Watch out! Directional threat-related postures cue attention and the eyes

Bobby Azarian¹, Elizabeth G. Esser², and Matthew S. Peterson¹,²

¹Department of Neuroscience, George Mason University, Fairfax, VA, USA
²Department of Psychology, George Mason University, Fairfax, VA, USA

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Previous work indicates that threatening facial expressions with averted eye gaze can act as a signal of imminent danger, enhancing attentional orienting in the gazed-at direction. However, this threat-related gaze-cueing effect is only present in individuals reporting high levels of anxiety. The present study used eye tracking to investigate whether additional directional social cues, such as averted angry and fearful human body postures, not only cue attention, but also the eyes. The data show that although body direction did not predict target location, anxious individuals made faster eye movements when fearful or angry postures were facing towards (congruent condition) rather than away (incongruent condition) from peripheral targets. Our results provide evidence for attentional cueing in response to threat-related directional body postures in those with anxiety. This suggests that for such individuals, attention is guided by threatening social stimuli in ways that can influence and bias eye movement behaviour.

Keywords: Attention; Threat; Orienting; Postures; Eye movements.

At any given moment the environment presents us with an abundance of visual information, necessitating preferential selection of certain relevant sensory inputs by attention. As what is relevant in the environment changes, so does the focus of attention. This moving focus is known as attentional orienting. Traditionally, the orienting of attention has been categorised as being either overt or covert, depending on whether saccades are present. A shift in covert attention involves movement of the “attentional spotlight” without a corresponding shift of the eyes, while overt orienting includes a matching eye movement. The three components of either type of attentional orienting include 1. the disengagement of attention from a stimulus, 2. the initial shifting of attention towards a new stimulus and 3. the engagement of attention with that stimulus. A wealth of research has been conducted investigating these components using what is known as the spatial cueing paradigm (Posner & Cohen, 1984). In the exogenous (reflexive) form of this task, a cue is presented to the left or right of fixation and may or may not predict the spatial location of a subsequent target, while in the endogenous (goal-directed) form, a central directional cue, such as an arrow, correctly or incorrectly indicates the position of the target. Trials in which the cue correctly
predicts the target location are known as valid trials, while invalid trials are those in which the cue falsely predicts the position of the target, requiring disengagement from the erroneous location and an additional shift to acquire the target. While faster reaction times on valid trials are thought to reflect a benefit due to enhanced orienting, slower reaction times on invalid trials reveal a cost associated with attention being cued in the direction opposite the target.

This task has since been modified in a number of ways to assess the effects of emotional or threat-related cues on the ability to shift and disengage attention. For example, Fox, Russo, and Dutton (2002), used faces with different emotional expressions as cues to a target location. On invalid trials, state-anxious individuals took longer to respond when the cue was an angry face as opposed to a neutral or happy face, suggesting difficulty in disengaging attention from threatening facial expressions. Delayed disengagement has also been observed in response to threat-related words (Fox, Russo, Bowles, & Dutton, 2001), fearful faces (Georgiou et al., 2005), and more recently, direct facing threatening postures (Bannerman, Milders, & Sahraie, 2010). Although often seen only in anxious populations, Belopolsky, Devue, and Theeuwes (2011) found impaired disengagement of overt attention from angry faces in the general population using eye tracking, a measure with greater sensitivity than the more traditionally used measure of manual reaction time. The current investigation also employed eye tracking to more directly trace the course of attentional orienting.

In addition to holding attention and eye gaze from disengaging, threatening faces have been shown to capture attention in a reflexive, bottom-up fashion by automatically drawing attentional resources to their location. Evidence from visual search paradigms reveal an advantage in the rate and accuracy for detecting threatening faces amongst distractors compared to neutral or happy faces (Öhman, Lundqvist, & Esteves, 2001), as well as for snakes and spiders (Öhman, Flykt, & Esteves, 2001) and threatening postures (Bannerman et al., 2010; Gilbert, Martin, & Coulson, 2011). Because of attentional mechanisms that are efficient and automatic (Pratto & John, 1991), humans are particularly well suited for detecting threat in the environment. However, with an overly sensitised attentional system, excessive emphasis on threat may cause one to perceive the environment as more threatening than it actually is. Indeed, high-anxious individuals show a tendency to initially orient attention towards threat (Bradley, Mogg, & Millar, 2000) and to remain focused on it for longer (Fox et al., 2001, 2002; Georgiou et al., 2005). This orienting behaviour constitutes an attentional bias for threatening information that has been described as “hypervigilance” (Eysenck, 1992). The present study further investigated this anxiety-related bias using averted threat-related posture stimuli.

