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CICLO XXIII

Gaze-mediated orienting of attention: a reflexive phenomenon modulated by social factors.

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Experiment 8 of the present work use the FERET database of facial images collected under the FERET program, sponsored by the DOD Counterdrug Technology Development Program Office.

Il presente lavoro ha lo scopo di indagare un fenomeno noto come orientamento dell'attenzione mediato dallo sguardo, ovvero la tendenza a spostare automaticamente l'attenzione nella stessa direzione indicata da uno sguardo deviato. In particolare, due grandi tematiche sono state affrontate: l'automaticità e la possibile influenza di variabili sociali.

Nel Capitolo 2, è stata indagata l'automaticità dell'orientamento dell'attenzione mediato dallo sguardo. In particolare, sono stati condotti 4 esperimenti con lo scopo di testare una interpretazione forte del concetto di automaticità per due indizi centrali, ovvero sguardo e frecce. I risultati hanno mostrato che, nonostante i due indizi fossero distrattori non rilevanti per il compito da svolgere, essi comunque generavano un orientamento dell'attenzione portando quindi a concludere che l'orientamento dell'attenzione originato da frecce e sguardo sia automatico.

Nel Capitolo 3, ci si è focalizzati sulla modulabilità dell'orientamento dell'attenzione mediato dallo sguardo. Infatti, sebbene sia stato dimostrato, anche nel precedente capitolo, che la semplice visione di uno sguardo deviato genera una risposta automatica di orientamento, è inverosimile che questo avvenga anche in situazioni reali. E' invece più probabile che alcuni fattori influiscano così che venga data una priorità ad alcuni sguardi rispetto ad altri. In vari esperimenti, è stata testata la possibilità che l'appartenenza di genere e lo status sociale modulino l'orientamento dell'attenzione, rispettivamente in bambini e adulti. I risultati hanno mostrato che, quando le caratteristiche sociali del volto sono salienti ai partecipanti, l'orientamento dell'attenzione può essere modulato da variabili sociali.

Nella Discussione Generale, è stata discussa l'ambivalenza dei risultati fin qui trovati, ovvero che l'orientamento dell'attenzione mediato dallo sguardo sia al contempo automatico e modulabile, cercando di conciliare queste due caratteristiche apparentemente opposte tra loro. In particolare, ci si è focalizzati sul ruolo sia del paradigma sperimentale che della salienza delle variabili sociali nell'influenzare i risultati trovati. Infine, è stata messa luce l'importanza di adottare una prospettiva

quanto più ecologica nello studio dell'attenzione.

The present work is aimed at investigating a phenomenon called gaze-mediated orienting of attention, namely the tendency to automatically shift attention in the direction signaled by an averted gaze. In particular, throughout my thesis, two topics will be discussed, namely the automaticity and modulability of gaze-mediated orienting.

In Chapter 2, the focus was on the automaticity of gaze-mediated orienting of attention. In particular, 4 experiments were conducted with the aim to test a strong interpretation of automaticity for two central cues, namely gaze and arrows. Results showed that, even though both cues were distractors not relevant for the task at hand, they nonetheless triggered an attentional shift thus leading to the conclusion that the orienting of attention mediated by gaze and arrows is automatic.

In Chapter 3, the focus was on the modulability of gaze-mediated orienting of attention. Even though the view of an averted gaze can trigger an automatic attentional shift, as demonstrated in Chapter 2, it is implausible that this happens also in real-life situations. It is more likely that some factors influence this phenomenon so that some eyes are prioritized over others. In several experiments we tested this assumption by investigating the role of gender membership and social status, respectively in children and adults, in modulating gaze-mediated orienting. Results showed that, when the social characteristics of the face are salient to participants, gaze-mediated orienting can be modulated by such variables.

In the General Discussion, the attempt was to reconcile the apparently opposite characteristics of gaze-mediated orienting of attention, namely automaticity and modulability by focusing on the role of both experimental paradigm and saliency of social variables. At last, the importance of taking into account an ecological perspective in studying attention was stressed.

CHAPTER 1.

General Introduction

1.1 The spatial cuing paradigm

In order to efficiently interact with the environment, people need to process the stimuli around them. To this aim, the visual system processes physical information about the stimuli (e.g., color, luminance, depth, shape) in order to form a coherent and meaningful image of the object of perception. Sometimes individuals might decide to focus attention on a specific stimulus, but there are also some stimuli that are able to capture attention or push attention towards other locations in the environment. For instance, the sudden appearance of a person crossing the street while we are driving represents an event which rapidly attracts attention. Or, in the case we are looking for an office, an arrow signaling the direction we have to take to reach the final location functions as a cue able to shift attention in the corresponding direction.

The paradigm that is mainly used to study attentional orienting triggered by a cue is referred to as the spatial cuing paradigm (e.g., Posner, 1980; Posner, Nissen, & Ogden, 1978; Posner, Snyder, & Davidson, 1980). In this paradigm, a cue meant to elicit an orienting response is presented before the appearance of a target in a lateralized location, and participants' task is to process the target so as to detect, localize or identify it. For many years, two categories of cues have been studied using this kind of paradigm: peripheral and central cues. In the case of peripheral cues, a sudden event (i.e., a flash of light or an abrupt change in color) is presented at the periphery of the visual field before the appearance of the target. The target might appear either nearby the location previously occupied by the cue (i.e., congruent trials) or in the opposite location with respect to the fixation point (i.e., incongruent trials). Peripheral cues are meant to pull attention towards the location in which they appear. In the case of central cues, a directional cue (e.g., arrow) is presented in the centre of the screen pointing either left or right with the target appearing in the location either signaled by the cue (i.e., congruent trials) or in the opposite location (i.e., incongruent trials). Hence, central cues are meant to push attention in the direction signaled by the cue. During spatial cuing experiments, participants are always instructed to maintain fixation at the centre of the screen without making any eye movement and to respond to the target as fast and accurately as possible.

Thus, the spatial cuing paradigm focuses on covert orienting of attention, namely a shift of attention without any concurrent movement of the eyes. This form of attentional orienting is opposed to overt orienting of attention which refers to a shift of attention that is accompanied by a concurrent movement of the eyes or head in order to foveate the desired object. The assumption behind the spatial cuing paradigm is that, if the cue is able to pull/push attention towards a location, then participants will be faster to process the target in the case of congruent trials as compared to incongruent trials, since, in the former case, attention would be already focused on the location in which the target will appear thus facilitating the processing of such a target. On the contrary, participants will be slower on incongruent trials in that, in order to process the target, they should disengage attention from the location signaled by the cue, and reorient it to the incongruent location (see Figure 1): the greater number of cognitive operations taking place when facing an incongruent trial would result in higher reaction times (RTs) (Posner, Petersen, Fox, & Raichle, 1988).

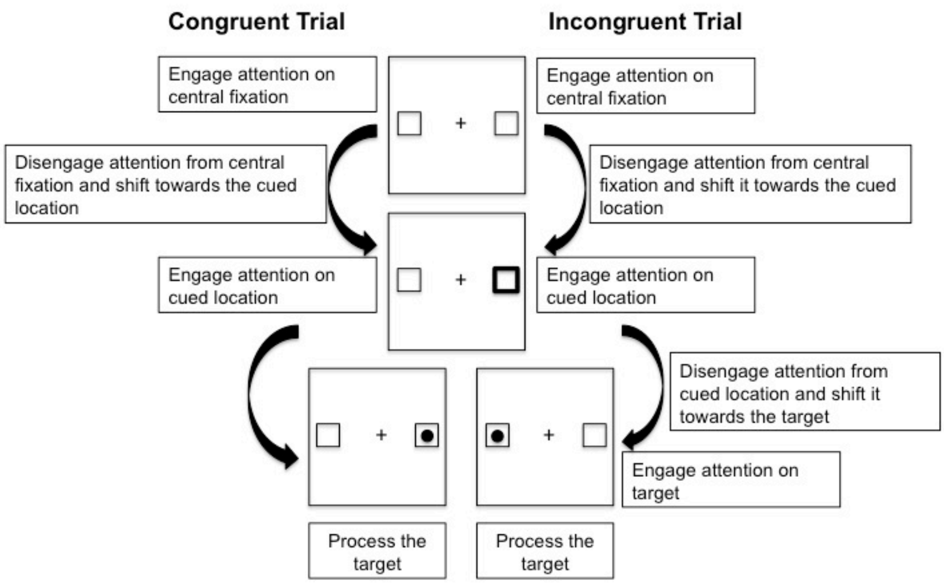

Figure 1. A schematic illustration of the cognitive operations needed for processing a target in the case of congruent versus incongruent trials.

For many years research has been investigating orienting of attention driven by central and peripheral cues. These two kinds of cues differ in their nature: indeed, central cues are sometimes referred to as symbolic cues given that participants have to interpret these cues and give them a meaning depending on the knowledge they have in memory. In contrast, peripheral cues do not need to be interpreted in that what pulls participants' attention in the location where the cue appears is a change suddenly happening in the visual field. Besides their nature, central and peripheral cues differ also for the kind of shift of attention they are able to trigger. In an extensive work, Jonides (1981) tested the degree of automaticity of the orienting of attention mediated by central and peripheral cues according to three criteria: (1) capacity demands, (2) resistance to suppression and (3) sensitivity to changes in expectancy. Peripheral cues were found to trigger an attentional shift when participants were asked to perform a memory task at the same time as the spatial cuing task (1^{st} criterion: capacity demands), when the cue was counterpredictive as to target location (2^{nd} criterion: resistance to suppression) and when its likelihood of occurrence was low (3^{rd} criterion: sensitivity to changes in expectancy). On the contrary, orienting of attention mediated by central cues was found to be disrupted in all the three conditions described above. These findings brought to the conclusion that peripheral cues trigger an automatic or reflexive shift of attention, whereas central cues would trigger a voluntary or volitional shift of attention. Based on this first result, central cues were used to study voluntary shifts of attention by presenting them in spatial cuing paradigms in which they were informative as to target location. On the contrary, peripheral cues were used to study automatic attentional shifts by presenting them in spatial cuing paradigms in which they were non informative or counterpredictive as to target location.

However, in recent years, evidence has been reported that undermines the classical association between automatic orienting and peripheral cues as opposed to voluntary orienting and central cues. Indeed, recent works have demonstrated that also arrows, which are central cues, can trigger an automatic orienting of attention (e.g., Hermens & Walker, 2010; Friesen, Ristic, & Kingstone, 2004) and, in Chapter 2, I will discuss in more details evidence regarding this issue. In addition, a great bulk of results has demonstrated that a cue we encounter very often in everyday life, which for its spatial collocation can be defined as central, namely eye gaze, can indeed trigger an automatic orienting of attention. In the next paragraph, orienting of attention mediated by gaze will be carefully described by focusing on its characteristics and time course. Later, in Chapter 2, great attention will be devoted to compare the orienting of attention mediated by arrows and gaze.

1.2 Gaze-mediated orienting of attention

Human beings are complex systems continuously interacting with external stimuli and conspecifics. However, the contrast between the richness of stimuli and the cognitive limits of human mind has made necessary the use of shortcuts in order to adequately deal with the environment. Indeed, individuals have a limited amount of cognitive resources at their disposal that does not allow to process all the information reaching their senses (see for instance research conducted on the change blindness phenomenon, in which participants have difficulties in detecting a change in the visual field unless their attention is focused on the changing location, see Simons & Ambinder, 2005 for a review). To this aim, several strategies have been developed in order to allow the least effortful but, at the same time, the most efficient exploration of the environment. Even though what is happening in front of a person can be easily detected, it is for sure more difficult to notice what is happening outside of the visual field. Thus, what if an event occurs in a location where we cannot see it as, for instance, when a car is approaching from behind? In this case, individuals may rely on signs of social attention conveyed by conspecifics. If something that is worthwhile to be noted is happening, it is likely that those people who are looking in that direction will focus on the event. Thus, by following others' line of sight, events that are not happening in front of someone might be detected. The role of gaze direction as a tool for exploring the environment has been extensively taken into consideration in the research. In his pioneering work, Yarbus (1965/1967) demonstrated that when participants face an image of an individual, they allocate more attention to the eyes as compared to the other parts of the body. In recent years, this effect has been widely replicated (e.g., Birmingham, Bischof, & Kingstone, 2008, 2009; Morton & Johnson, 1991) thus providing further support about the importance of the eyes for decoding a visual scene. Moreover, humans give a privileged attention to the eyes, but they also have a special ability in detecting gaze direction (Anstis, Mayhew, & Morley, 1969; Cline, 1967; Gibson & Pick, 1963). This ability is in part due to morphological factors concerning human eye which make the identification of gaze direction easier. Kobayashi and Kohshima (1997) compared the eye morphology of eighty-eight primate species showing that humans are the only species whose eye is characterized by a white sclera and a dark iris. Thus, the sharp contrast between the sclera and the iris in humans facilitates the detection of gaze direction in that a simple rule for detecting an averted gaze can be applied: when the dark iris is in the center of the eye, the person is looking forward, when the dark iris is on the left or on the right, the person is looking in the corresponding direction as the iris. Humans are not only capable of distinguishing an averted gaze from a direct gaze, but they can do it with great precision: indeed it was demonstrated that humans can easily distinguish an averted gaze when it is at least 1.4° from a direct gaze (Kobayashi & Kohshima, 1997).

Several authors suggested that gaze detection is so vital to social life that specific modules have developed to purposely process this information (e.g., eye-direction detector, EED, Baron-Cohen, 1995; direction of attention detector, Perrett & Emery, 1994). Electrophysiological and neuropsychological evidence clearly indicates specific brain regions devoted to gaze detection and interpretation, like the Superior Temporal Sulcus (STS; Allison, Puce, & McCarthy, 2000; Haxby, Hoffman, & Gobbini, 2000; Hoffman & Haxby, 2000; Perrett, Smith, Potter, Mistlin, Head, Milner, & Jeeves, 1985). Furthermore, evidence about the early appearance (i.e., among 2 days old babies) of the ability to discriminate between straight and averted gaze demonstrates the innate nature of gaze processing (Farroni, Csibra, Simion, & Johnson, 2002; see also Vecera & Johnson, 1995).

Research has recently dedicated great interest to the fact that an averted gaze can trigger a corresponding attentional shift in the same direction as signaled by the gaze. This phenomenon, known as gaze-mediated orienting of attention, was studied by means of a modified version of the spatial cuing paradigm (Driver, Davis, Ricciardelli, Kidd, Maxwell, & Baron-Cohen 1999; Friesen & Kingstone, 1998). In the classic experimental situation for investigating gaze-mediated orienting of attention (see Figure 2), a face is presented in the centre of the screen with direct gaze or with the eyes covered. After a specified time, the first image is replaced with the same face with eyes averted to the left or to the right (i.e., gaze cue). Then, a target may appear in the direction signaled by the eyes (i.e., congruent trials) or in the opposite direction (i.e., incongruent trials). The averted gaze represents the cue and its informativeness as regards to target location is usually one of the variable that is manipulated in such paradigms.

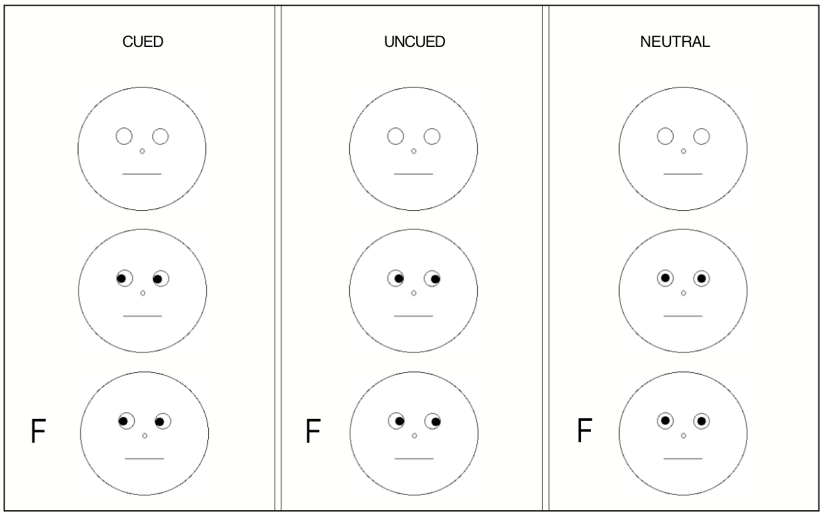

Figure 2. Example of a congruent (i.e., cued), an incongruent (i.e., uncued) and a neutral trial in a modified spatial cuing paradigm investigating gaze-mediated orienting of attention (redrawn from Friesen & Kingstone, 1998).

As in the classic spatial cuing paradigm, faster RTs on congruent trials as compared to incongruent trials (i.e., cuing effect) indicate that attention was pushed in the direction signaled by the gaze and participants were facilitated in processing the target since their attention was already focused on that location.

The first work investigating this phenomenon was carried out by Friesen and Kingstone (1998). In their work, participants were informed that gaze direction was not informative as to target location and thus participants had no incentive in paying attention to where the eyes were pointing. This manipulation was applied in order to investigate the likelihood that gaze cues triggered an attentional shift even when participants knew that there was no relation between gaze direction and target location and they were instructed not to pay attention to gaze direction. Even though the cue was not informative as to target location, a significant cuing effect was observed in that participants exhibited higher RTs on incongruent trials compared to congruent trials, independent of whether the task required an identification, a discrimination or a localization of the target.

In a later work, Driver, Davis, Ricciardelli, Kidd, Maxwell, and Baron-Cohen (1999) made a step further by presenting participants with a real face and a gaze cue counterpredictive as to target location: indeed, participants knew that the target was four times more likely to appear on the opposite side than indicated by gaze direction (see also Friesen et al., 2004). Nevertheless, Driver and colleagues (1999) found a significant cuing effect, thus suggesting that gaze cues cannot be ignored. These first results suggest that gaze-mediated orienting of attention might be defined as automatic in that it satisfies one of the criteria put forward by Jonides (1981), namely resistance to suppression. Indeed results demonstrated that even though gaze is uninformative or counterpredictive as to target location, participants cannot ignore it and a significant attentional shift is observed.

In a later study, Law, Langton, and Logie (2011) investigated the impact of a dual-task paradigm on gaze-mediated orienting of attention. Participants were asked to perform a task investigating gaze-mediated orienting of attention at the same time as a concomitant memory task (Experiment 1) or an auditory task (Experiment 2). Results showed that participants' performance in the gaze cuing task was unaffected by the concurrent tasks in that a significant cuing effect emerged in both experiments. The authors concluded that gaze-mediated orienting of attention fulfills also the first criterion of Jonides (1981), namely capacity demands, and can thus be defined as a strongly automatic phenomenon. In addition to this evidence, also the time course of gaze-mediated orienting of attention corroborates the view of this phenomenon as automatic. Indeed, it was found to emerge relatively early, namely when the *Stimulus Onset Asynchrony* (SOA: the time occurring between the presentation of the cue – the averted gaze – and the target) is around 100 ms (see Friesen & Kingstone, 1998). So far, it seems that, even though gaze should be defined as a central cue given its spatial collocation, its characteristics make it more similar to a peripheral cue, given that they both seem to share an automatic nature. However, there are some important differences in the orienting of attention mediated by peripheral cues and gaze cues. Indeed, a reliable gaze cuing effect was also found at SOAs of around 300 and 600 ms whereas, at SOA of 1000 ms the cuing effect disappeared. In contrast, the effect triggered by peripheral cues usually has its maximum at SOAs of around 100 ms and disappears soon after (Müller & Rabbit, 1989). Moreover, the cuing effect obtained for peripheral cues typically reverses at SOAs longer than 250-300 ms giving rise to the *Inhibition of Return* (IOR). IOR refers to the finding that, at specified SOAs, RTs are faster on incongruent trials as compared to congruent trials (Maylor, 1985). This mechanism is likely related to the possibility of performing a fruitful inspection of the environment: indeed, attention is initially devoted to the location indicated by the cue but, when nothing relevant (i.e., the target) happens in that location for a certain amount of time attention is likely reallocated to fixation and the location is inhibited so to encourage orienting towards novel locations (i.e., Klein, 2000 for a review). Unlike peripheral cues, IOR for gaze cues is obtained only for SOAs around 2400 ms and only if attention is previously drawn away from the gazed at location and back to the center of the screen (Frischen & Tipper, 2004).

