Cognition 117 (2010) 203–216

Contents lists available at ScienceDirect

Cognition

journal homepage: www.elsevier.com/locate/COGNIT

Distinguishing intentions from desires: Contributions of the frontal and parietal lobes

Claudia Chiavarino [a,b,*], Ian A. Apperly [b], Glyn W. Humphreys [b]

[a] Center for Cognitive Science, University of Turin, Italy
[b] Behavioural Brain Sciences Centre, University of Birmingham, UK

ARTICLE INFO

Article history:
Received 18 May 2009
Revised 30 June 2010
Accepted 11 August 2010

Keywords:
Brain damage
Action understanding
Mental states
Temporo-parietal junction
Social cognitive neuroscience

ABSTRACT

The ability to represent desires and intentions as two distinct mental states was investigated in patients with parietal ($N = 8$) and frontal ($N = 6$) lesions and in age-matched controls ($N = 7$). A task was used where the satisfaction of the desire and the fulfilment of the intention did not co-vary and were manipulated in a 2×2 set. In two experiments we show that lesions to the frontal lobe may impair the ability to deal with desires when their outcome is not congruent with that of the intention, and that parietal damage – especially if it encompasses the left temporo-parietal junction – may cause severe difficulties in the processing of both desires and intentions. The implications of the results for the neuropsychological and the developmental literature are discussed.

1. Introduction

The ability to reason in terms of desires and intentions and to discriminate between these two mental states is crucial in order to interpret and to predict human behaviour. The visible outcomes of desires and intentions often overlap, since agents tend to engage in intentional actions in order to accomplish specific desires (e.g., it is the desire to eat Chinese food that drives me to my local Chinese takeaway), and usually either the intention and the desire are both fulfilled (e.g., I go to the takeaway and get Chinese food), or they are both frustrated (e.g., I am unable to reach the takeaway and I do not get the Chinese food). However, both practically and conceptually, desires and intentions are rather distinct. In fact, it is possible for the intention to be fulfilled even though the desire is unsatisfied (e.g., I get to the takeaway and find out it is closed), as well as for the desire to be satisfied albeit the intention is unfulfilled (e.g., I am unable to reach the takeaway but I meet a friend who was just bringing me Chinese food). Hence intentions and desires may be separate in the cognitive mechanisms that implement them, but they may run together to determine behaviour.

A full understanding of intentions requires the ability to distinguish them from desires, when observing a given behaviour. Whereas the developmental literature has fully acknowledged distinctions in the development of the ability of using desires and intentions, our understanding of the relations between desires and intentions in adults is far from complete. This is potentially important because it means that most of the current literature on the processing of intentions in adults may in fact fall short of demonstrating a necessary role for intentions, and may instead reflect the operation of desire. It follows that conclusions about the functional and neural basis of understanding intentions must be viewed with considerable caution. The present study explores for the first time the functional and anatomical structure of the processing of desire and intention in adults, by testing patients with acquired brain damage to the frontal and the parietal lobes in a task designed to tease apart desire and intention attribution within the same action.

* Corresponding author at: Center for Cognitive Science, Department of Psychology, University of Turin, Via Po 14, 10123 Turin, Italy. Tel.: +39 011 6703068; fax: +39 011 8146231.
E-mail address: claudia.chiavarino@unito.it (C. Chiavarino).

0010-0277/$ - see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.cognition.2010.08.012

1.1. Intention processing in adults

Malle and Knobe (1997, 2001) contend that, whilst desire and intention share some important features (e.g., they both express a pro attitude toward a represented state of affairs in the world), adults quite easily distinguish between them by using three criteria: the type of content of the pro attitude (with desires potentially having any type of content and intentions always representing an action content), the role that the attitude plays in the agent's reasoning (typically, desires stand at the very beginning of the process while intentions are at the output), and the agent's degree of commitment to a particular course of action.

As for the mechanisms responsible for this type of processing, a key suggestion comes from the work of Povinelli and colleagues. They proposed that intention understanding relies on two functionally and anatomically distinct systems. One system is shared with non-human primates and involves the detection of the structural regularities associated with intentional behaviour, whereas the other system is specific to humans and entails an individual mentally representing and reflecting on intentions and other mental states (Povinelli, 2001; Povinelli & Preuss, 1995). If this is the case, it should be this higher-level system that distinguishes intentions from desires.

