Available online at www.sciencedirect.com
SCIENCE DIRECT®
COGNITION
Cognition 94 (2005) B55–B65
www.elsevier.com/locate/COGNIT

Brief article

Taking control of reflexive social attention

Jelena Ristic*, Alan Kingstone

Department of Psychology, University of British Columbia, Vancouver, BC, Canada V6T 1Z4

Received 26 January 2004; accepted 28 April 2004

Abstract

Attention is shifted reflexively to where other people are looking. It has been argued by a number of investigators that this social attention effect reflects the obligatory bottom-up activation of domain-specific modules within the inferior temporal (IT) cortex that are specialized for processing face and gaze information. However, it is also the case that top-down factors may modulate the activation of IT cells. Here we examined behaviorally whether reflexive social orienting is purely automatic or sensitive to top-down modulation. Participants were shown an ambiguous stimulus that could be perceived either as representing EYES or a CAR. In Experiment 1 we demonstrated between groups that an automatic shift of attention, equivalent to that triggered by a schematic FACE, occurred only when the stimulus was referred to as possessing EYES. In Experiment 2 all participants received the EYES and CAR conditions. When the stimulus was first referred to as a CAR and then as EYES, an attentional shift was only present for the EYES condition. However, when the stimulus was first referred to as possessing EYES, and then later as a CAR, attentional shifts were observed for both conditions. These data indicate that the emergence of a reflexive social attention effect is influenced by top-down mechanisms but in an asymmetrical manner. Top-down processes appear to be effective for triggering IT involvement, that is, for perceiving a stimulus as a face, which produces the social attention effect. But top-down mechanisms are ineffective once IT involvement has been triggered. That is, once a stimulus has been seen as having eyes, it continues to be seen that way, and accordingly, the social attention effect persists.

Keywords: Gaze; Inferior temporal cortex; Reflexive and volitional social attention

* Corresponding author. Tel.: +1 604 822 0069.
E-mail addresses: jelena.ristic@telus.net (J. Ristic), alan.kingstone@ubc.ca (A. Kingstone).

0022-2860/$ - see front matter
doi:10.1016/j.cognition.2004.04.005

Recent behavioral studies indicate that humans will attend to where someone is looking (e.g. Friesen & Kingstone, 1998; Langton & Bruce, 1999). In the typical laboratory demonstration, a picture of a face looking left or right is projected onto a screen and observers are required to respond as quickly as possible to a target that appears beside the face. The standard finding is that response time (RT) to the target is shorter when the face is looking at the target rather than away from it, indicating that attention has been shifted to where the eyes are looking.

Several reasons have been put forward for why this social orienting effect is reflexive in nature. First, it occurs rapidly, within a few hundred milliseconds after a gazing face is presented (e.g. Friesen & Kingstone, 1998). Second, it occurs even if eye direction is negatively correlated with where a target might to appear (e.g. Driver et al., 1999; Friesen, Ristic, & Kingstone, 2004). Third, cells in the right inferior temporal (IT) cortex are dedicated to processing gaze direction in an obligatory fashion, which dovetails with the finding that attention is shifted rapidly to where someone else is looking (Langton, Watt, & Bruce, 2000).

Whether this social orienting effect is *purely* reflexive or not, however, has been the focus of considerable speculation. Some investigators have suggested, either explicitly or implicitly, that the effect is driven in a purely "bottom-up" fashion by cells in IT (e.g. Friesen & Kingstone, 1998; Kingstone, Friesen, & Gazzaniga, 2000). For instance, in an early study of the social orienting phenomenon (Driver et al., 1999) observers were shown gazing faces and informed that on most trials a target would appear at the location opposite to where the eyes were looking (e.g. eyes looking left predicted that a target was likely to appear on the right). Even though the eyes were counterpredictive, observers first shifted attention to the gazed-at location (where the target was unlikely to appear), suggesting that the initial attention shift triggered by gaze direction operates independent of top-down executive control processes that are sensitive to the predictive nature of a stimulus.

