SPECIAL ISSUE: POSITION PAPER

WHAT RE-ENACTMENT EARNS US

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Abstract

Evidence from both behavioural and brain studies suggests that perception of actions and their outcomes may induce (overt or covert) production of related actions in perceivers. Three views of the proper function of such re-enactment have been suggested: imitation, identification, and anticipation. Here I propose that the proper function of re-enactment is to subserve anticipation of upcoming action. Re-enactment exploits the motor system's inbuilt capacity to anticipate the consequences of action and extends it from the planning of own action to the perception of foreign action.

Key words: re-enactment, mirror neurons, action anticipation, imitation, action understanding

Introduction

For the longest time, philosophers and psychologists have been claiming that people who observe other people's actions are prone to simulate those actions in a more or less rudimentary form – at least in their minds, but sometimes even with their bodies (e.g., Carpenter, 1874/1984; Chevreul, 1833; Goldman, 2002; James, 1890; Liberman et al., 1967; Smith, 1759/1976; Ueberwasser, 1787). In order to avoid confusions with broader uses of the concept of simulation in cognitive theorizing (e.g., Grush, 2003; Hesslow, 2002; Wolpert and Flanagan, 2001; Wolpert and Kawato, 1998) I will here use the term of re-enactment to address the specific notion that the perception of certain actions and their outcomes (performed by others) may induce the production of related actions (performed by the perceiver herself).

Whereas much of the classical literature is based on anecdotal evidence the notion of re-enactment has recently gained more systematic support from behavioural and neurophysiological studies. For instance, behavioural studies of action induction have provided insight into basic functional principles underlying overt re-enactment (Knuf et al., 2001; De Maeght and Prinz, 2004; Prinz et al., 2005; Prinz, 1987). Likewise, neurophysiological studies have identified populations of neurons at various brain sites that exhibit mirror-like properties. These neurons are involved in both, perceiving certain actions in others and performing those actions oneself (for overviews, see Gallese et al., 2002; Rizzolatti et al., 2001; Rizzolatti, 2004).

What For?

The question I wish to address here is what re-enactment is good for. If observing certain actions indeed goes along with (covertly or overtly) re-enacting them – what does such re-enacting earn the observer? I will briefly discuss the merits of three answers that have been proposed: imitation, identification, and anticipation.

Imitation

At first glance it may appear to be plausible that mirror systems should be built into animals' brains and minds for the sake of imitation: If parts of the neural structures in charge of the perception of others' actions coincide with structures in charge of the production of those actions, then imitation of other individuals' actions may come for free just as a by-product of perceiving them. This idea was initially promoted by some researchers after the first discoveries on mirror neurons had been made. Yet, attractive as it appeared at first glance, it was soon abandoned for two major reasons. First, as Rizzolatti et al. (2001) had pointed out from the beginning, monkeys don't ape. Though they do dispose of a rich mirror system in their premotor cortex, they do not imitate – suggesting that the mirror system must be good for something else. Second, mirror activity and re-enactment appear to be mandatory consequences of action perception, whereas imitation – whenever it occurs in humans (and other primates) – is extremely context-bound. True, humans and primates are capable of imitating certain actions they observe – but they certainly don't do it all day long as one would have to expect if imitation were to follow from mirror-neuron activity. In fact, if they did so, they would have to count as endangered species. Their fitness will be much more dependent on their ability to respond to foreign action through own complementary action than through own imitation.

In sum, it is not likely that the architecture for re-enactment has been built into our brains and minds for the sake of imitation – of course, this does not preclude that re-enactment may subserve imitation whenever it occurs.

