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A Bayesian approach to person perception

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ABSTRACT

Here we propose a Bayesian approach to person perception, outlining the theoretical position and a methodological framework for testing the predictions experimentally. We use the term person perception to refer not only to the perception of others' personal attributes such as age and sex but also to the perception of social signals such as direction of gaze and emotional expression. The Bayesian approach provides a formal description of the way in which our perception combines current sensory evidence with prior expectations about the structure of the environment. Such expectations can lead to unconscious biases in our perception that are particularly evident when sensory evidence is uncertain. We illustrate the ideas with reference to our recent studies on gaze perception which show that people have a bias to perceive the gaze of others as directed towards themselves. We also describe a potential application to the study of the perception of a person's sex, in which a bias towards perceiving males is typically observed.

1. Introduction

When we look at another person what do we expect to see? And what role do those expectations play in the processing of our sensory input and in determining what we perceive? When we look at a body or a face we have a clear expectation of its basic structure in terms of the constituent elements and their configuration (Fig. 1). There are also well-documented asymmetries or biases in the perception of attributes such as sex and age indicating a role for prior expectation at a perceptual and/or cognitive level. For example, when presented with an image of a face, there is a bias to respond 'male' when asked about that person's sex (e.g. Armann & Bülthoff, 2012) and to judge their age as closer to your own (e.g. Voelkle, Ebner, Lindenberger, & Riediger, 2012). However, there is currently no adequate theoretical framework within which to interpret these effects or to generate new testable predictions. This leaves the field with no clear idea about how perceptual and decision processes are dissociated and therefore at what level prior expectations are operating and biases generated. Specifically, are these *perceptual* biases in the processing of sensory information that actually affect the way things look to the observer or are they *cognitive* response biases in the decision criteria used to categorize that sensory information? This is an important question because such biases may have a large impact on how we interact with people in a range of consequential settings.

To establish the level at which prior expectations are implemented in the system, we propose a Bayesian framework for the study of person perception. We do not intend the term "person perception" to be taken to refer to the perception of

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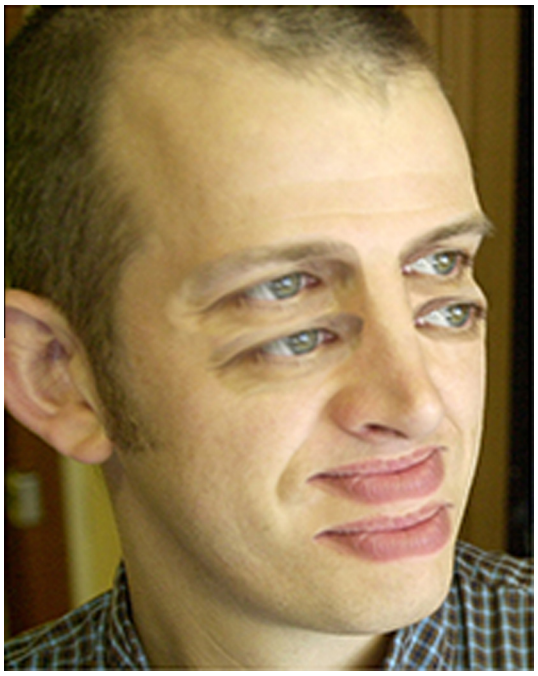

Fig. 1. The dissonance we experience while looking at this image indicates that we have strong expectations about the basic structural properties of a face that cannot help but influence our perception (see Hancock & Foster, 2012).

identity, although we speculate that the Bayesian framework may also be of relevance to identity recognition in the sense that information about the context in which a person is encountered provides prior expectation as to who they are. The Bayesian framework provides a principled approach to understanding person perception using a method that has proven successful in designing and interpreting psychophysical experiments in the sensory and motor domains (see Kersten, Mamassian, & Yuille, 2004; Knill & Pouget, 2004; Trommershäuser, Körding, & Landy, 2011).

A Bayesian estimator combines sensory evidence with stored knowledge, represented as the prior probability distribution. The prior probability distribution can embody not only expectations about the structure of the environment (e.g. Girshick, Landy, & Simoncelli, 2011; Stocker & Simoncelli, 2006a) but also the likely consequences of errors for the observer (Haselton & Buss, 2000; Haselton & Nettle, 2006). For example, we expect the structure of a face to be two eyes above a noise and a mouth (and can feel quite disconcerted when that expectation is violated, as in Fig. 1). In terms of errors, the consequence of misidentifying a man as a woman might be more costly than misidentifying a woman as a man. Similarly, in the context of gaze perception, the cost of missing an instance of gaze directed at you might be greater than the cost of a false alarm when gaze is in fact directed elsewhere.

The Bayesian approach has proved influential in understanding the role of prior expectation in vision. For example, experimental evidence indicates that humans have a prior expectation for motion to be slow (Stocker & Simoncelli, 2006a), contours to be horizontal or vertical (Girshick et al., 2011) and lighting to come from above and slightly to the left (Gerardin, Kourtzi, & Mamassian, 2010). A Bayesian framework has also been proposed in the context of social cognition and its disorders in conditions such as autism and schizophrenia (Fletcher & Frith, 2009; Hohwy & Palmer, 2014; Kilner, Friston, & Frith, 2007). In a recent paper, we applied the Bayesian approach for the first time to the processing of a socially relevant perceptual feature, namely the direction of another's gaze (Mareschal, Calder, & Clifford, 2013b). This has provided an important insight into gaze perception, namely that humans have an expectation that gaze is directed towards them that acts to "pull" the perceived direction of gaze towards the observer, particularly under conditions of high stimulus uncertainty (see also Mareschal, Otsuka, & Clifford, 2014; Martin & Jones, 1982; Martin & Rovira, 1981; Sheldrake, 2003). We believe that this approach will prove readily extendable to the investigation of how our visual systems deal with the task of extracting socially relevant information from often uncertain, incomplete or ambiguous visual input to the perception of personal attributes from images of the face and body.

2. Bias in the perception of a person's sex

As an illustration of the potential applicability of the Bayesian approach, consider the perception of a person's sex. There is a well-established bias to respond 'male' when asked to report a person's sex from an image of their face (e.g. Armann &

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