There are, however, also reasons to think that the social orienting effect depends at least in part on top-down processes that interpret the trigger stimulus. For instance, Dolan et al. (1997) observed that ambiguous pictures activated face-processing cells in IT *only* when observers recognized the pictures as depicting faces. Similarly, Bentin, Sagiv, Mecklinger, and Friederici (2002) have recently demonstrated that neutral stimuli, such as a pair of dots, will trigger a face-specific brain potential *only* when the neutral stimuli are first represented as depicting the eyes of a face.

Importantly, each of these lines of evidence also has its shortcomings. For example, in Driver et al. (1999) study observers never actually oriented attention to the predicted target location, raising the possibility that top-down control processes were never even engaged. Conversely, the studies by Bentin et al. (2002) and Dolan et al. (1997) lack behavioral data against which to compare the neural imaging results. Thus whether or not the social orienting effect, measured as a behavioral facilitation for targets appearing at the gazed-at location, is driven purely by bottom-up processes remains very much an open question. The aim of the present study was to address this issue directly.

1. Experiment 1

The present study used ambiguous displays to assess whether top-down processes have a behavioral effect on attentional orienting to gaze direction. Participants were tested in one of three conditions. In the FACE condition (based on the original work of Friesen & Kingstone, 1998), participants were presented with a schematic face that gazed to the left or right of center. Target onset occurred 100–1000 ms after the face stimulus and was uncorrelated with gaze direction. In the other two conditions participants were presented with an ambiguous stimulus (see Fig. 1). In the EYES condition participants were instructed that the stimulus was a picture of a hat pulled down to the eyes of a face. In the CAR condition participants were instructed that the stimulus depicted an automobile.