To sum up, gaze-mediated orienting of attention has challenged the domain of attention research. Indeed, the classic view concerning orienting of attention mediated by different stimuli was built around the automatic orienting triggered by peripheral stimuli and the voluntary orienting triggered by central stimuli. However, gaze does not tap onto either one of the two categories. Indeed, gaze-mediated orienting of attention is not impaired by either memory load or the degree of predictiveness of the cue, similarly to peripheral cues. However, unlike both central and peripheral cues, gaze-mediated orienting of attention is early rising and long lasting, before disappearing and giving rise to IOR (see Figure 3).

Starting from these findings, new interest rise in exploring gaze-mediated orienting of attention. Besides its peculiar characteristics, gaze-mediated orienting of attention has also attracted great interest because it was perceived as being the lost ring of a chain in attention research connecting the laboratory and the real world (see Kingstone, Smilek, Ristic, Friesen, & Eastwood, 2003). Indeed, even though suddenly appearing peripheral

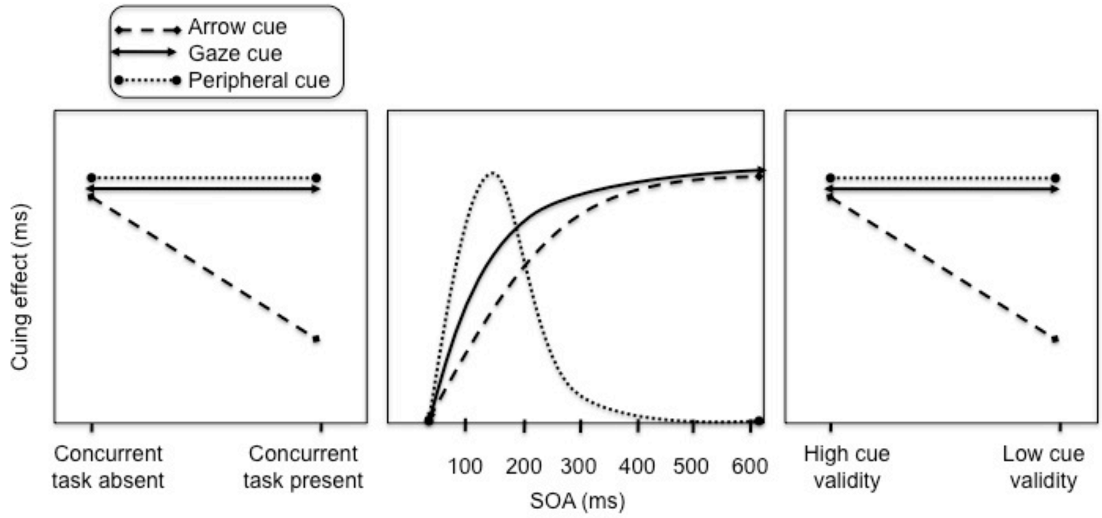

Figure 3. A comparison of the characteristics of three different cues: arrow, gaze and peripheral cues. On the y axis the cuing effect as a function of three different conditions: a) presence or absence of a concurrent task; b) variable SOA; c) high or low cue validity.

cues are highly salient and ecological in everyday life, the stimuli used in the experiments to study attentional orienting triggered by them are artificial and far from being similar to events encountered in everyday life.

On the contrary, gaze is a highly ecological cue, frequent in everyday life, salient for each individual which maintains these characteristics when brought in a laboratory setting. Thus, the simple fact of presenting participants with a face of another individual instead of an arrow or a flash of light was perceived as catching the social nature of attentional orienting. However, so far, the potential of a phenomenon such as gaze-mediated orienting of attention has not been fully exploited. It is not sufficient to present participants with an ecological stimulus, such as a face, to have an ecological experimental paradigm. Indeed, the situations in which we encounter other people in everyday life are very different from what is usually presented to participants in a classic gaze cuing task.

In my thesis, the aim is to highlight the two-faced nature of gaze-mediated orienting of attention. In the following chapters, I will focus on two different, and apparently opposite, aspects concerning this phenomenon.

In Chapter 2, the focus will be on the comparison between the attentional orienting triggered by two central cues, namely arrows and gaze. As we have described in the previous pages, the classic research in the attention domain has considered the attentional shift triggered by central cues, such as arrows, as voluntary for a long time. However, recent evidence is in sharp contrast with this label. Indeed, some studies showed that both centrally presented directional words (Hommel, Pratt, Colzato, & Godijn, 2001) and centrally presented arrows (e.g., Eimer, 1997; Pratt & Hommel, 2003; Tipples, 2002) trigger a corresponding attentional shift even when uninformative as to target location, thus suggesting an automatic attentional orienting for these two cues. Moreover, as previously discussed, gaze, which for its spatial collocation should be defined as a central cue, was found to trigger an automatic attentional orienting. Thus, in Chapter 2, I will review in more details the recent literature on this topic and I will present 4 experiments which are meant to test a strong interpretation of automaticity for gaze and arrows thus letting me to corroborate or disconfirm previous results.

In Chapter 3, I will focus on a more ecological aspect related to gaze-mediated orienting of attention, namely on the social factors which can influence this phenomenon. We know that the mere observation of a movement of the eyes can trigger a corresponding shift of attention but we still have little knowledge of how social characteristics associated to face stimuli can impact on this phenomenon. The most sharpening difference between the results obtained so far in the laboratory and real-world situations refers to the contrast between automaticity and modulability. If we assume that gaze-mediated orienting of attention is strongly automatic, we should conclude that each time we see a person with gaze averted we shift attention in the corresponding direction in an automatic way. However, this is implausible because, if it were the case, individuals would be continuously wandering among the eyes of several individuals and the object they are looking at. It is more reasonable to hypothesize that a sort of prioritizing process takes place, through which an individual will focus more on the information conveyed by the eyes of some people while ignoring others. This prioritizing process might have its basis on several factors: for instance, it is likely that the gaze of the persons we are interacting with is more worthwhile to be followed as compared to the gaze of a person passing by. Or, it might be that characteristics related to the social identity of a person play a role in modulating gaze-mediated orienting of attention. In recent years, few research have paid attention to this topic by investigating factors such as emotional expression (see Yiend, 2010 for a review) or familiarity (Deaner, Shepherd, & Platt, 2007). In Chapter 3, I will first review the literature pertaining this topic and, subsequently, I will focus on gender membership and social status as possible moderators of gaze-mediated orienting of attention by presenting several experiments investigating their role throughout different contexts.

CHAPTER 2.

The automaticity of gaze-mediated orienting of attention

2.1. Overview of the literature on the orienting of attention mediated by two central cues: arrows and gaze

For a long time, research devoted great interest to the fact that certain stimuli are able to drive an attentional shift. As extensively described in the previous chapter, initially, stimuli have been divided into two categories, namely central and peripheral cues, and the orienting of attention driven by these two kinds of stimuli was investigated by means of the spatial cuing paradigm (Posner et al., 1980). For many years, central cues have been considered as opposed to peripheral cues given the characteristics of the attentional shift they are able to drive: the former were thought to trigger an automatic orienting, whereas the latter were thought to trigger a voluntary orienting (e.g., Jonides, 1981). However, in recent years, two different kinds of results have undermined this distinction. On one side, there is growing evidence showing that arrows, a central cue, can trigger an automatic shift of attention. In one of the first studies, Eimer (1997) investigated the impact of informative (i.e., the cue indicated target location in 75% of the trials) and uninformative arrows (i.e., the target was equally likely to appear at congruent or incongruent location) on the orienting of attention. He reasoned that, when the cue is informative as to target location, participants should voluntarily shift attention in the same direction as the cue; when the cue is uninformative, participants have no incentive in voluntarily shift attention and thus, a significant cuing effect in this condition would reflect an automatic attentional orienting. Results showed faster RTs in the congruent than in the incongruent trials for both informative and uninformative arrows, thus supporting the view that arrows can trigger an automatic shift of attention. In a later work, Gibson and Bryant (2005) implemented a spatial cuing paradigm demonstrating for the first time that the kind of attentional orienting obtained with arrows (i.e., automatic or voluntary) strongly depended on the experimental procedure. They showed that when cue duration and SOA (i.e., cue to target Stimulus Onset Asynchrony) were relatively brief (i.e., 25 and 50 ms respectively) arrows triggered an automatic shift of attention whereas, when cue duration and SOA were longer, arrows triggered a voluntary shift of attention thus pointing out that the controversial results obtained in previous studies (e.g., Jonides, 1981) might be due to the characteristics of the experimental procedure.

On the other side, another phenomenon undermined the classic scenario that opposes peripheral versus central cues which are thought to respectively trigger an automatic versus voluntary orienting: namely, gaze-mediated orienting of attention (see Chapter 1 for a detailed description of the phenomenon). According to the classic view gaze should be categorized as a central cue given its spatial collocation and, thus, it should be expected to trigger a voluntary attentional orienting. On the contrary, gaze-mediated orienting of attention has proved to be a strongly reflexive phenomenon (e.g., Driver et al., 1999; Galfano, Rusconi, & Umiltà, 2006; Law et al., 2011). According to some authors, this unexpected behaviour of gaze would be due to the fact that eyes represent a special cue characterized by a strong significance given their relevance in everyday life (Kingstone, 2009) and, for such reasons, humans would have developed a reflexive attentional shift in response to the view of an averted gaze that would also be supported by a dedicated neural circuit (Hietanen, Nummenmaa, Nyman, Parkkola & Hämäläinen, 2006).

Starting from these findings, new interest rise in comparing the attentional orienting driven by two central cues: arrows and gaze. Ristic, Wright and Kingstone (2007) demonstrated that eyes trigger a more automatic shift of attention than arrows since the former was not influenced by top-down factors such as cue-target color congruency. Previous results showed that arrows triggered an attentional shift only when the color of the arrow was congruent with the color of the target thus suggesting that arrows did not generate an automatic attentional response, since this was influenced by contextual factors (Pratt & Hommel, 2003). Ristic et al. (2007) presented participants with a gaze cuing paradigm showing that, unlike arrows, eyes triggered an attentional response both when the colors of cue and target were congruent and incongruent thus concluding that gaze-mediated orienting of attention could not be influenced by contextual factors and, thus, it could be defined as automatic. Friesen et al., (2004) presented participants with counterpredictive gaze and arrows so that the target could appear in the location cued by arrow/gaze direction, in the location predicted by arrow/gaze (namely opposite with respect to the cued location) or in a location nor cued neither predicted (see Figure 4).

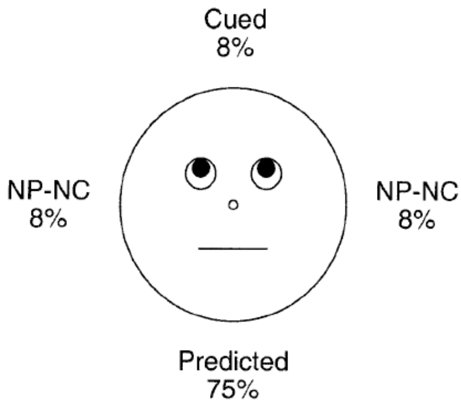

Figure 4. Illustration of the three types of trials in Friesen et al. (2004). (redrawn from Friesen et al., 2004)

When a gaze cue was presented, attention was shifted voluntarily to the predicted location and automatically to the cued location, whereas, when arrow cue was presented, attention was only shifted volitionally to the predicted location. The authors concluded that if orienting of attention triggered by gaze is made up of both a voluntary and an automatic component, orienting triggered by arrows is only constituted of a voluntary component. In contrast to these results, other research has shown that the shift of attention driven by both eyes and arrows is very similar and can be defined as automatic. Several studies focused on paradigms investigating overt orienting of attention (i.e., orienting of attention accompanied by movements of the eyes). For instance, in Kuhn and Benson (2007) study, participants were instructed to make a saccade in the direction signaled by an instruction: for half of the participants a red square indicated a saccade towards left and a green square a saccade towards right, and the reverse association for the other half of the participants. At the same time as the presentation of the colored square, an arrow or a face with gaze averted was presented as a distractor given that their direction had no relation with the instructed saccade. Results showed that participants were slower and made more directional errors in making the saccade when the distractor was incongruent with the saccade direction, irrespective of whether it was gaze or an arrow. Similar results as Kuhn and Benson (2007) were obtained in other studies which used a similar paradigm (e.g., Hermens & Walker, 2010; Kuhn & Kingstone, 2009, but see Ricciardelli, Bricolo, Aglioti, & Chelazzi, 2002 for contrasting results).

Other research focused on covert orienting of attention triggered by eyes and arrows. For instance, Tipples (2008) found that when participants were presented with counterpredictive eyes and arrows, a significant cuing effect was exhibited for both cue types suggesting that even though participants knew that the target was more likely to appear in the opposite direction as the one signaled by the cue, they were unable to ignore the directional information provided by the cues. Stevens, West, Al-Aidroos, Weger, and Pratt (2010) investigated the automaticity of the attentional shifts driven by arrow and gaze cues. Based on previous results which showed that reflexive shifts of attention facilitate response speed but not perceptual accuracy (Prinzmetal, McCool, & Park, 2005), Stevens et al. (2010) showed that both cue types only facilitated response speed thus suggesting that the orienting of attention mediated by arrows and gaze cues can be defined as automatic and similar for both cue types. To sum up, recent research has tried to shed light on the automaticity of orienting of attention triggered by eyes and arrows but results were mixed: on the one side, arrows and gaze were found to trigger a similar automatic orienting response, on the other side only gaze was thought to be defined as triggering an automatic form of orienting.

2.2 The present research

In the present series of experiments, the aim was to further investigate the orienting of attention triggered by arrows and gaze as regards its automaticity trying to shed light on the controversial results obtained so far. Indeed, a strong definition of automaticity for the orienting of attention driven by arrows and gaze was tested by applying a different version of the second principle of Jonides (1981), namely resistance to suppression. This second criterion states that if orienting of attention triggered by a certain stimulus is automatic, participants should have difficulty in ignoring it even when it is not relevant for the task. Previous works already operationalized the resistance to suppression criterion by making the cue uninformative or counterpredictive as to target location.

However, the manipulation adopted in the present series of experiments was different from past research. For instance, in the study conducted by Jonides (1981), participants were presented with a cue that was predictive of the target location only in 12.5% of the trials. Also Tipples (2008) presented participants with counterpredictive gaze and arrows in that the target appeared in the opposite direction than indicated by the cue in 75% of the trials. It is important to note that, in the research described so far, a processing of the cue is always necessary in order to infer the most likely location in which the target will appear. Indeed, the location in which the target will appear is the opposite as indicated by the cue and, thus, participants have to process the directional information provided by the cue in order to extract information about future's target location. Unlike previous research, in the present work, an experimental situation was designed so as to test a stronger version of the resistance to suppression criterion: indeed, in the experiments presented in the next paragraphs, participants knew with 100% probability where the target would have appeared in each trial and they had to press a key each time they saw the target. Arrows and gaze were distractors presented before the target not informative as to target location and totally irrelevant for the task. Thus, unlike previous studies, participants had no need to process gaze/arrow cues in that it did not convey any information about target location. The manipulation adopted in our research was more similar to the paradigm usually adopted in experiments involving overt orienting in which participants were instructed to make a saccade in a specific direction and gaze or arrows were used as distractor for the task (e.g., Kuhn & Benson, 2007 see page 20 for a detailed description of the paradigm). We might have expected two possible outcomes: if both arrow and gaze cues triggered an automatic shift of attention, we should have expected that RTs in detecting the target were slower when the distractor was incongruent with target location. Indeed, this would have meant that, even though participants knew with 100% probability where the target would have appeared, they were unable to ignore the direction cue that pushed participants' attention in an automatic way, thus interfering with target detection. If only eyes triggered an automatic shift of attention, then we should have expected an interference when participants were presented with the gaze distractor but not with the arrow distractor.

In the next paragraphs, four experiments will be presented: two involving gaze (Experiment 1a & 2a) and two involving arrows (Experiment 1b & 2b). For each of the cues, two experiments were conducted: the first was designed on a trial-by-trial basis (Experiments 1a & 1b). On each trial, participants were presented with a direction word (i.e., "left" or "right") signaling with 100% probability the future location of the target. Previous research demonstrated that direction words are able to push participants attention in the corresponding direction (Hommel et al., 2001). After the direction word, a gaze or an arrow were presented as distractors, uninformative as to target location. The rationale was to test whether the distractors were able to trigger an attentional shift even though participants' attention was focused on the future location of the target by means of the direction word (see Yantis & Jonides, 1990 for a similar rationale).

The second experiment was designed on a block-by-block basis (Experiment 2a & 2b), that is, for the whole duration of a block, the target always appeared on the left or on the right and participants were informed with 100% probability about the future location of the target before the beginning of each block. All the experiments presented in the next paragraphs were conducted on a eye-tracker Tobii T120 in order to monitor participants' eye movement for the whole duration of the experiment. At the beginning of the experiment, participants were asked to maintain fixation in the centre of the screen for the whole duration of a block trying not to make any eye movements. They were also informed that their eye movements were recorded and that the experimenter could see whether they were maintaining fixation in the centre or moving the eyes around. This was done in order to ensure that the distractor were properly processed, Indeed, if participants were overtly attending to the future location of the target as signaled by the direction word, the distractor would not be in the fovea thus leading to a decreased probability of triggering an attentional shift. This would result in a non significant interference of the distractor on participants' RTs. Thus, if results will not show a significant interaction between the direction word and the distractor, then it will be noteworthy to analyze data regarding participants' eye movements so to disentangle two possible explanations for a null effect: first, the distractors did not trigger an automatic attentional shift since participants were able to ignore them or, second, participants were overtly looking in the direction signaled by the word thus minimizing the possibility for the distractors to elicit an attentional shift.

Experiment 1a

Participants

Twenty-eight students from the University of Padova participated in the experiment on a voluntary basis. All participants had normal or corrected to normal vision.