A separate body of research has been dedicated to examining attentional orienting in response to directional social cues such as averted eye gaze (Friesen & Kingstone, 1998). There is an evolutionary reason to believe that such behaviour is worth investigating. Humans are inherently social in nature and require an attentional system that is suited for rapid processing of helpful social information. This information can be quickly extracted from monitoring the attentional systems of others, clueing one in on potential areas of interest and circumventing the laborious and time-consuming task of scanning an entire scene. In addition, the direction in which someone is looking is often predictive of intentions and their next likely action. Consequently, another’s eye gaze provides a powerful socially informative cue that our cognitive systems have evolved to exploit.

Establishing what has been called “joint attention” by social cognition researchers requires following another’s attention to a destination of shared focus. Much of the experimental research concerning joint attention has used the same design as the endogenous form of the spatial cueing task. A face with averted eye gaze is presented centrally, followed by a target that can appear on either the gazed-at side or the opposite side. Evidence for gaze-cueing of attention has been indicated by faster reaction times to targets spatially congruent with gaze direction, even when gaze cues are non-predictive of target location (Friesen & Kingstone, 1998).
The wealth of evidence supporting the cueing properties of eye gaze has led some to believe in the existence of an “eye-direction detector” (Baron-Cohen, 1995), placing all emphasis on the morphology of the eye as the instrument of shared attention. However, neurophysiological evidence exists that supports a more dynamic “direction-of-attention detector” sensitive to conjunctions of eye, head and body orientations (Langton, Watt, & Bruce, 2000). The present study is novel in that it is the first to use the gaze-cueing paradigm to determine whether averted human body postures cue attention in a fashion similar to averted gaze, directional head cues (Langton & Bruce, 1999) and hand gestures (Langton & Bruce, 2000). Should averted postures trigger an attentional shift in the signalled direction, this would implicate a more general social cueing mechanism in support of a “direction-of-attention” detection system.

Since gaze direction can allow one to make inferences concerning another’s mental state (Moore & Dunham, 1995), it can be used to detect social cues that signal the presence of a threat in the environment. Past studies have shown facilitated orienting in response to fearful faces with gaze averted in the direction predicted by the eyes in those with anxiety (Fox, Mathews, Calder, & Yiend, 2007). Whether angry facial expressions with directed gaze also cues attention has yet to be seen conclusively. While Fox et al. (2007) observed a reduced cueing effect for angry faces relative to neutral expressions in anxious individuals, Holmes, Richards, and Green (2006) found the opposite; enhanced cueing by averted eye gaze when the face expressed anger. Fox and colleagues (2007) have suggested that fearful gaze-cueing might be found more consistently because while averted fear clearly warns of an external source of threat, an angry face with averted gaze is more ambiguous (Adams & Kleck, 2003). However, we believe the case to be quite different with angry postures, since an offensive stance clearly indicates an engagement with an agent of attack in the immediate proximity. Based on the assumption that attentional cueing occurs when a directional social cue implies an imminent danger, we expected anxious individuals to show automatic spatial shifts of attention in response to both fearful and angry averted postures. Such an automatic effect should emerge quickly and be detectable at short stimulus onset asynchronies (SOAs).

While past findings have been consistent with the notion of a neural system that combines information specifically from gaze direction and facial expression (Adams & Kleck, 2003; Fox et al., 2007) to enhance orienting, similar cueing by postures would predict the presence of a more flexible module that can also extract and integrate information about emotional expression and the direction of attention solely from posture orientation. This investigation adds to a small but growing body of research that demonstrates that threatening postures capture and delay attention (Bannerman et al., 2010) by asking whether such postures cue attention as well.

**METHODS**

**Participants**

George Mason University undergraduate students participated in this experiment for course credit. Informed consent was obtained from all participants, and the experimental procedures were approved by George Mason University’s Institutional Review Board. Participants first completed the STAI-Trait survey online, and those scoring 45 and above or 35 and below were assigned to the high and low anxiety groups, respectively. Twenty-six undergraduates (15 female) with ages ranging from 18–29 (mean age = 21) met the criteria, yielding 13 subjects for each anxiety group. All participants had normal or corrected-to-normal vision. Sample size was chosen based on previous oculomotor disengagement studies.

