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Brief article

Mental attribution is not sufficient or necessary to trigger attentional orienting to gaze

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ABSTRACT

Attention can be shifted in the direction that another person is looking, but the role played by an observer's mental attribution to the looker is controversial. And whether mental attribution to the looker is *sufficient* to trigger an attention shift is unknown. The current study introduces a novel paradigm to investigate this latter issue. An actor is presented on video turning his head to the left or right before a target appears, randomly, at the gazed-at or non-gazed at location. Time to detect the target is measured. The standard finding is that target detection is more efficient at the gazed-at than the nongazed-at location, indicating that attention is shifted to the gazed-at location. Critically, in the current study, an actor is wearing two identical masks – one covering his face and the other the back of his head. Thus, after the head turn, participants are presented with the profile of two faces, one looking left and one looking right. For a gaze cuing effect to emerge, participants must attribute a mental state to the actor – as looking through one mask and not the other. Over the course of four experiments we report that when mental attribution is *necessary*, a shift in social attention does *not* occur (i.e., mental attribution is not sufficient to produce a social attention effect); and when mental attribution is *not* necessary, a shift in social attention *does* occur. Thus, mental attribution is neither sufficient nor necessary for the occurrence of an involuntary shift in social attention. The present findings constrain future models of social attention that wish to link gaze cuing to mental attribution.

1. Introduction

A cornerstone to human existence is our ability to communicate with one another. During face-to-face interactions, information is conveyed both verbally and non-verbally. Research indicates that amongst the nonverbal signals, human eyes are critical to coherent communication (Argyle & Cook, 1976; Kendon, 1967; Wu, Bischof, & Kingstone, 2014). Indeed, human eyes may be so important to communication that their morphology, with a white sclera surrounding a dark iris, is distinct among primates and makes it easy for people to observe where another is looking (Emery, 2000; Kobayashi & Kohshima, 1997). The implication is that humans, unlike nonhuman primates, sacrificed gaze camouflage for gaze communication during evolutionary development.

An early laboratory demonstration of the influence of eye gaze communication was provided by Friesen and Kingstone (1998; see also Driver et al., 1999; Langton & Bruce, 1999) who presented participants with a face on a computer screen that looked either to the left or the right before a visual target appeared to the left or right of the face. Gaze direction and target location were randomized, so there was no statistical reason to attend to the gazed-at location any more than the nongazed-at location. Nevertheless, response times (RTs) to targets at the gaze-at (cued) location were shorter than to targets at the nongazed-at (uncued) location, indicating that an observer's attention is committed involuntarily to the location that is looked at.

Several investigations, however, soon challenged the original interpretation that this effect represents a social phenomenon particular to eye gaze. Tipples (2002) reported that a centrally-presented arrow stimulus, pointing to the left or right, is sufficient to trigger involuntary orienting effects that are similar to, if not indistinguishable from, the orienting effects produced by gaze. Though subsequent studies revealed qualitative and quantitative differences between orienting to gaze and arrows (see Frischen, Bayliss, & Tipper, 2007 for a review), the fact that an involuntary attention effect to a central stimulus is not unique to biological stimuli appeared to narrow the original socio-theoretical scope of the gaze cuing effect.

Yet the similarity in behavioural effects from different stimuli need not demand the conclusion that the stimuli engage similar cognitive

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and/or brain systems (Böckler, van der Wel, & Welsh, 2014, 2015). Indeed, studies have revealed gaze cuing effects may be modulated by the mental attribution made to the cue by an observer. Nuku and Bekkering (2008) presented observers with a face that was turned left or right, and critically, the eyes of the face were open or not, or were covered (e.g., by duct tape or sunglasses). Cuing effects were reduced when the central face would not be able to see the target stimulus (see also Teufel et al., 2009).

Langton (2009), however, makes the excellent point that these findings need not demand the conclusion that top-down mental attribution to a face stimulus is involved in the gaze cuing effect. Other variables, such as the attention to the cue, or the ease of discriminating the left/right directionality of the cue, may have produced changes in the gaze effect.