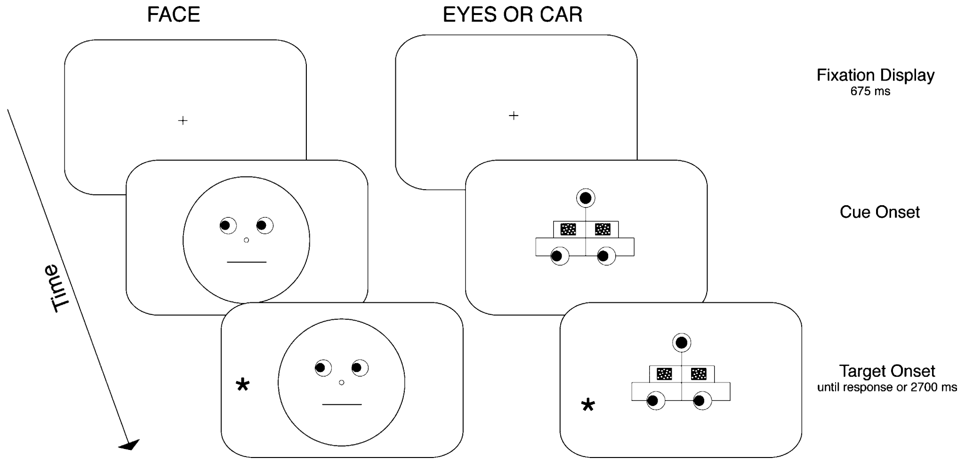

Fig. 1. Illustration of stimuli (not to scale) and sample sequence of events. Every trial began with a 675 ms presentation of a fixation point (subtending 1°) followed by a central stimulus cue (FACE, EYES, or CAR). The stimulus onset asynchrony (SOA) separating the presentation of the central cue and the target was 100, 300, 600, or 1000 ms. Cue direction (e.g. eyes left or right), target position, and SOA were varied randomly. Participants were instructed to maintain central fixation and press the spacebar on a computer keyboard as quickly as they could when the target was detected. Both the central stimulus and the target remained present until a response was made or the trial timed-out after 2700 ms. Response time (RT) was measured from the onset of the target. The intertrial interval was 680 ms. The central stimulus condition was manipulated between participants. All computer stimuli were black drawings shown on a white background. The FACE stimulus was comprised of a circle outline (8.2° long and 7.2° wide) with two inner upper circles representing eyes, middle small circle representing the nose (0.2°) and the straight line representing the mouth (2.5° in length). The circle outline of eyes subtended 1° and filled-in circles representing pupils measured 0.6°. The pupils were positioned so that they were either touching the left or right circle outline. The central stimulus was identical for the EYES and CAR conditions. This stimulus was a symmetrical black and white line drawing. It measured 5° in width and 4° in height. The line drawings of three circles subtended 1° and black filled in circles measured 0.6°. The target was a black asterisk appearing on either left or right side of the central cue with an eccentricity of 7° of visual angle. The asterisk was 1° high and 0.9° wide.

Our predictions were as follows. In the baseline FACE condition we expected to replicate the results of Friesen and Kingstone (1998), and many others (e.g. Langton & Bruce, 1999; Ristic, Friesen and Kingstone, 2003) with shorter RT at the gazed-at (valid) location versus the nongazed-at (invalid) location. A similar result was expected to emerge in the EYES condition, where the central stimulus would again be represented as gazing left or right. Two possible outcomes were plausible in the CAR condition. If face processing mechanisms in IT proceed in a purely modular bottom-up manner independent of top-down processing mechanisms, then performance in the CAR condition should replicate the EYES condition. That is, the cells in IT will analyze the stimulus as having the geometric shape of eyes, and trigger an attentional shift—a prediction well articulated by Pinker "… If objects other than faces (animals, facial expressions, or even cars) have some of these geometric features, the module will have no choice but to analyze them" (1997, p. 273). Alternatively, it is possible that top-down processing of the stimulus as depicting a gazing face is necessary for the social orienting effect to occur. If this is the case then in the CAR condition, and only in the car condition, a social orienting effect will be absent.

1.1. Participants

All 45 participants were naive to the purpose of the experiment and assigned randomly to one of the three groups ($N=15$/group). Each completed 10 practice trials followed by 10 blocks of 60 trials for a total of 600 experimental trials. Catch trials, in which a target was not presented, varied randomly across trials and ranged from 6 to 10% in a given block.

In the FACE condition, participants were informed that the central stimulus depicted a face, and that eye direction did not predict target position. The instructions for the EYES and CAR conditions were carefully scripted so that the only difference between the two was the information regarding the identity of the central stimulus, i.e. a hat pulled down to the eyes or a car. Participants were informed that any changes in the central stimulus (e.g. eyes or car) did not predict target position.

1.2. Results

Key press errors, false alarms, anticipations ($RT < 100$ ms), and slow RTs ($RT > 1000$ ms) were classified as errors and excluded from analysis. For all conditions, false alarms occurred on less than 4.33% on catch trials. Additionally, less than 2.6% of all target present trials in each cue condition were trimmed because of errors. Mean RT, standard deviations, and error rates for each condition are presented in Table 1. Mean RTs were calculated for correct target trials for each condition as a function of validity and SOA across all participants. The means are illustrated in Fig. 2 and show that for both the FACE and EYES conditions RT was shorter when a target appeared at a gazed-at (valid) versus a nongazed-at (invalid) location, i.e. the social attention effect. In contrast, there was no reliable effect of validity in the CAR condition.

Table 1
Mean RTs, standard deviations, and error rates for Experiment 1

Condition	FACE			EYES			CAR		
	M	SD	*%E*	*M*	SD	*%E*	*M*	SD	*%E*
100 ms SOA									
Valid	341.30	48.7	0.5	353.08	55.4	0.2	349.69	36.3	0
Invalid	341.86	49.8	0.8	353.93	57.1	0.8	349.06	36.4	0.3
300 ms SOA									
Valid	317.83	38.1	2.3	322.29	52.9	1.6	322.57	42.2	1.3
Invalid	328.68	42.9	2.3	336.68	53.4	2.2	327.78	43.4	1.3
600 ms SOA									
Valid	297.02	38.4	0.8	304.68	44.2	0.4	312.06	37	0.5
Invalid	309.56	41.7	0.7	318.43	46.4	0.4	314.30	37.3	0.6
1000 ms SOA									
Valid	308.65	46.4	0.6	313.75	39.2	0.7	331.74	41	0.9
Invalid	312.73	41	0.6	320.87	46.9	0.3	329.51	37.5	0.5

