Title
Gaze and arrow induce different effects on attentional orienting as a function of target context

Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 31(31)

ISSN
1069-7977

Authors
Casagrande, Maria
Maccari, Lisa
Marotta, Andrea
et al.

Publication Date
2009

Peer reviewed

Gaze and arrow induce different effects on attentional orienting as a function of target context

Marotta Andrea (andrea.marotta@uniroma1.it)
Department of Psychology, "Sapienza" Università di Roma

Casagrande Maria (maria.casagrande@uniroma1.it)
Department of Psychology, "Sapienza" Università di Roma

Raffone Antonino (antonino.raffone@uniroma1.it)
Department of Psychology, "Sapienza" Università di Roma

Martella Diana (diana.martella@uniroma1.it)
Department of Psychology, "Sapienza" Università di Roma

Sebastiani Mara (mara.sebastiani@uniroma1.it)
Department of Psychology, "Sapienza" Università di Roma

Maccari Lisa (lisa.maccari@uniroma1.it)
Department of Psychology, "Sapienza" Università di Roma

Abstract

This study aimed to evaluate whether the magnitude of attentional cueing can be modulated by the context in which the target appears. Both an arrow or a directional eye-gaze were used as non-informative cues. Targets, i.e. red patches – were presented over faces or boxes, that rapresented the peripheral placeholders. A larger cueing effect was found when targets appeared on faces rather than on standard placeholder boxes. This effect was found only when a directional eye-gaze was used as non-informative cue; arrow cues did not show effects. These results suggest that gaze properties could have a social special status in orienting attention.

Keywords: Attention; Covert Attention; Gaze Cueing; Arrow Cueing; Social Attention.

Introduction

Both processing and expression of human gaze are essential in making a person as the unique social being that is, since the motor intention of others can be inferred from their gaze (e.g., Baron-Cohen, Weelwright, & Jolliffe, 1997). We are sensitive to where another individual is looking and their gaze give us a good idea of their focus of interest, inducing to orient our attention to the same location (e.g., Driver, Davis, Ricciardelli, Kidd, Maxwell & Baron-Cohen, 1999). This behaviour is known as 'joint attention' and has been posited as vital in interpersonal interactions (Emery, 2000; Moore & Dunham, 1995). This behaviour is of interest not only for researchers investigating the mechanisms of visual attention, but also for those investigating social cognition and human development. Many studies have also demonstrated that gaze direction – used as a spatial cue - reflexively triggers attentional shift (for a review, see Frischen, Bayliss & Tipper, 2007). These studies have applied a spatial cueing paradigm, first introduced by Posner (1980) and reviewed by Friesen and Kingstone (1998). In their experiments, a central unpredictive gaze was used as a cue to orient attention to both left or right. A target appeared in either the direction in which the gaze was directed, or in another location. Participants were typically faster to detect or identify the target when it appeared in the direction signalled by the gaze, as compared to when it is presented in other locations ('gaze effect'). This effect occurs even when the gaze direction is not predictive of the subsequent target location and observers are instructed to ignore the gaze direction (see, e.g., Friesen and Kingstone, 1998), and even when they are told to expect targets at the opposite location (see, e.g., Driver et al., 1999). On the basis of these findings, some researchers have proposed that automatic orienting to eye gaze may represent an unique attentional process and reflect the operation of a specialized cognitive mechanism (e.g., Langton and Bruce 1999). However, when arrows are used as cues, normal subjects behave more or less in the same manner as to gaze (Tipples, 2002): faster reaction times are observed when targets appear congruent to the arrow direction, and slower when incongruent ('arrow effect'). Therefore, the arrow represents a relevant instrument to evaluate the socio-biological importance of a gaze-cue, because it has a directional property just like gaze, but no biological significance.

In order to test whether gaze cues have a special social status in orienting attention, in this study we manipulated the social relevance of the target context. In most gaze-cueing studies the target appears on a placeholder box or on a blank screen. However, in more naturalistic situations persons orient attention to a particular event, object or person in the scene. To establish a representation of another's attentional state, we must be able to orient not only in the general direction of observed gaze, but to the correct object of attention (Emery, 2000; Emery, Lorincz, Perrett, Oram & Baker, 1997). So far only the study of Bayliss and Tipper (2005) has evaluated the role of the target context on the magnitude of attentional cueing, via the observation of non-informative directional arrows or eye-gaze. In this study, a target was displayed on faces in half of the trials, whereas during the other half of the trials the same target appeared on scrambled faces. When targets appeared on faces, cueing effects were larger compared to those showed when the same target appeared on scrambled faces. This effect was found for both gaze-cues and arrow-cues, suggesting that cue properties had little effects on cueing magnitude. However, one interpretation of these data could be that differences on cueing magnitude as a function of target placeholders (faces or scrambled faces) do not reflect differences between social and non-social contexts; rather they would only reflect differences between coherent meaningful and incoherent meaningless context. Based on this hypothesis, there are no reasons to expect that the type of used cue (gaze or arrow) is different in operation as a funtion of the target context, thus resulting in different effects.