Consistent with this point, Cole, Smith, and Atkinson (2015) reported that when one manipulates what a face cue could see by placing a divider between it and the target, robust cuing effects persisted even when the divider hid the target from the face cue (see also Kuhn, Vacaityte, D'Souza, Millett, & Cole, 2018). This dovetails with previous reports that the gaze cue effect is difficult to override. Driver et al. (1999) for example reported that attention is shifted involuntarily in response to gaze direction, even when gaze direction is counter-predictive. A similar result has been shown for changes in cognitive load (Hayward & Ristic, 2013). In sum, it is clear that gaze cues shift attention, but the role played by top-down mental attribution is controversial.

To date, researchers addressing this issue have taken the approach of first generating a gaze cuing effect and then trying to reduce or negate it by manipulating an observer's mental attribution to the face. While the logic is sound, and it has produced a number of useful findings, the fact that the results are mixed suggests that the approach comes with limitations. As Langton (2009) suggests, one potential shortcoming is that other factors, in addition to (or in place of) a change in mental attribution, may modulate the gaze cuing effect. Factors that could alter the gaze cuing effect include the discriminability of gaze direction, the response executed, and the cue-target characteristics (e.g., visual complexity/realism of the cue as well as the relative cue-target colors and onset asynchrony). If the manipulation to mental attribution inadvertently impacts the manner in which these factors engage spatial attention, or interact with one another, then it is difficult to conclude that a modulation of the cuing effect directly results from mental attribution to the cue.

The present study utilized a different research approach. Rather than first generating a gaze cuing effect and then trying to reduce or eliminate it by manipulating the mental attribution made to the cue (e.g., Nuku & Bekkering, 2008), we created a situation that *required* a mental attribution to the cue for a gaze cuing effect to emerge. Details of our research approach are provided below.

2. Experiment 1

Observers viewed a video of a real person turning his head to the left or to the right before a visual target randomly appeared at the gazed-at or nongazed-at location. The unique feature was that a mask covered his face and, most critically, an identical mask covered the back of his head (Fig. 1). Thus, a head turn presents observers with two identical masks, one directed to the left and one to the right. What distinguishes the masks is the mental attribution that the person looking through the mask, that was originally oriented towards the observer, is now gazing left or right. If top-down mental attribution to this central cue triggers the gaze cuing effect, then RTs to targets presented at the gazed-at (cued) location will be shorter than those to the nongazed-at (uncued) location. Otherwise the null hypothesis of no effect will be confirmed.

2.1. Methods

2.1.1. Participants

Thirty UBC undergraduates (ages 19–45, 20 females) provided informed consent prior to participating the study for course credit.

2.1.2. Stimuli

Two Guy Fawkes masks from the *V for Vendetta* franchise were taped together at their elastics and placed at the back and front of the actor's head. During each video, the actor clearly started with his face oriented towards the participant and then smoothly turned 90° either left or right, with the turn taking 4 s to complete. The size of a mask was 22.86 cm high and 17.28 cm wide full-face, and 11.43 cm wide in profile (yielding, across the two masks, 27 cm nose-to-nose).

A red target (1.5 cm diameter) appeared 21 cm to the left or right of centre 500 ms after the actor completed the turn (past research indicates that 500 ms should be ample time for a shift of attention to occur). There were six videos: the dot appearing on the right or left side of the screen, or not at all (catch trial) after the actor turns to the right or left. The display was extinguished following a key press, or 3 s after the turn was completed, whichever came first. The inter-trial interval was 2 s.

2.1.3. Procedure

Each of the participants were instructed to respond to the onset of the visual target as quickly and as accurately as possible by pressing the spacebar of a computer keyboard with their dominant hand. If a target did not appear, the participant was to withhold a response. Participants were also informed that the target was equally likely to appear at the gazed-at location as the nongazed-at location.

At the beginning of the experiment, participants saw three example videos. These were extended versions of the videos used in the experiment and included the actor in the process of putting on the masks. Participants were shown the videos to demonstrate that there was indeed one person wearing two masks, and his eyes were looking out from the front mask at the start of each trial. Upon watching the example videos, participants were given an opportunity to ask questions. Participants completed 100 trials, 10% were catch.