These observations were supported by a $3\times2\times4$ analysis of variance (ANOVA) with condition (FACE, EYES, CAR) as a between subject factor and validity (valid, invalid) and SOA (100, 300, 600, and 1000 ms) as within subject factors.

There were main effects for validity [$F(1,42)=19.97$, $p<0.0001$] reflecting the overall facilitative effect of attention being allocated to a valid location; and SOA [$F(3,126)=91.69$, $p<.0001$] reflecting the general decline in RT that occurs as participants prepare to respond to a target (called a foreperiod effect; Bertelson, 1967). SOA also interacted with condition [$F(6,126)=2.48$, $p<0.05$], and validity, [$F(3,126)=6.43$, $p<0.001$] reflecting that the foreperiod effect was most pronounced in the FACE and EYES condition, and when the target was at the valid location. Most importantly, there was a significant condition$\times$validity interaction [$F(2,42)=3.41$, $p<0.05$] consistent with attention being allocated to the valid location in the FACE and EYES conditions but not in the CAR

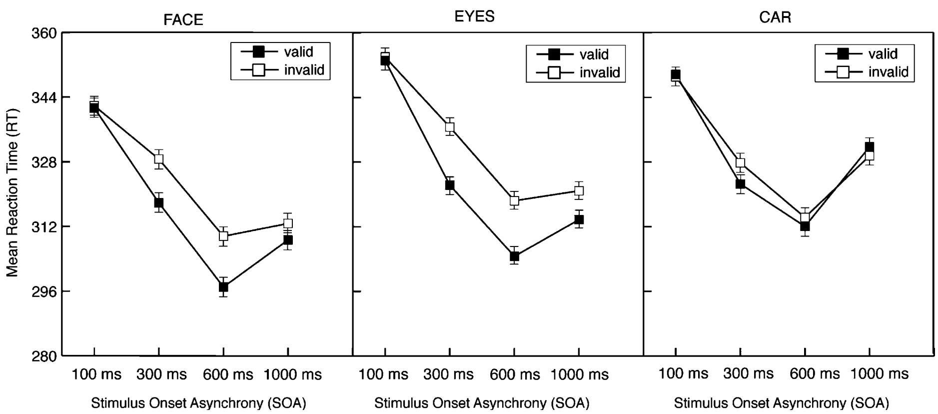

Fig. 2. Mean RTs in milliseconds as a function of SOA and validity for the three stimulus cue conditions (FACE, EYES, CAR) manipulated in Experiment 1. Error bars depict standard error of the difference of the means.

condition. In agreement with this interpretation, when each condition is analyzed individually, there is a significant main effect of validity for the FACE and EYES conditions [both Fs > 9.4, ps < 0.01] but not for the CAR condition [$F < 1$; the only significant effect being SOA [$F(3,42) = 19.98$, $p < 0.0001$].

1.3. Discussion

The results of Experiment 1 were clear cut. Attention was shifted reflexively by stimuli that were represented as eyes in the FACE and EYES conditions. However, the very same ambiguous stimulus used in the EYES condition failed to trigger reflexive orienting in the CAR condition. As noted in the introduction to Experiment 1, this data pattern agrees with the position that bottom-up orienting mechanisms triggered by perceived gaze direction are modulated by top-down processes. We return to this issue in the general discussion.

