

available at www.sciencedirect.comwww.elsevier.com/locate/brainres**BRAIN
RESEARCH****Research Report****How we predict what other people are going to do****Chris D. Frith^{a,*}, Uta Frith^b**^aWellcome Department of Imaging Neuroscience, UCL Institute of Neurology, 12 Queen Square, London WC1N 3BG, UK^bUCL Institute of Cognitive Neuroscience, 17 Queen Square London WC1N 3AR, UK

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ABSTRACT

We present a framework for discussing two major aspects of social cognition: the ability to predict what another person is like and what another person is likely to do next. In the first part of this review, we discuss studies that concern knowledge of others as members of a group and as individuals with habitual dispositions. These include studies of group stereotypes and of individual reputation, derived either from experience in reciprocal social interactions such as economic games or from indirect observation and cultural information. In the second part of the review, we focus on processes that underlie our knowledge about actions, intentions, feelings and beliefs. We discuss studies on the ability to predict the course of motor actions and of the intentions behind actions. We also consider studies of contagion and sharing of feelings. Lastly, we discuss studies of spatial and mental perspective taking and the importance of the perception of communicative intent. In the final section of this review, we suggest that the distinction between top-down and bottom-up processes, originally applied to non-social cognitive functions, is highly relevant to social processes. While social stimuli automatically elicit responses via bottom-up processes, responses to the same stimuli can be modulated by explicit instructions via top-down processes. In this way, they provide an escape from the tyranny of strong emotions that are readily aroused in social interactions.

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1. Introduction

A principal function of the various processes that are involved in social cognition is to enable us to predict what other people are going to do. In this essay, we will present a framework for discussing the different components of this aspect of social cognition and explore their neural underpinnings. The neural substrates we will mainly focus on are well-accepted components of the social brain, such as the medial prefrontal cortex (MPFC), the superior temporal sulcus (STS), orbitofrontal cortex (OFC), the amygdala and the anterior insula (Adolphs, 1999; Brothers, 1990). All these regions are activated when we try to understand other people.

Because we have not been impressed by the consistency of the pattern of activations obtained in different studies, we will not attempt to delineate in detail the anatomy of social cognition. However, when reviewing neuroimaging studies, which indicate differential activations, we will refer to brain regions in terms of Talairach coordinates. We believe that the coordinates can prevent confusion that is often introduced by using different labels to refer to similar brain regions.

The simple framework that we will use distinguishes two kinds of knowledge on which our predictions of other people's behaviour are based: knowing who people are and knowing what people do. Each of these categories spans many different

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domains that rely on a range of neural mechanisms and brain regions.

Cutting across these categories is the distinction between top-down and bottom-up processes, which can be loosely mapped onto explicit and implicit knowledge. This distinction emerged from the study of processes that evolved for making predictions about the physical world. We believe that it is also useful for making predictions about the social world.

1.1. The structure of this review

Our review is divided into three parts. The first part deals with knowledge about people; within the broad category of knowledge of people, we will discuss two subcategories, one to do with group stereotypes, the other with individual dispositions. Here, we focus on one major aspect of this knowledge, namely, reputation. Knowledge about people is relatively enduring.

The second part deals with knowledge about what people do, feel or believe. This section is accordingly divided into a number of subheadings: prediction of actions and intentions, contagion and sharing feelings and, lastly, prediction from belief and knowledge. This last section reviews studies on spatial perspective taking, mental perspective taking and communicative intent. Knowledge of what people do, feel and believe can be computed on the fly and is constantly updated.

In the third part of the review, we will consider the effects of top-down and bottom-up processes on our predictions of what people are going to do. In our conclusions, we comment on the interplay and sometimes conflict between the different types of knowledge and on the success and failure of our ability to predict the behaviour of other people.

2. Knowledge of other people

2.1. Knowledge of other people as members of groups

Individuals may be experienced as members of a group, and this enables prediction of their behaviour in terms of stereotypes when we know nothing about them as individuals. The two major types of stereotypes studied to date are race and gender. Group stereotypes can be remarkably effective predictors of behaviour, even though they are very rough and often incorrect. For instance, to boost sales, retailers offer different lists of presents to choose for men and for women. This is despite the fact that some women like to have toolkits for presents and some men would like to have baking trays. Here, we are simply categorising the person as a member of a group.

Race prejudice has been studied in a number of imaging paradigms, and amygdala activation has been consistently shown as a sign of fear that is elicited unconsciously by viewing a face from another race. When white Americans were shown the faces of unknown black Americans, activity was elicited in the amygdala (Phelps et al., 2000). The magnitude of the activity in the amygdala correlated with implicit measures of race prejudice. In this experiment, the amygdala is responding to black faces in the same way as it

responds to any object that has acquired a conditioned fear response (Buchel et al., 1998).

Extensive research with animals has shown that the amygdala is part of a system that learns to associate value with stimuli (Dolan, 2002) whether or not these stimuli are social (LeDoux, 2000). This system operates on both positive and negative values. For example, the amygdala responds to objects that elicit fear because of their association with punishment (negative value), but the amygdala also responds to objects associated with food and sex (positive value). The involvement of this system in social cognition arises because social prejudices are fundamentally about how much we value other groups of people, but there is nothing specifically social about this system.

Amygdala damage does not remove race prejudice (Phelps et al., 2003), and amygdala response magnitude does not correlate with explicit measures of race prejudice. Our consciously held attitudes about race are often at variance with our implicit prejudices, and there is evidence that we try to suppress these rapid automatic responses. The amygdala response to black faces was reduced when the faces were presented for 525 ms rather than 30 ms, and, associated with this reduction, there was increased activity in areas of frontal cortex concerned with control and regulation (Cunningham et al., 2004). Amodio et al. (2004a) had subjects perform a task, which purported to measure their race bias while measuring EEG. ‘Errors’ in performance (i.e. race-biased responses) elicited larger error-related negativity waves (ERNs). In both these studies, the brain system implicated in the control of race bias is one generally concerned with the top-down regulation and control of action. Likewise, Wheeler and Fiske (2005) discuss attention to particular social goals as a means to modify prejudice.

Of course, there is more to prejudice than fear. Fiske et al. (2002) demonstrated that the perception of out-group could evoke distinctly different feelings of envy, pity, admiration and contempt. Trust is another emotion that plays a vital role in interaction with people even when we do not know them individually. There is quite good agreement about what untrustworthy people look like, even though this has nothing to do with reality. Amygdala damage impairs the ability to rate trustworthiness (Adolphs et al., 1998). In healthy volunteers, presentation of the faces of unknown people rated as untrustworthy elicits activity in the amygdala and the insula. Activity in these areas is seen even when subjects are not required to rate the trustworthiness of the faces explicitly. Activity in posterior STS, in contrast, is only observed when subjects make explicit trustworthiness judgements (Winston et al., 2002).

The neural systems that support gender stereotypes have been studied less frequently. However, a study by Milne and Grafman (2001) showed that patients with ventromedial lesions did not show the typical effect that is obtained in the well-known implicit association task (Greenwald et al., 1998), here involving female and male names and adjectives denoting strength and weakness. These patients therefore seemed to lack access to the implicit knowledge of gender stereotypes, which appears to be dependent on intact ventromedial cortex functioning. However, they still showed explicit knowledge of gender stereotype.

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