Identification

The second suggestion is that re-enactment subserves the perceptual identification of action. For instance, Rizzolatti et al. (2001) hold "… that we understand actions when we map the visual representation of the observed action onto our motor representation of the same action. An action is understood when its observation causes the motor system of the observer to 'resonate'" (p. 661). Intuitively appealing as these statements may appear, it is not overly clear what they actually imply. There are two questions here. First: What does it mean to understand an action? Understanding an action will usually entail more than mere identification of the spatio-temporal pattern of its underlying body movements. To understand an action is more than that; it goes beyond the physics of the movements and captures the semantics of the act in terms of meaning, goal, and/or underlying intentions. This is what mirror neurons actually seem to do: They respond to classes of actions that share a common goal (like, e.g., grasping an object), but differ in physical details of the movements involved– suggesting that, for these neurons, the semantics of actions is more relevant than the physics of the underlying movements. Second: How could re-enactment subserve action understanding? Here, I believe we encounter a logical problem that cannot easily be overcome. The problem is how the appropriate re-enactment gets selected. Choosing an appropriate re-enactment for a given action will always require that the action be identified in the first place. In other words, the identification of both, the action's physical and semantic features needs to be completed before the appropriate re-enactment can be run. Running the appropriate re-enactment can only be a later addition to the action's preceding identification. It will certainly add new information to the resulting representation of that action, but it cannot contribute to its initial identification.

In principle, the same argument holds if one assumes that re-enactment is involved earlier on, i.e. at processing stages that precede full identification. For instance, if one thinks of re-enactment occurring at the level of automatic priming of candidates for later identification, it is still true that such re-enactment is completely dependent on visual coding: At this level, too, the principle holds that you can only re-enact what you have visually identified in the first place. Therefore, I do not see how the claim that re-enactment subserves action identification and understanding can be maintained – at least not if understanding an action is strictly taken to refer to assessing the identity of ongoing action (see below).

Anticipation

If this is true, re-enactment does not subserve the process of identification, but it does enrich its outcome. The third answer believes that this enrichment, though it may be redundant with respect to assessing the identity of ongoing action, does play an important role for anticipating the further course of that action. In other words, re-enactment does not so much help the perceiver to understand what the other is already doing, but rather to anticipate what s/he is going to do next. Related views have recently been advanced by, for example, Chaminade et al. (2001), Grush (2003), Schubotz and von Cramon (2001, 2002), Verfaillie and Daems (2002), and Wilson (2001, 2005). To be sure, the claim is not that action anticipation requires re-enactment on any logical ground. In principle, such extrapolations could also be computed by those representational systems that identify the action in the first place and code for its physical and semantic features. However, there is a crucial advantage of leaving the job of anticipation to the motor system. Motor systems are engineered as anticipation devices (c.f., e.g., Desmurget and Grafton, 2000; Wolpert and Flanagan, 2001; Jordan and Wolpert, 1999). The efficiency of action planning and control is critically dependent on the system's capability of predicting the sensory consequences of planned movements (forward models). Hence, motor systems are engineered for anticipating the consequences of the movements they plan for their own body. Thus, when they become engaged in action perception, that capacity is applied and extended to movements perceived in other bodies.

According to this view, re-enactment exploits the motor system's anticipatory potential for the prediction of upcoming action. The proper function of re-enactment is not to identify what is going on (let alone imitate it), but to *anticipate what comes next.*

Concluding Remark

For social animals like we are, the capacity to anticipate what our conspecifics are going to do is, of course, of crucial importance in terms of survival and fitness. In a way, one could perhaps argue that anticipating what others are doing next is an essential constituent of understanding what they are doing now. The proof of really understanding what is going on now will often be in knowing what comes next. For instance, when a predator hunts for a prey, there is no real dividing line between understanding what the prey is doing in this moment and anticipating what it is going to do next. Rather, the perception of the oncoming action seems to imply the anticipation of upcoming action. Thus, if we broaden our notion of what it means to understand an action to encompass both, identification of ongoing and anticipation of upcoming action, then our specific proposal (i.e., re-enactment subserves anticipation) is even compatible with Rizzolatti's (2004; Rizzolatti et al., 2001) general claim that re-enactment subserves action understanding. Understanding requires knowing what comes next – and this is what re-enactment earns us.

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