The reason why we chose to assign different participants to different conditions in Experiment 1 was because there is recent neuroimaging evidence suggesting that once people perceive an ambiguous stimulus as representing a face, they have difficulty representing it as another type of object (Bentin & Golland, 2002). In Experiment 2, we turned this bias toward face representation to our advantage. All the participants in Experiment 2 received both the EYES condition and the CAR condition, with half receiving the EYES condition first and half receiving the CAR condition first.

2. Experiment 2

Manipulating the EYES and CAR conditions within the same participants is crucial for two reasons. First, a between group comparison of performance after the first half of testing provides a direct replication of the EYES versus CAR comparison in Experiment 1. Here we expected that if the difference we observed previously between these conditions is real and replicable we should find again that attention is shifted only in the EYES condition.

Second, and most importantly, a different prediction is made for the second half of testing. Here we expected that the participants who had first received the CAR condition would now show evidence of reflexive orienting in the EYES condition because the central stimulus would now be perceived as a face. This prediction stands in contrast to the outcome expected for the participants who had received the EYES condition first. Because of the asymmetry noted above, where a stimulus persists in being perceived as a face once it is seen as a face, we expected that participants who received the CAR condition second—that is, after receiving the EYES condition—would continue to show a validity effect in that condition.

2.1. Method

All 36 participants were naive to the purpose of the experiment and to the condition change that occurred half-way through testing. The apparatus and the ambiguous fixation stimuli were the same as in Experiment 1. Design and procedure were also the same with the following exceptions. Half the participants received the EYES condition before

Table 2
Mean RT, standard deviations, and error rates for Experiment 2

Condition	Group											
	CAR–EYES						EYES–CAR					
	CAR			EYES			EYES			CAR		
	M	SD	*%E*	*M*	SD	*%E*	*M*	SD	*%E*	*M*	SD	*%E*
100 ms SOA												
Valid	335.84	33.3	0.1	335.48	36.3	0.3	330.09	34.6	0.3	323.65	39.3	0.9
Invalid	339.13	32.9	0.1	340.62	43.5	0.1	336.91	34.3	0.2	324.74	41.6	0.2
300 ms SOA												
Valid	306.75	28.6	2	305.14	33.9	2.1	304.20	32.7	0.7	304.96	42.6	0.9
Invalid	314.67	32.6	1.5	315.14	41.9	1.4	312.80	30.2	0.8	307.96	38	1.5
600 ms SOA												
Valid	306.35	34.8	0.2	301.71	37.9	0.3	288.52	28.6	0.3	287.10	33.5	0.7
Invalid	305.50	27.2	0.8	306.91	36.2	0.5	297.94	28.3	0.4	295.71	37.5	1.0
1000 ms SOA												
Valid	316.66	33.5	0.2	310.60	35.7	0.4	305.53	31.2	0.3	298.97	36.8	0.6
Invalid	315.05	32.3	0.2	314.32	32.2	0.3	307.43	30.6	0.7	301.45	29.9	0.2

the CAR condition; the remaining participants received the reverse order of conditions. Each condition was preceded by 10 practice trials followed by 8 blocks of 60 trials, for a total of 960 test trials. Instructions for these conditions were as before.

2.2. Results

False alarms occurred on less than 2.5% of the catch trials, and less than 0.5% of all target present trials were in error. Mean RTs, standard deviations, and their associated error rates are presented in Table 2. Mean RTs for correct target trials were calculated for each participant. Interparticipant means across SOA and validity conditions for both conditions are shown in Fig. 3.

To test whether the effects observed in Experiment 1 were replicated in the present study, we conducted a 2 (condition)×2 (validity)×4 (SOA) ANOVA with EYES [first] versus CAR [first] as a between subject factor and validity and SOA as within subjects factors. The results replicated Experiment 1, with significant main effects of validity [$F(1,34)=16.57$, $p<0.001$] and SOA [$F(3,102)=85.24$, $p<0.0001$] as well as the crucial interaction between condition and validity [$F(1,34)=4.26$, $p<0.05$] reflecting again the presence of a validity effect in the EYES condition and the absence of one in the CAR condition. No other effects were significant.[1]

We had predicted that both the EYES [second] and CAR [second] conditions would reveal a significant effect of validity. A 2 (condition)×2 (validity)×4 (SOA) ANOVA

[1] Note that, as in Experiment 1, when CAR [first] was analyzed using a separate 2 (validity)×4 (SOA) within-subjects ANOVA, only a main effect of SOA was significant [$F(3,52)=35.71$, $p<0.0001$]. The lack of a significant validity effect ($p>0.12$) or validity×SOA interaction ($p>0.19$) indicates there was no social attention effect in this condition.

