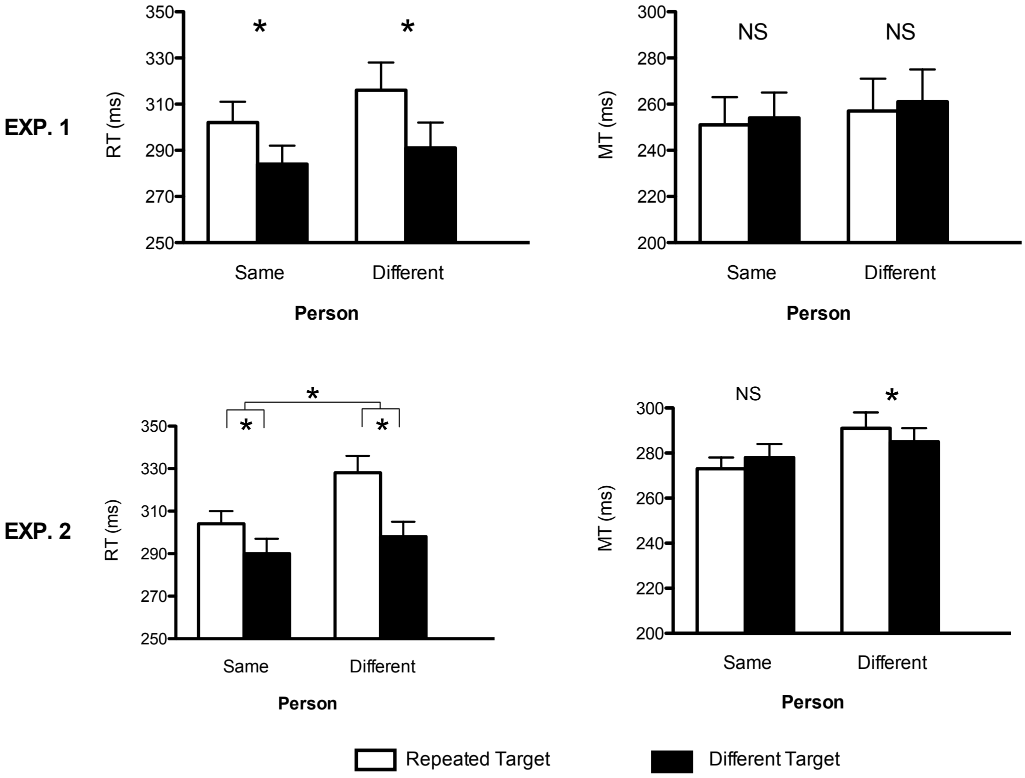

Figure 16. RT (ms) and MT (ms) as a function of Person and Target position in Experiment 1 and in Experiment 2. Error bars represent standard errors. Asterisk denotes t-test $p < .05$. NS = not significant.

Discussion

In Experiment 1 the main results observed by Welsh et al. (2005) have been replicated. In fact, RTs were greater in response to the same rather than to a different target position, and this pattern was present both for the within-person and for the between-person trials, confirming the presence of both IOR and SIOR. In so doing I have also validated the correct functioning of the experimental apparatus, allowing me to persecute with Experiment 2.

Experiment 2

Experiment 2 was aimed to investigate whether the perceived similarity between participants could modulate the magnitude of the SIOR. In particular, I expected that the SIOR of naïve participants was greater in the case of higher than lower perceived similarity. Moreover, the gender of couple, that could be either the same that different, was considered as well. In so doing, I wanted to evaluated also the potential influences of this factor in modulating SIOR, if any.

Methods

Participants

Forty students (Mean age = 23 years, *SD* = 2.64, 20 females, 4 left-handed) of the University of Padova took part in this study on a voluntary basis. A male (Age = 21 years, right-handed) and a female (Age = 25 years, left-handed) student participated as confederates. All participants, except for the two confederates, were naïve to the purpose of the experiment. The local ethic committee approved the study.

Stimuli, apparatus, and procedure

Twenty students (10 females and 10 males) were coupled with the male confederate, the remaining 20 students (10 females and 10 males) were coupled with the female confederate. In so doing, 20 same-gender couples and 20 different-gender couples were obtained, in order to evaluate any potential influence of this variable. In most of the cases, each couple resulted also matched for handedness. When this was not possible, the confederate performed the task with the same hand used by the naïve participant, in order to reduce any potential confounds related with this variable. Perceived similarity was manipulated by asking to both participants to fill a questionnaire aimed to facilitate the mutual knowledge between them. This questionnaire was composed by 13 questions regarding some "*hot social topics*" such as death penalty (i.e., "Are you in favour of death penalty?") or abortion (i.e., "Are you in favour of abortion?"; see Appendix B). Participants were informed that after the filling of the questionnaire they could read the answer provided by the other. To do that, the naïve participant was conducted in a different room with the excuse that it was important to fill the questionnaire in a quiet environment. After that the naïve participant filled the questionnaire, this was brought by the experimenter into the confederate's room. At this point, the experimenter filled the confederate's questionnaire on the basis of the responses provided by the naïve participant. In a counterbalanced manner between participants, the experimenter could fill the questionnaire to create a version with a high degree of similarity, in which all the responses, except one, were identical, or to create a version with a low degree of similarity, in which all the responses, except one, were different. Subsequently, this fictive copy of the confederate's questionnaire was delivered to the naïve participant with the request to read it, paying attention to every single answer, in order to get an idea of the other participant. Finally, the naïve participant was took back to the laboratory to complete the joint action task, whose procedure was identical as that used in Study 1.

Results

The very first trial of each block was eliminated because, for its nature, it was not preceded by a response (3% of total trials), as well as trials on which participants broke the alternation pattern or went to the incorrect location (1.9% of total trials). Moreover, trials in which RTs were smaller than 100 ms or greater than 1000 ms were removed, as judged as anticipations and outliers, respectively (0.7% of total trials).