**Materials and apparatus**

Emotional posture stimuli were created depicting angry, fearful, happy and neutral expression. In a pilot study, 20 participants were asked to choose which of the four emotions was being expressed by each posture presented at random. Results confirmed all
were correctly recognised above 80%. Three male actors each provided three versions of each of the four different emotions, yielding 36 unique averted posture stimuli. These were then mirrored to give a set of 72 left and right facing stimuli. Male postures were used since they have been shown to elicit arousal more strongly than females when expressing fear or anger (Kret, Pichon, Grèzes, & de Gelde, 2011). Images subtended a 7 × 19° visual angle and were made grayscale with the faces blurred. Postures were presented centrally at a viewing distance of 60 cm. Target letters subtended 0.3° of visual angle and were presented 14° to either the left or right of fixation. They were small enough that identification required foveation, necessitating an eye movement to their location. This was done to ensure that participants were not performing the task using covert attention. Letters were surrounded by a box that subtended 2 × 2° of visual angle so that target onset could be easily detected. A MacPro (2x2 Ghz Dual-Core Intel Xenon) equipped with a 20-inch CRT monitor operating at 75 Hz with a resolution of 1024 × 768 was used to present stimuli. A Dell Pentium 4 was used in conjunction with the MacPro to collect data using an Eyelink 2 eye tracker (SR Research, Ontario, Canada), sampling at a rate of 250 Hz with a 0.2 spatial resolution.

**Procedure**

Trials started with a fixation cross displayed centrally for 1000 ms that was replaced by a posture stimulus. A non-predictive target letter (x or p) then appeared either on the left or the right of the posture, 200 ms or 500 ms after posture onset, which remained on the screen until a response was made or 2000 ms passed. An example of a trial with an angry posture expression is illustrated in Figure 1. Participants were instructed to fixate the central posture until the target appeared. At this point, they were to saccade towards it as quickly and accurately as possible, while responding to the target letter with a keypress response (“z” key for an “x” target, “/” key for a “t”). When a saccade left the central posture towards the target, meaning movement

![Figure 1. Example of an incongruent anger trial (not to scale).](image-url)
further than 2.5° visual angle to the right or left of fixation, that saccade was marked and the start time recorded. Saccadic reaction time was defined as the time between target onset and the saccade start time. The keypress response was included to keep the participant engaged, and to ensure that the eyes went towards the target. If before target appearance the eyes deviated more than 2.5° visual angle to either side of fixation, the message “you moved your eyes too soon” appeared and that trial was recycled and inserted randomly at a later point in the experiment. Participants completed one experimental block of 288 trials, whereby each of the 72 unique cue-target combinations were repeated four times. This was preceded by one practice block of 12 trials.

RESULTS

Saccadic reaction times were defined as the time it took for an eye movement towards a peripheral target to be initiated. Trials with incorrect key responses and saccade latencies less than 80 ms were discarded since they were likely to be express saccades and not under voluntary control. Latencies longer than 500 ms were also rejected because they were likely to be outliers given the average length of saccade latencies (Ottes, Van Gisbergen, & Eggermont, 1985).  

Analysis of manual response accuracy confirmed that all participants scored above 85%, thus none were excluded due to poor accuracy performance. For each participant, differential cueing effects were calculated by subtracting mean saccadic RTs for congruent trials from mean saccadic RTs for incongruent trials for each condition. These RT differences, which reflect the cueing effect, were entered into a 2 (anxiety: high or low) × 4 (expression: fear, anger, happy and neutral) × 2 (SOA: 200 or 500 ms) mixed ANOVA with anxiety as a between-subjects factor. There was a main effect of SOA, \( F(1, 24) = 7.1, p = .013, \eta_p^2 = .229, \) and emotion, \( F(3, 22) = 7, p < .001, \eta_p^2 = .231, \) A three-way interaction arose between emotion, SOA and anxiety group, \( F(3, 22) = 3.4, p = .023, \eta_p^2 = .124. \)