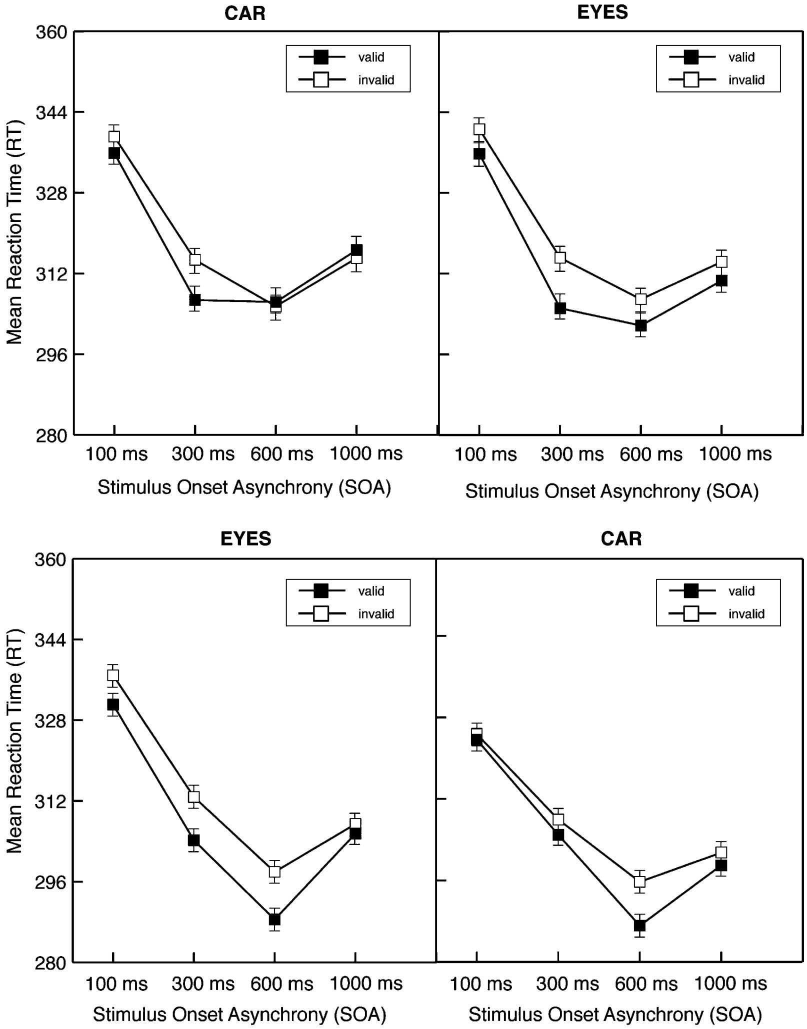

Fig. 3. Mean RTs in milliseconds as a function of stimulus onset asynchrony (SOA) and stimulus cue validity in Experiment 2. The top row illustrates results for the CAR [first]–EYES [second] group and the bottom row shows the results for the EYES [first]–CAR [second] group. Error bars depict standard error of the difference of the means.

confirmed this prediction. The main effects of validity [$F(1,34)=18.9$, $p<0.0001$] and SOA [$F(3,102)=68.98$, $p<0.0001$] were highly significant with no significant interactions (all Fs<1.8, ps>0.14). In particular, there was no condition$\times$validity interaction ($F<1$), demonstrating that there was a significant, and equivalent, effect of validity for both the EYES and CAR conditions.