Apparatus, Stimuli, and Procedure

Presentation of the stimuli and registration of responses were controlled by the E-prime 1.2. Stimuli were presented on a 17 in. computer monitor, with a resolution of 1152x864. Testing was conducted on a Tobii T120 so that we could monitor participants' eye movement for the whole duration of the experiment. We used the Tobii so as to give participants an incentive to keep fixation in the centre of the screen throughout the experiment. Indeed, prior to the beginning, we told participants that their eye movements would be recorded and that we were able to monitor the position of their eyes. Moreover, instructions clearly stated that it was important to keep fixation in the centre of the screen without making any eye movement. Participants were instructed to ignore the distractors while focusing on target detection. The monitor was set to a black background. Each trial began with a fixation point remaining on the screen for 1000 ms (see Figure 5). Then, the word "destra" (i.e., right in Italian) or "sinistra" (i.e., left in Italian) appeared in the centre of the screen written in capital letters. After 1000 ms, the word was replaced by a schematic face with gaze averted which could remain on the screen for 100 ms or 1200 ms depending on the *Stimulus Onset Asynchrony* (*SOA*). These two different SOAs were used in order to investigate the time course of the effect. Indeed, it might be that the shorter SOA did not allow participants to disengage attention

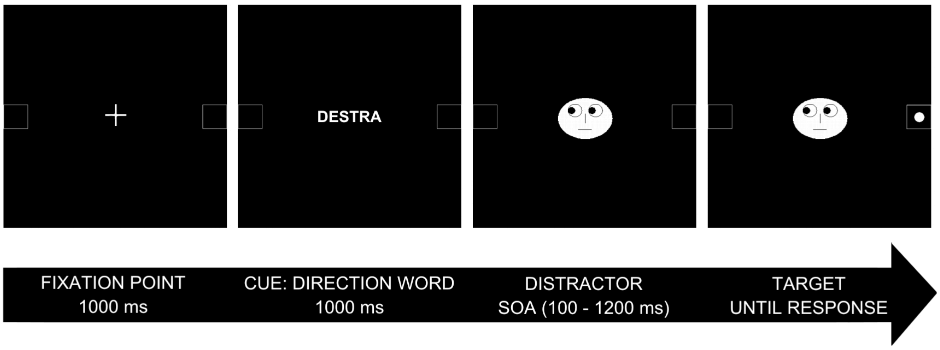

Figure 5. Trial sequence for Experiment 1a. The word "destra" means right

from the location signaled by the distractor and re-orient it to the location signaled by the word. On the contrary, when participants have 1200 ms between distractor presentation and target presentation they could have enough time to ignore the attentional information provided by the distractor. Gaze direction was randomized and it could point left or right with the same probability. Then, a white dot could appear in one of two possible boxes placed on the right and on the left of the fixation point on the same horizontal meridian. The dot appeared at about 10° of visual angle from the centre of the screen. Participants went through 288 trials divided into 4 different blocks of 72 trials each. 1/3 of the total number of trials were catch trials and the dot was not shown. The dot had the same probability to appear on the right or on the left throughout each block. Catch trials and experimental trials were randomly presented but their proportion was constant in each block. Participants were instructed to press the spacebar as fast as possible each time they saw the dot on the screen, and to refrain from responding and wait for the next trial to begin when a catch trial was displayed. If participants' response was not provided in 2000 ms, the next trial began.

Results

Data were collapsed across gaze's direction and target location and a new variable called Congruency was obtained. On congruent trials, gaze direction was the same as the target location whereas on incongruent trials gaze direction was in the opposite direction as to target location. The same procedure for what concerns offline data processing was applied to Experiment 1b. Trials in which an error was committed were discarded from the analyses (0.2%). Both trials in which participants omitted to press the space bar in response to target appearance and catch trials in which participants press the space even though the target did not show up were considered as errors. A 2 (Congruency: Congruent trials versus Incongruent trials) x 2 (SOA: 100 versus 1200 ms) within participants ANOVA was performed on RTs. A main effect of Congruency emerged, $F(1,27) = 7.894$, $p = .009$, $\eta^2_p = .23$, showing that participants were faster in detecting the target on congruent trials as compared to incongruent trials (see Figure 6). A main effect of SOA emerged, $F(1,27) = 22.727$, $p < .001$, $\eta^2_p = .46$, likely reflecting the classical warning effect (Sanders, 1975). No interaction between Congruency and SOA was found, $p = .476$.

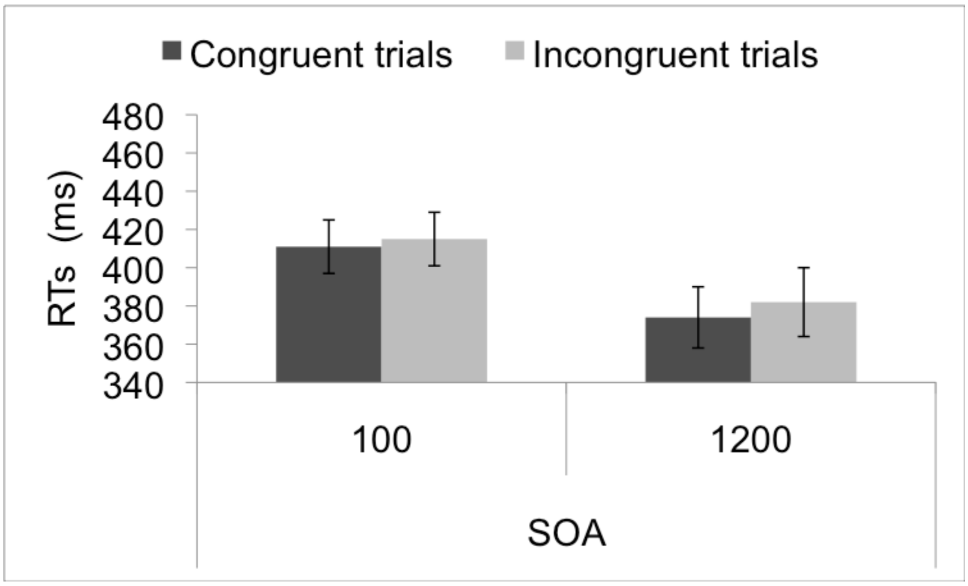

Figure 6. RTs and Standard Errors for congruent and incongruent trials as a function of SOA in Experiment 1a

Experiment 1b

Participants

Thirty students from the University of Padova participated in the experiment on a voluntary basis. All participants had normal or corrected to normal vision. None of them had taken part in the previous experiment.

Apparatus, Stimuli, and Procedure

Everything was the same as in Experiment 1a, except for the schematic face that was replaced by an arrow pointing left or right. The arrow was designed so as to occupy the same area as the schematic face, with a symmetric tale and head so that to be comparable to the two eyes conveying directional information (see Figure 7).

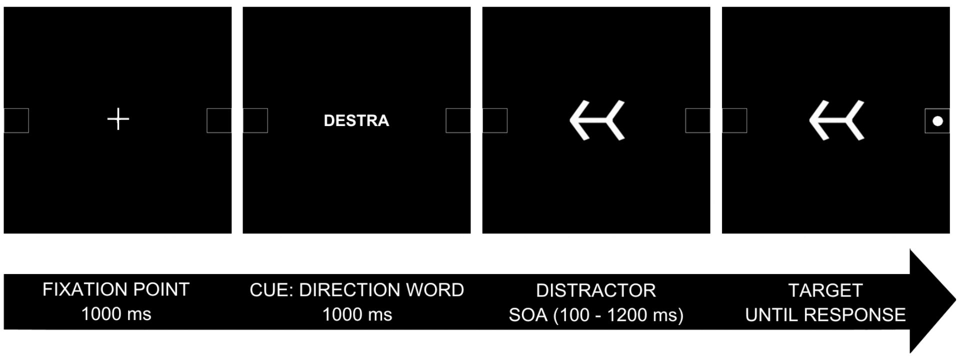

Figure 7. Trial sequence for Experiment 1b

Results

No participants committed any error and, thus, no trial was discarded from analyses. A 2 (Congruency: Congruent trials versus Incongruent trials) x 2 (SOA: 100 versus 1200 ms) within participants ANOVA was performed on RTs. A main effect of Congruency emerged, $F(1,29) = 27.555$, $p<.001$, $\eta^2_p=.48$, showing that participants were faster in detecting the target on congruent trials as compared to incongruent trials (see Figure 8). A main effect of SOA emerged, $F(1,29) = 15.677$, $p < .001$, $\eta^2_p = .35$, likely reflecting the classical warning effect (Sanders, 1975). No interaction between Congruency and SOA was found, $p = .629$. In the next two experiments, one involving gaze and the other arrows, another manipulation was used. Indeed, the information about the future location of the target was given on a block-by-block basis. Unlike Experiment 1a and Experiment 1b, in Experiment 2a and 2b participants had not to update the information about the location of the target on every trial as indicated by the direction word, but the future location of the target was kept constant among each block and the same spatial set was used throughout a block of trials. This means that participants could preventively shift attention in one location without the need to wait for the direction word.

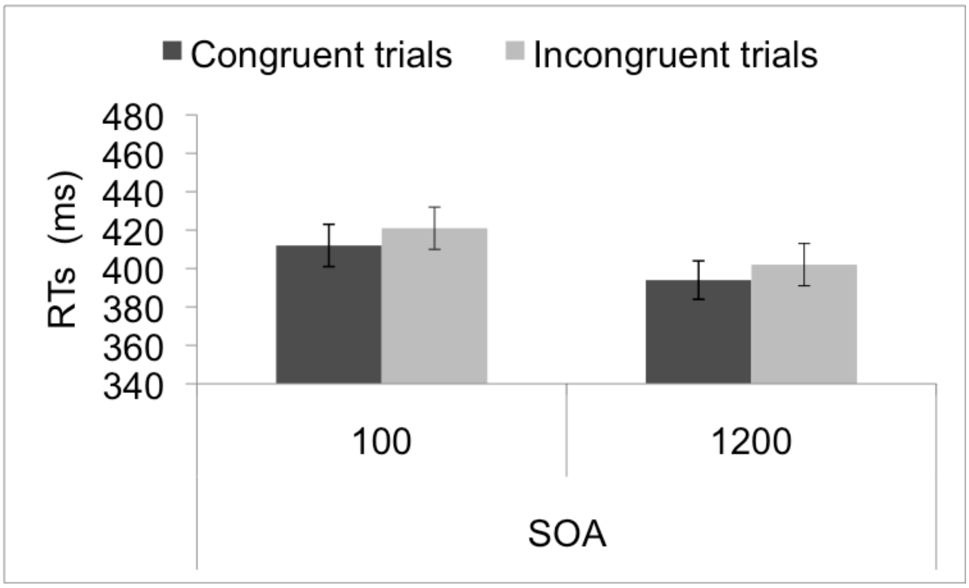

Figure 8. RT and Standard Errors for congruent and incongruent trials as a function of SOA in Experiment 1b

<u>*Experiment 2a*</u>

Participants

Thirty-four students from the University of Padova participated in the experiment on a voluntary basis. All participants had normal or corrected to normal vision. None of them had taken part in the previous experiments.

Apparatus, Stimuli, and Procedure

Apparatus and stimuli were the same as in Experiment 1a. Procedure was changed in that the indication about the future location of the target was given on a block-by-block basis (see Figure 9). Before beginning the task, participants were told the future location of the dot (i.e., left or right) for the next 72 trials. The experiment was divided into 4 four blocks. Half of the participants completed the blocks in this sequence: dot on the right, dot on the left, dot on the right and dot on the left. The other half participants completed the 4 blocks in the reverse order.

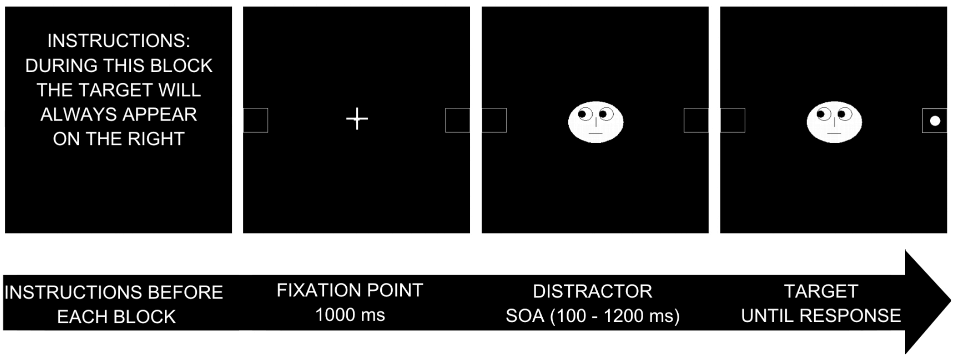

Figure 9. Trial sequence in Experiment 2a. The instructions about the future position of the target were presented to participants before the beginning of each block, and not in each trial.

Results

Data were collapsed across arrow direction and target location and a new variable called Congruency was obtained. On congruent trials, arrow direction was the same as the target location whereas on incongruent trials, the arrow pointed in the opposite
direction with respect to target location. The same procedure was applied as regarded offline data processing to Experiment 2b. Trials in which an error was committed were discarded from the

analyses (0.2%). Both trials when participants omitted to press the space bar in response to target appearance and catch trials in which participants press the space even though the target did not show up were considered as errors. A 2 (Congruency: Congruent trials versus Incongruent trials) x 2 (SOA: 100 versus 1200 ms) within participants ANOVA was performed on RTs. A main effect of Congruency emerged, $F(1,33) = 7.760$, p=.009, η^2_p=.19 showing that participants were faster in detecting the target on congruent trials as compared to incongruent trials (see Figure 10).

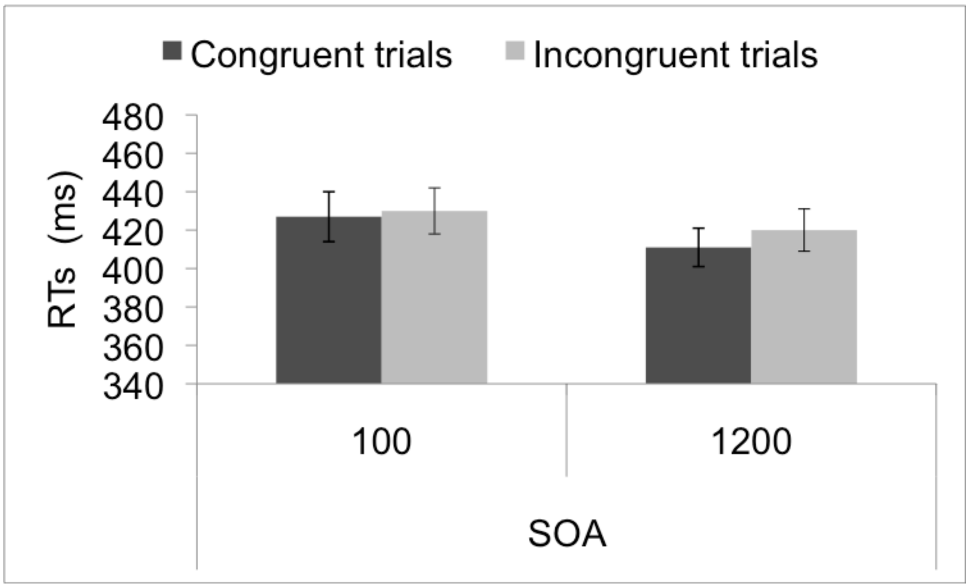

Figure 10. RTs and Standard Errors for congruent and incongruent trials as a function of SOA in Experiment 2a

A main effect of SOA emerged, $F(1,33) = 5.804$, p =.022, η^2_p=.15, likely reflecting the classical warning effect (Sanders, 1975). No interaction between Congruency and SOA was found, p=.341.

Experiment 2b

Participants

Twenty-one students from the University of Padova participated in the experiment on a voluntary basis. All participants had normal or corrected to normal vision. None of them had taken part in the previous experiments.

Apparatus, Stimuli, and Procedure

Apparatus and stimuli were the same as in Experiment 1b. Instead, procedure was the same as in Experiment 2a in that the information about the future position of the target was given to participants on a block-by-block basis (see Figure 11).

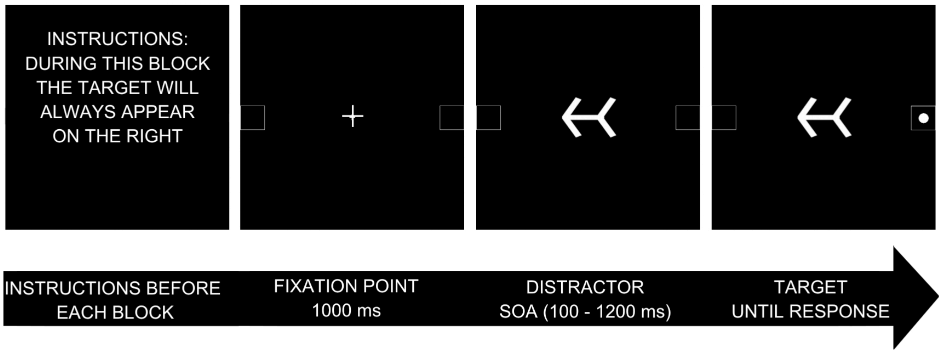

Figure 11. Trial sequence in Experiment 2b. The instructions about the future position of the target were presented to participants before the beginning of each block, and not in each trial.

Results

Trials in which an error was committed were discarded from analyses (0.2%). Both trials when participants omitted to press the space bar in response to target appearance and catch trials in which participants press the space even though the target did not show up were considered as errors. A 2 (Congruency: Congruent trials versus Incongruent trials) x 2 (SOA: 100 versus 1200 ms) within participants ANOVA was performed on RTs. A main effect of Congruency emerged, $F(1,20) = 13.280$, $p=.002$, $\eta^2_p=.40$, showing that participants were faster in detecting the target on congruent trials as compared to incongruent trials (see Figure 12). A main effect of SOA emerged, $F(1,20) = 6.322$, $p=.021$, $\eta^2_p=.24$, likely reflecting the classical warning effect (Sanders, 1975). No interaction between Congruency and SOA was found, $p=.158$.

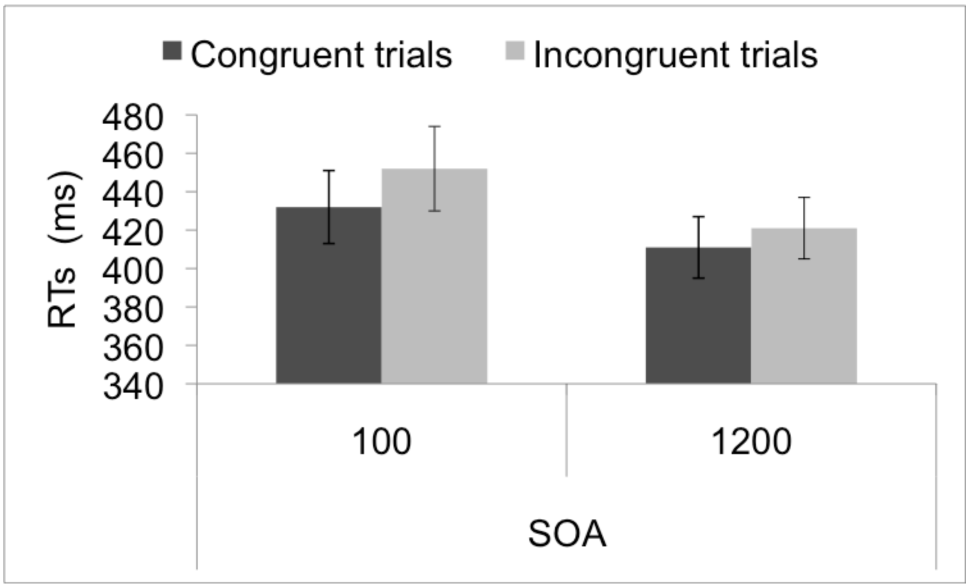

Figure 12. RTs and Standard Errors for congruent and incongruent trials as a function of SOA in Experiment 2b

2.3 Discussion

In recent years, a flourishing literature (e.g., Driver et al., 1999; Tipples, 2002) has challenged the traditional view according to which central cues trigger a voluntary attentional orienting whereas peripheral cues trigger an automatic attentional orienting. Recent evidence has shown that gaze trigger an automatic shift of attention, whereas, results concerning arrows are less straightforward. Indeed, some studies supported the automatic nature of orienting of attention driven by arrows (e.g., Tipples, 2002) whereas some did not (e.g., Friesen et al., 2004).