2.2. Results & discussion

RTs shorter than 100 ms (anticipations) and longer than 1000 ms (inattention/miss errors) were excluded, 0.53% and 1.3% of the data, respectively. Responses made on catch trials (false alarms) accounted for 0.12% of the data and were also excluded from analysis. If a participant had a cumulative error rate $>10\%$ s/he was excluded. No participant reached this criterion.

A paired samples *t*-test revealed that mean RTs to a target appearing at the cued (gazed-at) location were not statistically different from RTs for a target appearing at the uncued location (Fig. 2), $t(29) = 0.56$, $p = 0.58$, $d_z = 0.10$, 95% confidence intervals of the difference scores (95% CI_{DS}) = −12.84 to 7.32. Thus, the results of Experiment 1 do not provide evidence that mental attribution alone is sufficient to trigger an attentional shift in the direction of an individual's gaze direction.

3. Experiment 2

In Experiment 1, the time interval between the completion of the actor's head turn and the target onset was always 500 ms. Hence, the potential to detect an attentional shift was limited to this time-window. In Experiment 2, the range of the cue-target interval was broadened to include shorter (0 ms and 200 ms) and longer (800 ms) cue-target intervals. These additional SOAs were introduced to assess any potential time course in the gaze-cuing effect.

Additionally, in Experiment 1, the size of the central cue and the eccentricity of the target were approximately four times larger than

Fig. 1. Example of the stimuli and types of trials in Experiment 1. Each column illustrates the actor (who in all experiments always appears first looking forward), turning to look to the right side of the screen (note direction of rotation was random in the experiments). In the left panel the visual target appears at the uncued (not gazed-at) location, and in the right panel the target appears at the cued (gazed-at) location. If mental attribution is made to the cue then attention is predicted to be directed to the cued location, resulting in cued target detection RT < uncued target RT, i.e., a gaze cuing effect. The direction of the head turn did not predict the target location. The middle panel represents a catch-trial, when no target appears.

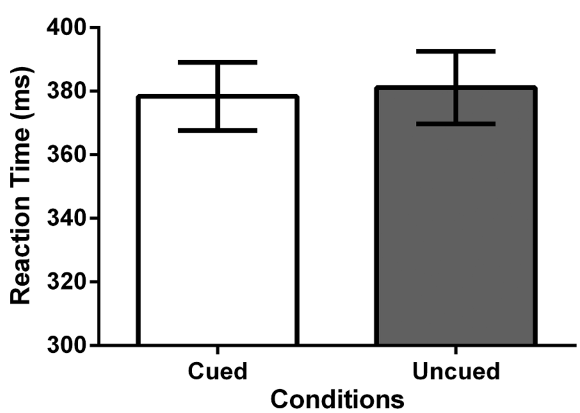

Fig. 2. Mean correct detection RT (in ms) and standard error of the mean to a target that appears a cued (gazed-at) or uncued (nongazed-at) location for Experiment 1.

what is normally used in gaze-cuing studies. We chose the larger size to closer approximate the natural head size of the person wearing the mask. The stimuli in Experiment 2 were reduced by a factor of four so the size of the central cue had dimensions comparable to previous gaze-cuing studies (e.g., Friesen & Kingstone, 1998). Thus, the SOA distribution and cue stimuli in Experiment 2 were consistent with past gaze cuing studies.

3.1. Methods

3.1.1. Participants

Thirty-two UBC undergraduates (ages 18–23, 16 females) participated for course credit.

3.1.2. Stimuli and procedure

The videos used in Experiment 1 were reduced to 25% of the original size. In addition, target onset could occur at one of four time intervals after the head stopped turning: 0 ms, 200 ms, 500 ms, and 800 ms. Finally, because the SOAs introduce uncertainty as to when a target will occur, we decreased the percentage of catch trials to 5% of the 168 trials, with trial time-out occurring at 1000 ms. An equal number of trials of all combinations of gaze direction, target location and SOA were randomly presented. The remaining aspects of the procedure were identical to Experiment 1.

3.2. Results & discussion

Data reduction was consistent with Experiment 1. One participant was excluded from analyses because of a cumulative error rate of 45% leaving a final sample of 31. For the remaining participants, anticipation, miss, and false alarm rates were 1.0%, 0.10%, and 2.3% respectively.