Together these data converge on the conclusion that the validity effect varied as a function of condition only for those participants that received the CAR condition first.

This was confirmed by two separate within-group 2 (condition)×2 (validity)×4 (SOA) ANOVAs. For the CAR [first]–EYES [second] group, main effects of validity [$F(1,17)=9.28$, $p<0.01$] and SOA [$F(3,51)=55.54$, $p<0.0001$] were highly significant, as was the condition×validity interaction [$F(1,17)=4.61$, $p<0.05$]. No other effects were reliable [all Fs<2.1, all ps>0.1]. In contrast, for the EYES [first]–CAR [second] group, the main effects of validity [$F(1,17)=23.52$, $p<0.001$] and SOA [$F(3,51)=46.62$, $p<0.0001$] were significant but importantly there was no interaction involving validity (all ps>.17).[2]

2.3. Discussion

The results of Experiment 2 extended the results reported in Experiment 1 in two important ways. One, we found again that attention was shifted reflexively when the ambiguous stimulus was first perceived as EYES but not when it was initially seen as a CAR. Importantly when these participants in the CAR condition were presented with the EYES condition, they began to shift attention reflexively.

Two, we found that the participants who received the EYES condition first continued to shift attention reflexively when presented with the CAR condition. This new result converges with, and provides behavioral support, for Bentin and Golland (2002) finding that once an ambiguous stimulus is perceived as a face it will persist in being perceived as such.

3. General discussion

Attention is shifted reflexively to where someone else is looking. A wealth of evidence implicates face processing mechanisms specific to inferior temporal (IT) cortex as being crucial to this social attention effect (e.g. Hoffman & Haxby, 2000; Kanwisher, 2000). In the present study we asked whether this social attention effect is driven by neurons in IT in a purely bottom-up manner independent of top-down control processes responsible for stimulus interpretation. The answer is no. The reflexive social attention effect is modulated by top-down control processes. Two lines of evidence in the present study converge on this conclusion.

[2] We were concerned that the validity effect emerged in the CAR [first]–EYES [second] group because of practice effects rather than because of the perception of the ambiguous stimulus as possessing eyes. A close examination of the data eliminated this concern. For Experiment 2, we compared the last two blocks (blocks 7 and 8) of the first condition with the first two blocks (blocks 9 and 10) of the second condition. As before, in the CAR [first]–EYES [second] group there was a significant condition×validity interaction [$F(1,17)=4.6$, $p<0.05$] reflecting the emergence of a validity effect when the condition was switched from CAR to EYES. In contrast, in the EYES [first]–CAR [second] group a significant validity effect was observed [$F(1,17)=6.55$, $p<0.05$] which persisted across conditions [condition×validity interaction, $F<1$]. Critically, when the CAR condition in Experiment 1 was examined in an identical manner (blocks 7 and 8 vs. blocks 9 and 10), there were no significant effects involving validity (all Fs<1). Together these data demonstrate conclusively that the validity effect emerged in the CAR [first]–EYES [second] group, and persisted in the EYES [first]–CAR [second] group, because of the perception of the ambiguous stimulus as possessing eyes.

First, in Experiment 1, we showed that whether the same stimulus triggers a reflexive shift in attention depends on how it is perceived by the observer. That the absence or presence of the reflexive social attention effect can be triggered by a slight change in stimulus interpretation demonstrates that this attention effect is sensitive to top-down control.

Second, in Experiment 2, we found an asymmetry in the ability to manipulate the attention shift triggered by the ambiguous stimulus. Specifically, when first informed that the stimulus was a CAR and then later informed that it contained EYES, an attention shift was observed only in the EYES condition. However, when first informed that the stimulus possessed EYES, and then that it was a CAR, the attention shift in the EYES condition persisted into the CAR condition. This provides strong and convergent behavioural evidence that once top-down processes lead to the perception of a stimulus as a face, it is extremely difficult to avoid seeing that stimulus as a face.