After data reduction, mean RTs and MTs were submitted to two distinct mixed-design repeated-measures ANOVAs with Target position (same vs. different) and Person (same vs. different) as within-participants factors, and Gender of the couple (same vs. different) and Degree of similarity (high vs. low) as between-participants factors. With regards to RTs, the main effect of target position was significant, $F(1,36) = 130.52$, $p < .001$, $\eta^2_p = .784$, owing to greater RTs in response to the same ($M = 316$ ms, $SE = 6.91$) than to a different ($M = 294$ ms, $SE = 6.46$) target position, as well as the main effect of person, $F(1,36) = 17.03$, $p < .001$, $\eta^2_p = .321$, owing to greater RTs for between-person ($M = 313$ ms, $SE = 7.48$) than for the within-person ($M = 297$ ms, $SE = 6.28$) trials. Also the interaction Target position × Gender of the couple was significant, $F(1,36) = 5.33$, $p = .027$, $\eta^2_p = .129$. Two-tailed paired-samples t-tests between same and different target position divided by gender of the couple revealed that RTs were greater when participants had to move towards the same than towards a different target position either when the gender of the couple was the same, $t(19) = 5.756$, $p < .001$, that different, $t(19) = 11.665$, $p < .001$, but IOR was bigger in the latter case (17 vs. 26 ms). Finally, the interaction Target position × Person was also significant, $F(1,36) = 16.62$, $p < .001$, $\eta^2_p = .316$. Two-tailed paired-samples t-tests between same and different target position divided by person revealed that RTs were greater when participants had to move towards the same rather than towards a different target position either in the within-person, $t(39) = 4.925$, $p < .001$, that in the between person, $t(39) = 10.59$, $p < .001$, trials, but IOR was bigger in the latter case (13 vs. 30 ms; see Figure 16). No other results were significant (*p*s > .28).

With regards to MTs the main effect of Target position was significant, $F(1,36) = 35.44$, $p < .001$, $\eta^2_p = .496$, owing to greater MTs when participants had to move towards the same ($M = 288$ ms, $SE = 6.33$) rather than towards a different ($M = 276$ ms, $SE = 5.05$) target position. The interaction Target position × Degree of similarity was also significant, $F(1,36) = 4.33$, $p = .045$, $\eta^2_p = .107$. Two-tailed paired-samples t-tests between same and different Target position and divided by Degree of similarity revealed no differences either when the degree of similarity was low, $t(19) = 1.711$, $p = .103$, that high, $t(19) = -1.078$, $p = .295$, but in the latter case the difference between MTs for same target position trials and MTs for different target position trials was negative (3 ms vs. - 3 ms). Finally, also the interaction Target position × Person was significant, $F(1,36) = 11.62$, $p = .002$, $\eta^2_p = .244$. Two-tailed paired-samples t-tests between same and different target position and divided by person revealed that MTs were bigger for same target position than for different target position for between-person, $t(39) = 3.201$, $p = .003$, but not for within-person, $t(39) = -1.886$, $p = .067$, trials. No other results of crucial interest were significant (*p*s > .057; see Table 4).

Table 4. Mean RT and mean MT for each condition in Experiment 2. Values in brackets are SEM. V = Valid; I = Invalid.

Person	Same								Different							
Condition	Similar				Different				Similar				Different			
Gender	Same		Different		Same		Different		Same		Different		Same		Different	
Trial	V	I	V	I	V	I	V	I	V	I	V	I	V	I	V	I
RT (ms)	297	288	303	287	292	284	323	303	315	294	323	291	315	285	359	324
	(12)	(13)	(12)	(13)	(12)	(13)	(12)	(13)	(16)	(14)	(16)	(14)	(16)	(14)	(16)	(14)
MT (ms)	273	277	264	273	277	288	280	276	287	286	285	282	298	291	294	280
	(10)	(11)	(10)	(11)	(10)	(11)	(10)	(11)	(13)	(12)	(13)	(12)	(13)	(12)	(13)	(12)

Discussion

IOR has been traditionally investigated by testing participants individually (e.g., Frischen & Tipper, 2004; Posner & Cohen, 1984). However, recently IOR has been observed even when pair of individuals were asked to take part together in a joint action task (e.g., Welsh et al., 2005). This task consists of performing alternatively aiming movement towards peripheral targets. Typically, results show that one person's responses are slower when these movements are directed towards a location previously reached. More importantly, this slowdown in responses emerges both in the case the location was previously reached by the same and by the other individual, confirming the presence of both IOR and SIOR, respectively.

The purpose of this study was twofold. Firstly, I wanted to replicate the main results observed by Welsh et al. (2005), namely the presence of IOR and SIOR in a joint action task. To this end, I conducted Experiment 1 in which a perfect reproduction of the apparatus as well as the paradigm employed by Welsh and colleagues have been used. Results showed clearly that both IOR that SIOR emerged, confirming the correct functioning of the whole experimental procedure. Secondly, I wanted to investigate whether manipulating perceived similarity between participant could modulate SIOR. To this end, I conducted Experiment 2 in which I employed the same apparatus and paradigm as that used in Experiment 1. Perceived similarity between participants has been obtained by asking to naïve participants to read some fictive information regarding a confederate. In a between-participant design, the confederate could be described as very similar or very dissimilar to the naïve participant. The main results of Experiment 2 showed that in naïve participants SIOR was greater than IOR. That means that their attentional mechanisms have been stronger modulated by the observed confederate's aiming movements rather than by those they executed individually. More interestingly, this pattern of results has been observed independently of the fact that the confederate was described to naïve participants as very similar or very dissimilar to him/her. This result was unexpected. In fact, on the basis of recent evidence, I expected to observe that higher and lower perceived similarity should lead to an enhancement and a decrement in social attention processes, respectively (e.g., Hungr & Hunt, 2012; Liuzza et al., 2011).