Therefore, in order to make evident differences in the cueing effects, induced by eye-gazes and arrows, in this experiment we manipulated the social relevance of the context in which the target appear (on a face or on a standard placeholder box). The predictions were straightforward: if the gaze activates a social orienting mechanism, then it should induce a larger attentional shift when the target appears on faces than when the target appears on a standard placeholder box. Such social mechanisms are not predicted to be so strongly active when the spatial cue is an arrow; this type of cue should not induce different cueing effect as a function of the context conditions (faces or boxes). Moreover, differences in cueing magnitude as a function of target placeholders were directly probed: in each trial both face and box placeholders were presented in the display. Thus, the different patterns of results obtained as a function of the target context are not expected to arise from differences in participant strategies, but rather from the type context per se.

METHOD

Participants

Eighteen students (mean age of 24 ± 3 years) signed an informed consent form before participating as volunteers in the study. The local ethical committee approved the study. All of the participants had normal or corrected-to-normal vision, and were unaware of the purpose of the experiments.

Apparatus

Stimuli were presented on a 21-inch color VGA monitor. An IBM-compatible PC running E-Prime software controlled the presentation of the stimuli, timing operations, and data collection. Responses were gathered with a standard keyboard.

Stimuli

Stimuli and trial sequences are illustrated in Figures 1 and 2. The placeholder set consisted of two schematic faces and two boxes. The placeholder faces have a straight-ahead gaze. The dimensions of the placeholders (both faces and boxes) were 2 x 2.5 cm. In Experiment 1A a central face with the pupils directed either to the left or to the right was used as gaze-cue. In Experiment 1B a directional arrow was used as cue. Targets were presented as red patches over the faces, or over the boxes. The area that the target covered was matched to the size of the faces.

Procedure

Participants were seated at the distance of 56 cm in front of a computer monitor, in a dimly lit, sound-attenuated room, and their heads were held steady with a chin/head rest. Each trial began with a display consisting of a central fixation stimulus and four peripheral placeholder targets (one face and one box for each side of the screen).

The fixation stimuli differed depending on the cue types. With gaze cueing (Experiment 1A) the fixation stimulus was a central face with the pupils centered vertically in the eyes. With arrow cueing (Experiment 1B) the fixation stimulus was a horizontal line centered on the screen. This display was presented for 700 ms. The cue appearance resulted from the movement of the eyes, or the appearance of arrow-heads. These cues were not predictive of target location. The target would then appear on one of the peripheral placeholders, after 150, 300 or 600 ms. This display remained until response, or until 1500 ms had elapsed. A blank screen was then presented for 700 ms after each trial. Participants were instructed to respond to the presentation of a target by pressing the spacebar as soon as they detected the onset of the red patch. They were also informed that the direction of the central cue did not predict target location, and that they should ignore it, while maintaining central fixation throughout each trial. Participants completed a practice block of 25 trials, followed by an experimental block of 104 trials. Cue direction, target location, placeholder position, and cue–target stimulus onset asynchrony (SOA) were selected randomly and equally. Eight catch trials, in which no target was presented, occurred randomly in each block.

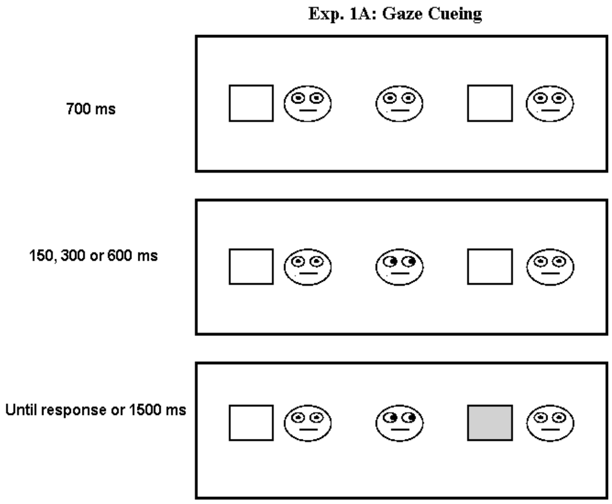

Figure 1: Illustration of the procedure of Experiment 1A, depicted here in the validly cued condition. The target appears after gazing to one side for 150, 300 or 600 ms.