In the present series of experiments, the aim was to compare the orienting of attention triggered by gaze and arrows by answering the following question: is an automatic attentional orienting unique to gaze or both gaze and arrows are able to trigger an automatic attentional orienting? In answering this question, two distinct scenarios might have been anticipated. On one side, gaze may be hypothesized to be a "special cue" given its social significance and saliency in everyday life and its uniqueness would be reflected in the automatic nature of the orienting of attention triggered by this cue (see Hietanen et al., 2006), whereas arrows would be less socially meaningful and the orienting of attention triggered by this cue would be less automatic, if not voluntary (e.g., Friesen et al., 2004). On the other side, arrows may be thought of as a well-learned symbol which conveys a strong spatial information and thus the orienting of attention mediated by arrows would be as automatic as it happens for gaze, although for different reasons. Indeed, arrows are likely to trigger an attentional orienting because they are an over-learned cue with a spatial connotation that is reinforced everyday (see, for instance, roadsigns). In a different way, gaze-mediated orienting of attention seems to be an innate phenomenon since it is present both in newborns as young as 2 day-old (Farroni et al., 2002) and in several species of non-human primates (Deaner & Platt, 2003; Tomasello, Call, & Hare, 1998). Results from the four experiments conducted support this latter interpretation. In the first two experiments, participants were reliably informed about the future location of the target on a trial-by-trial basis by means of a direction word presented at the beginning of each trial. Gaze (Experiment 1a) and arrows (Experiment 1b) were distractors, presented after the direction word, not informative as to target position thus congruent with target location in 50% of trials only. Results showed that when the direction signaled by the distractor was congruent with the direction word, participants were faster in detecting the target as compared to when the distractor signaled the opposite direction as the direction word. This effect was significant for both eyes and arrows thus suggesting that both cues can not being ignored. In Experiments 2a and 2b, participants were informed at the beginning of a block about the future location of the target that was constant for the whole duration of that block. Thus, participants did not have to update the information about the target location on each trial. Results showed that, similar to what observed in the trial-by-trial manipulation, both eyes and arrows triggered an automatic attentional shift in that participants were faster in detecting the target when the locations signaled by the distractor and the direction word were congruent.

Interestingly, in all the four experiments the interfering effect was not modulated by the SOA between distractor and target presentation. Two different SOAs were randomly presented: a very brief SOA of 100 ms and a longer one of 1200 ms. A significant interference effect was hypothesized to emerge when the 100 ms SOA was employed: indeed, if the distractors were found to trigger an automatic orienting of attention, participants had not enough time to disengage attention from the indicated location and re-orient it to the location in which the target was expected to appear. Thus, RTs were hypothesized to be slower when the distractor and the direction word conveyed opposite information. On the contrary, at 1200 ms SOA, participants had enough time to disengage attention from the location signaled by the distractor and re-orient it to the location in which the target as meant to appear and thus we expected the interference effect to disappear. Contrary to this prediction, the interference effect for both gaze and arrows was not modulated by SOA showing that the ability of the distractor to influence participants' attentional deployment was similar for both 100 ms and 1200 ms SOAs. Thus, when the distractor remained on the screen shortly before target appearance it was able to push participants' attention in the indicated location. The same happened when the target appeared 1200 ms after distractor presentation: in this condition, even though participants had plenty of time at their disposal to disengage attention from the distracting location and re-orient it to the opposite location, attention was hold at the location indicated by the distractor and, thus, the interference effect emerged also with the 1200 ms SOA. The fact that the distractor interfered with the information conveyed by the direction word in triggering an attentional shift suggests that the orienting of attention mediated by both eyes and arrows can be defined as automatic. Indeed, even though participants had no reason to shift attention in the direction signaled by the distractor, they could not ignore it. However, it is important to point out that the mere fact that gaze and arrows trigger an automatic attentional orienting is not like saying that they behave exactly as peripheral cues (see also results obtained by Hermens & Walker, 2010). Indeed, there is an important difference between peripheral cues on one side, and gaze and arrows on the other side, namely the reason why they trigger an attentional shift. The orienting of attention driven by peripheral cues is also called stimulus-driven attentional capture to indicate that there is no need for participants to decode the meaning of the cue in order for the attentional orienting to happen. In fact, the attentional orienting for peripheral cues takes place in response to a sudden change in the visual field (for instance in luminance or color) that is independent from the identity of the cue. On the contrary, the orienting of attention triggered by gaze and arrows is dependent on the identity of the cues. Moreover, also the fact that gaze and arrows elicited an automatic shift of attention does not necessarily imply that the processes underlying the attentional shift are the same for these two cues. As pointed out in the previous pages, orienting of attention mediated by arrows has resulted to be automatic likely because arrows are an over-learned directional cue. On the contrary, the effect observed for gaze is likely to depend on the innate nature of gaze-mediated orienting of attention.

In conclusion, there is growing evidence showing that both gaze and arrows are able to trigger an automatic attentional orienting. The present research supports this scenario by showing that, even applying a strong interpretation of automaticity, the attentional orienting mediated by both gaze and arrows can be defined as automatic. The experimental paradigm used in our experiments allows to draw stronger conclusions as compared to past research which used counterpredictive cues. Indeed, unlike counterpredictive cues which have to be processed in order to infer the most likely target location, in our Experiments both gaze and arrows were task-irrelevant distractors not useful in order to infer the target future location. Nonetheless, results showed that both gaze and arrow cues can not be ignored thus supporting the automatic nature of these cues. However, there is still some debate in the literature with different studies leading to opposite results. Thus, on the one side, further research should be conducted in order to put all the findings into a coherent framework so to understand the reason for the discrepancy in recent results. On the other side, some efforts should be put in understanding the applicability of the obtained results in more ecological situations. Indeed, if we conclude that gaze-mediated orienting of attention is an automatic phenomenon which cannot be suppressed we should apply this principle also to everyday life by saying that, if we walk on a crowded street, we orient attention in response to every averted gaze that we meet and towards what other people are looking at. However, this is implausible and researchers should be aware of the problem of generalizing results to more ecological contexts. In the next Chapter, I will deal with this issue by investigating the role of social factors in influencing gaze-mediated orienting of attention.

CHAPTER 3.

Social influences on gaze-mediated orienting of attention

3.1. Overview of the literature on the modulability of orienting of attention mediated by gaze

3.2. Gaze-mediated orienting of attention in children: the influence of gender membership

- Experiment 3
- Experiment 4

3.3. The role of status in modulating gaze mediated orienting of attention in adults

- Experiment 5: The high-status group perspective
- Experiment 6: The low-status group perspective
- Experiment 7: The role of contextual factors
- Experiment 8: Manipulating social status

3.1 Overview of the literature on the modulability of orienting of attention mediated by gaze

Throughout Chapter 2, I have described several experiments showing that gaze-mediated orienting of attention can be defined as an automatic phenomenon. In Experiments 1a, 1b, 2a and 2b we have shown that gaze cues cannot be ignored since an attentional shift takes place in response to the view of an averted gaze even when the cue is totally irrelevant for the task at hand.

A possible explanation for the rootedness of gaze-mediated orienting of attention in our cognitive system is related to its fundamental role both in a developmental and an evolutionary perspective. For instance, Hood, Willen, and Driver (1998) found that even children as young as 3 months are able to shift attention in response to the mere view of an averted gaze. Moreover, the understanding of others' line of sight and the subsequent orientation in the same direction is not only a mere automatic behavior but it seems to be the basis for the development of infants' linguistic and imitative abilities: indeed, it allows to establish a triadic relation between the child, another person and a common object of attention (Striano & Reid, 2006). Indeed, some research demonstrated that infants follow adults' gaze primarily when there are some anticipatory signals which hint a communicative relationship with them, such as prolonged eye contact or infant-directed speech (e.g., Senju & Csibra, 2008; Senju, Csibra, & Johnson, 2008). Moreover, longitudinal studies have revealed that an early onset of gaze-following ability is a valid predictor of efficient development in linguistic abilities (Brooks & Meltzoff, 2005). In addition, Ristic, Mottron, Friesen, Iarocci, Burack, and Kingstone (2005) have shown that high functioning Autistics with a deficit in social competence, did not show an automatic gaze-driven orienting in that they shifted attention towards the location signaled by an averted gaze only when gaze direction was informative as to target location. This suggests that Autistics could efficiently process information as regards the location of the upcoming target stimulus, but gaze in itself was not special for them, because it did not elicit a shift of attention when uninformative of target location. Another study showed that a group of patients suffering from chronic Schizophrenia, known to heavily affect social competence similarly to Autism, reported a weak attentional orienting in response to gaze, whereas the attentional orienting in response to arrows was not impaired (Akiyama, Kato, Muramatsu, Maeda, Hara, & Kashima, 2008). All together, these findings strongly support the idea that the ability to shift attention according to the direction of someone's gaze and the development of communicative and social skills may strongly interact with each other.

Further evidence regarding the rootedness of gaze-mediated orienting of attention in the human cognitive system can be found in the evolutionary nature of such a phenomenon. Indeed, research conducted with non-human primates can give us a cue about the origin of the gaze-following behavior. One of the first contributions in this area comes from the pioneering work conducted by Chance (1967) in his field studies. Moving from the observation of non-human primates, he hypothesized that the aggressive behavior shown by the animals was one of the signals through which the hierarchical relations within a group could be inferred, but it was not necessarily the most important. According to Chance (1967), a better indicator of group organization was the so-called *attentional structure* that can be defined as the pattern of distribution of social attention among group members depending on their status. Indeed, higher-status members (i.e., alpha males) are those who are primarily attended to by lower-status members who engage in a continuous monitoring of their location and movements (for more recent studies supporting this hypothesis see for example McNelis & Boatright-Horowitz, 1998; Pannozzo, Phillips, Haast, & Mintz, 2007). In this way, every movement of the group leader will be registered and this will result into an appropriate reaction of his conspecifics. For example, if the leader starts to move from the original location, the other members of the group will record this movement and this will lead to a relocation of the whole group in the leader direction. Moreover, this leader-directed attention allows low-status members to examine high-ranking animals' line of sight and to infer the object of attention by following their gaze. This is fundamental for low-status members' survival in that it prevents them from competing for the same partner or the same food since they would obviously be at a disadvantage in a fight with higher-status conspecifics. Furthermore, when thinking about the living environment of non-human primates, it is clear that it is impossible for every single member of the group to continuously monitor all his surroundings scanning for potential dangers. Thus, it can be useful to rely on conspecifics' gaze to infer what is happening around. In this way, a sudden turn of the head or a movement of the eyes of another group member can be interpreted as a signal of something noteworthy coming into sight such as the appearance of a predator, of a potential mate or of a source of food. Thus, it is beneficial for every animal to follow others' gaze in order to detect what caught their eyes. This allows for a more efficient control of the surroundings and, at the same time, for a considerable saving of resources which can be used in other activities. Starting from these examples, it is not surprising that some studies have reported that non-human primates automatically orient their attention in response to the view of the averted gaze of a conspecific, resembling the characteristics of the gaze-following behavior in humans (Deaner & Platt, 2003; Goossens, Dekleva, Reader, Sterck, & Bolhius, 2008; Shepherd & Platt, 2008). Moreover, an intriguing empirical study conducted by Shepherd, Deaner and Platt (2006) shed light on the relation between social status and gaze-mediated orienting of attention providing a strong support to Chance's (1967) hypothesis about attentional structure. Shepherd et al. (2006) demonstrated that rhesus macaques responded differently depending on the status of the animal exhibiting the gaze cue: high- status monkeys responded solely to the averted gaze of their high-status conspecifics while ignoring gaze cues provided by low-status monkeys, whereas low-status monkeys followed the gaze of all their conspecifics independently of their ranking. These findings advise us that social variables such as social status can have an important role in shaping the orienting response and the allocation of attention of non-human primates, providing an interesting insight on how attention behaves in an ecological environment.

So far, we have described studies conducted with non-human primates suggesting a malleability of gaze-mediated orienting of attention (Shepherd et al., 2006). Thus, if in non-human primates this phenomenon can be modulated by the social characteristics of the cuing face, then it is hard to believe such a mechanism to be independent of these social aspects in humans. As discussed earlier, it is a robust finding that, when presented with a face whose gaze is averted, humans respond with an automatic orienting of attention in the corresponding direction (Driver et al., 1999; Friesen & Kingstone, 1998). Indeed, gaze-mediated orienting of attention is exhibited even when the cue is counterpredictive with respect to target position (Driver et al.,1999; Friesen et al., 2004) or when it is not relevant for the task (Ricciardelli et al., 2002). In support of the automaticity of this phenomenon, Quadflieg, Mason, and Macrae (2004) presented participants with a modified spatial cuing paradigm in which the eyes were presented either in isolation or embedded in another object such as an animal face, an apple or a glove. They showed that, even if the context in which the eyes were embedded was artificial, a cuing effect was nonetheless exhibited by participants. They concluded that gaze-mediated orienting of attention was not modulated by the characteristics of the context in which gaze is presented thus confirming the unconditional automaticity of this phenomenon.

However, when trying to imagine how gaze-mediated orienting of attention can contribute to everyday life, it is implausible to think that people respond with an automatic attentional shift every time they see an averted gaze on their way. If this were the case, we would be continuously engaged in directing attention where others are looking, independently of whether others are physically near or meaningful for us. It is more reasonable to hypothesize that certain eyes are somehow prioritized over others depending on several characteristics: for instance, the prioritization might depend on the social proximity of the persons according to the principle that the gaze of the person we are interacting with is more valuable than that of a stranger passing by. Or, it might depend on physical proximity so that the gaze of a person far away is less important than the gaze of someone near. Another criterion might be based on the characteristics of the people the eyes belong to and on the interplay between our identity and the identity of the person providing the cue. Recently, research is moving in this direction and, even if there are still few studies conducted on this topic, they provide some indications on the malleability of gaze-mediated orienting of attention in humans. Research in this domain can be divided into two branches: on one side, great interest has been devoted to the investigation of the physical features which can influence the cuing effect triggered by gaze (e.g., Jones, DeBruine, Main, Little, Welling, Feinberg, & Tiddeman, 2010; Yiend 2010); on the other side, some research paid attention to the role of the social relationship between the participant and the cuing face in influencing gaze-mediated orienting (e.g., Deaner, Shepherd, & Platt, 2003; Wilkowski, Robinson, & Friesen, 2009). In the next pages, I will deal with these two distinct but complementary topics describing the contribution of the literature in showing the malleability of gaze-mediated orienting of attention.

First of all, a great bulk of research focused on the role that the emotional expression shown by the cuing face can have in moderating the orienting response. The assumption behind this idea is that people shift attention in response to an averted gaze because this would function as a cue to detect important events in the surroundings. Apart from the information provided by eye gaze, a face can convey the valence of what a person is looking at through its emotional expressions. If we are talking to someone who suddenly moves her/his eyes from ourselves to a point behind us, it does matter if she/he has an happy expression or a fearful one. A happy expression suggests that something nice is happening and, if we turn our head slowly or rapidly it probably makes no difference. If, for example, the happy expression is motivated by from a friend approaching, there is no reason to detect her/his presence as fast as possible but that to satisfy our curiosity. However, if our conversation partner moves his eyes behind us with a fearful expression on his face, it is better to immediately follow his gaze in order to detect whether what he sees constitutes a threat or not. Following this rationale, Mathews, Fox, Yiend and Calder (2003) studied gaze-mediated orienting of attention in response to faces with either a neutral or a fearful expression. Participants were administered a gaze cuing paradigm in which they were asked to identify a target letter which could appear either right or left of the cuing face, independently of gaze direction. Before going through the computerized task, participants were administered the State-Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) in order to measure their level of anxiety. On the basis of their scores, they were divided into two groups: high-anxious and low-anxious participants. Results showed that low-anxious participants responded faster on spatially congruent over spatially incongruent trials, but the magnitude of the cuing effect was unaffected by the emotional expression bore by the face. In sharp contrast, high-anxious participants, which are more sensitive to possible threats in the environment, showed a stronger cuing effect when the cue was provided by a face with fearful expression as compared to when the cue was provided by a face with neutral expression. Another study conducted by Tipples (2006) gives further support to the findings of Mathews et al. (2003). Tipples (2006) manipulated the emotional expression of the cuing face in that it could exhibit a happy, neutral or fearful expression. Participants were asked to fill in some questions aimed at measuring a personality construct called "trait fearfulness" which indexes the intensity of emotional reactions to fearful stimuli. Results showed that the cuing effect was stronger in response to fearful faces compared to both neutral and happy faces, which, on the other hand, elicited a similar cuing effect. Analyses conducted taking into consideration the "trait fearfulness" measure revealed a positive correlation between the scores on this scale and the cuing effect in response to fearful faces: the more the sensitivity of participants to fearful stimuli, the greater the cuing effect. On the same line, other studies bring support to this conclusion showing a heightened cuing effect in response to fearful faces. Moreover, they also highlight the fundamental role of individual differences in shaping this behavior in that such an increase was found only for those participants who reported a high level of anxiety (Fox, Mathews, Calder, & Yiend, 2007; Holmes, Richards, & Green, 2006; Putman, Hermans, & van Honk, 2006). In a recent study, Graham, Friesen, Fichtneholtz, and LaBar (2010) has demonstrated that the cuing effect was enhanced for emotional faces as compared to neutral faces but only when the SOA was long (i.e., over than 475 ms), whereas when the SOA was short, results showed no interaction between congruency and emotional expression. Besides studies which showed a modulation of the gaze cuing effect by means of the emotional expressions, other studies did not find such an interplay (e.g., Galfano, Sarlo, Sassi, Munafò, & Fuentes, in press; Hietanen & Leppanen, 2003). The discrepancy in the results might depends upon several factors: for instance, Graham et al. (2010)

used dynamic facial expressions in their study and this factor could have enhanced the likelihood of obtaining a modulation of the cuing effect given the more realistic context; or, it might also be possible that only when individual differences are taken into account the modulation emerges (see Mathews et al., 2003; but see Galfano et al., in press for contrasting results). Future studies will need to address in more detail the boundary conditions of the interplay between emotional expressions and gaze-mediated orienting of attention.