The results observed in Experiment 2 are difficult to explain. First of all, the lack of a manipulation check, that would ensure that naïve participants actually perceived the confederate as very similar/dissimilar to them, represents a remarkable limit that does not allow me to exclude that this kind manipulation has worked properly. Furthermore, with this in mind, on the one hand, one could speculate that the simple fact to know some personal information about others could be sufficient to modulate SIOR. On the other hand, another explanation could emerge taking into account the modality to which the questionnaire was filled. In fact, higher and lower perceived similarity was obtained by filling the fictive confederate's questionnaire in two opposite and polarized manners, in which all the responses, except one, were identical (i.e., higher perceived similarity) or different (i.e., lower perceived similarity) to those provided by the naïve participants. If we consider similarity as a variable that develops along a continuum, the probabilities to meet an individual extremely similar or extremely different to us are both particularly scarce. However, in the case this happens, these particularly rare and peculiar individuals could exert a comparable influence on our social attentional processes, as suggested by the data collected in the present study.

In order to test these two different hypothesis, future studies are currently planned in which responses that will appear in the fictive questionnaires will be always 50% identical to those provided by the naïve participants. In the case knowing something about others is sufficient to modulate SIOR, the same pattern of results as that observed in Experiment 2 should emerge, namely a greater SIOR with respect to IOR. In the case that the peculiarity which characterized confederates in Experiment 2 was responsible of the observed modulation, no differences in the magnitude of IOR and SIOR should emerge. In this manner, further evidence regarding the role of individual differences in modulation social attention could be provided.

CHAPTER 4

VISUAL WORKING MEMORY FOR OTHER-RACE FACES: THE ROLE OF GAZE DIRECTION

One issue of utmost importance in psychology refers to how differences in race comes to influence behaviour, but only in the last decade advances in neuroscience have provided powerful tools to explore brain responses to race shedding light on the multi-faced dilemma of racial discrimination. Indeed, a growing body of work is finding that people exhibit different patterns of neural activity in response to other-race compared with own-race individuals (e.g., Amodio, Harmon-Jones, & Devine, 2003; Avenanti, Sirigu, & Aglioti, 2010; Ito & Bartholow, 2009; Ito & Senholzi, 2013; Phelps et al., 2000; Richerson et al., 2003; Sessa et al., 2012). For instance, recently Sessa et al. (2012) used the Event-Related Potentials (ERPs) approach to investigate whether the quality of Visual Working Memory (VWM) representations of faces can be modulated by race. In a change detection task, White participants were cued to memorize one or two White (own-race) or Black (other-race) faces displayed in one visual hemifield. These authors quantified the amount of information encoded in VWM by monitoring a posterior lateralized negative-going neural activity starting roughly 300 ms after the presentation of the to-be-encoded own- and other-race faces, namely, the Sustained Posterior Contralateral Negativity (SPCN; e.g., Dell'Acqua, Sessa, Jolicœur, & Robitaille, 2006) also known as Contralateral Delay Activity (CDA; e.g., Vogel, McCollough, & Machizawa, 2005). The SPCN is an excellent marker of the maintenance of objects representations in VWM (e.g., Vogel & Machizawa, 2004), as it increases in amplitude along with the amount of information encoded up to the level of VWM saturation (e.g., 3-4 simple stimuli, such as colours) at which point the SPCN amplitude usually reaches an asymptote (e.g., Vogel & Machizawa, 2004). More interestingly, it has also been reported that VWM representations of faces characterized by lower resolution (less accurate encoding of each facial feature and features integration) would correspond to reduced SPCN amplitudes (e.g., Sessa, Luria, Gotler, Jolicœur, & Dell'Acqua, 2011). In line with this assumption, Sessa et al. (2012) found that White participants showed an overall reduced SPCN amplitudes when they were asked to memorize two Black faces rather than two White faces.

According to Valentine (1991) race effects in face perception and recognition arise because of the lack of perceptual experience at processing phenotypical features of other-race faces (that are clearly different from those of own-race faces), leading to other-race faces representations that are less distinctive than own-race faces representations. This hypothesis predicts that the functional source of low-precision representations of other-race faces compared to own-race faces (that is reduced SPCN amplitudes for own-race faces relative to other-race faces) would be the lack of the observer's perceptual experience (i.e., expertise) at processing other-race faces.

To note, one aspect of critical relevance is that Sessa and collaborates (2012) employed as stimuli faces depicting White and Black individuals with direct gaze. As discussed in Chapter 1, a key-role in processing information concerning gaze direction seems to be played by the amygdala and evidence is accumulating showing that even faces depicting individuals of different race activate differentially this subcortical structure. In particular, studies have shown that activity in the amygdala can be greater (e.g., Cunningham et al., 2004) and habituates more slowly (e.g., Hart et al., 2000) following the presentation of other- than own-race faces, and correlates with implicit measures of racial prejudice, even if this last pattern was not observed when the faces used as stimuli belonged to familiar and positively regarded other-race individuals (e.g., Phelps et al., 2000). More related with the present study, a fMRI study revealed that amygdala activity can be moderated by race membership and gaze direction in conjunction (Richeson, Todd, Trawalter, & Baird, 2008). In more detail, in this study amygdala activity of White participants was enhanced when Black faces displayed directed gaze than when boring averted gaze. By contrast, White faces with direct and averted gaze produced similar levels of amygdala activity. The same pattern of results emerged even when participants where asked to rate on how threatening the faces were, namely, Black faces with direct gaze were judged as more threatening as compared to Black faces with averted gaze, whereas no differences emerged for White faces with direct and averted gaze. In other words, Black faces showing a direct gaze would activate the associated threat value to a greater extend compared to when they display an averted gaze. This result can be explained by the fact that direct gaze can signal negative approach tendencies, such as hostility and impending peril (Argyle & Cook, 1976; see also Study 3). Hence, direct gaze may be especially significant to observers when communicated by a (potentially) threatening other-race member such as a Black individual. Overall, Richeson's et al. (2008) study supports the idea that gaze direction is a critical factor in conveying threat and in engaging the amygdala. This evidence suggests that a source, other than the observer's perceptual experience (i.e., expertise) with other-race faces, might intervene in reducing the precision of other-race faces' representations (compared with own-race faces' representations), namely the threat signalled by an outgroup.