Mean RTs (Fig. 3) were submitted to a 2 (Target Location: cued, uncued) by 4 (SOA: 0, 200, 500, 800 ms) two-way repeated measures ANOVA. This analysis revealed a main effect of SOA, $F(3,90) = 24.89$, $p < 0.01$, $\eta_p^2 = 0.453$, reflecting a standard foreperiod effect. Critically there was no main effect of Target Location, $F(1,30) = 0.491$, $p > 0.4$, $\eta_p^2 = 0.016$, and no SOA × Target Location interaction, $F(3,90) = 0.148$, $p > 0.9$, $\eta_p^2 = 0.005$. Thus, despite sampling a broader range of cue-target SOAs, and decreasing the size of the stimuli, there was no evidence of a gaze cuing effect. The implication of this null effect is that making a mental attribution to the cue is *not* sufficient to trigger a gaze-cuing effect.

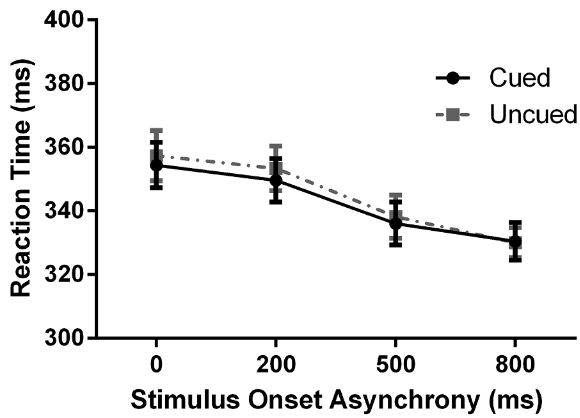

Fig. 3. Mean correct detection RT (in ms) and standard error of the mean to a target that appears a cued (gazed-at) or uncued (nongazed-at) location as a function of cue-target SOA (0, 200, 500, 800 ms) for Experiment 2.

4. Experiment 3

Experiment 3 was designed to address two alternative interpretations to our conclusion that making a mental attribution to the central cue was not sufficient to trigger a gaze-cuing effect.[1] One possibility is that the gaze cuing effect is so robust that turning a mask toward a location triggers an orienting effect, whether that location is gazed-at by the actor in the mask or not. In other words, *both* masks in Experiments 1 and 2 *were* triggering orienting effects to both locations, and as a result, there was no RT difference between the two locations.

A variation on this possibility is that although participants have ample time to compute the actor's gaze direction and mental state (Kuhn et al., 2018), the participants often misattribute the gaze direction to the wrong mask (e.g., they get confused or forget which of the two masks is on the front of the actor's face and which is on the back of his head). According to this account, participants are just as likely to direct attention to the gazed-at (cued) location as the nongazed-at (uncued) location because they are not sure which mask is actually being seen through. The end result, again, is that RT performance is equivalent at both locations.

In the following experiment, we address these possibilities. To test if both masks are triggering an attention shift, we present a target above or below the central cue, as well as to the left and right. As the masks were never directed up or down, the vertical (above/below) targets could never be gazed-at and, as such, are unattended. If attention is shifted in the direction of both masks, then RTs to the vertical targets should be longer than those to the horizontal (left/right) targets because vertical targets are unattended and the horizontal targets are attended. Note that this prediction holds even if participants misattribute gaze direction to the wrong mask (e.g., they forget which way the actor is looking) because half of the horizontal targets, and none of the vertical targets, would appear at an attended location. However, as an additional and direct test of whether participants can remember the true direction of the actor's gaze, in the final block of testing participants reported which of the two masks the actor was looking through.

4.1. Methods

4.1.1. Participants

Thirty-three UBC undergraduates (ages 17–30, 21 females and 12 males) participated for course credit.

4.1.2. Stimuli & procedure

The stimuli and procedure were as in Experiment 2, with the critical difference being that the target could appear equally at left, right, top, and bottom locations. Participants completed 341 trials, 16 of which were catch trials. A final additional block of 9 trials were included, which also included 1 no target (catch) trial. In this block, in addition to detecting any target after the cue had turned left or right, the participant reported verbally to the experimenter which mask was being looked through. Note, because of the unique dual-task nature of this final block, the button-press data were excluded from analysis.

