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Averted body postures facilitate orienting of the eyes

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ABSTRACT

It is well established that certain social cues, such as averted eye gaze, can automatically initiate the orienting of another's spatial attention. However, whether human posture can also reflexively cue spatial attention remains unclear. The present study directly investigated whether averted neutral postures reflexively cue the attention of observers in a normal population of college students. Similar to classic gaze-cuing paradigms, non-predictive averted posture stimuli were presented prior to the onset of a peripheral target stimulus at one of five SOAs (100 ms–500 ms). Participants were instructed to move their eyes to the target as fast as possible. Eye-tracking data revealed that participants were significantly faster in initiating saccades when the posture direction was congruent with the target stimulus. Since covert attention shifts precede overt shifts in an obligatory fashion, this suggests that directional postures reflexively orient the attention of others. In line with previous work on gaze-cueing, the congruency effect of posture cue was maximal at the 300 ms SOA. These results support the notion that a variety of social cues are used by the human visual system in determining the "direction of attention" of others, and also suggest that human body postures are salient stimuli capable of automatically shifting an observer's attention.

1. Introduction

Given that the social world is an integral aspect of human existence, the social signals of others can be viewed as highly salient events in everyday life. Social cues, such as facial expressions and body postures, contain a wealth of information about the internal state of others and the surrounding environment. Such information can guide approach or avoidance and alert individuals to threats in the environment. Studies suggest that human infants can recognize and mimic the expressions of others within two days of birth (Field, Woodson, Greenberg, & Cohen, 1982) and acquire the ability to discriminate gaze direction by four months of age (Vecera & Johnson, 1995). Understanding how adults process the social information of others is a highly important aspect of cognitive science.

One of the most well studied forms of social cues is directed eye gaze. It has been shown that the direction in which a social partner's eyes are oriented reflexively cues the attention of others. In a typical gaze-cuing paradigm, modeled after Posner, Snyder, and Davidson's (1980) spatial cueing task, a face stimulus with non-predictive averted eye gaze is presented at central fixation, followed by the presentation of a peripheral target. In such a cueing task, participants are instructed to detect, localize, and identify the peripheral target stimulus. Numerous studies provide evidence of reflexive gaze cueing, as measured by shorter response times to targets appearing in the location congruent with gaze direction, even when it has been noted that the gaze does not predict the target's location (Baron-Cohen, 1995; Driver et al., 1999; Friesen & Kingstone, 1998). This reflexive gaze cueing effect endures even when the target is more likely to appear in the direction incongruent with that indicated by the gaze direction (Driver et al., 1999). The accumulated evidence supporting the theory that eye gaze uniquely cues attention is in line with the existence of an "eye-direction detector" module, which automatically detects and computes the direction of eye gaze based on the specific morphology of the eye (Baron-Cohen, 1995).

Beyond the extensive work investigating the ability of eye gaze to cue visuospatial attention, studies have also supported the notion that other social cues, such as head direction (Langton & Bruce, 1999) and hand gestures (Langton & Bruce, 2000), are also capable of directing attention. This suggests the existence of a more general "direction-of-attention detector" (Perrett & Emery, 1994) which postulates that information from eye gaze, as well as from head direction and body posture, all contribute to the cueing of attention (Langton, Watt, & Bruce, 2000).

Similar lines of argument have been made by Hietanen (2002,

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1999). It should also be noted that non-social cues, such as arrows or words, are also capable of cueing attention (Hommel, Pratt, Colzato, & Godijn, 2001; Ristic, Friesen, & Kingstone, 2002), however the focus of the present report is on how social signals can direct attention. If social information other than eye gaze can direct the attention of others, then it is conceivable that human postures may also serve as attentional cues, as posture direction can be a strong indicator of the location of one's attentional focus. However, to date, little work has investigated whether body postures can in fact direct attention.

Previous work has shown that human attention can be *captured* by either static (Bannerman, Milders, & Sahraie, 2010) or moving (Buzzell, Chubb, Safford, Thompson, & McDonald, 2013) depictions of the human body. Additionally, it has been shown that videos depicting the walking direction of humans can *guide* the attention of observers, as measured by manual response times (Shi, Weng, He, & Jiang, 2010). This suggests that in addition to human eye gaze and head direction, a human body in motion can *direct* attention. However, walking direction stimuli are dynamic displays that convey a direction of motion that may be independent of the social cue itself. Furthermore, it remains unclear if static postures alone could direct attention in a manner similar to eye gaze or head direction. This latter point is particularly important, given that at least one study has demonstrated that when free-viewing computer-generated natural scenes, body posture appears to direct attention (Zwickel & Võ, 2010). However, it should be noted that viewing naturalistic scenes is very different than the methodology typically employed to test for attentional guidance by gaze direction. Thus, it is important that researchers test whether postures can indeed direct attention using methodology similar to a traditional gaze-cueing paradigm.