Under a neuroanatomical prospective, in adults it is well known the existence of connections between the amygdala and prefrontal areas (e.g., Gee et al., 2013) and faces characterized by emotional valence seem to be particularly effective to act as a probe of this amygdala-prefrontal connection (e.g., Whalen et al., 2013). Prefrontal areas would be involved in working memory processes (e.g., Courtney, Ungerleider, Keil, & Haxby, 1997; Grecucci, Soto, Rumiati, Humphreys, & Rotshtein, 2009; McNab & Klingberg, 2008) and, more importantly, they would project to posterior areas (Voytek & Knight, 2010) in which VWM would be generated (e.g., Todd & Marois, 2004, 2005). Taken together, this evidence suggests the possibility to observe a modulation of VWM, reflected in SPCN amplitude, depending on the direction of the gaze displayed by other-race members *via* amygdala activity. In particular, when the perceived threat conveyed by an other-race member is low (i.e., averted gaze) the amygdala would be similarly active to the condition in which an own-race member is displayed, and consequently − if threat perception is a critical factor in modulating own- and other-race faces' representations − the SPCN amplitude should be similar for own- and other-race faces. On the contrary, when the perceived threat conveyed by an other-race member is high (i.e., direct gaze) an enhanced amygdala activity, would lead to a greater interference on VWM processing of faces' identities. Along with these considerations it is indeed crucial to investigate whether VWM representations of other- and own-race faces can be modulated also by gaze direction, and Study 6 has been conducted with this purpose.

2.6. Study 6

Visual working memory for other-race faces is modulated by gaze direction

Sessa, P., & Dalmaso, M. (In preparation). Visual working memory for other-race faces is modulated by gaze direction.

The current investigation was aimed to assess the SPCN modulation in a change detection task which required White participants to maintain in VWM representations of White (own-race) and Black (other-race) faces displayed with direct and averted gaze. I predicted that both race and gaze direction modulate the engagement of VWM processing. In particular, I expected to observe a) poorer VWM representations of Black faces, with respect to White faces, when displayed with direct gaze, and b) comparable VWM representations for Black and White faces when displayed with averted gaze.

Experiment

Methods

Participants

27 White students (M= 24 years, *SD* = 2.22; 13 females; two left-handed) from the University of Padova took part in this study on a voluntary basis. All reported normal or correct-to-normal vision and were naïve to purpose of the

experiment. Informed consent was obtained from all of them. The local ethic committee approved the study.

Data from two participants were excluded because of too many EEG recording artefacts, leaving 25 participants for the analyses (*M* = 24 years, *SD* = 2.29; 12 females; two left-handed).

Stimuli, apparatus, and procedure

Face stimuli were taken by the Minear and Park (2004) database. In particular, I selected 12 White and 12 Black faces with neutral expression. For each face there were two versions, the original version depicting faces with direct gaze, and a new version depicting faces with averted gaze rightwards or leftwards. This new version was created *ad-hoc* by moving the irises about 0.25° to the right or to the left from the original central position using Photoshop CS5. All faces were then resized converted in a grey-scale, resized to 3.3° wide × 4.5° height from a viewing distance of approximately 70 cm, normalized for contrast and luminance and cropped with an ovoid mask in order to omit extraneous cues such as ears, neck and hairline. The memory and test arrays were composed by two faces of the same race with both direct or averted gaze that were located at the corners of an imaginary rectangle centred around fixation. The faces were horizontally aligned and occupied either the upper or the lower two quadrants of the visual field. The horizontal distance between the centre of two faces was 7° and the distance between the centre of the face and the fixation cross was 4.9°.

Examples of trials are depicted in Figure 17. A centrally-placed black fixation cross remained on the screen throughout the trial (Fixation cross frame, Figure 17).

After trial initiation, 500 ms elapsed before the presentation of two arrow cues, one above and one below the fixation cross, both pointing rightwards or leftwards (Predictive cue frame). The two arrow cues were displayed for 200 ms and were followed, after a variable Interstimulus Interval (ISI) of 200–400 ms (ISI frame), by the memory array of faces, which was displayed for 200 ms (Memory array frame). The memory array was composed of two faces. Following the memory array, a blank interval of 900 ms (Retention interval frame) preceded the onset of the test array, which was exposed until the response (Test array). Each memory and test array contained faces of the same race, and trials with white faces and black faces were presented in separate blocks presented in a random order.

Participants were instructed to maintain fixation throughout the trial and to memorize only the face in the memory array displayed on the side indicated by the arrow cues, and were explicitly informed that the face displayed on the opposite side were of no importance for the response they had to make at the end of the trial. The task was to compare the cued side of the memory array and test array in order to indicate whether the identity of the face had changed. On 50% of the trials, the memory array and the test array were identical. On the other 50% of trials, the face on the arrow-cued side of the memory array was replaced with a different face in the test array. When a change occurred, one face was replaced with a different fac. Half of the participants pressed the ‘‘F’’ key to indicate that the face had changed between the memory array and the test array and the ‘‘J’’ key to indicate that the memory array and the test array were identical. The other half of the participants responded using the opposite mapping. The response had to be made without speed pressure and participants were explicitly informed that speed of response would not be considered to assess their performance. Following the response, a variable intertrial interval of

1510-1600 ms elapsed before the presentation of the fixation cross indicating the beginning of the next trial.

