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Fixations to the eyes aids in facial encoding; covertly attending to the eyes does not

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ABSTRACT

When looking at images of faces, people will often focus their fixations on the eyes. It has previously been demonstrated that the eyes convey important information that may improve later facial recognition. Whether this advantage requires that the eyes be fixated, or merely attended to covertly (i.e. while looking elsewhere), is unclear from previous work. While attending to the eyes covertly without fixating them may be sufficient, the act of using overt attention to fixate the eyes may improve the processing of important details used for later recognition. In the present study, participants were shown a series of faces and, in Experiment 1, asked to attend to them normally while avoiding looking at either the eyes or, as a control, the mouth (overt attentional avoidance condition); or in Experiment 2 fixate the center of the face while covertly attending to either the eyes or the mouth (covert attention condition). After the first phase, participants were asked to perform an old/new face recognition task. We demonstrate that a) when fixations to the eyes are avoided during initial viewing then subsequent face discrimination suffers, and b) covert attention to the eyes alone is insufficient to improve face discrimination performance. Together, these findings demonstrate that fixating the eyes provides an encoding advantage that is not availed by covert attention alone.

1. Introduction

When looking at an image of a face, people will most often look to the internal features, including the eyes, mouth, and nose (Henderson, Falk, Minut, Dyer, & Mahadevan, 2001; Walker-Smith, Gale, & Findlay, 1977; Yarbus, 1967). Of those features, the eyes are the most frequently fixated (e.g., Henderson, Williams, & Falk, 2005; Janik, Wellens, Goldberg, & Dell'Osso, 1978; Langton, Watt, & Bruce, 2000). Though specific task demands may influence the magnitude of this bias (e.g., Birmingham, Bischof, & Kingstone, 2008a; Eisenbarth & Alpers, 2011; Laidlaw, Risko, & Kingstone, 2012; Schyns, Bonnar, & Gosselin, 2002), observers nevertheless look to the eyes more often than would be predicted based only on the low-level salience of the feature (Birmingham, Bischof, & Kingstone, 2009), or their position on the face (Levy, Foulsham, & Kingstone, 2012). That people will so frequently attend to this feature raises the question of whether this behaviour may be functionally beneficial. Face learning in particular appears to rely heavily on information provided by the eyes (Caldara et al., 2005; Itier, Alain, Sedore, & McIntosh, 2007; O'Donnell & Bruce, 2001; Schmalzl, Palermo, Green, Brunsdon, & Coltheart, 2008; Sekiguchi, 2011). For instance, recognition performance is impaired when the upper face or eye region, but not the lower face or mouth region, is masked during initial encoding (McKelvie, 1976). Similarly, when select features are exposed via a 'bubbles' technique, participants appear to rely on information presented within the eyes in order to successfully identify faces (Gosselin & Schyns, 2001; Schyns et al., 2002; Vinette, Gosselin, & Schyns, 2004). Recognition is also improved when the face is learned with direct gaze as opposed to when the eyes are averted or closed (Farroni, Massaccesi, Menon, & Johnson, 2007; Hood, Macrae, Cole-Davies, & Dias, 2003).

As evident from the studies cited above, a common theme in testing the importance of the eyes in face learning is to manipulate the visibility of the feature to the observer. An interesting but relatively unexplored question to emerge from this work is whether the benefits conferred from having the eyes visible is due to participants fixating and attending to the region, or if instead attention being allocated to the eyes - without a corresponding shift in gaze - is sufficient to yield the observed benefits. Though people will often shift their eyes and their attention at the same time - that is, they deploy attention overtly - it is also true that oculomotor and attentional mechanisms are dissociable and can work independently (Hunt & Kingstone, 2003a, 2003b; Juan, Shorter-Jacobi, & Schall, 2004; Posner, 1980). This means that attentional resources can be directed covertly to a peripheral location in the visual field, without requiring a subsequent eye movement. In other words, covert attention serves to improve visual processing of select locations in peripheral or para-foveal vision (e.g., Carrasco, 2011; Gazzaley, Cooney, McEvoy, Knight, & D'Esposito, 2005; Moran & Desimone, 1985; Polk, Drake, Jonides, Smith, & Smith, 2008). For this reason, the common practice of testing the importance of the eye region to face learning by

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manipulating the visibility of the eyes confounds the role of covert and overt orienting. When the eyes are masked, attention can be neither overtly nor covertly directed to that feature; when the eyes are made visible, the observer is able to attend to them in both manners. In sum, the current findings do not establish whether a shift in attention to the eyes of a face without a corresponding shift in fixation is sufficient to produce the beneficial effects of eye processing to face learning.

There are reasons both for and against thinking that fixating the eyes is critical for effective face learning. While attending either overtly or covertly enhances visual processing (Gazzaley et al., 2005; Moran & Desimone, 1985; Polk et al., 2008), orienting attention overtly allows for greater visual acuity, greater colour processing, and also for serial scanning of information that is not otherwise available using para-foveal or peripheral vision. As planning and executing saccades takes time, simple peripheral detection or discrimination tasks can be accomplished more efficiently by employing 'passive' strategies that involve fewer fixations and greater reliance on covert attentional control (e.g., Watson, Brennan, Kingstone, & Enns, 2010). In contrast, however, the eyes and surrounding area are highly detailed, and while they show great variability across individuals in terms of their colour and shape, these details may be encoded more effectively when directly fixated.