Two-tailed planned comparisons were carried out between congruent and incongruent trial saccadic RTs using paired-sample \( t \)-tests. Specifically, we were interested in testing the threat hypothesis: whether both fearful and angry postures led to a cuing effect for the high anxiety group. Because we had two groups and two SOAs, this leads to four sub-families of tests. Within a sub-family, we are interested in whether both fearful and angry postures lead to a significant cueing effect. The sub-family-wise error rate (sFWE) for this joint probability is low, at sFWE = 0.015 (joint probability of two tests reaching significance \((0.05^2)\) multiplied by the number of possible emotion pairs within a sub-family family of four tests \(\frac{N(N-1)}{2} = 6\)). Because of this, the overall FWE across the four sub-families is \(1 - (1 - \text{sFWE})^2\), or 0.0298, and therefore no alpha corrections were necessary at the individual test level. As predicted, in the high anxiety group congruent trials were significantly faster than incongruent trials when the posture expressed fear, \( t(12) = -2.6, p = .022, \eta_p^2 = .365, \) or anger, \( t(12) = -3.4, p = .006, \eta_p^2 = .486, \) indicating spatial cueing in the direction signalled by the threat-related posture. This effect was only present at the 200 ms SOA. No other comparisons showed this RT benefit for trials with congruent cue-target pairings. Unexpectedly, at the 500 ms SOA, congruent trials were significantly slower than incongruent trials in the neutral condition in both the high, \( t(12) = 2.6, p = .023, \eta_p^2 = .362 \) and low anxiety group, \( t(12) = 2.9, p = .013, \eta_p^2 = .416. \) Possible reasons for this are explained in the discussion section. No other comparisons reached significance. Figure 2 represents cueing effects as a function of SOA, expression and trait anxiety.

DISCUSSION

Eye movements made towards targets showed shorter latencies when target position was congruent with the direction that a posture was facing, compared to when it was incongruent, but only
when the posture cue was threat-related (expressing fear or anger). This effect was only present in high anxious individuals, who have long been described as being “hypervigilant” for threat (Eysenck, 1992). Since a directional social threat cue implies danger in the vicinity, it is logical that those reporting anxiety would possess an automatic attentional response aimed at threat-detection. These results are in agreement with previous research that has shown threatening facial expressions with averted eye gaze to elicit shifts of attention in the gazed-at direction.

Faster saccadic RTs occurred on congruent trials even though the posture cues were not predictive of target location, suggesting that the observer’s shift of attention was triggered automatically. In addition, the posture’s emotion was always task-irrelevant, supporting the claim that the threat-related attentional shift was involuntary. This effect emerged at the shorter (200 ms) SOA and disappeared by 500 ms, as might be expected from a reflexive and automatic response (Baron-Cohen, 1994).

Prior to this study, attentional cueing by directional social threat cues in anxious individuals

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**Figure 2.** Mean congruency effect (i.e., difference between incongruent and congruent trial saccadic RTs) as a function of SOA, expression and trait anxiety.
had only been demonstrated with threatening faces that had averted eye gaze (Fox et al., 2007). It was largely unknown whether this effect generalised to other forms of emotional directional stimuli, since both eye gaze detection and facial expression analysis have often been thought of as unique, specialised processes carried out by specialised brain modules (Adams & Kleck, 2003). As such, Baron-Cohen (1994, 1995) proposed the existence of an “eye direction detector” that serves to detect eye-shaped stimuli and compute their direction. However, our results show that threatening postures similarly induce reflexive shifts of spatial attention in an observer, lending support to the notion of a more general “direction of attention detector” (Perret & Emery, 1994).