There were 4 practical blocks each composed by 16 trials followed by 4 experimental blocks each composed by 96 trials for a total of 384 experimental trials.

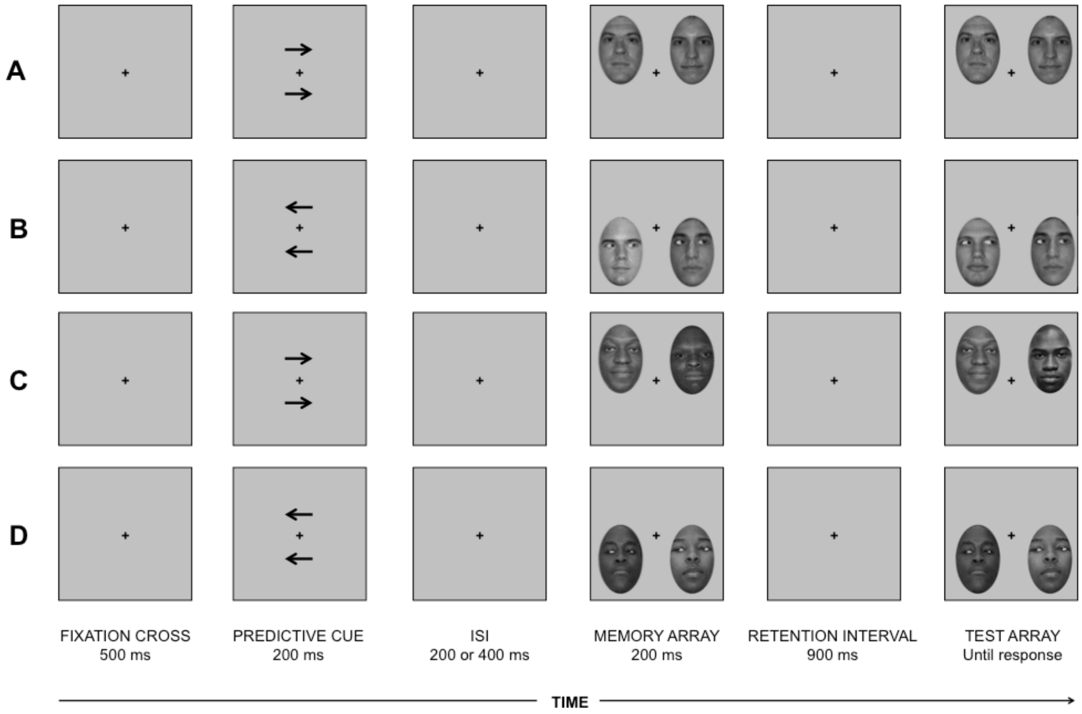

Figure 17. Illustration of the procedure and examples of White (A and B) and Black face-stimuli (C and D) with direct (A and C) and averted (B and D) gaze. Arrows indicated the to-be-memorized face during the memory array, that in the test array could remain the same (A and D) or change (B and C) with same probability.

ERPs recording and analysis

EEG activity was recorded from 64 standard electrodes distributed over the scalp according to the international 10/20 system referenced to the left earlobe. The EEG was re-referenced offline to the average of the left and right ear- lobes. Trials contaminated by eye blinks, large horizontal eye movements or incorrect responses in the change detection task were discarded from analysis. I computed contralateral waveforms by averaging the activity recorded at right hemisphere electrodes when participants were cued to encode the face stimulus on the left side of the memory array with the activity recorded from the left hemisphere electrodes when they were cued to encode the face stimulus on the right side of the memory array. SPCN was quantified at posterior electrodes sites (P7/P8) as the difference in mean amplitude between the ipsilateral and contralateral wave-forms in a time window of 300−750 ms relative to the onset of the memory array.

Results

ERPs data: SPCN component

SPCN was quantified at posterior electrodes sites (P7/P8) as the difference in mean amplitude between the contralateral and the ipsilateral waveforms in a time window of 300−750 ms relative to the onset of the memory array. Mean SPCN amplitudes were submitted to an ANOVA that considered Gaze direction (direct vs. averted) and Race (White vs. Black) as within-subjects factors. The main effect of Gaze direction was significant, $F(1,24) = 7.852$, $p = .01$, $\eta^2_p = .247$, owing to a greater amplitude of SPCN for averted ($M = -1.267$ μV, $SE = .189$) than for direct ($M= -.782$

μV, *SE* = .237) gaze, whereas the main effect of race was not significant (p = .589). The interaction Gaze direction × Race was, however, significant, F(1,24) = 5.162, p = .032, η^2_p = .177. Planned comparisons indicated that SPCN amplitude did not differ between Black (*M*= -1.365 μV, *SE* = .211) and White (*M* = -1.17 μV, *SE* = .19) faces with averted gaze, $t(24)$ = 1.532, p = .139, whereas SPCN amplitude was smaller for Black (*M* = -.633 μV, *SE* = .276) then for White (*M* = -.931 μV, *SE* = .22) faces with direct gaze, $t(24)$ = 1.891, p = .07, even if this result approached the statistical level of significance. Moreover, SPCN amplitude did not differ between White faces with direct and averted gaze, $t(24)$ = 1.553, p = .134, whereas SPCN amplitude was smaller for Black faces displayed with direct rather than with averted gaze, $t(24)$ = 2.989, p = .006 (see Figure 18).