As it turns out, understanding social cueing becomes more complicated when the eyes and body are both visible. Attention cueing does not occur for averted postures when both the eye gaze and the orientation of the posture match, but does occur when they mismatch (Hietanen, 1999, 2002). Specifically, averted gaze cues attention when the body (or head, if only the head is visible) is oriented toward the viewer (Hietanen, 1999, 2002). That is, if the body or head is facing forward toward the viewer, then laterally averted eyes will cue attention. The opposite occurs with averted postures (or head, if only the head is visible) when the stimulus is looking at the observer (Hietanen, 1999, Pomianowska, Germeys, Verfaillie, & Newell, 2012). That is, no cueing (even reverse cueing) occurs when the eyes are looking at the observer and the body or head is averted toward a stimulus. Pomianoswska and colleagues have suggested that this reverse cueing effect might occur because the observer is encoding the cue in allocentric coordinates. For example, when the body is oriented toward the target, but the gaze is on the observer, this might imply that the cue is looking over it's shoulder, and therefore attention should be allocated in the opposite direction that the body is oriented.

To complicate things, Zwickel and Võ (2010) demonstrated using a free-viewing task that an oriented posture embedded in a scene can cause the eyes to be biased toward objects that intersect with the posture's orientation. Cueing does not occur for other objects with a facing direction, such as loud-speakers, which suggests that cueing only occurs for social objects. Unlike the studies discussed in the previous paragraph, the eyes were not visible. This would suggest that body orientation is able to cue attention in the absence of gaze information (but note that this effect only occurred when the eyes first landed on the head, and not the body). However, using a Posner-cueing type task, Gervais, Reed, Beall, and Roberts (2010) found postures (gaze was not visible) that had an implied direction of action (e.g. throwing, running) cued attention, whereas postures with no implied direction of action (e.g. standing, squatting to jump up) did not. Similarly Azarian, Esser, and Peterson (2015) found no cueing for neutral standing postures (gaze was not visible), but did find cueing by threatening postures, but only for anxious individuals.

One possibility for this discrepancy could be that social cueing occurs differently during free viewing. Another possibility is that a carry-over effect occurred in the studies by Gervais et al. (2010) and Azarian et al. (2015). That is, the presence of the other stimuli in the study, such as action-oriented or threatening postures, might have overridden the ability of neutral postures to cue attention. The goal of our study is to determine whether neutral postures can cue attention when the possibility of a carry-over effect has been removed.

In the present study, we investigated whether static body postures without facial features direct attention in a manner similar to gaze. Participants performed a spatial cuing task in which non-predictive averted postures preceded the presentation of a target stimulus presented in the periphery. Using eye tracking, we investigated whether postures facing the direction of target stimuli resulted in faster initiation of saccades to the target location. Given previous research demonstrating the absence of a posture-cueing effect at a 200 ms SOA, and an anti-cueing effect at a 500 ms SOA (Azarian et al., 2015), we chose to investigate posture cueing at a series of SOAs (100 ms–500 ms). If postural information is able to cue attention, we would expect participants to respond faster when posture direction is congruent with the target location. In line with previous research demonstrating that gaze-cueing effects typically emerge by approximately 300 ms (Driver et al., 1999; Friesen & Kingstone, 1998), we expected any posture-cueing effects to also manifest at a similar latency.

2. Methods

2.1. Participants

Twenty-eight George Mason University undergraduate students (16 female) ranging in age from 18 to 30 years (*M* age = 22.6 years) were recruited for the study. All participants had normal or corrected-to-normal vision.

2.2. Procedure

Participants completed a spatial cuing task in which averted, neutral body postures preceded target presentation (Fig. 1). At the beginning of each trial, a fixation cross was displayed at the center of the screen for

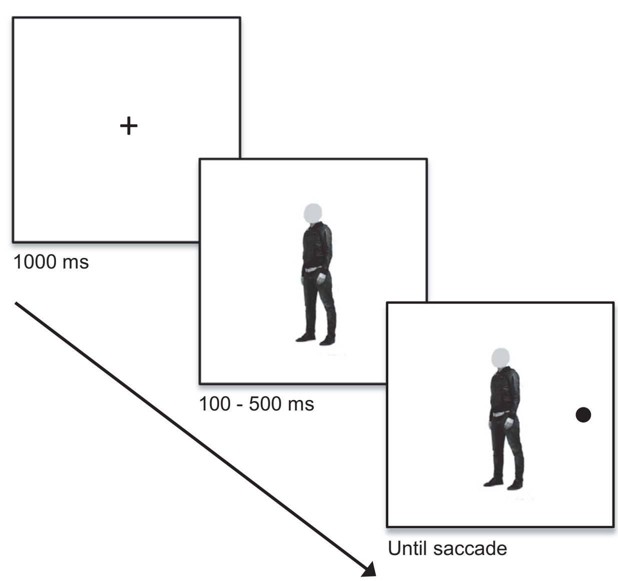

Fig. 1. Experimental task design. A fixation cross was displayed at the beginning of each trial for 1000 ms, followed by an averted posture cue for 100–500 ms (SOA manipulation) before the presentation of the peripheral target dot. A successful trial required a saccade toward the target dot. The posture cue and the target dot remained on the screen until the participant successfully made a saccade toward the target or 2000 ms had elapsed. The above example is an incongruent trial, in which the posture faces away from the saccade target.