Another point of interest concerns the importance of the directionality of a threatening social stimulus. It appears that the mechanism of attentional orienting that is affected depends not only on the emotional and social content of the cue (i.e., a fearful or angry body posture), but critically on the spatial orientation of that cue. In fact, our current results combined with those from a previous investigation show that the same emotional stimulus (a threatening posture) positioned in different orientations (direct vs. averted) modulate attentional orienting in exactly opposite ways. While here we observed attentional shifting away from central angry and fearful averted posture cues, a recent study (Azarian, Esser, & Peterson, under review) using stimuli from the same actor set found that direct-facing angry and fearful postures instead delayed the eyes from leaving. It has been proposed that such a delay may allow for defence strategizing while reducing superfluous movement (Fox et al., 2002). With averted threat, such processes are not necessary, since the threat cue itself presents no direct harm to the observer. It is more important that the relevant threat be located, which in this case would be the implied peripheral stimulus that was eliciting emotion from the observed posture stimulus. As it would confer apparent survival advantages, selection pressures may have favoured an automatic threat-detection system sensitive to the direction of a threatening stimulus. This agrees with the gaze-cueing literature, which has shown that threatening facial expressions with averted eye-gaze cue attention, while those same faces with direct gaze delay it (Fox et al., 2007). Furthermore, our findings are the first to provide evidence that in addition to integrating information about gaze direction and facial expression (Adams & Kleck, 2003) to modulate orienting, the brain can also integrate information about posture direction and posture expression to compute one’s emotional state and direction of attention. Such a property would paint a picture of a cognitive system that processes emotional and social information more dynamically and flexibly than previously thought.

Although prior work on emotional cueing with faces and averted gaze has reported mixed conclusions regarding the matter, our results report that both fearful and angry social directional cues induce reflexive shifts of attention in an observer. However, we should point out that there are stark differences between averted emotional postures and gaze cues. Like eye gaze, posture orientation is indicative of where attention is being directed, since one is often attending to the direction that they are facing. But unlike threatening facial expressions, a threat-related posture expression may be more foretelling of a looming threat for the following reasons. Our fearful and angry postures often displayed clear offensive and defensive actions that are more expressive of an actual physical engagement with something in the periphery that is likely on the attack. In the case of fear, arms were commonly shielding the body or face, while the angry postures frequently had arms arranged in a striking position. These cues may indicate a violent exchange, whereas an angry face with averted gaze can just be a sign of extreme disapproval of another. Consequently, it can be argued that threat-related posture expressions are more salient cues of danger than face cues, especially when there is an expression of anger. Our findings may differ from those of Fox et al. (2007) that showed reduced cueing by averted anger simply due to fundamental differences in the two types of stimuli. It should also be noted that it was the threat-relatedness of the posture that
caused the cueing effects rather than emotion in general, since happy posture cues showed no benefit for targets appearing in locations congruent with posture direction.

Although our findings only indicate that postures cue attention when they express threat-related emotion and anxiety levels are high, whether directional neutral postures cue attention in the general population similarly under different conditions is inconclusive. Although we failed to find a congruency effect in the neutral condition, only two SOAs were examined, leaving open the possibility that neutral postures cue attention at some yet-to-be tested stimulus duration. We bring up this possibility in light of the fact that both high and low anxiety groups showed faster RTs on incongruent trials at the longer SOA when the postures were neutral. Such an unintuitive result has been found extensively with classic exogenous cueing studies that used abrupt onset cues that could correctly (valid trial) or incorrectly (invalid trial) predict target location. These faster responses to invalid targets at longer SOAs occur due to a phenomenon known as “inhibition of return” (IOR), which causes a delayed response to targets appearing in the cued location where attention had been previously drawn (Posner & Cohen, 1984). This is assumed to occur so that attention can more effectively scan an environment rather than revisiting already attended locations. If IOR had in fact been the reason for faster RTs on incongruent trials when the posture cue was neutral, it would mean that at an earlier untested SOA, neutral postures were causing the observer to reflexively shift attention in the cued direction. Since faces with averted eye gaze have been shown to shift attention in a reflexive manner similar to exogenous cueing (Friesen & Kingstone, 1998), and to elicit inhibition-of-return effects at long SOAs (Frischen & Tipper, 2004), it may be that averted postures do the same.

Our results provide further evidence of a robust attentional bias for threatening information in individuals reporting high levels of anxiety (Matthews & MacLeod, 1994). Anxious individuals experienced involuntarily shifts of attention in the direction cued by threat-related postures while non-anxious individuals did not. Thus, attention was automatically guided towards a location that might harbour a potential threat. Although it would seem that this threat-detection function would always be beneficial, in modern times it may be an inappropriate use of cognitive resources since fearful or angry expression rarely signals true physical danger. Instead, threatening facial and posture expressions are most often experienced in various forms of visual entertainment, such as violent movies and television, and with high frequency. As such, anxious individuals may be spending more time mentally occupied with threatening information than before, potentially yielding an overly threat-conscious appraisal of surroundings and presumably inducing a state of hyper-arousal.

REFERENCES


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