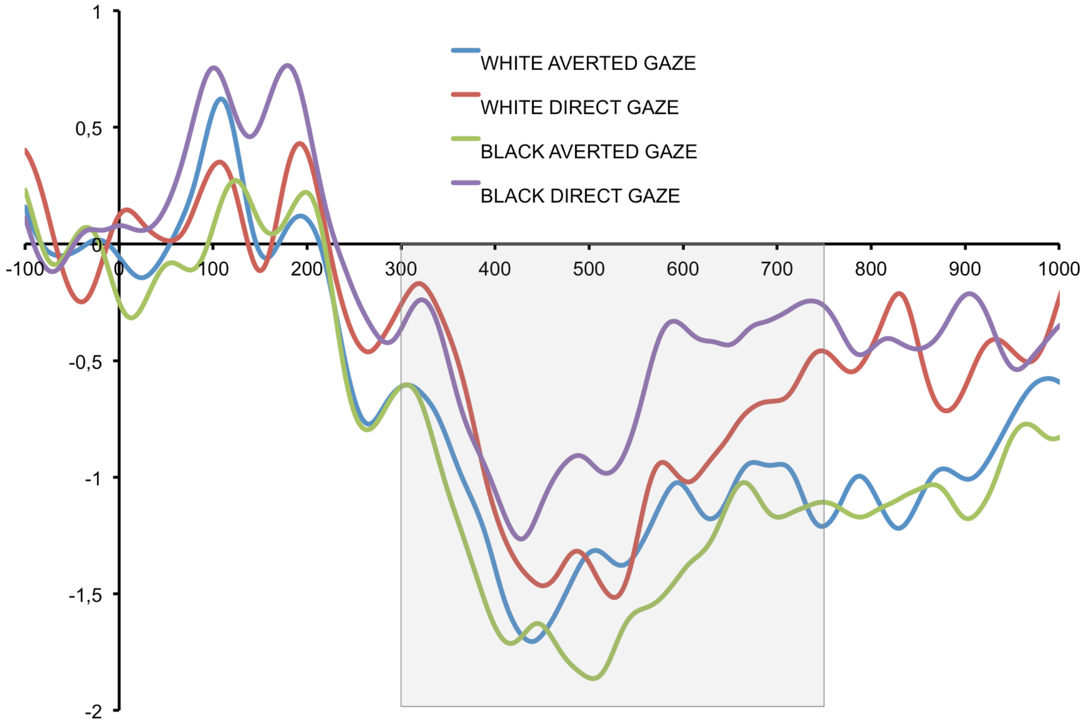

Figure 18. SPCN plotted as a function of race (black vs. white) and gaze direction (averted vs. direct). The grey rectangle indicates the SPCN temporal window (300–750 ms).

Behavioural data: Accuracy and Reaction Times

Mean accuracy was submitted to a repeated measures ANOVA that considered Gaze direction (direct vs. averted) and Race (white vs. black) as within-subjects factors. The main effect of Gaze direction was significant, $F(1,24) = 7.86$, $p = .01$, $\eta^2_p = .247$, owing to greater mean accuracy in response to direct (Mean accuracy = 86 %, *SE* = 1.17) than averted (Mean accuracy = 84 %, *SE* = 1.17) gaze. No other results were significant (*p*s > .373).

A second repeated measures ANOVA conducted on the mean RTs of correct trials (84.94 % of total trials), with the same factors as earlier, did not reveal any significant main effect or interaction (*p*s > .326).

Discussion

In the present study, I used the ERP approach to assess whether gaze direction influenced the efficiency of VWM maintenance of information about the identity of own- and other-race individuals. To this end, I used a spatially cued variant of a standard change detection task and I quantified neural activity associated with VWM maintenance of own-race (White) and other-race (Black) faces, displaying both direct and averted gaze, by monitoring SPCN responses (e.g., Dell'Acqua et al., 2006; Sessa et al., 2011, 2012). As expected, results showed that SPCN amplitude tended to be smaller for Black than for White faces when these were presented with direct gaze. On the contrary, no differences in SPCN amplitude have been observed in response to Black and White faces displayed with averted gaze. Furthermore, SPCN amplitude was larger for Black faces displaying averted rather than direct gaze, whereas for White faces SPCN amplitude was unaffected by gaze direction. Overall, this pattern of results is in line with my general hypothesis and confirm that White individuals tend to form a worse representation of Black faces when these are present with direct.

Interestingly, the behavioural data of accuracy failed to capture an analogous pattern of results. In fact, overall participants committed less errors in response to faces with direct than with averted gaze. Despite, on the one hand, this could be interpreted as a discrepancy with ERPs results, on the other hand it is consistent with previous behavioural studies which showed that faces displaying direct eye gaze facilitates person construal and social categorization (e.g., Macrae et al., 2002). So, it seems that also in the present study, it was easier to discriminate a change in facial identity when stimuli appeared with direct rather than averted gaze, at least at the behavioural level. It is worth to point put that discrepancies between behavioural and

ERPs results are quite common. In fact, in many different studies variations at the neural level did not find an analogous correspondence at the behavioural level of observation (e.g. Luck, Vogel, & Shapiro, 1996; Phelps et al., 2000; Heil, Rolke, & Pecchinenda, 2004). A shared view about that would suggest that brain responses may be more sensitive to subtle processing differences than behavioural measures and, therefore, owing to their higher sensitivity, neural measures of brain activity may convey information on possible modulations affecting the processing underlying a particular cognitive task even when such modulations do not translate into overt, or even the same, behavioural manifestations. Moreover, behavioural and neural measures could also reflect different stages in the process concerning face identification (see Wilkinson & Halligan, 2004).

As discussed in the introductory section, ERPs results may be explained taking into account the possible modulatory effect that amygdala, which should be involved in processing the emotional valence of faces, would have on the posterior areas in which VWM would be generated. In particular, greater or lesser amygdala activation would lead respectively to worse or better representation of the identity of the faces in VWM. Therefore, the results of the present study seem consistent overall with the available neuroimaging and neuropsychological data.