4.2. Results & discussion

Data reduction was consistent with previous experiments. Three participants were excluded from analyses because of a cumulative error rate of greater than 10% leaving a final sample of 30. For the remaining participants, anticipation, miss, and false alarm rates were 1.3%, 0.10%, and 1.7% respectively.

To determine if there was a gaze cuing effect in the present experiment, we conducted two analyses. The first, mirrored that in Experiment 2; the second included the uncued vertical targets. Mean RTs for both analyses are presented in Fig. 4.

In the first analysis, trials on which the target appeared on the left or the right of the central head were submitted to a 2 (Target Location: cued, uncued) by 4 (SOA: 0, 200, 500, 800 ms) two-way repeated measures ANOVA. Note only trials on which the target was on the left or right were included in this analysis because the central head never looked towards the potential target locations on the vertical axis. The analysis of RTs to targets to the left and right of the central head revealed a main effect of SOA, $F(3,87) = 22.69$, $p < 0.01$, $\eta_p^2 = 0.439$, reflecting a standard foreperiod effect with decreasing RTs as SOA increases. Critically there was no main effect of Target Location, $F(1,29) = 0.216$, $p > 0.6$, $\eta_p^2 = 0.007$, and no SOA × Target Location interaction, $F(3,87) < 1$, $p > 0.39$ $\eta_p^2 = 0.033$. Thus, the results of this analysis are consistent with those of Experiments 1 and 2 in that there is no evidence of a gaze cuing effect.

To address the main aim of Experiment 3, the RTs on trials to uncued targets in the vertical positions were compared to the RTs for cued and uncued target trials on the horizontal position using a 3 (Location: Cued Horizontal, Uncued Horizontal, Uncued Vertical) by 4 (SOA: 0, 200, 500, 800 ms) repeated measures ANOVA. The analysis revealed a main effect of SOA, $F(3,87) = 28.29$, $p < 0.01$, $\eta_p^2 = 0.494$, reflecting a standard foreperiod effect with decreasing RTs as SOA increases. Critically, there was a main effect of Target Location, $F(2,58) = 83.51$, $p > 0.01$, $\eta_p^2 = 0.742$, that revealed RTs to uncued vertical targets (M = 403; SD = 39.4) were actually shorter than cued horizontal targets (M = 433; SD = 40.8), $t(29) = 29.7$, $p < 0.05$, $d_z = 2.09$ and uncued horizontal targets (M = 431; SD = 43.7), $t(29) = 28.4$, $p < 0.05$, $d_z = 2.09$. As before RTs to horizontal cued and uncued targets were not statistically different, $t(29) = 1.25$, $p > 0.45$, $d_z = 0.09$. The SOA × Target Location interaction approached conventional levels of statistical significance, $F(3,87) = 1.94$, $p < 0.08$, $\eta_p^2 = 0.063$. This trend in the pattern of RTs was due to the relatively larger vertical-horizontal RT differences at the 0 ms and 200 ms SOAs than at the 500 ms and 800 ms SOAs.[2] A series of paired sample *t*-tests revealed

[1] We thank Stephen Langton for raising both alternatives, and for suggesting two elegant ways to test them, which we pursued.

[2] Finding *longer* RTs for horizontal than vertical targets is fundamentally inconsistent with the possibility that masks are driving attention to the horizontal locations. We wondered, however, if there was *any* evidence that a baseline difference in horizontal versus vertical RT (Horizontal > Vertical) was concealing a gaze cuing effect for the horizontal targets? In particular, if the trend toward a location × SOA interaction might provide that evidence. We know from a wealth of past studies that when a gaze cueing × SOA interaction emerges, it normally reflects a larger gaze cueing effect at earlier SOAs. In the present case if attention is being committed to the horizontal locations, and this especially shortens RTs to horizontal targets at earlier SOAs, the difference

