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  Where my Actions meet Your Actions: Mirror neurons, perspective and interaction

Mirror neurons are a set of neurons, first described in the monkey premotor area F5, that respond both when the monkey performs an active goal-directed motor act and when he observes the same motor act performed by others. The most accepted interpretation of the function of mirror neurons is that they are involved in action understanding. However it remains largely unclear how exactly mirror neurons map observed actions onto the motor repertoire of the observer. This mapping bridges the gap between primarily visual and motor representations and forms the core of action understanding. Furthermore, it is not clear if mirror neurons have a broader cognitive role than action understanding and imitation as hypothesised so far. In a series of experiments we tried to understand the mechanism of the abstraction of mirror neurons with respect to the observed action. By means of filmed action we investigated the degree of generalization of mirror neurons to actions as observed by different point of view. We found that mirror neurons differentiate between actions observed by a subjective perspective and from a third person perspective. The encoding of the observed action showed a preference for the subjective point of view and, mostly, in a view dependent fashion. In another study we tested the involvement of mirror neurons in the distinctions of actions depending on the possibility of interaction between observer and actor. We found that about half of the tested mirror neurons recorded in area F5 of two monkeys are differentially modulated by the location in space, relative to the monkey, of the observed motor acts, either preferring the monkey s peripersonal or extrapersonal space. A part of these spatially selective mirror neurons encode space according to a metric representation, whereas other neurons encode space in operational terms, changing their properties according to the possibility of the monkey to interact with the object. Finally we tested if the benefit for the monkey associated with an action (rewarded or non-rewarded) modulates the activity of mirror neurons. We found that more than half of the tested mirror neurons are modulated by the presence or absence of a reward associated with the observed action. Taken together, these results propose new insights into the origin and function of the mirror neurons. At the same time these results suggest a novel and broader role for mirror neurons as a system that analyzes the observed action in terms of features that are relevant to generating appropriate behaviours.

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