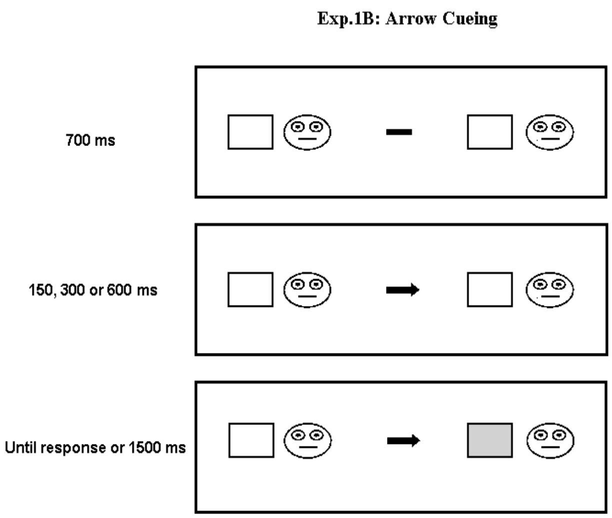

Figure 2: Illustration of the procedure of Experiment 1B, depicted here in the validly cued condition. An arrow was directed to one side for 150, 300 or 600 ms, before the target appeared.

Design

Each experiment had a three-factor repeated measure design. Validity had two levels: valid trials (direction of the cue was congruent with target location) and invalid trials (direction of the cue was incongruent with target location). SOA had three levels: 150, 300, 600 ms. Context had two levels: Faces and Boxes. Duncan tests were used for the *post-hoc* analysis of the means. The order of cueing paradigms (gaze / arrow) was counterbalanced across participants.

Results

Experiment 1A: Gaze Cueing

The mean RTs are shown in Table 1. A SOA (150, 300 and 600ms) x VALIDITY (valid vs. invalid) x CONTEXT (Faces vs. Boxes) repeated measures ANOVA revealed that RTs on valid trials (Mean= 318 ms) were significantly faster than RTs on invalid trials (Mean=330 ms; $F_{1,17}$=11.52; p< .004). In addition, the mean RTs decreased with SOA ($F_{2,24}$=25.06; p< .00001). The main effect of CONTEXT was significant ($F_{1,17}$=14.33; p< .002): RTs were slower when the target appeared on faces (Mean=330 ms) than when the target appeared on a standard placeholder box (Mean=319ms). More importantly, the interaction VALIDITY x CONTEXT was significant ($F_{1,17}$=5,10; p<.04; figure 3). A *post-hoc* analysis revealed a facilitation effect when the target appeared on faces (p<.0004), whereas no differences were registered between cued and uncued trials when the target appeared on boxes (p<1). The interactions SOA x VALIDITY (F<1), SOA x CONTEXT (F<1) and SOA x VALIDITY x CONTEXT (F<1) were not significant.

Table 1: Mean RTs for each experimental condition, in Experiment 1A.

SOA	FACES		BOXES	
	VALID	INVALID	VALID	INVALID
150	330.92	353.98	322.14	331.67
300	322.44	342.35	319.59	321.64
600	308.76	321.27	305.49	311.46

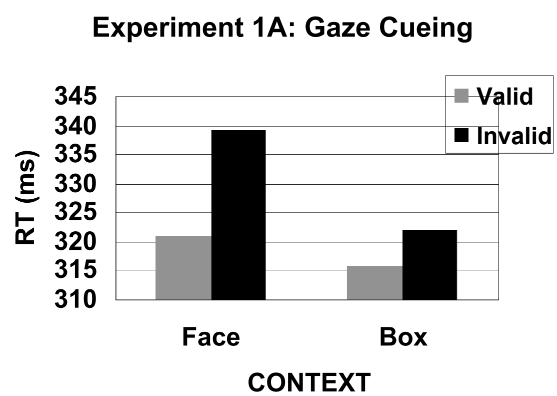

Figure 3: Mean reaction times for both valid and invalid trials at each of the CONTEXT levels, in Experiment 1A.

Experiment 1B: Arrow Cueing

The mean RTs are shown in table 2. A SOA (150, 300 and 600ms) x VALIDITY (valid vs. invalid) x CONTEXT (Faces vs. Boxes) repeated measures ANOVA revealed that RTs on valid trials (Mean=326 ms) were significantly faster than RTs on invalid trials (Mean=336 ms; $F_{1,17}$=6.17; p<.03). The main effect of CONTEXT was significant ($F_{1,17}$=8.79; p<.009): RTs were slower when the target appeared on faces (Mean=335 ms) than when the target appear on a standard placeholder box (Mean= 327ms). In addition, the mean RTs decreased with SOA ($F_{2,24}$=14.04; p<.00001). More importantly, the interaction VALIDITY x CONTEXT was not significant ($F_{1,17}$<1; figure 4). No other interaction was significant (Fs< 1).