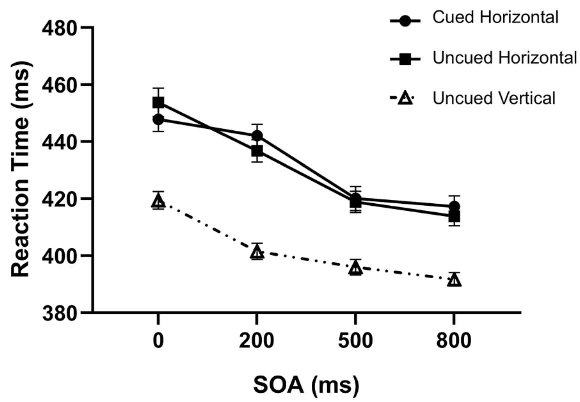

Fig. 4. Mean correct detection RT (in ms) and standard error of the mean to a target that appears a cued (gazed-at) or uncued (nongazed-at) horizontal and vertical locations as a function of cue-target SOA (0, 200, 500, 800 ms) for Experiment 3.

that RTs to targets at the vertical locations were shorter than those at horizontal locations at all SOAs – *ts* (29) > 4.34, *ps* < 0.001, d_zs > 0.86.

These analyses converge on the conclusion that the masks are not triggering a gaze orienting effect to the left/right target locations. Dovetailing with these findings is our discovery that when participants are asked, in the last block of testing, to report on each trial which mask is being gazed through, their performance is perfect. Collectively then, these data, combined with those of Experiments 1 and 2, indicate that mental attribution to the cue is *not* sufficient to trigger a gaze-cuing effect.

5. Experiment 4

In light of our failures to observe a gaze-cuing effect in the previous studies, Experiment 4 tested if the mask-cue can ever trigger a gaze cuing effect. We repeated Experiment 2 (left/right targets only) but removed one of the two masks for the videos. Note that like the classic gaze (and arrow) cuing paradigm, the cue now provides a directional signal of left or right (i.e., the mask is oriented to the left or to the right). Thus, mental attribution to the gaze cue is no longer necessary for a cuing effect to arise.

5.1. Methods

5.1.1. Participants

Thirty UBC undergraduates (ages 18–40, 25 females) participated for course credit.

5.1.2. Stimuli & procedure

The stimuli and procedure were as in Experiment 2, with the critical difference being that the actor only wore one mask (see Fig. 5).

5.2. Results & discussion

Data reduction was the same as previous studies. Anticipation, miss, and false alarm rates were 1.0%, 0.02%, and 0.5% respectively. No participants met the criteria for removal.

An ANOVA of the mean RTs (Fig. 6) revealed a main effect of SOA, $F(3,87) = 21.12, p < 0.01, \eta_p^2 = 0.421$. Of greater theoretical relevance,

(*footnote continued*)
between horizontal and vertical RTs should be smaller at the earlier SOAs than the later SOAs. There is no evidence of this pattern. Indeed, our trend toward a location × SOA interaction reflects precisely the opposite pattern to the one expected if the masks were orienting attention on the horizontal.

Fig. 5. Illustration of a target appearing at an uncued (non-gazed at) location in Experiment 4.

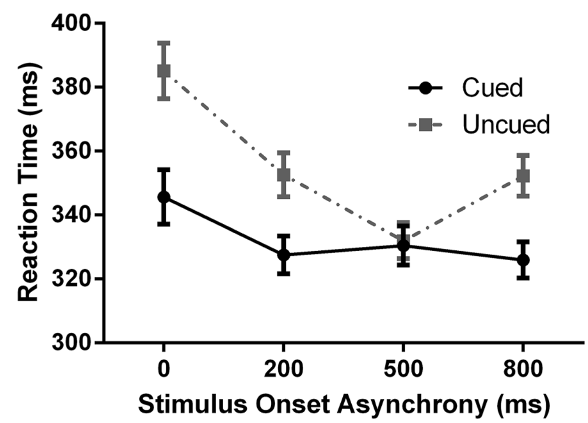

Fig. 6. Mean correct detection RT (in ms) and standard error of the mean to a target that appears a cued (gazed-at) or uncued (nongazed-at) location as a function of cue-target SOA (0, 200, 500, 800 ms) for Experiment 4.

there was a main effect for Target location, $F(1,29) = 91.10, p < 0.01, \eta_p^2 = 0.759$, indicating that RTs to cued targets were shorter than to RTs to uncued targets. The interaction between Target Location and SOA was also statistically significant, $F(3,87) = 12.60, p < 0.01, \eta_p^2$ 0.303. A series of post hoc paired sample *t*-tests revealed significant cuing effects (*ps* < 0.01; d_zs > 1.0) at all SOAs except 500 ms: 500 SOA, $t(29) = 0.30, p > 0.7, d_z = 0.06$, 95% $CI_{DS} = -8.6$ to 11.59. Thus, when mental attribution to the face cue was not necessary, significant cuing effects were returned.