Besides research on emotional expressions, other studies focused on the role of physical characteristics of the cuing face in influencing gaze-mediated orienting of attention. For instance, Jones et al. (2010) investigated the role of dominance as inferred by the physical traits of the face. To this aim, faces of both males and females were modified in order to accentuate their feminine or masculine traits, and participants were presented with these faces in a gaze cuing paradigm. Faces characterized by masculinity traits are known to be perceived as more dominant whereas faces characterized by femininity traits are perceived as subordinates (e.g., DeBruine, Jones, Little, Boothroyd, Perrett, Penton-Voak, Cooper, Penke, Feinberg, & Tiddeman, 2006; Perrett, Lee, Penton-Voak, Rowland, Yoshikawa, Burt, Henzi, Castles, & Akamatsu, 1998). Results showed that masculinized faces triggered a greater cuing effect as compared to feminized faces. The studies described above show that the physical features of a face and the message they convey can influence the orienting process triggered by gaze. On the other side, only few studies addressed the influence of the social relationship existing between the participant and the cuing face in modulating the gaze-mediated orienting of attention. For instance, it was found that when pictures of familiar faces were used as stimuli, the cuing effect was enhanced, even though only for female participants (Deaner et al., 2007). The reason why the effect was restricted to the female sample has been linked to previous results which showed that females exhibit a stronger cuing effect in comparison to males (Bayliss, di Pellegrino, & Tipper, 2005) and, moreover, females seem to be more sensitive to social cues such as status or familiarity (Geary, 1998).

In another study, Wilkowski et al. (2009) showed that when participants were under a condition of low relational value, either because it was experimentally primed or because participants were characterized by a low self-esteem, gaze-mediated orienting of attention was enhanced. Interestingly, this modulation was not replicated when participants were presented with a spatial cuing paradigm in which arrows were used as cue thus demonstrating the social nature of such an influence.

The studies we have just reviewed are crucial to understand the inner nature of gaze-mediated orienting of attention. On the one side, it was demonstrated that physical characteristics of the cuing face and the message they convey can influence gaze-mediated orienting of attention (e.g., Fox et al., 2007; Holmes et al., 2006; Jones et al., 2010; Mathews et al., 2003; Putman et al., 2006; Tipples, 2006). Also social characteristics which become meaningful depending on participants' identity (e.g., Deaner et al., 2007) and psychological characteristics of the participants (Wilkowski et al., 2009) have been demonstrated to play a role. It seems that, when participants are presented with the possibility to categorize the cuing faces according to a given feature (e.g., emotionality or familiarity), they are more prone to involuntarily prioritize some eyes over others. Based on chronic or contextually accessible goals, selection processes can be at work. Sometimes, as said, the salient characteristics are related to the situation: for example, it is more plausible to follow the gaze of people who are physically closer to us rather than that of a person passing by at a greater distance. Other critical features could be related to group membership as inferred from physical cues as well as to inter-group dynamics.

In the next paragraphs, I will present the experiments that I have conducted on this topic. In particular, I will describe experiments conducted with both children and adults in the attempt to shed light on the social side of gaze-mediated orienting of attention.

3.2 Gaze mediated orienting of attention in children: the influence of gender membership

Experiment 3

Introduction

In the present research, the possible impact of shared gender between participant and cuing face on social attention was addressed in children attending Grade 4 at primary school. During childhood, gender is one of the most prominent dimensions on which informal groups are based on and, thus, it has a great relevance in children's social life (Maccoby, 1998). Children base the formation of their social group on gender: indeed, they use to cooperate, share game practices and interests preferentially with mates of the same gender. This phenomenon, defined as *gender segregation* is present from the age of three years and reaches its peak at about ages 8-11 (Pellegrini, 2004). Given this preferential interaction with same-gender peers, we hypothesized that the gaze direction of a child belonging to the same gender would be prioritized as compared to the gaze of a different gender child. Indeed, given the commonality of interests and practices between same-gender children, it is reasonable to assume that, if a child of the same gender looks at an object, that object will likely be more worthwhile to be noticed than an object looked at by a different-gender child.

In an attempt to investigate gaze cuing and its social moderators embedded in an ecological context, in the present experiment all children taking part in the experiment all belonged to the same school class and played the role of both participants and stimuli. Indeed, photographs of each child were taken one week before the experimental section. The experimental procedure was designed so that participants were presented with a modified spatial cuing paradigm in which the cuing faces were those of their classmates.

To summarize, we investigated the effect of shared gender identity on gaze cuing in female and male children predicting a stronger orienting effect in response to the averted gaze of a child belonging to the same gender group.

Participants

Twelve children took part in the experiment (6 females). Their age ranged from 9 to 10 years and they were all attending the same class (i.e., Grade 4 at primary school). Photographs of each child were used as stimuli in the task. Photographs were taken individually one week before the experimental session. A written consent was provided by children's parents for both taking their photographs and participating in the experiment.

Apparatus, Stimuli and Procedure

Stimuli were presented on a 15.4 in color monitor with a resolution of 1024 x 768. Presentation of the stimuli and registration of responses were controlled by E-Prime 1.2 software. Three photographs for each child were used as stimuli in a gaze cuing paradigm. One photograph depicted the child with direct gaze while the other two depicted the child with gaze averted to the right or to the left. All photographs had the same background luminance. Distance between participants and camera, and visual angle displayed by participants in the averted gaze conditions were kept constant. Each face subtended 15.2° in height and 16.4° in width. On each trial, a fixation cross appeared centrally for 900 ms, then the photograph of one of the children with direct gaze appeared. After 900 ms, this was replaced by the photograph of the same child displaying an averted gaze. After 200 ms, a target picture appeared 11.9° to the left or right of the centre of the screen in one of two possible locations: spatially congruent or incongruent with gaze direction (see Figure 13). The target pictures depicted Uncle Scrooge or Donald Duck. Each picture subtended 5.7° in height and width. Participants' task was to identify the target by pressing the associated key ("k" for Uncle Scrooge and "d" for Donald Duck). Gaze direction was uninformative as regards target location and participants were instructed to maintain fixation at the centre of the screen while ignoring the face stimulus and its gaze direction.

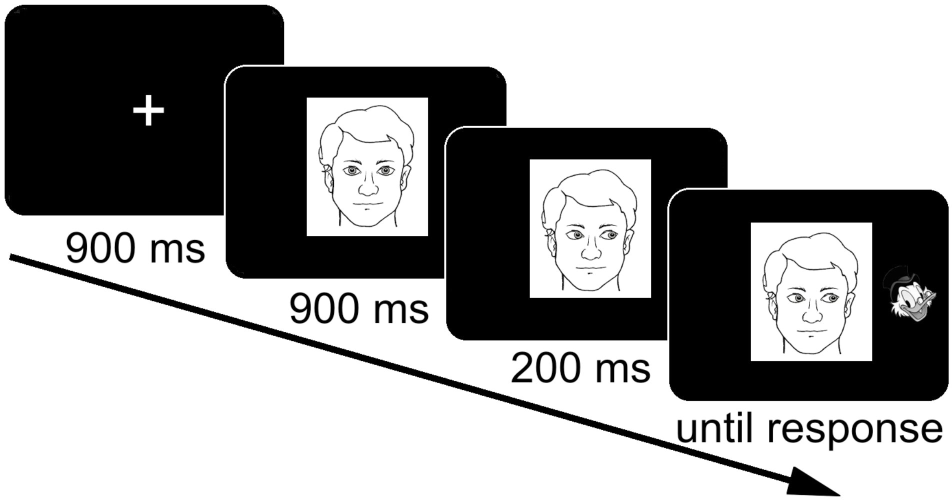

Figure 13. Example of a trial sequence. For privacy reason, the picture of the child was here replaced with a schematic face. A congruent trials is illustrated.

In order to ensure that children correctly understood the instructions before the beginning of the task, they were presented with an object to fixate and another object in the periphery of the visual field they had to attend to, without moving eyes on it. Then, participants went through 10 practice trials before completing 192 experimental trials divided into two blocks (48 trials per each relevant cell of the design). If participants were not totally comfortable with the task, they had the possibility to repeat the practice session. Once the experimenter was sure that participants were familiar with the task, the experimental session began. Children were tested individually.

Results

RTs of the incorrect trials (4.9%) were eliminated from the analyses. RTs exhibited by children were highly variable, likely because participants were not used to deal with this kind of task. Thus, RTs more than 2.5 standard deviations above each participant's mean (8.3%) were eliminated from the analyses. RTs of the trials in which the face stimuli were the same as the participant were also excluded.

A new variable called Cue-target spatial congruency was obtained prior to analyses, the variable was set to Congruent when the cue signaled the location of the target and to Incongruent when the cue pointed in the opposite direction as the target. A 2 (Cue-target spatial congruency: congruent vs. incongruent) x 2 (Gender of the cuing face: female vs. male) x 2 (Gender of the participant: female vs. male) repeated measure ANOVA was conducted on mean RTs. The effect of Gender of the participant was significant, $F(1,10) = 7.968$, $p = .018$, $\eta^2_{partial} = .443$, indicating that males (M = 996, SE = 72) were overall faster than females (M = 1285, SE = 72), in line with previous results in the literature obtained with adult participants (see Bayliss et al., 2005). The three-way interaction was also significant, $F(1,10) = 8.722$, $p = .014$, $\eta^2_{partial} = .466$. One-tailed planned comparisons confronting mean RTs between the incongruent and congruent trials showed that female participants exhibited a significant cuing effect only towards their female classmates, whereas in the case of male classmates the effect was even reversed. In the same way, male participants exhibited a significant cuing effect towards their male classmates but not towards females (see Table 1). Importantly, no Gender of the cuing face x Gender of the participant interaction emerged, $p = .884$, indicating that there was no difference in attentional disengagement between same gender and different gender faces.

	female participants		male participants	
	cuing effect	p	cuing effect	p
female faces	170 (73)	.033	19 (36)	.306
male faces	-143 (73)	.053	96 (18)	.001

Table 1. Cuing effect (meanRTs$_{incongruent}$ - meanRTs$_{congruent}$) and Standard Errors (in brackets) presented separately for participants and stimuli's gender. P-values for one-tailed planned comparisons confronting mean RTs for incongruent and congruent trials are also presented. Results are presented in two separate panels for male and female participants

An ANOVA on the percentage of errors with the same factors as above did not reveal any significant effect and the critical three-way interaction was not significant, $p = .19$ thus making any possibility of a speed-accuracy trade-off unlikely.

Participants' RTs were then collapsed across gender of both participant and cuing face, thus obtaining a new variable called Gender group at two-levels: Same group (participant and cuing face were both males or females) and Different group (participant and cuing face were a male and a female or viceversa). Then, an additional 2 (Cue-target spatial congruency: congruent versus incongruent) x 2 (Gender group: same versus different) repeated measure ANOVA was conducted. The two-way interaction was significant, $F(1,11) = 7.266$, $p = .021$, $\eta^2_{partial} = .398$ (see Figure 14a).

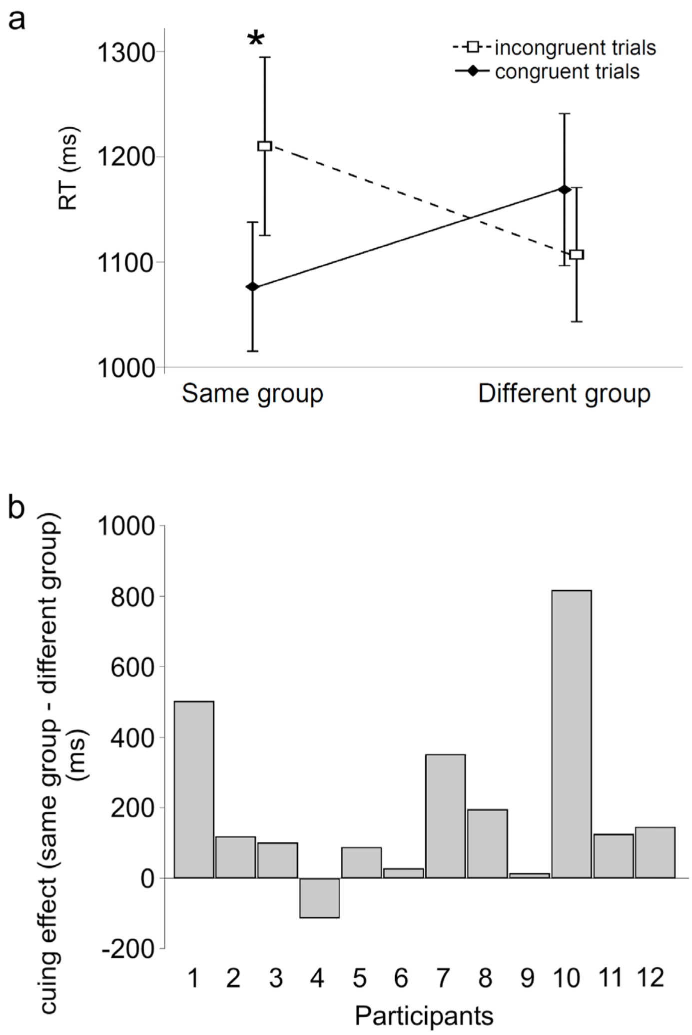

Figure 14.Panel a) Mean RTs for congruent and incongruent trials differentiated by gender membership. "Same group" means that participant and cuing face were of the same gender whereas "Different group" means that participant and cuing face differed in gender. Panel b)

Cuing effect exhibited for same group minus cuing effect exhibited for different group faces for each participant.

Planned comparisons showed that the cuing effect was significant in the same gender condition $F(1,11) = 12.802$, $p = .004$, $\eta^2_{partial} = .538$, but not in the different gender condition, $p =.205$.
As shown in Figure 14b the advantage for same gender faces was present in 11 out of the 12 participants.

As can be noted from Figure 14b, participant 1 and 10 exhibited an oddly large cuing effect towards same-gender classmates as compared to different-gender classmates. Given that the sample of the present research was rather small, one could wonder whether these two abnormal values were the source of the significant interaction emerged from previous analyses. In order to ensure that this was not the case, an ANOVA with the same factors as the previous one was conducted after removing participants 1 and 10. The critical interaction was still significant and the pattern was comparable to the one reported above, $F(1,9) = 7.228$, $p =.025$, $\eta^2_{partial} = .445$.

To further ensure that results were uncontaminated by possible speed-accuracy trade-offs, efficiency scores (i.e., RT/proportion correct; Townsend & Ashby, 1983) were computed and submitted to an ANOVA with the same factors as above. Although the two-way interaction fell shortly over significance, $F(1,11) = 3.529$, $p = .089$, $\eta^2_{partial} = .243$, planned comparisons demonstrated that cuing effect emerged for same gender peers, $F(1,11) = 7.214$, $p = .021$, $\eta^2_{partial} = .396$, but not for different gender peers, $F(1,11) = .794$, $p = .392$, $\eta^2_{partial} = .067$.

One may note that participants' mean RTs were longer (*M*=1140 ms; *SE*=51) than what often reported in gaze cuing studies with adults (e.g., Deaner et al., 2007). In order to check whether the observed pattern of results was dependent on participants' slower responses, in a final analysis, RTs were submitted to distribution statistics (Ratcliff, 1979) to differentiate faster from slower responses. For each participant and for each critical condition, the distribution of RTs was divided into two groups: slower (i.e., above the 50° percentile) and faster (i.e., below the 50° percentile) RTs. Planned comparisons were performed in order to ascertain whether the modulation of the cuing effect as a function of gender group was present in slower responses only (which would be suggestive of a late, goal-driven, effect) or both in slow and fast responses. The results showed that gaze cuing was significant for the same gender condition only, for both fast, $t(11) = -2.6$, $p = .025$, and slow responses, $t(11) = -3.4$, $p = .006$. Although far from being a conclusive demonstration, this pattern speaks in favour of a reflexive modulation. One possible explanation for the surprisingly long RTs exhibited by participants refers to the fact that children were required to identify complex pictures, whereas, usually, simpler tasks are used such as target detection, or identification based on simple features. Alternatively, the permanence of the averted gaze face after target onset may have delayed disengagement of attention from fixation.

Discussion

The aim of the present research was to investigate the role of shared gender identity on the gaze cuing effect. Children of 9-10 years old attending Grade 4 at the primary school participated in the present experiment. It is widely known that gender is one of the most important dimensions in children's life during this age (Maccoby, 1998). Indeed, children usually base the formation of their social group upon gender, interacting preferentially with same-gender peers. This phenomenon, called *gender segregation*, is reflected in the different playing practices and interests which males and females have during their childhood. We hypothesized that the gaze of a same-gender classmate was likely to be considered as more relevant and informative since his/her gaze was likely to be directed to an object of potentially shared interest. Thus, *gender segregation* would act as a modulator of gaze-mediated orienting of attention.

The results obtained confirmed the hypotheses showing that female participants exhibited a gaze-mediated orienting only in response to the averted gaze of a female classmate, whereas the reverse pattern was obtained for male participants.

Importantly, the present experiment addressed gaze-mediated orienting of attention in a strongly ecological way. Indeed, stimuli were faces well-known to participants, being those of their classmates, whereas, stimuli usually used in literature are schematic or real, but unknown, faces. However, this experiment has some limitations that need to be addressed in more details in future experiments. First of all, even though the explanation related to *gender segregation* is surely plausible, we have no measure related to this factor in the experiment. Indeed, other possible explanations for our results are conceivable. One possibility is related to the physical similarity between same gender classmates. It might be that the cuing effect is enhanced when the cue is conveyed by someone who share the physical appearance of the participant, in this case gender. Otherwise, children may have followed the gaze of those they are more familiar with, namely same gender classmates they preferentially group with during this age. In addition, the large variability in the responses might suggest that individual differences are here relevant. For instance, gender attitudes and the amount of shared activities might affect gaze cuing for different gender peers.

In conclusion, the present work is in line with recent research investigating how social attention works when embedded in a social context. Here, we explored for the first time the topic of gender membership in children. In the next paragraph, a new experiment will be presented with the aim to explore in more details the effect found in the present research. In the next experiment the size of the sample will be enlarged so to obtain more stable effects and to have a stronger statistical power. In order to have a larger sample, participants attending different classes will take part in the experiment. This change in the sample's composition leads to an important consequence: indeed, participants are likely be more familiar with peers of the same class rather than of a different class and this factor could influence results. In order to deal with this issue, in Experiment 4 the procedure will be slightly changed so to take into account also the effect of class membership.

Experiment 4

Participants

Sixty-one children participated in the experiment on a voluntary basis. Twenty-seven children were attending Grade 4 at primary school (thirteen were attending class A and fourteen class B), and the remaining thirty-four were attending Grade 5 (seventeen were attending class A and seventeen were attending class B), thus having 4 different classes participating in the experiment, namely 4A, 4B, 5A, and 5B.

Photographs of each child were used as stimuli in the task. Photographs were taken individually one week before the experimental session. A written consent was provided by children's parents for both taking their photographs and participating in the experiment.