Table 2: Mean RTs for each experimental condition, in Experiment 1B.

SOA	FACES		BOXES	
	VALID	INVALID	VALID	INVALID
150	336.7	354.92	323.43	342.45
300	338.59	340.28	331.41	338.39
600	314.47	326.62	314.15	310.43

.

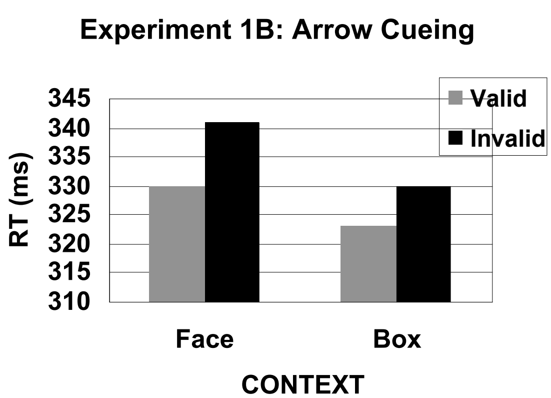

Figure 4: Mean reaction times for both valid and invalid trials at each of the CONTEXT levels, in the Experiment 1B

Discussion

Results showed that the magnitude of orienting induced by non-informative directional eye-gaze could be modulated by the context in which the target appear. Consistent cueing effects were found in all conditions, replicating several studies, with non-predictive gaze cues (e.g. Driver et al., 1999; Friesen & Kingstone, 1998)[1], and non-predictive arrow cues (Hommel, Pratt, Colzato & Godijn, 2001; Tipples, 2002). When eye-gaze was used as a cue, it induced larger cueing effects when targets appeared on faces than when targets were presentd on standard placeholder boxes. This effect was not found for non-informative arrow cues. These results confirm our hypothesis according to which any modulation of cueing towards faces or placeholder boxes would only be evident when the cue is a directional gaze, produced by a face.

In addition, the present results seems to suggest that observing a social interaction between cue and target, when both are faces, results in larger cueing effects (20ms), compared to the condition showing an arrow pointing to a face (10ms). In conclusion, when eye-gazes and arrows were used as spatial cues they induced different effects on attentional orienting. The origin of these differences could reside in dissimilar encoding and function required by eye-gazes and arrows.

References

Baron-Cohen, S., Wheelwright, S., & Jolliffe, T. (1997). Is there a “language of the eyes”? Evidence from normal adults, and adults with autism or Asperger syndrome. *Visual Cognition, 4,* 311–331.

Bayliss, A. P., & Tipper, S. P. (2005). Gaze and arrow cueing of attention reveals individual differences along the autism spectrum as a function of target context. *British Journal of Psychology, 96,* 95–114.

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

Emery, N. J. (2000). The eyes have it: The neuroethology, function and evolution of social gaze. *Neuroscience and Biobehavioral Reviews, 24,* 581–604.

Emery, N. J., Lorincz, E. N., Perrett, D. I., Oram, M. W., & Baker, C. I. (1997). Gaze following and joint attention in rhesus monkeys (*Macaca mulatta*). *Journal of Comparative Psychology, 111,* 286–293.

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

Frischen, A., Bayliss, A. P. & Tipper, S. P. (2007). Gaze Cueing of Attention: Visual Attention, Social Cognition, and Individual Differences. *Psychological Bulletin, 133, 694–724.*

[1] In experiment 1A, the facilitation effect did not revert to an IOR effect even at the 600 ms SOA. With gaze cues reliable inhibition effects were observed only at a very long SOA of 2400 ms (Frischen & Tipper; 2004; Frischen, Smilek, Eastwood & Tipper, 2007).

Frischen, A., & Tipper, S. P. (2004). Orienting attention via observed gaze shift evokes longer term inhibitory effects: Implications for social interactions, attention, and memory. *Journal of Experimental Psychology: General* , 133, 516-533.

Frischen, A., Smilek, J. D., & Tipper, S. P. (2007). Inhibition of return in response to gaze cues: The roles of time course and fixation cue. *Visual Cognition*, 15, 881-895.

Hommel, B., Pratt, J., Colzato, L., & Godijn, R. (2001). Symbolic control of visual attention. *Psychological Science, 12,* 360–365.

Langton, S. R. H., & Bruce, V. (1999). Reflexive visual orienting in response to the social attention of others. *Visual Cognition, 6,* 541–567.

Moore, C., & Dunham, P. J. (Eds.). (1995). *Joint attention: Its origins and role in development.* Hove, United Kingdom: Erlbaum.

Posner, M. I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology, 32,* 3–25.

Tipples, J. (2002). Eye gaze is not unique: Automatic orienting in response to uninformative arrows. *Psychonomic Bulletin & Review, 9,* 314–318.