To conclude, these results further demonstrate the importance of eye-gaze cues in shaping processes involved in social cognition (e.g., Baron-Cohen, 1995; Emery, 2000; Frischen et al., 2007; Shepherd, 2010). In future work, I hope to build upon the findings of the present study to determine the pattern of results could emerge when the sample is composed by Black individuals. In fact, converging evidence is showing that even Black individuals, who live in Western countries, would show more positive prejudice towards Whites than Blacks (e.g., Clark & Clark, 1939;

Steele, 1997; Gündemir, Homan, de Dreu, van Vugt, 2014). This overall positive disposal towards Whites could lead to similar results as those reported in the present study, with an SPCN amplitude that could be larger for Black faces displaying averted rather than direct gaze, whereas the SPCN amplitude for White faces could still remain unaffected by gaze direction.

CHAPTER 5

GENERAL DISCUSSION AND FUTURE DIRECTIONS

Human beings, as well as other animal species, are particularly interested in where other individuals are looking at (e.g., Emery, 2000; Shepherd, 2010). The ability to orient our own attentional resources in response to spatial cues provided by others, which is generally called social attention (e.g., Nummenmaa & Calder, 2008), is crucial to successfully navigate within environment and social groups. In fact, on the one side, social attention allows to discover potential interesting stimuli around us, such as a source of food or a danger (e.g., Frischen et al., 2007). On the another side, it is considered to be a precursor to more refined and complex social skills, such as the capacity to establish an empathic contact with others (e.g., Baron-Cohen, 1995; Emery, 2000). Others' focus can be inferred by using, in particular, gaze direction, head direction, and body orientation (e.g., Perrett & Emery, 1994). Because these three social cues would be able to influence orienting independently (e.g., Hietanen, 2002; Langton & Bruce, 2000), they have been presented in isolation in the vast of the majority of the studies concerning social attention (e.g., Frischen et al., 2007).

Aim of the present thesis was to investigate the potential role of some social variables in modulating social attention. Due to the fact that social attention can be considered a multifaceted phenomenon, I have decided to employ different paradigms and different techniques to deal with this complexity, approaching social attention both from behavioural and neural perspectives. In Chapter 2 I have widely employed a behavioural paradigm known as gaze-cueing paradigm (e.g., Dalmaso et al., 2012, 2013; Friesen & Kingstone, 1998), that consists, generally, of presenting centrally-placed faces with averted gaze rightwards or leftwards. Despite this paradigm has been introduced almost two decades ago, researchers have surprisingly neglected for many years the potential impact of social variables in modulating gaze-mediated orienting of attention. Only in recent years this aspect has gained the interest that it deserves, as confirmed by a number of studies that is consistently increasing. In Chapter 3, another behavioural paradigm has been used to investigate a particular aspect of social attention known as social inhibition of return (e.g., Welsh et al., 2005). This has represented to me the first attempt to push my research towards a more ecological perspective. In fact, unlike the studies illustrated in Chapter 2 in which all participants, tested individually, were asked to “interact” with simulated people, here two participants were asked to sit opposite each other and to complete together a joint action task. In so doing, I have tried to reproduce what actually happens during real life interactions which are based on continuous and repeated mutual influences with other real individuals. Finally, Chapter 4 represents a change in perspective with respect to the previous two chapters, since here I have employed ERP technique to investigate the role of gaze direction in modulating VWM. This kind of deviation from the main topic of my research should be seen as an attempt to explore a related aspect of social attention. In fact, eye gaze, which is probably the most important cue used by individuals to infer others’ focus (e.g., Emery, 2000), plays a crucial role even on basic aspects of processes concerning person perception (e.g., Macrae et al., 2002). For this reason, I believe that every researcher interested in social attention should consider the idea to explore even this complementary field of research, in order to obtain a more holistic view about the impact of social cues provided by others on our cognitive processes.

Overall, I think that my studies provide further evidence in support of two main phenomena. On the one hand, I have confirmed that attentional resources of human beings can be modulated by spatial cues provided by others. On the other hand, the way in which such modulation occurs is related to a large extent with many social features that characterize individuals. From my point of view, one of the greatest limitations of my studies is represented by the degree of ecological validity, which is still particularly weak. In fact, the phenomenon of social attention is, by definition, a social phenomenon. Despite the fact that the simplification of the experimental setting imposed by the scientific rigor is a key factor to achieve a robust and a consistent advancement of knowledge, it should not be forgotten that the purpose of any research conducted in in the field of social cognition would be to study social processes as they take place, namely as an interaction that two, or more, individuals have in a social context in the real world. The potential lack of ecological validity that can affect many researches regarding the study of human behaviour, has been the focus of a lively and interdisciplinary debate which involved not only psychologists, but more in general thinkers and scientists belonging to many different sectors of social sciences (e.g., Birmingham & Kingstone, 2009; Dennett, 1969, 1978; Kingstone, 2009; Kingstone, Smilek, Ristic, Friesen, & Eastwood, 2003; Neisser, 1976; Skarratt, Cole, & Kuhn, 2012). In particular, Kingstone and collaborators proposed an innovative approach to study human cognition, which to some extent can be considered as a point break with respect to traditional studies in experimental psychology, that has been named "cognitive ethology" (e.g., Kingstone, Smilek, & Eastwood, 2008). The main assumption of the cognitive ethology approach proposed by Kingstone is that researchers should firstly observe how people behave in their natural environments and, only later, move to the laboratory to develop paradigms and techniques that allow to test hypothesis generated by real-world observations. In so doing, some of the limitations that generally characterized artificial laboratory experiments could be overcome (see also Skarratt et al., 2012; Pfeiffer, et al. 2013). In that sense, Study 5 could be considered as a quite good example of a cognitive ethology approach. However, I believe that another effort can be done along this direction, that is the idea that experiments concerning social attention should not be conducted necessarily in a laboratory but can even take place in the real world. This is now made possible thanks to the introduction of new generation instruments such as, for instance, portable eye trackers or cameras. These instruments allow to monitor participant's eye movements providing information about what participants see as well as where they are looking whilst they are carrying out different types of everyday tasks, or simply interacting with other individuals (e.g., Gallup, Chong, & Cozin, 2012; Gallup et al., 2012). This real-world approach could be applied successfully not only to assess the impact of many social variables on social attention, but even to more sophisticated abilities such as Theory-of-Mind Mechanism (ToMM), namely the ability to assign mental states to oneself and to others (see Chapter 1). For instance, despite the considerable and growing interest surrounding the study of ToMM, the question of whether ToMM occurs automatically, namely without any conscious effort, or instead it is subject to a volitional control is still open and represents the focus of a lively debate. On the one hand, evidence in support of an automatic ToMM has been reported by using many different paradigms which also include the gaze-cueing paradigm (e.g., Teufel et al., 2009, 2010a,b). In fact, when an observer notices that another individual is looking towards a spatial location or an object, a mental state such as an intention or a goal towards that spatial location or object can be assumed to be occurring (see also Calder et al., 2002). On the other hand, other studies have challenged the idea that ToMM can take place automatically (e.g., Apperly, Riggs, Simpson, Samson, & Chiavarino, 2006). Regardless of what may be the solution to this problem, which go beyond the scope of this thesis, I believe that even in this case a more ecological approach, based on paradigms that involve real social interactions, could provide new ideas and new starting points. Indeed, since in most of the studies concerning ToMM participants are generally required to attribute (consciously or not) a mental state to an individual, this individual should be real and not a simulated agent, given that a simulated agent should not be able to generate, by definition, any kind of mental state.