Together the data go a long way toward reconciling a point of contention within the field—whether or not the reflexive social attention effect is sensitive or not to top-down control. On the one hand our study shows clearly that the social attention effect *is* sensitive to top-down control insofar as determining whether a stimulus is at first perceived as possessing facial features or not. On the other hand, the social attention effect *is not* sensitive to top-down control insofar as a stimulus will persist in being seen as having face features once it has been perceived that way. This latter finding highlights why the social attention effect must ultimately be considered as reflexive in nature, for once a stimulus activates IT and is perceived as having features such as eyes, the attentional effect of this stimulus appears to be insensitive to top-down modulation. This complex interplay between reflexive and volitional attention, and how the activation of bottom-up processes may rely on executive top-down processes, dovetails with a growing recognition that reflexive attention may depend ultimately on the meaning that individuals attach to stimuli (see Rauschenberger, 2003 for a recent review on this issue).

Acknowledgements

This research was supported by graduate awards to JR from the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Michael Smith Foundation for Health Research (MSFHR) and by grants to AK from NSERC, the Human Frontier Science Foundation, and MSFHR. Parts of this manuscript were presented at the 12th annual meeting of Canadian Society for Brain Behavior and Cognitive Science, June 2002, Vancouver, BC, Canada.

References

Bentin, S., & Golland, Y. (2002). Meaningful processing of meaningless stimuli: The influence of perceptual experience on early visual processing of faces. *Cognition*, *86*, B1–B14.

Bentin, S., Sagiv, N., Mecklinger, A., & Friederici, A. (2002). Priming visual face-processing mechanisms. *Psychological Science*, *13*(2), 190–193.

Bertelson, P. (1967). The time course of preparation. *Quarterly Journal of Experimental Psychology*, *19*, 272–279.

Dolan, R. J., Fink, G. R., Rolls, E., Booth, M., Holmes, A., Frackowiak, R. S. J., & Friston, K. J. (1997). How the brain learns to see objects and faces in an impoverished context. *Nature*, *389*(9), 596–599.

Driver, J., Davis, G., Ricciardelli, P., Kidd, P., Maxwell, E., & Baron-Cohen, S. (1999). Gaze perception triggers visuospatial orienting by adults in a reflexive manner. *Visual Cognition*, *6*, 509–540.

Friesen, C. K., & Kingstone, A. (1998). The eyes have it!: Reflexive orienting is triggered by nonpredictive gaze. *Psychonomic Bulletin and Review*, *5*, 490–495.

Friesen, C. K., Ristic, J., & Kingstone, A. (2004). Attentional effects of counterpredictive gaze and arrow cues. *Journal of Experimental Psychology: Human Perception and Performance*, *30*, 319–329.

Hoffman, E. A., & Haxby, J. V. (2000). Distinct representations of eye gaze and identity in the distributed human neural system for face perception. *Nature Neuroscience*, *3*, 80–84.

Kanwisher, N. (2000). Domain-specificity in face perception. *Nature Neuroscience*, *3*(8), 759–763.

Kingstone, A., Friesen, C. K., & Gazzaniga, M. S. (2000). Reflexive joint attention depends on lateralized cortical connections. *Psychological Science*, *11*, 159–165.

Langton, S. R. H., & Bruce, V. (1999). Reflexive social orienting. *Visual Cognition*, *6*, 541–567.

Langton, S. R. H., Watt, R. J., & Bruce, V. (2000). Do the eyes have it? Cues to the direction of social attention. *Trends in Cognitive Sciences*, *4*, 50–59.

Pinker, S. (1997). *How the mind works*. New York, NY: Norton.

Rauschenberger, R. (2003). Attentional capture by auto- and allo-cues. *Psychonomic Bulletin and Review*, *10*, 814–842.

Ristic, J., Friesen, C. K., & Kingstone, A. (2002). Are eyes special? It depends on how you look at it. *Psychological Bulletin and Review*, *9*, 507–513.