Supporting the latter view, a study by Henderson et al. (2005) showed that compared to when participants maintain central fixation, freely viewing faces during encoding – which meant that participants looked most often, but not exclusively, to the eyes – led to better performance on a subsequent facial recognition task. Rightfully, Henderson and colleagues concluded that fixations in general improve face learning. Considering the strong eye bias during free viewing, however, these results may be suggestive of a functional role of fixating the eyes in particular: performance was still worse in the central fixation condition even though the feature was available to be attended covertly. Thus, fixations on the eyes may serve a unique function in face learning.

However, it may also be that the behaviour of looking to the eyes occurs in service of directing attention more generally to this area. Unless circumstances discourage coupling of covert attention to eye movements, people may use eye movements as a relatively easy way to redirect attentional resources and make detailed visual discriminations. Whereas observers may choose to rely on covert attentional mechanisms when performing a reasonably simple peripheral detection or discrimination task (Kingstone & Pratt, 1999; Posner, 1980), decoupling covert attention from saccades may also be worthwhile when viewing social stimuli, such as faces. When viewing other people's faces in everyday social situations, eye movements are not only used to process visual information, they also serve to signal social information to those nearby (Risko, Richardson, & Kingstone, 2016). Maintaining eye contact with another person can be both attentionally demanding and arousing, which may contribute to why most people will naturally break eye contact within a few seconds (Argyle & Dean, 1965; Helminen, Kaasinen, & Hietanen, 2011; Jarick, Laidlaw, Nasiopoulos, & Kingstone, 2016). Further, certain gaze behaviours have ascribed meanings depending on the context and culture. For example, frequently looking to another person's eyes may be perceived as demonstrating competence (Sodikoff, Firestone, & Kaplan, 1974), social intimacy (Argyle & Dean, 1965), or aggression (Ellsworth, 1975; Ellsworth et al., 1972). Being able to encode identity or expression information in the eye region without having to directly fixate the eyes would enable individuals to more flexibly use their own gaze behaviour to facilitate social signalling rather than be restricted to sensory processing.

At present however, there is only indirect support of the view that covert attention may be sufficient to encode facial information. For instance, during face recognition, looking near, but not necessarily on, the eyes has been shown to be an effective recognition strategy (Hsiao & Cottrell, 2008; Peterson & Eckstein, 2012; Sæther, Belle, Laeng, Brennen, & Øvervoll, 2009); the same may also be true for encoding. Further, one study that restricted para-foveal visual information during face encoding found that even participants who did not show a strong natural bias to fixate the eyes nevertheless looked to the region when para-foveal information was unavailable, implying that the eyes are the source of para-foveal focus under unrestricted circumstances (Caldara, Zhou, & Miellet, 2010). Thus, covertly attending to the eyes to process both eye information and relational information (i.e. inter-ocular distance, distance from the nose, etc.) could be accomplished without looking directly at the feature, and could support holistic processing known to be important for subsequent recognition performance (Richler, Cheung, & Gauthier, 2011).

The aim of the current paper was to explore whether the eye advantage during face learning requires direct fixation, or if instead directing only covert attention to the eyes can elicit the same benefit. To accomplish this, we tested face recognition performance following a face viewing task where participants either avoided fixating the eyes or focused only covert attention on the region.

1.1. Studies overview

Experiment 1 aimed to determine whether simply avoiding looking - that is, restricting overt attention - to the eyes would result in a recognition detriment in keeping with that observed in other tasks in which the eyes were masked or not otherwise available (e.g., McKelvie, 1976). Participants were shown a series of unaltered faces and were given one of two viewing instructions, either Free Viewing, in which they were to look at the faces naturally, or Don't Look (DL), in which they were told to look naturally but to avoid looking at a particular feature. For half of the participants, they were asked to avoid looking at the eyes (DL: Eyes), whereas the other half of participants were asked to avoid looking at a control feature, the mouth (DL: Mouth). As the feature they were to avoid looking at was not removed or masked, covert attention was unrestricted and could conceivably be directed anywhere on the face. Participants were later given a recognition test in which they were tasked with reporting if the faces shown were new or previously seen in the first half of the experiment. If overt attention to the eyes is necessary for superior face learning, then the recognition of faces encoded during the DL: Eyes condition should be worse than for all other conditions, even when compared to the DL: Mouth group that was similarly restricted in their viewing patterns, but to a different feature. If, however, covert attention to the eyes can be effectively used to encode faces, then presumably, groups should not differ in their recognition performance. In addition, half of the participants were told of the upcoming recognition test prior to face encoding, while half were not. It was reasoned that while looking to the eyes may be beneficial, later successful face recognition may be possible using an alternative strategy involving attending to distinguishing features elsewhere on the face. As such, any proposed recognition detriment to avoiding the eyes during encoding may be limited to the condition in which participants are unaware of the task and thus cannot compensate in some other manner.

For Experiment 1, although covert attention was free to be directed anywhere on the face, even to features where the participant was restricted from looking, it is unclear where covert attention actually was directed. Would attention stay linked with oculomotor behaviour, or instead would participants try to attend peripherally to the features they were told to avoid? In order to more directly probe whether covert attention to the eyes would be sufficient to incur a face learning benefit, Experiment 2 asked participants to avoid making any fixations (i.e. maintain fixation on a central point) but to direct their covert attention to either the eyes or the mouth. In one block, they were told to covertly attend to the eyes, whereas in the other encoding block, they were told to covertly attend to the mouth. A recognition test like that used in Experiment 1 followed, once again with or without participants being informed of the test ahead of time. If covertly attending to the eyes incurs any advantage during face learning, then participants should perform better for faces in which they attended to the eyes as compared to faces that were presented when attention was to be directed to the