Dispatch

Gaze Perception: Is Seeing Influenced by Believing?

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Gaze perception has been thought to be stimulus-driven. This view is challenged by a new demonstration that a gaze direction aftereffect can be influenced by beliefs about the gazer's ability to see.

Stare for a while at a photograph of a face of someone whose eyes are gazing over your left shoulder. If, after having done this, you look at a photograph of someone whose eyes are actually directed towards your left ear, you are likely to mistakenly perceive this person to be looking straight at you. In other words, prolonged exposure to a face gazing in one direction will bias subsequent perception of gaze direction in the opposite direction —a complex example of a perceptual aftereffect [1–4]. In a paper in this issue of *Current Biology*, Teufel *et al.* [5] report that judgements of eye-gaze direction can be similarly influenced after repeated exposure to a person wearing mirrored goggles whose head was angled in a particular direction, *but only when participants believed that the gazer could see through the goggles*. The implication is that the perceptual coding of gaze direction can be influenced by the attribution of a mental state to the gazer.

The process by which perceptual aftereffects arise is known as adaptation and is thought to reflect changes in the responses of neural mechanisms that encode the visual property in question [6]. The classic example occurs when staring for a minute or two at a

waterfall — unchanging downward motion — results in the perceptual distortion of a subsequently viewed stationary object, which appears to be moving upwards. Similar effects occur with other relatively low-level perceptual properties such as colour, size and tilt [6]. More recently, however, researchers have observed that adaptation can occur with more complex stimuli such as faces [7–9].

Aftereffects are important because they tell us something about the mechanisms underlying perceptual experience. For example, the work on gaze adaptation [4] has suggested that gaze direction is likely to be signalled by the pooled output of separate cell populations each broadly tuned to a different gaze direction (for example, left, right and direct). Aftereffects that have been observed following adaptation to heads rotated at different angles have led to similar conclusions about the coding of head orientation [10].

The gaze and head adaptation studies marry reasonably well with earlier work by Perrett and colleagues [11,12], whose recordings of single cells in macaque brains identified separate populations of cells that were maximally responsive to different eye-gaze directions, different views of the head, and also for bodies adopting upright or bent-over postures. Their influential suggestion was that a neural mechanism functions to signal the direction of another individual's social attention by combining information from eye-gaze, head orientation and body posture. Teufel *et al.*'s [5] finding that adaptation transfers from head direction to the perception of eye-gaze direction seems to implicate this neural mechanism.

According to one view, this neural circuitry is hard-wired and functions to compute attention direction when provided with the appropriate input [13,14]. Indeed, given how readily a pair of white circles containing smaller black circles is perceived as a pair of eyes, it seems that the human brain computes gaze direction given something that only vaguely resembles the appropriate input. Furthermore, a reasonable assumption is that the system

operates in a bottom-up fashion, carrying out its operation in ignorance of its owner's knowledge, desires and expectations; believing that your beloved only has eyes for you won't stop you from noticing if these eyes are gazing longingly in the direction of an attractive rival.

Teufel *et al*.'s [5] finding, however, seems to challenge this notion. In their study, knowing that someone was unable to see through a pair of mirrored goggles seemed to prevent activation of the putative attention-detecting system, a system that is nevertheless activated by the same person, wearing the same goggles, when the belief is that they can see. At first glance (forgive the pun), this appears to be an example of high-level knowledge reaching back and affecting perception, and harks back to a long-standing debate about the extent to which visual perception is continuous with cognition [15].

What kind of knowledge might be doing the work here? Teufel *et al.* [5] explain their finding in terms of participants attributing a mental state to the gazer. However, things might not be as straightforward. Perhaps the relevant content of participants' beliefs is that the other person's perceptual machinery is, or is not, functioning properly. In this case, they are not necessarily attributing a mental state to the gazer; their belief isn't really about whether or not the gazer is actually experiencing whatever it is they are attending to. Things are further complicated by the fact that participants were fooled into thinking that the gazer — the person whose be-goggled face they could see on their computer monitors — was actually sitting in a nearby room and enjoying a kind of video-mediated interaction with them. Does the perceived engagement in a social interaction facilitate the attribution of mental states to the gazer?

An interesting question, then, is whether or not the cleverly designed deception was actually necessary. Would the same modulation of the adaptation effect be observed if participants knew they were watching pre-recorded video clips? This is an important question, because much of the recent experimental work conducted on gaze perception and social

attention uses photographs of faces or short movie clips. Furthermore, in much of this work, these faces are isolated from any surrounding context, arguably making it even harder for observers to attribute mental content to the gazer (they aren't really looking at anything!). If profoundly different effects emerge when participants view real-life people situated in social contexts, then there is a case for complementing lab-based research with studies where people are observed under real-world conditions [16].

If mental state attributions really do influence the perception of gaze and social attention direction in real-world social interactions, this might potentially explain away at least one rather awkward implication of some experimental findings in this area. Many studies have shown that another person's gaze or head orientation triggers a rapid, reflexive shift in a viewer's visual attention in the direction of the gaze or head turn [17], and that this behaviour involves the same brain areas identified by single cell recordings [18]. These gaze-cued attention shifts may well serve as a useful early warning if the person with whom you are interacting has spotted something threatening or of interest in the immediate environment (such as that love-rival again), but it is hard to believe that *every* shift in another's gaze inevitably triggers this response. It can only be distracting, for example, to follow an averted gaze made while someone is thinking, or attempting to hold the conversational floor, when in neither case might the gazer actually be looking at anything that is worthy of your attention. However, if changes in moment-to-moment context — including the intentions we attribute to another's behaviour — can influence the way that their attention direction is encoded, then this may well prevent these types of gazes from triggering inappropriate attention shifts on the part of a viewer.

Perhaps some caution is warranted, however, before we leap to the conclusion that our beliefs about what people are thinking influence how we perceive where they are attending.

One possibility is that Teufel *et al.*'s [5] result reflects the operation of mental imagery, rather than mental state attributions. Participants in Teufel *et al.*'s [5] experiments were asked to think about whether or not the person whose face was viewed in the adaptation trials could see. One possibility is that this instruction encouraged participants to form a mental image of the person's eyes. To the extent that mental imagery shares some processes with visual perception [19,20], the small adaptation effects they observed in this condition may then have been produced by *imagined* eye-gaze stimuli adapting gaze-specific neurons, just as real eyes did in the earlier gaze adaptation studies.

Whatever the precise explanation of their results, Teufel *et al.*'s [5] study may encourage similarly innovative researchers to seek new ways of studying how people perceive and react to social attention cues in situations that more closely resemble those we encounter in everyday life.

References

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