These results contrast those observed in Experiments 1–3 wherein no cuing effect was observed when the actor wore two masks. To determine if the cuing effects in Experiment 2 were different from those in Experiment 4 (the two experiments which only differed on the number of masks), a mixed ANOVA was conducted with Experiment (2, 4) as a between-subjects factor and Target Location and SOA as within-subject factors. This analysis revealed a 2-way interaction between Experiment and Target Location, $F(1,59) = 29.13, p < 0.01, \eta_p^2 = 0.331$, and a 3-way interaction among Experiment, Target Location, and SOA, $F(3,177) = 5.82, p < 0.01, \eta_p^2 = 0.09$. In sum, the classic cuing effect in Experiment 4 differed significantly from the non-effect in Experiment 2.

6. General discussion

Human eyes are a key source of information and, as such, are often the focus of our attention. The gaze-cue paradigm represents a task for assessing the impact of another person's eyes on the allocation of an observer's attention. While there is no question that attention is allocated to where the eyes of a central cue are directed, the role of mental attribution in this effect remain mixed.

Prior investigations have typically tackled this issue by taking a standard gaze cuing effect and investigating its sensitivity to changes in mental attribution. This reasonable approach, however, is vulnerable to modulation of the cuing effect from other variables being misattributed to a change in mental attribution. At best, the extant evidence is convergent on the conclusion that mental attribution is a volitional process that can modulate a gaze cuing effect (see, for example, an excellent paper by Kuhn et al., 2018).

What the prevailing work does not address, and what the present study examined, is whether mental attribution alone is *sufficient* to generate a gaze cuing effect? In our novel paradigm, a gaze cuing effect can occur if, and only if, a mental attribution is made to the cue (Experiments 1–3). Without that mental attribution, no cuing effect should occur.

Experiments 1–3 did not provide any evidence of a gaze cuing effect when the actor wore two masks and mental attribution was necessary for a cuing effect to emerge. In Experiment 4, when the central cue conveyed an unambiguous left/right directional signal, and mental attribution to the central cue was no longer necessary to yield a cuing effect, a significant attentional effect was returned. Thus, collectively, the present series of investigations indicate that mental attribution to a gaze cue is neither necessary (Experiment 4) nor sufficient (Experiments 1–3) for the emergence of a gaze cuing effect.

The present findings support the recent report of Cole et al. (2015; see also Kuhn et al., 2018) who failed to find evidence that mental attribution modulates the gaze cuing effect. It also provides support for their and Langton (2009) concern that previous reports that mental attribution will modulate the gaze cuing effect may have been due merely to how the direction cue was perceived, rather than whether any mental attribution was made to the cue itself. Indeed, other studies raise a similar concern for the mental attribution explanation of the gaze effect. Tipper, Handy, Giesbrecht, and Kingstone (2008) for instance, found that when an ambiguous stimulus possesses two inherent and opposing directionalities (e.g., an A on its side can be perceived either as an eye in profile or an arrow), the cuing effect can be reversed by representing it as an eye or an arrow (see Ristic & Kingstone, 2005 for a similar demonstration).

Collectively, these data suggest that the standard gaze paradigm may be a flawed method for assessing mental attribution. Using a novel design, our findings indicate that when mental attribution is necessary, a shift in social attention is absent (i.e., mental attribution is not sufficient to produce a social attention effect); and when mental attribution is not necessary a shift in social attention does occur. Thus, mental attribution is neither sufficient nor necessary for the occurrence of an involuntary shift in social attention.

Ethics statement

The work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

Declarations of interest

None.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cognition.2019.03.010.

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