Even if I am pretty sure that the cold walls of the laboratory will still remain standing for a long time, the new insights that, potentially, could emerge by applying these two new approaches, will push the study of social attention towards stimulating, and probably unexpected, frontiers. Hopefully, in my small way, I hope that even my future studies will help to any extent to reach that unexplored land.

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Appendix A.

High- and low-status CVs, associated with older adult faces, used in Study 1 (Experiment 1). CVs from 1 to 3 of both categories have been used also in Experiments 2/A and 2/B.

High-status CVs	Low-status CVs
1. Dean of a Faculty of Architecture. President of the “European Eco-Sustainable Constructions Society”.	1. Retired factory worker. After the elementary school he worked in the textile industry.
2. Dean of a Faculty of Economy. He is director of the journal “Economy & Management”.	2. Retired agricultural worker. After the elementary school he worked as a labourer in a farm.
3. Dean of a Faculty of Medicine. He developed an innovative surgical techniques for the treatment of digestive tract tumours.	3. Retired mason. He started to work after two years of elementary school.
4. Dean of a Faculty of Agricultural. He is president of the “Italian Association of Plant Biology”.	4. Retired dustman. He left middle school after two years.
5. Dean of a Faculty of Biology. He is member of the “Centre for International Studies and Research in Toxicology".	5. Retired factory worker. He holds the middle school diploma and he has always worked in the food industry.
6. Dean of a Faculty of Veterinary Medicine. He coordinates the “International Society for Animal Genetics”.	6. Retired waiter. He attended a vocational school.
7. Dean of a Faculty of Mathematics. His research has found numerous applications in the field of space exploration.	7. Retired factory worker. He did not complete primary school.
8. Dean of a Faculty of Engineering. He is involved in the Atlas project, the biggest experiment on the physic of High Energies.	8. Retired janitor. He has no qualification.

High- and low-status CVs, associated with younger adult faces, used in Study 1 (Experiment 1).

High-status CVs	Low-status CVs
1. Graduated with honours in Pharmaceuticals Chemistry. He is currently working in the research centre of a multinational pharmaceutical company.	1. After the compulsory education he started to work as a workman in a textile industry.
2. Graduated with honours in Aerospace Engineering. He is working as a researcher at a company engaged in the development of civil aircrafts.	2. After the compulsory education he is still looking for stable employment. He works occasionally as a dishwasher in a pizzeria.
3. Graduated with honours in Biotechnology. He is currently doing a PhD in the field of animal biotechnology.	3. After the compulsory education he got a job at a call centre with a time limited contract.
4. Graduated with honours in physics. He is currently working as researcher in a famous European laboratory.	4. After the compulsory education he started to work as a warehouseman in a small provincial company.
5. Graduated with honours in Computer Science. He is currently working as a developer in one of the world's most appreciated software houses.	5. He terminated the compulsory education and he is still looking for a job.
6. Graduated with honours in Economics. He works as a researcher at a leader institution that deals with financial analysis.	6. After repeating the last year of high school, he started to work occasionally in the workshop of a friend.
7. Graduated with honours in Mathematics. He started a PhD at a prestigious university.	7. After the compulsory education he is looking for a job in industry though a temporary employment agency.
8. Graduated with honours in Medicine. He is currently doing a specialization in cardiac surgery at a famous clinic of transplants.	8. After beginning his university studies without success he is currently doing leafleting for a supermarket.

Appendix B.

Questions and possible answers that composed the questionnaire used in Study 5.

1. Are you in favour of death penalty? YES - NO
2. What is your political temperament? LIBERAL - CONSERVATIVE
3. Are you in favour of abortion? YES - NO
4. What is your religious orientation? CATHOLIC - ATHEIST - OTHER
5. Are you in favour of the legalization of the light drugs? YES - NO
6. Are you in favour of the use of nuclear energy in Italy? YES - NO
7. Are you in favour of Italian military interventions abroad? YES - NO
8. Are you in favour of the extension of civil rights to same-sex couples? YES - NO
9. Are you in favour to adoption by same-sex couples? YES - NO
10. Do you think that euthanasia should be legalized in Italy? YES - NO
11. Do you agree with the recent installation of a technical government? YES - NO
12. Are you in favour of the parliamentary immunity? YES - NO
13. Are you in favour of the intervention of the Church in Italian politics? YES - NO