There is increasing evidence that a universally shared and relatively encapsulated mechanism might subserve humans' ability to discern intentions from visual motion information and to discriminate between intentional and unintentional actions (Barrett, Todd, Miller, & Blythe, 2005; Blakemore & Decety, 2001; Malle & Knobe, 1997). The neural underpinnings of this basic intention reading skill appear to be located within the parietal and the frontal lobes. In particular, the left intraparietal cortex has been involved in the perception of biological motion (Battelli, Cavanagh, & Thornton, 2003; Grèzes et al., 2001), in the comprehension of pantomimes (Hermsdörfer, Terlinden, Mühlau, Goldenberg, & Wohlschläger, 2007; Moll et al., 2000) and in the observation of goal-directed actions (Buccino et al., 2001; Hamilton & Grafton, 2006). Within the frontal lobes, increased activity in the ventral premotor cortex has been linked to the processing of both transitive and intransitive actions (Buccino et al., 2001; Lui et al., 2008) and to the interpretation of action based on contextual cues (Iacoboni et al., 2005).

This relatively low-level system certainly makes it possible to recognize, within the behavioural stream, the spatio-temporal regularities that characterize intentional action. However, it is unlikely to be sufficient to process the semantic and logical attributes of the unobservable mental states that drive those same actions, because this operation requires a conceptual representation of their motivational, causal and epistemic components (Moses, 2001). The existing imaging and neuropsychological evidence shows that the frontal and the parietal lobes play an important role also in higher level mental state processing. In particular, the prefrontal cortex and the temporo-parietal junction have been implicated in belief reasoning (Apperly, Samson, Chiavarino, & Humphreys, 2004; Grèzes, Frith, & Passingham, 2004), in the discrimination between pretend and real actions (Chiavarino, Apperly, & Humphreys, 2009; German, Niehaus, Roarty, Giesbrecht, & Miller, 2004), and in the high-level representation of behaviour (Sirigu et al., 1996; Zalla, Pradat-Diehl, & Sirigu, 2003).

On the bases of these findings, a recent review by Van Overwalle and Baetens (2009) proposed that humans rely on two largely independent systems in their understanding of behaviour: the mirror system, encompassing the anterior intraparietal sulcus and the premotor cortex, is concerned with the processing of temporary goals and intentions at a perceptual level of representation, while the mentalizing system, including the temporo-parietal junction and the medial prefrontal cortex, is dedicated to the understanding of norms and intentionality at a more abstract level. Thus, there is a growing consensus among researchers from different perspectives suggesting that the same observed behaviour might be processed at different levels of complexity by distinct functional processes and differentiable neural networks within the frontal and parietal lobes (Keysers & Gazzola, 2007; Pacherie, 2000). However, there have been few attempts to contrast these levels and to specify the role of distinct frontal and parietal circuits within the same task. In one such case, De Lange and co-workers found higher activation in the inferior frontal gyrus in response to the observation of unusual intentions (e.g., a woman bringing a cup to her ear); however, if subjects were explicitly instructed to pay attention to the intention (vs. to the means) of the action, increased brain activity was detected in a wider network encompassing frontal as well as posterior areas (De Lange, Spronk, Willems, Toni, & Bekkering, 2008).

1.2. Distinguishing intentions from desires

Research on adults has rarely been concerned with the distinction between intentions and desires, and in those instances it mostly aimed at describing, from the perspective of folk psychology, the criteria we use to differentiate these two mental states (Malle & Knobe, 1997, 2001). Developmental studies, in contrast, have been very sensitive to this issue and have equally investigated the mechanisms responsible for young children's interpretation of behaviour in terms of desires and intentions, and the later processes that grant them the capacity to distinguish these two concepts. The present work conceptually and methodologically draws from this literature, which we will therefore briefly review.

Goal attribution appears very early in infancy. Three-month-old infants already show some degree of sensitivity to the inter-relatedness of movement patterns, as revealed by their ability to discriminate between random and social (e.g., chase) two-figure dynamic displays (Rochat, Morgan, & Carpenter, 1997) and by the time they are a year old, infants can interpret identical behaviours as goal-directed or not depending on the causal context (Phillips & Wellman, 2005), draw inferences on the presence of states of affairs (e.g., goals or obstacles) that they have not actually seen (Csibra, Biro, Koos, & Gergely, 2003), and understand the relation between an actor and the object of his gaze, therefore going beyond manual actions (Woodward, 2003). As for desire understanding, Repacholi and Gopnik (1997) reported that 18-month-old infants (but not 14-month-olds),