Apparatus, Stimuli and Procedure

Stimuli were presented on a 15.4 inch color monitor with a resolution of 1024 x 768. Presentation of the stimuli and registration of responses were controlled by E-Prime 1.2 software. Three photographs for each child were used as stimuli in a spatial cuing paradigm: one depicted the child with direct gaze while the other two depicted the child with gaze averted to the right or to the left. All photographs were taken keeping the characteristics of the shoot equal to Experiment 3. The timing line of the experimental procedure was the same as in Experiment 3 (see Figure 13). The only difference between Experiment 3 and Experiment 4 consisted in the way stimuli were presented to participants. Indeed, during the experiment, children attending Grade 4 were presented only with faces of same-grade peers, and the same happened for children attending Grade 5. As previously described, for each Grade, children attended two different classes, namely A and B. Given that, in the gaze cuing paradigm, participants were

presented with both faces of children attending their own and a different-class, it was important to take into account also the possible effect of class membership. Indeed, it might be that, being more familiar with peers of the same-class, children exhibit a significant gaze cuing effect towards same-class peers and not towards different-class peers (see Deaner et al., 2007 for results showing that familiarity can influence gaze-mediated orienting of attention). Moreover, it was possible that the class membership effect was stronger than the gender effect thus minimizing the likelihood of finding an effect related to *gender segregation*. For these reasons, we decided to manipulate the presentation of stimuli so that, in one case, class membership was salient to participants, whereas, in the other case, it was less salient. We employed a specific experimental manipulation that is known to shape the salience of social factors. Indeed, research from the person perception domain has shown that the automaticity of category activation is modulated by the task environment, so that categorical knowledge is activated when participants are presented with exemplars belonging to two different categories (i.e., in mixed order), but not when stimuli are blocked according to their category (e.g., Hosie & Milne, 1996; Macrae & Cloutier, 2009). In the former condition, categorical membership is highly salient due to context-induced comparison processes, whereas in the latter case the distinctiveness of the exemplars is reduced by the presence of a homogeneous stimulus context. Thus, when children belonging to different classes are shown to participants in a mixed order, the possibility to directly compare children belonging to the same class as the participant and children attending another class enhances the saliency of class membership. In this way, class membership might interact with gender membership in modulating gaze-mediated orienting of attention. Otherwise, when stimuli are homogeneous for a whole block, a comparison between children attending class A or class B is less likely to occur because, within a block, stimuli all belong to the same category. In this way, class membership is no more salient and this variable is likely not to have any influence on gaze-mediated orienting of attention. To sum up, we hypothesized to observe different results as a function of the interaction between the way in which stimuli were presented and gender. In particular, we expected a gender membership effect to modulate gaze cuing when stimuli were presented in a blocked order, whereas we expected gender and class membership to interact in the mixed order presentation.

Participants went through 10 practice trials before completing 216 experimental trials for Grade 4 and 272 for Grade 5. Number of trials was different between Grade 4 and Grade 5 because the number of children attending each Grade and, consequently, of stimuli used in the task was different. If participants were not totally comfortable with the task when finishing the practice trials, they had the possibility to repeat the practice session. Once the experimenter was sure that participants were familiar with the task, the experimental session began. Children were tested individually. After completing the computerized task, children were asked to fill in a questionnaire. The questionnaire was made up of three different parts: the first asked for a rating of participant's classmates regarding friendship, guide for a teamwork and leadership in the class, the second assessing the subjective perception of how similar male and female children are in their games and interests, and the third asking for a judgment towards participant's own and different class. The questionnaire was included in the experiment in order to investigate the impact of individual differences on the possible modulation of gaze-mediated orienting of attention.

Results

RTs of the incorrect trials (8.2%) were eliminated. Since RTs exhibited by children were highly variable, likely because participants were not used to deal with this kind of task, also RTs more than 2.5 standard deviations above each participant's mean were eliminated (2.8%).

Analyses on RTs and errors were conducted separately for Grade 4 and Grade 5. In order to evaluate if the effect of gender emerged depending on the way stimuli were presented, a 2 (Cue-target spatial congruency: congruent vs. incongruent) x 2 (Presentation: mixed vs. blocked) x 2 (Gender of participants: male vs. female) x 2 (Gender of stimuli: male vs. female) mixed-design repeated measures ANOVA was conducted on mean RTs of children attending Grade 4. A main effect of Congruency emerged, $F(1,23) = 9.934$, $p = .004$, $\eta^2_{partial} = .302$ indicating that participants were overall faster on congruent trials ($M = 976$, $SE = 51$) as compared to incongruent trials ($M = 1028$, $SE = 64$). A significant interaction between Congruency and Gender of stimuli emerged, $F(1,23) = 7.623$, $p = .011$, $\eta^2_{partial} = .249$ indicating that the cuing effect in response to male faces was stronger as compared to female faces (see Figure 15). Planned comparisons showed that the cuing effect was significant both when the face stimulus was a male, $F(1,23) = 10.548$, $p = .004$, $\eta^2_{partial} = .314$, and a female, $F(1,23) = 7.192$, $p = .013$, $\eta^2_{partial} = .238$. The two-way interaction was not qualified by a three-way interaction involving also Gender of participants, thus highlighting that the greater gaze cuing for male faces as compared to female faces was homogeneous for both male

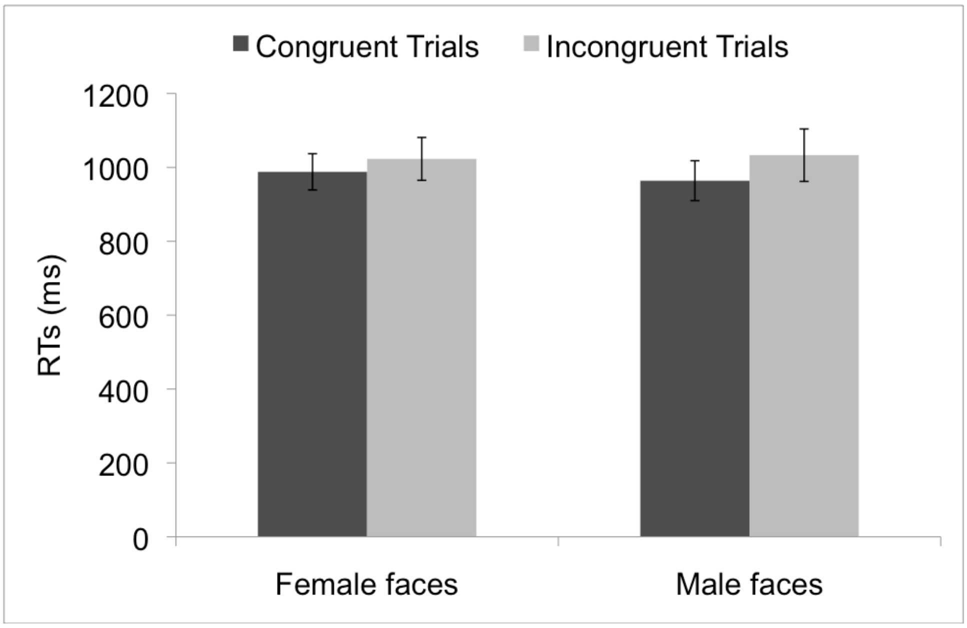

Figure 15. RTs and Standard Errors of congruent and incongruent trials as a function of the gender of the cuing face

and female participants. No other significant effect emerged for children attending Grade 4.

A 2 (Cue-target spatial congruency: congruent vs. incongruent) x 2 (Presentation: mixed vs. blocked) x 2 (Gender of participants: male vs. female) x 2 (Gender of stimuli: male vs. female) mixed-design repeated measures ANOVA was conducted on the percentage of errors. The only significant effect was an interaction between Gender of participants and Gender of stimuli showing that both males and females committed more errors when the Gender of the cuing face was different from their own (see Table 2). No effect involving Congruency was significant, thus making any possibility of a speed-accuracy trade-off unlikely.

		Gender of participants	
		male	female
Gender of stimuli	male	9.2 % (2.2 %)	7.3% (1.7 %)
	female	10.9 % (2.2 %)	6.6 % (1.6 %)

Table 2. Percentage of errors and standard error (in brackets) as a function of gender of stimuli and participants.

An identical 2 (Cue-target spatial congruency: congruent vs. incongruent) x 2 (Presentation: mixed vs. blocked) x 2 (Gender of participants: male vs. female) x 2 (Gender of stimuli: male vs. female) mixed-design repeated measures ANOVA was conducted on mean RTs of children attending Grade 5. A main effect of Congruency emerged, $F(1,30) = 7.169$, $p = .012$, $\eta^2_{partial} = .193$ indicating that participants were faster on congruent ($M = 851$, $SE = 27$) as compared to incongruent trials ($M = 872$, $SE = 29$). No other significant main effect nor interaction emerged. The same repeated measures ANOVA was conducted on the percentage of errors committed by participants. No significant effect emerged thus suggesting the absence of any speed-accuracy trade-off.

Further analyses were conducted in order to evaluate the possible impact of individual differences on the cuing effect. First, the overall cuing effect for male and female stimuli was calculated (i.e., $meanRT_{incongruent}$ minus $meanRT_{congruent}$) and, then, a new variable, called Gender cuing effect, was created by subtracting the cuing effect for female stimuli to the cuing effect for male stimuli. The higher the scores of the new variable and the strongest the cuing effect for male stimuli as compared to female stimuli. As concerned the questionnaire, mean evaluation was calculated separately for male and female regarding friendship, guide for a teamwork and. Three indexes were calculated for each of these three questions by subtracting the scores obtained by females to the scores obtained by males. Pearson correlations were then calculated between the three indexes and the Gender cuing effect measure separately for Grade 4 and Grade 5. No significant effect emerged either for Grade 4, all *ps* > .212 or Grade 5, all *ps* > .231 thus suggesting that individual differences did not influenced participants' RTs.

Discussion of Experiments 3 and 4

Results of Experiment 3 showed that children shifted attention only in response to the gaze of a same-gender peer. The hypothesized explanation for such an effect was related to *gender segregation*, namely the tendency, during childhood, to preferentially group and interact with children of the same gender. The aim of Experiment 4 was to replicate the results obtained in Experiment 3. Unfortunately, if results of Experiment 3 were pretty straightforward, results of Experiment 4 were not as clear and did not replicate what found in the previous experiment. The analyses conducted on children attending Grade 5 did not show any significant effect related to gender. In contrast, children attending Grade 4 showed a stronger cuing effect for males rather than for females, independent of participants' gender. This result is different from what expected based on the *gender segregation* hypothesis.

Even though the effects that we have found in Experiment 4 and in Experiment 3 are very different from each other, they can nonetheless give us some hints about the social malleability of gaze-mediated orienting of attention. Indeed, one of the possible alternative explanation for the *gender segregation* effect obtained in Experiment 3 was related to the physical similarity of the participants and the stimuli. Indeed, it might have been that seeing another face with similar physical traits was sufficient to enhance the cuing effect. However, in light of the results obtained in Experiment 4, a conclusion can be drawn: the results that we have found are likely to depend upon social variables rather than physical factors. Indeed, if the hypothesis about physical similarity were true, we should have observed in Experiment 4 a similar effect as that obtained in Experiment 3. On the contrary, the variability in the results suggests that the effects are not due to mere perceptual features of the stimuli but they are more likely to be related to social variables that are peculiar to each specific context.

A strong point of Experiments 3 and 4 was the attempt to study the social variables influencing gaze-mediated orienting of attention in a situation as ecological as possible. Indeed, in both experiments, faces of participants' peers were used as stimuli in the paradigm. However, besides making the laboratory setting more similar to real life, this factor has also brought some negative consequences. Indeed, each face stimulus used in the paradigm was associated to specific knowledge and feelings that are impossible to fully control for. Thus, it is likely that the variety of relationships taking place within a class strongly influenced the outcome of the present experiments. The results obtained are likely to be influenced by more than the mere hypothesized variables and this makes it difficult to draw strong conclusions about the reasons for the effects that have emerged.

In the next chapters, other experiments will be presented in which the possible social influence on gaze-mediated orienting of attention will be investigated. We will move to another population for our experiments, namely adults by investigating the effect of social status.

3.3 The role of status in modulating gaze-mediated orienting of attention in adults

In the experiments presented in the previous paragraphs, an attempt has been made in order to investigate the impact of gender membership on gaze-mediated orienting of attention in children. In the following paragraphs, I will focus on the influence of social status on gaze-mediated orienting of attention. This topic has been explored only recently in the literature. As described in the introduction to Chapter 3, a study by Jones et al. (2010) investigated the impact of status as inferred by facial cues. In their work, Jones et al. (2010) modified the perceptual features of faces of both males and females by accentuating their masculine or feminine traits. Based on previous evidence (DeBruine et al., 2006; Perrett et al., 1998), masculinized faces are perceived as dominant compared to feminized faces, which are perceived to be subordinate. Results showed that participants, both males and females, exhibited a stronger cuing effect in response to the view of a "dominant" face as compared to a "subordinate" face. Another research on the role of status was conducted with monkeys (Shepherd et al., 2006). Results showed that low-status monkeys shifted attention in response to the gaze of both high- and low-status conspecifics, whereas high-status monkeys showed an attentional orienting only in response to high-status conspecifics. Thus, results showed a modulation of gaze-mediated orienting of attention that is likely to reflect the behavioral practices and hierarchies endorsed by the social group.

In the present research, we aimed to explore the role of hierarchical relations in modulating the cuing effect in adults. In an attempt to investigate our hypothesis in an ecological setting, we considered two real groups, namely Black and White people. Research in social psychology widely demonstrated that in most Western societies Black people are perceived as a low-status minority compared to White people and that prejudice towards them is still highly rooted (Jost, Banaji, & Nosek, 2004). This is true also in the social context where the present research was conducted, namely the Italian context. Indeed, Black people are a stigmatized minority group, not yet fully integrated in the society (Sniderman, Peri, de Figueiredo, & Piazza, 2000). A recent survey from the Italian Statistical Institute has highlighted that African immigrants represent about 1% of the Italian population. Moreover, they have the lowest level of education and they mainly work in low-qualified positions thus depicting them as a low-status minority (ISTAT, 2008) .

Based on these premises, we aimed at providing a conceptual replication with human participants of the pattern obtained with monkeys (Shepherd et al., 2006). In particular, in Experiment 5, participants from the high-status group (i.e., White participants) were presented with a modified spatial cuing paradigm including pictures of same-status individuals (i.e., White faces) and low-status individuals (i.e., Black faces). We hypothesized to observe a reliable cuing effect only towards same-status individuals. In Experiment 6, the phenomenon was explored from the perspective of low-status participants (i.e., Black participants).

Experiment 5: the high-status group perspective

Participants

Twenty White university students (ten females) from the University of Padova participated as volunteers. Their mean age was 24 years.

Apparatus, Stimuli, and Procedure

Presentation of the stimuli and registration of the responses were controlled by E-prime 1.1. Stimuli were presented on a 17” monitor with a resolution of 1024 × 768 connected to an IBM compatible Pentium IV computer. The participants sat 57 cm from the computer monitor.

Sixteen avatar 3-D full-color faces created with FaceGen 3.1 software (2006) were used (4 Black females, 4 Black males, 4 White females, and 4 White males). For each face, the same software was used for creating a first image with direct gaze, a second image with averted gaze to the right and a third image with averted gaze to the left. Faces did not display additional characteristics such as hair or clothes. Each face subtended a visual angle of 16.8° in height and 14.4° in width.

Each trial began with a fixation point which remained on the screen for 900 ms, then a face with direct gaze appeared remaining on the screen for another 900 ms. Next, the image of the same face with gaze averted leftwards or rightwards was superimposed, thus conveying the impression of the eyes looking left or right. A target letter (either L or T) then appeared to the left or to the right of the face after 200 ms (see Figure 16). This short duration was employed in order to tap into exogenous processes (Müller & Rabbitt, 1989).

Gaze direction was not informative with respect to target location and trial order was randomized. The target letter appeared at approximately 11° from the centre of the screen, aligned with the horizontal meridian. The background color of the monitor was set to black and the target letter was set to white and written in 24-point Arial bold font. The specific color of the target is likely to be irrelevant, in line with previous research

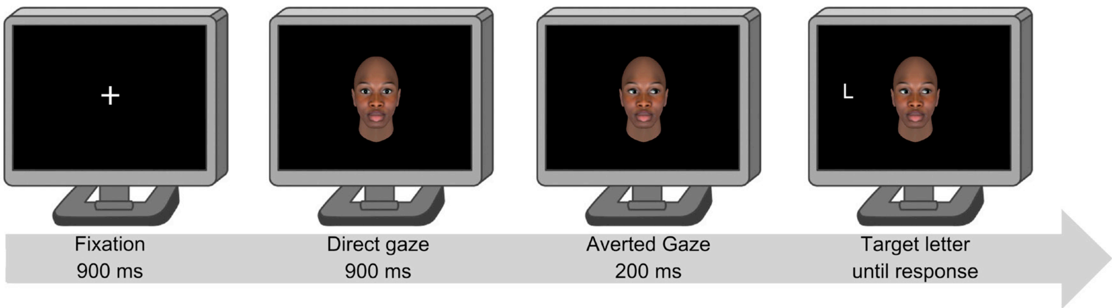

Figure 16. Schematic illustration of the sequence of events in Experiments 5, 6 and 7. Gaze direction was not informative as to target location. A cue-target spatially incongruent trial is illustrated.

showing that chromatic aspects do not affect gaze cuing (Ristic et al., 2007). Participants were required to identify the target letter by pressing one of two labeled response keys of the keyboard, namely "d" and "k", with their index fingers. The association between target letter and response key was counterbalanced across participants. The experiment comprised 256 trials. There were 64 trials for each level of cue-target spatial congruency and status of the cuing face. Before starting the experiment, participants were explicitly told that gaze direction was not informative as regards target location and they were instructed to ignore it and maintain fixation at the centre of the screen.

Results

Since participants were all adults, no data trimming was applied. A 2 (Cue-target spatial congruency: congruent vs. incongruent) × 2 (Status: High vs. low) repeated measure ANOVA was performed on mean reaction times for correct responses. Participants were faster to identify the target when it appeared in the gazed-at location (i.e., spatially congruent trials, *M* = 526 ms, *SE* = 16) as compared to when it appeared in the opposite location (i.e., spatially incongruent trials, *M* = 536 ms, *SE* = 16), $F(1,19) = 8.520$, $p = .009$, $\eta^2_{partial} = .310$. More importantly, this main effect was qualified by a significant Congruency × Status interaction, $F(1,19) = 12.721$, $p = .002$, $\eta^2_{partial} = .40$, indicating that participants shifted their attention in response to the averted gaze of a high-status face, $t(19) = -3.82$, $p = .001$, but not in response to the averted gaze of a low-status face, $t(19) = -1$, $p = .330$ (see Figure 17a). An identical repeated measure ANOVA was conducted on the percentage of errors (4.3%). No significant effect emerged, thus making the occurrence of any speed-accuracy tradeoff unlikely.

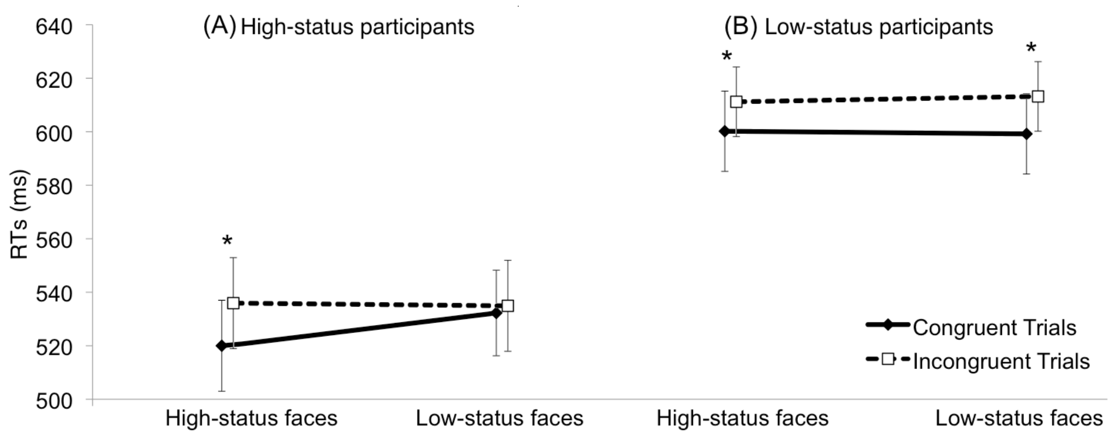

*Figure 17. Mean reaction times in Experiment 5 (panel A) and Experiment 6 (panel B) as a function of Congruency and Social status. The black line illustrates spatially congruent trials, the dashed line illustrates spatially incongruent trials. Bars represent SEM. *p<.05.*

The present results are fully consistent with the idea that participants from the high-status group shift attention only in response to the gaze of an individual belonging to their same social group. In

Experiment 6, we explored this effect from the perspective of low-status group members. There is consistent evidence that, since their childhood, minority group members interiorize the subordinate status associated with their group membership (Dunham, Baron, & Banaji, 2006; Jost et al., 2004). Accordingly, and in line with Shepherd et al.'s (2006) study, we predicted that low-status group members would orient their attention in response to both high- and low-status individuals.

Experiment 6: the low-status group perspective

Participants

Thirty-two Black university students (16 females) from the University of Padova participated on a voluntary basis and were paid 10 euros for their participation. Their mean age was 26.5 years.

Apparatus, Stimuli, and Procedure

Apparatus, stimuli, and procedure were the same as those used in Experiment 5.

Results

Data from one participant were excluded from the analyses because 25.2% of his reaction times were above 1000 ms thus leaving thirty-one participants for the analyses.

A 2 (Cue-target spatial congruency: congruent vs. incongruent) × 2 (Status: High vs. low) repeated measures ANOVA was performed on mean reaction times for correct responses. Participants were faster to identify the target when it appeared in the gazed-at location (i.e., spatially congruent trials, $M = 599$ ms, $SE = 14$) as compared to when it appeared in the opposite location (i.e., spatially incongruent trials, $M = 611$ ms, $SE = 13$), $F(1,30) = 10.477$, $p = .003$, $\eta^2_{partial} = .259$. The Congruency × Status interaction was not significant, $p = .71$. To further ensure that there was no difference in the cuing effect according to the status of the cuing face, planned contrasts were conducted showing that participants shifted their attention in response to the averted gaze of both high-status, $t(30)=-2.419$, $p = .022$, and low-status faces, $t(30)=-2.326$, $p = .027$ (see Figure 17b). An identical repeated measure ANOVA was conducted on the percentage of errors (2.2%). Only a significant main effect of Congruency emerged, $F(1,30) = 5.091$, $p = .031$, $\eta^2_{partial} = .145$, showing that participants committed more errors on incongruent trials ($M = 2.6$ %, $SE = .6$) than on congruent trials ($M = 1.8\%$, $SE = .4$).

Results from Experiments 5 and 6 nicely paralleled results obtained with monkeys (Deaner et al., 2006). Indeed, White participants (i.e., high-status group) showed a significant cuing effect only towards same-status but not towards low-status individuals, whereas Black participants (i.e., low-status group) showed a significant cuing effect towards both same-status and high-status individuals.

Overall, the two experiments indicate that social factors impact onto the cuing effect. In order to further support this interpretation, in Experiment 7, we employed a specific experimental manipulation that is known to shape the salience of social factors and that has already been used in Experiment 3. Previous research from the person perception domain has shown that the automaticity of category activation depends on the task environment, so that categorical knowledge is activated when participants are presented with exemplars belonging to two different categories (i.e., in mixed order), but not when stimuli are blocked according to their category (e.g., Hosie & Milne, 1996; Macrae & Cloutier, 2009). Therefore, in Experiment 7, we aimed to ascertain whether the modulation of gaze cuing observed in Experiment 5 for high-status participants was sensitive to whether low- and high-status faces were presented either in a mixed order or in a blocked order. We expected to replicate the pattern obtained in Experiment 5 when both high- and low-status faces were presented in a mixed order. In contrast, when stimuli of different status categories were presented in separate blocks, we expected both high- and low-status faces to trigger a significant cuing effect since the status of the faces was likely to be no longer salient given the absence of any term of comparison.

Experiment 7: The role of contextual factors

Participants

Seventy-two White university students (sixty females) participated in partial fulfillment of course credits. Their mean age was 20 years.

Apparatus, Stimuli, and Procedure

The apparatus, stimuli, and procedure were the same as in the previous experiments, with only one exception, namely the manipulation of an additional between-participants factor. Indeed, participants were randomly assigned to either a Mixed condition (N=36) or a Blocked condition (N=36). In the Mixed condition, we aimed at replicating the results obtained in Experiment 5 by increasing the number of participants and, thus, the statistical power of the test. The procedure was exactly the same as in Experiment 5 (see Figure 16). In the Mixed condition, participants completed 256 trials divided into two blocks where Black and White faces could appear in a random order within each block. In the Blocked condition, participants completed 256 trials divided into two blocks with the status of the cuing face kept constant within each block. The relative order of the two blocks was counterbalanced across participants.

Results

There were no outliers in the RTs and, thus, no data trimming was applied. For completeness, a 2 (Cue-target spatial congruency: congruent vs. incongruent) × 2 (Status: high vs. low) mixed-design repeated measure ANOVA with Condition (Mixed vs. Blocked) as a between participant factor was performed on mean reaction times for correct responses only. The three-way interaction was not significant, $F(1,70) = 2.912$, $p = .092$, $\eta^2_{partial} = .040$. However, given our strong a priori hypotheses, we submitted mean reaction times for correct responses to two identical 2 (cue-target spatial congruency: congruent vs. incongruent) × 2 (status: High vs. low) repeated measure ANOVA separately for the two conditions: Mixed and Blocked. In the Mixed condition, we replicated the effect obtained in Experiment 5. A significant effect of Congruency emerged revealing that participants were faster to identify the target when it appeared in the congruent location (*M* = 540 ms, *SE* = 12) as compared to the incongruent location (*M* = 552 ms, *SE* = 12), $F(1,35) = 12.849$, $p = .001$, $\eta^2_{partial} = .269$. Moreover, a significant Congruency × Status interaction emerged, $F(1,35) = 4.255$, $p = .047$, $\eta^2_{partial} = .108$. Planned contrasts showed a significant cuing effect in response to high-status faces, $t(35) = -4.616$, $p < .001$, but not to low-status faces ,$t(35) = -1.146$, $p = .260$ (see Figure 18a). In the Blocked condition, a significant effect of Congruency emerged in that participants were faster to detect the target when it appeared in the congruent (*M* = 537 ms, *SE* = 11) as compared to the incongruent location (*M* = 552 ms, *SE* = 12), $F(1,35) = 28.670$, $p = .001$, $\eta^2_{partial} = .450$. Importantly, in this case the interaction between Congruency and Status was not significant $p = .896$. Planned contrasts showed that the cuing effect was significant and of comparable magnitude independent of whether the cue was provided by a high-, $t(35) = -5.644$, $p < .001$, or a low-status face, $t(35) = -3.358$, $p = .002$ (see Figure 18b).

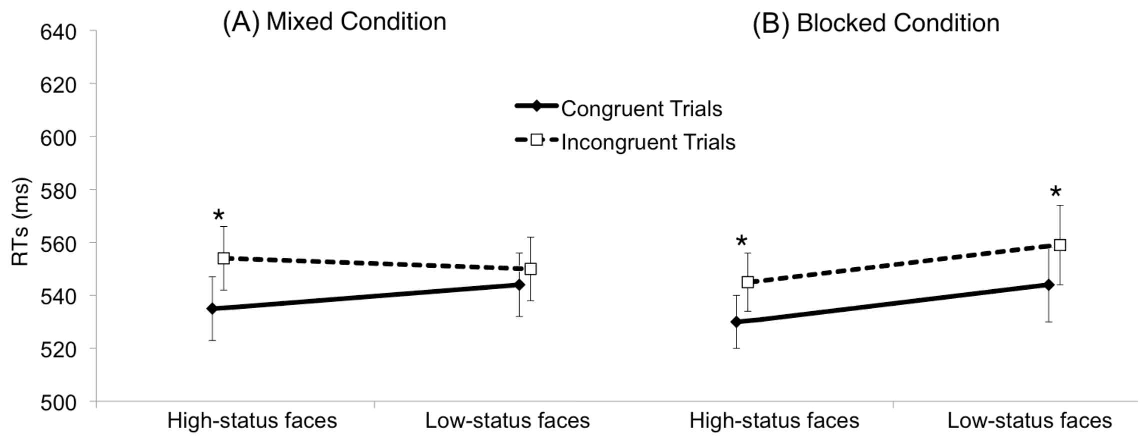

*Figure 18. Mean reaction times in Experiment 7 for the Mixed Condition (panel A) and for the Blocked Condition (panel B) as a function of Congruency and Social status. The black line illustrates spatially congruent trials, the dashed line illustrates spatially incongruent trials. Bars represent SEM. *p<.05.*

Two identical mixed-design repeated measure ANOVAs were conducted on the percentage of errors for the Mixed condition (2.2%) and the Blocked condition (2.1%). A significant effect of Congruency emerged only in the Blocked condition, $F(1,35) = 7.785$, $p = .008$, $\eta^2_{partial} = .182$, indicating that participants made more errors in the case of incongruent ($M = 2.5\%$, $SE = .4$) as compared to congruent trials ($M = 1.7\%$, $SE = .3$). Thus, no evidence for speed-accuracy trade-off emerged.

These results show that, when high- and low-status faces were presented in a mixed order, participants exhibited a gaze cuing effect only in response to high-status faces. In contrast, when participants faced two different blocks in which status was invariant in a block, they shifted attention to every available cue and a cuing effect emerged in response to both high- and low-status faces. In an attempt to understand in more details the absence of modulation emerged in the Blocked Condition, we analyzed participants' reaction times taking into account the order in which the two blocks were presented: indeed, half of the participants (n=16) first completed the block showing only low-status faces whereas the other half of the participant (n=16) first completed the block showing high-status faces. The hypothesis was that a significant cuing effect should be always observed for high-status faces. For low-status faces, the prediction was to observe a cuing effect when those faces were presented in the first block, given that participants had no terms of comparison and, therefore, their low-status was not salient. In contrast, when they were presented in the second block, the cuing effect was expected to disappear in the initial trials, because of carry-over effects (i.e., the high-status faces seen in the previous block were still active in memory as a term of comparison). To this aim, we pooled together data from the first half (trials 1–64) and the second half of each block (trials 65-128) and then computed the cuing effect separately for each cluster. As shown in Table 3, the results of planned comparisons confirmed the hypotheses, suggesting that having been exposed to high-status faces in the previous block, was sufficient to activate a comparison context and thus low-status faces did not initially trigger a significant cuing effect. However, when high-status faces viewed in the previous block were likely no longer active in memory, a significant cuing effect emerged, as can be seen in cluster 2.

First block: low-status faces				**Second-block: high-status faces**			
Cluster 1		*Cluster 2*		*Cluster 1*		*Cluster 2*	
19ms (10)	p=.06 η^2_p=.10	27 ms (8)	p=.002 η^2_p=.26	17 ms (6)	p=.013 η^2_p=.17	11 ms (5)	p=.043 η^2_p=.12
First block: high-status faces				**Second block: low-status faces**			
Cluster 1		*Cluster 2*		*Cluster 1*		*Cluster 2*	
20 ms (6)	p=.004 η^2_p=.22	13 ms (5)	p=.026 η^2_p=.14	2 ms (10)	p=.876 η^2_p=.001	16 ms (8)	p=.05 η^2_p=.11

Table 3. Cuing effects (mean (SE)) in the blocked condition of Experiment 7 as a function of block order. p-value refers to significant planned comparisons between RTs in congruent and incongruent trials for the specific cell.

Discussion of Experiments 5,6 and 7

In the present set of experiments, we aimed at exploring how status modulates gaze-mediated orienting of attention in human adults. To this aim, participants belonging to a high- and a low-status group participated in the research and they were presented with a gaze cuing paradigm in which the stimuli could be faces of high- or low- status individuals.

Social status was inferred by ethnic membership in that previous research (Sniderman et al., 2000) and socio-economic indexes (ISTAT, 2008) clearly indicate that, in the Italian context, Black people are perceived as a low-status group and White people as an high-status group. Results showed that low-status individuals, namely Black people, exhibited a cuing effect towards both same-status and higher-status individuals, whereas high-status individuals, namely White people, exhibited a cuing effect only towards same-status individuals, thus nicely paralleling results obtained with monkeys (Shepherd et al., 2006). Previous work (Deaner & Platt, 2003) showed that the time course and magnitude of the cuing effect in humans and monkeys are very similar. In the present research, we showed that also the modulation of this effect by status is similar among the two species. This seems to suggest an evolutionary significance and an adaptive function of gaze-mediated orienting of attention.

For monkeys, hierarchical relations are at the root of their social life (Chance, 1967), and it could be speculated that the modulation of gaze-mediated orienting as a function of social status may be related to social monitoring behavior. In particular, it is well known that low-ranking animals monitor other monkeys in the group more frequently than high-ranking animals (Keverne, Leonard, Scruton, Young, 1978; McNelis & Boatright-Horowitz, 1998), likely for avoiding conflict (Pannozzo et al., 2007). In humans, social status is also crucial (Cummins, 2000), and it has recently been demonstrated that high-status individuals are gazed at more often than low-status individuals (Foulsham, Cheng, Tracy, Henrich, & Kingstone, 2010). Our results that high-status individuals do not show a significant gaze-mediated orienting when they see the face of a low-status individual seems to suggest that high-status members tend to save attentional resources for more relevant individuals, as if following the direction of gaze of a low-status individual would not convey any particular advantage. In light of this reasoning, we speculate that the observation that social status can influence gaze-mediated orienting in the present set of data suggests a common evolutionary root of gaze-mediated orienting behavior for both human and non-human primates and that its role may rely in the proper maintenance of social hierarchies aimed to preserve the stability of the social structure in species for which the social dimension is critical to survive.

In Experiment 7, we tested whether the modulation of gaze cuing observed in Experiment 5 was sensitive to context. In particular, we aimed to ascertain whether for high-status participants, low-status faces triggered a cuing effect depending on the way stimuli were presented. Results showed that when the experimental context allowed for a comparison between low- and high-status faces (i.e., mixed condition), high-status faces were prioritized over low-status faces, thus replicating results obtained in Experiment 5. On the contrary, when low- and high-status faces were kept constant among two distinct blocks (i.e., blocked condition), they both triggered gaze-mediated orienting. This result is important in that it shows that the modulation of gaze cuing as function of status critically depends upon whether or not the context favored the activation of status differences. Moreover, this pattern is taken as additional evidence that the modulation of gaze cuing observed in the present set of data is related to social rather than low-level perceptual properties of the stimuli. In this regard, one may have argued that the absence of cuing effect exhibited by high-status participants for low-status faces in Experiment 5 was simply due to the different physical properties (e.g., contrast between the skin and the sclera) of low- and high-status faces, with faces of Black individuals eliciting a weaker perception of averted gaze than faces of White individuals. The observation that low-status faces were able to trigger a cuing effect only under specific contextual circumstances allows us to rule out this alternative account and highlights that the broader experimental context can have a fundamental role in the emerging of the cuing effect, thus challenging the unconditional automaticity of gaze-mediated orienting of attention (e.g., Driver et al., 1999; Kuhn & Kingstone, 2009; Stevens et al., 2008).

Some limitations for the obtained results have to be acknowledged: for instance, it might be that the modulation of gaze-mediated orienting of attention observed for high- and low-status participants reflects not only the influence of status but also the role of the preference for the ingroup and the outgroup. Indeed, it is widely demonstrated that members of dominant groups exhibit a strong ingroup preference, whereas results for members of non-dominant groups are less straightforward in that, sometimes, they do not show a preference either for their own group or the dominant one and, other times, they even show a preference for the outgroup (Jost et al., 2004; Nosek, 2007). Given the interplay between group-preference and social status it might be that the present results are not purely due to the status but derive from a concurrent role of both status and group membership.

To conclude, we found that social status modulates gaze-mediated orienting of attention in humans in a similar manner as in monkeys (Shepherd et al., 2006), highlighting the evolutionary nature of this phenomenon that is detectable also in non human primates and in other animal species (Ferrari, Coudè, Gallese, & Fogassi, 2008; Tomasello et al., 1998; see Shepherd, 2010 for a review). It could be argued that, even though it is a safe bet to say that Black individuals are a low-status group in

Italy, social status was not explicitly measured in the present research. In order to provide a strong demonstration that social status can impact on gaze-mediated orienting of attention, in Experiment 8 we implemented a more controlled experimental situation in which the status of the cuing face was manipulated.

<u>*Experiment 8: Manipulating social status*</u>

Introduction

The present experiment was aimed at investigating the role of social status in influencing gaze-mediated orienting of attention. In the present experiment, we have tried to overcome some of the limitations that characterized the previous experiments.

Indeed, unlike Experiment 5, 6 and 7 in which the social status was inferred by facial characteristics of the stimuli (i.e., ethnic identity), in the present research social status was experimentally manipulated and explicitly communicated to participants. Participants were initially presented with several faces, each associated to a Curriculum Vitae. Each face could be associated to a low-status or high-status Curriculum Vitae and the association between status and face was counterbalanced across participants. The same faces were then used in the gaze cuing task. This kind of paradigm allowed us to take under control the role of facial characteristics of the stimuli in influencing the cuing effect since the same faces were perceived as being of high- or low- status depending on the experimental condition participants were assigned to.

Because it has been shown that females are more sensitive to social cues such as familiarity (see results from Deaner et al., 2007) and status (Geary, 1998), only female participants took part in the present research.

Participants

Twenty-four female undergraduate students were recruited as volunteers at the University of

Padova. Their mean age was 23 years old.

Apparatus, Stimuli and Procedure

Before beginning the computerized task, participants were given a documentation to read. The documentation contained 16 colored photos of male faces taken from "the Color FERET Database" (Phillips, Moon, Rizvi, & Raus, 2000; Phillips, Wechsler, Huang, & Raus, 1998): 8 adults aged between 50 and 60 (i.e., older adults) and 8 adults aged 20 years old (i.e., young adults). Each face was associated to an alleged Curriculum Vitae containing information on the social status of the person. The social status was described in terms of kind of job and years of education. For 10 participants (Condition 1), young adults were described as being of high-status (e.g., "Graduated with honors in physics. He is currently involved in an important research project in a famous Research lab") whereas older adults were described as being of low-status (e.g., "Retired factory worker. He did not finish primary school"), whereas for 14 participants (Condition 2), young adults were described as being of low-status (e.g., "He wants to try the matriculation exam at the Faculty of Architecture. This choice has been strongly influenced by the advises of his brother, who is an architect") and older adults as being of high-status (e.g., "Dean of a Faculty of architecture. President of the European Ecosustainable Construction Society"). The mapping between age range and status was done in order to make easier for participants to remember the social status by simply associating each social category to a specific social status.

After reading the documentation, participants went through a gaze cuing task. The same pictures of the 16 individuals presented in the documentation were used as stimuli in the gaze cuing task. Each image subtended 21° in height and 14° in width. For each individual, two images were created: one with gaze averted to the right and one the left. This was done by moving the iris 0.25° with respect to the centre of the eyes to the left or to the right. Stimuli were presented on a AMD Athlon Dual Core PC connected to a 17 inch monitor set to a resolution of 1024x768. Stimuli presentation and registration of responses were controlled by the software E-Prime 1.2. Each trial began with the presentation of a fixation cross in the centre of the screen for 900 ms (see Figure 19).

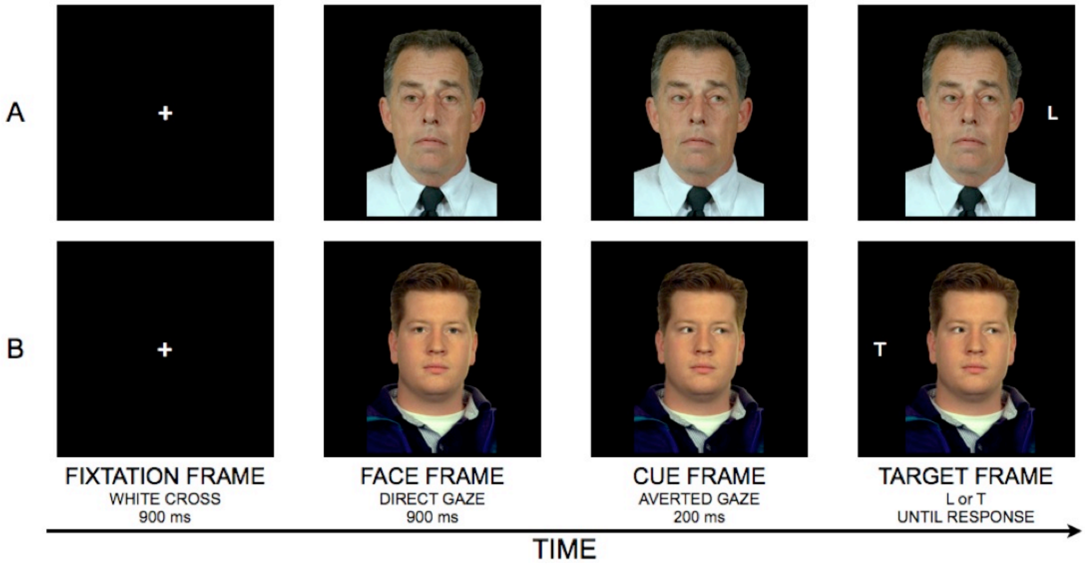

Figure 19. An example of a trial presenting an older adult (Panel A) and a young adult (Panel B). A congruent (Panel A) and an incongruent (Panel B) trial are shown.

Then, a face with direct gaze was presented in the centre of the screen for 900 ms followed by the same face with gaze averted. After 200 ms (SOA), a target appeared in the location congruent or incongruent with gaze direction. The target could be either a "T" or "L" letter and participants' task was to identify the letter by pressing one of two keys on the keyboard, namely the letter "k" or "d". Participants were informed that gaze direction was not informative as to target location and that they had to ignore the face and respond to the target as fast and accurately as possible. In case participants committed an error by pressing the wrong key, the word "ERROR" appeared on the screen for 500 ms, followed by the next trial. Participants went through 256 trials divided into two blocks.

Results

Because participants were all adults, no data trimming was applied. Trials in which participants committed an error (4%) were removed prior to analyses. A 2 (Cue-target spatial congruency:

congruent vs. incongruent) x 2 (Face: old vs. young) x 2 (Condition: 1 vs. 2) mixed-design repeated measures ANOVA was conducted on mean RTs. A main effect of Congruency emerged, $F(1,22) = 6.820$, $p = .016$, $\eta^2_{partial} = .237$, indicating that participants' RTs were faster on congruent trials (M = 512 ms, SE = 13) as compared to incongruent trials (M = 522 ms, SE = 12). Also the three-way interaction between Congruency, Face and Condition was marginally significant, $F(1,22) = 3.825$, $p = .063$, $\eta^2_{partial} = .148$. Planned comparisons showed that the cuing effect was non significant in response to the gaze of an individual described as of low-status, irrespective of whether it was an older, $p = .642$ (i.e., Condition 2), or a young adult, $p = .577$ (i.e., Condition 1). In sharp contrast, when participants were presented with an high-status face, the cuing effect was significant when it was an older adult, $F(1,22) = 8.856$, $p = .007$, $\eta^2_{partial} = .287$ (i.e., Condition 1), and marginally significant when it was a young adult, $F(1,22) = 3.436$, $p = .077$, $\eta^2_{partial} = .135$ (i.e., Condition 2) (see Figure 20).

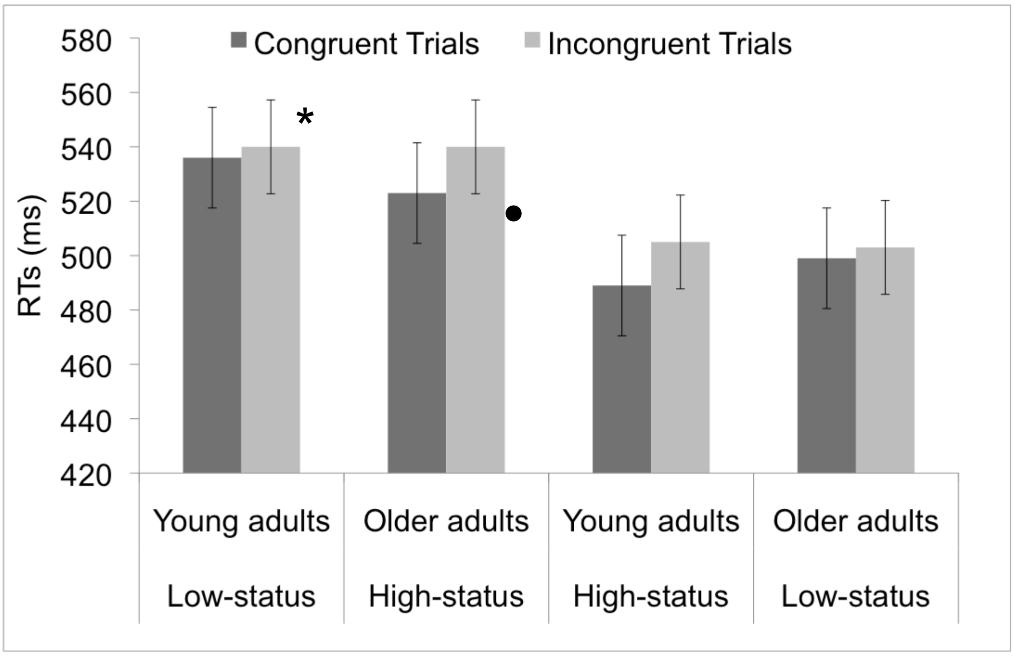

*Figure 20. RTs for Congruent and Incongruent trials as a function of type of face and condition. * p<.05;*
• p<.1

An identical analysis conducted on the percentage of errors showed a significant interaction between Face and Condition, $F(1,22) = 5.064$, $p = .035$, $\eta^2_{partial} = .187$, indicating that participants committed more errors in responding to faces of older adults rather than faces of young adults in Condition 1, whereas the opposite happened in Condition 2 (see table 4).

Since no effect involved Congruency, the occurrence of a speed-accuracy trade-off was unlikely.

		% errors (SE)
Condition 1	Young adults (low-status)	7.0 % (1.7 %)
	Older adults (high-status)	5.8 % (1.3 %)
Condition2	Young adults (high-status)	1.9 % (1.4 %)
	Older adults (low-status)	3.0 % (1.1 %)

Table 4. Percentage of errors and standard error in brackets as a function of the Condition

Discussion of Experiment 8

The results showed that the ability of a gaze to trigger an attentional shift depended on the social status related to the face the eyes belonged to. In the present experiment, participants were first assigned to one of two conditions and, then, they were given a documentation to read. The material depicted several male faces, half of young adults and half of older adults, each associated to a description about social status. For half participants, faces of young adults were associated to high-status profile and faces of older adults to low-status profile, and this association was reversed for the other half of the participants. In this way, all participants were presented with the same stimuli, the only difference being in the attributed social status. After having read the documentation, participants went through a gaze cuing paradigm in which the stimuli were the same faces previously seen in the documentation. Results showed that participants exhibited a cuing effect only when the gaze cue was conveyed by a high-status face, irrespective of whether it was the face of an old or a young adult.

Unlike Experiments 5, 6 and 7 in which social status was inferred from ethnic identity, in the present experiment participants were explicitly informed about the social status of the stimuli and this variable was manipulated. Indeed, participants in the two conditions viewed the same faces associated to different status and thus the physical features of the stimuli were kept constant across conditions. In this way, we can conclude that the effects found in the present experiment are uniquely due to the status manipulation and not to other low-level properties of the stimuli.

On a more general level, social status inferred from socio-economic cues was found to impact onto gaze-mediated orienting of attention. Importantly, this is the first research directly addressing this issue. Previously, Jones et al. (2010) showed that dominant faces elicited a stronger cuing effect as compared to subordinate faces. In their research, the dominance or submissiveness were inferred from physical cues related to the presence of masculine or feminine traits. The present research makes a substantial step forward in that social status was inferred by socio-economic information that represents an ecological type of information that people use almost everyday in order to form an impression of a person.

Social hierarchies deeply shape human behavior by defining expectations about future actions and by modulating one's own conduct as a function of the interaction partner (Cummins, 2000). Given the pervasiveness of social status in human life, we hypothesized that this factor would have influenced also a social phenomenon such as gaze-mediated orienting of attention. Non-human primates follow their leader line of sight to infer the future movements of the social group and follow him, or to avoid to compete for the same resources, food or mate (Chance, 1967). In the same way, the present findings suggest that humans are more sensitive to the gaze of high-status peers in that this allows them to properly and rapidly conform to the leaders' behavior.

Future research will need to investigate this issue with male participants in order to see if they are as sensitive as females to social status. Moreover, it would be interesting to vary the gender of the face stimuli. Indeed, it might be that the effect is not replicated with female stimuli in that the high-status characteristic is seen as less prototypical of the category.

To conclude, the present findings demonstrate that social status influences gaze-mediated orienting of attention so that the information conveyed by the gaze of high-status individuals is prioritized compared to the gaze of low-status individuals. Importantly, in the present research, all the factors related to the physical features of the face stimuli, which could have influenced the obtained effects, were controlled for by presenting participants with a between-participants design in which the same face was associated to high- or low-status depending on the condition.

CHAPTER 4.

General Discussion

4.1. Gaze-mediated orienting of attention: an automatic phenomenon…

4.2. …modulated by social factors

4.3. The two-faced nature of gaze-mediated orienting of attention

Great interest has been devoted to gaze-mediated orienting of attention in recent years and much research has focused on this topic. Gaze-mediated orienting has been considered by some researchers as the lost ring of the chain connecting the laboratory and real-life situations in that gaze is considered as an highly ecological stimulus, salient in everyday life (Kingstone et al., 2003). However, even though great effort was put in the study of this phenomenon, there is still an almost neglected aspect in the literature. Indeed, the eyes are always embedded in a person and their salience is strongly linked to the person the eyes belong to. In this regard, it is important to focus on two distinct but overlapping aspects of gaze-mediated orienting of attention: on one side, it is noteworthy to investigate the characteristics of this phenomenon as concerns its automaticity whereas, on the other side, it is necessary to go beyond the classic experiments by investigating the social influences exerted on this phenomenon.

Indeed, the aim of the present work was to highlight this two-faced nature of gaze-mediated orienting of attention by focusing on the automaticity of gaze-mediated orienting of attention and the possibility that the identity of both participants and cuing faces and the relationships between these two factors influence gaze-mediated orienting. In the next paragraphs, I will discuss in more details the results that we have obtained throughout several experiments and I will try to put the obtained results that, at first sight seem to be opposite, into a coherent framework.

4.1 Gaze-mediated orienting of attention: an automatic phenomenon…

Previous research on gaze-mediated orienting of attention has defined it as an automatic phenomenon in that it is observable even when gaze is non informative or counterpredictive as to target location (e.g., Driver et al., 1999) or when participants face dual-task paradigms (Law et al., 2011). Studies conducted with another central cue, namely arrows, did not lead to straightforward results as concerns the automaticity of attentional orienting (e.g., Friesen et al., 2004; Tipples, 2008).

Throughout Chapter 2 we have compared the attentional orienting triggered by gaze and arrows with the aim to clarify the controversial results obtained in the literature. We presented participants with a paradigm which tested a strong interpretation of automaticity in that the cue, in a different way from previous studies, was totally irrelevant for the task at hand. In the experiments that we have conducted, participants were informed in advance with 100% certainty about where the target would appear on a trial-by-trial (Experiments 1a & 1b) or on a block-by-block basis (Experiments 2a & 2b). Gaze was presented as a distractor totally task-irrelevant and participants could ignore it without losing any information about target location. We have found that gaze and, in a similar vein, arrows, triggered an attentional shift thus depicting gaze- and arrows-mediated orienting of attention as automatic phenomena. A conclusion that can be drawn from the experiments presented in Chapter 2 is that gaze cues cannot be ignored and, every time we see an averted gaze, an attentional shift takes place. However, if we try to apply such a conclusion to a real-life situation, it is implausible to believe that we shift attention in response to every available gaze likely because the paradigms that are used are mostly artificial and do not capture the social nature of such a phenomenon.

4.2 ...modulated by social factors

In Chapter 3, the aim was to investigate the social influences on gaze-mediated orienting of attention. This is an almost unexplored topic in the literature and, only in recent years, some studies have addressed this issue (e.g., Deaner et al., 2007; Jones et al., 2010; Wilkowski et al., 2009). First, two experiments were conducted with children investigating the impact of gender membership and, next, I focused on the impact of social status in adults.

In the experiments conducted with children, participants were presented with faces of their classmates in a gaze cuing task and we investigated if gaze-mediated orienting was influenced by the gender of both participants and cuing faces. In a first experiment, results showed that children shifted attention only in response to the gaze of same gender peers, as predicted by the *gender segregation* hypothesis (Maccoby, 1998). In a subsequent experiment (i.e., Experiment 4) the aim was to replicate the effect and to link results to participants' judgments about their peers. However, the *gender segregation* effect was not replicated: in one Grade (i.e., Grade 4), participants exhibited a stronger cuing effect for male peers as compared to females, whereas in the other Grade, no modulation of gender was observed. The variability in the obtained results pointed out a negative consequence of pursuing an ecological approach to gaze-mediated orienting. Indeed, it is likely that, being the faces of their classmates, each stimulus was associated to specific knowledge and affective evaluations which influenced the results. Thus, the possibility to obtain the hypothesized effect is likely to depend on the social context in which a phenomenon is investigated and on the relationships among children. Anyway, the fact that we obtained different results among different contexts suggests that social factors are here relevant in influencing gaze-mediated orienting of attention because, if this were not the case, results would have been similar in all the contexts that we tested.

In the second part of Chapter 3 we focused on the influence of social status in adults.

Results from the experiments conducted with real groups, as defined by ethnic identity, demonstrated that low-status individuals showed an indiscriminate orienting of attention towards both same-status and high-status peers, whereas high-status individuals only showed a significant effect for same-status peers nicely paralleling results obtained with non-human primates (see Shepherd et al., 2006). Interestingly, this modulation for high-status participants depended on contextual factors so that the influence of social status was observable only when the comparison between high- and low-status faces was salient.

In Experiment 8, we further investigated this issue by presenting participants with several faces, each associated to a low- or high-status profile. The association between each face and social status was counterbalanced across participants in a between-participants design. The same faces were subsequently used as stimuli in a gaze cuing task. Results showed that participants shifted attention only in response to the gaze of a high-status individual. Interestingly, the fact that the same faces were described as high-status to half of the participants and as low-status to the other half allows us to rule out alternative explanations for the effect related to physical characteristics of the stimuli. Thus, throughout Chapter 3, we provided evidence suggesting that social factors modulate gaze-mediated orienting of attention.

4.3 The two-faced nature of gaze-mediated orienting of attention

At a first sight, it might seem that the conclusions from Chapter 2 and 3 are in sharp contrast and support two opposite positions. Indeed, as pointed out in the previous pages, it is hard to conceive that the automaticity of gaze-mediated orienting of attention can be considered as truthful when the experimental situation moves closer to real-life. In fact, it is implausible to assume that people automatically shift attention in response to an averted gaze independent of factors such as physical distance or social relationship with the person conveying the cue. Thus, I think that the different results reflect the experimental paradigms that are used to investigate the two faces of gaze-mediated orienting of attention. This suggestion is corroborated by results obtained in Experiment 7. Indeed, it was shown that social status modulates gaze-mediated orienting of attention when status is made salient by randomly presenting stimuli that differ along this characteristic (i.e., Mixed order presentation), whereas the influence of social status is not exerted when stimuli presented to participants are homogeneous as concerns social status and, thus, this factor is not salient (i.e., Blocked order presentation). It seems that, when the experimental paradigm allows for an influence of social variables, such variables are found to exert an effect, whereas this does not happen when participants are not provided with this possibility. By adopting this view, results obtained in Chapter 2 and 3 are not contradictory but they simply represent different faces of the same medal. The present thesis highlights two novel aspects in gaze-mediated orienting of attention studies. On one side, as described above, the importance of the experimental context is stressed: indeed, a modulation of the gaze cuing effect is likely to take place when participants are presented with the possibility to compare different kinds of stimuli. On the other side, the variables that are taken into consideration have to be meaningful to participants in order to elicit an influence. In the experiments that I have described, we have taken into account factors such as gender membership and social status that are likely to be relevant to participants in their everyday life. On the contrary, previous research which focused on more artificial aspects did not find a modulation of gaze-mediated orienting of attention as a function of the identity of the stimuli (e.g., Quadflieg et al., 2004).

To sum up, in my thesis I focused on two aspects related to gaze-mediated orienting, namely the automaticity and the modulability driven by social factors. Research investigating both these aspects is worthwhile to be pursued. Indeed, the first field of research can give demonstrations about the rootedness of gaze-mediated orienting in human and non-human primates cognitive system. Moreover, it can give us some hints about the salience of gaze cues by demonstrating that, in paradigms in which gaze cues is not useful and could consequently be ignored, participants cannot draw back from processing it. Second, investigating the social modulation of gaze-mediated orienting of attention is of great importance in that, even though succeeding in such a goal might be more difficult than what expected, it can help us to shed light on how gaze-mediated orienting takes place when it is investigated in contexts which take into account variables that are salient in real-life situations.

The work conducted in the present thesis about the social nature of gaze-mediated orienting of attention is only the first brick of the wall and the challenge for the future of attention studies is to create a stronger bridge between real-life and the laboratory by adopting paradigms which take inspiration from situations that each individual faces everyday in the real world.

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