MIRROR NEURONS

Towards a clearer image

CORBIS

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Mirror neurons were identified in monkeys as neurons that fire both when the monkey performs a particular action and when it sees that action being performed. Do humans also have mirror neurons? Imaging experiments have shown that select areas in the human brain, including in the inferior parietal lobe, the superior temporal sulcus and the inferior frontal gyrus, become active in response to both observing an action and performing it. However, it is unknown whether this reflects true mirror properties of individual neurons, or whether in these brain areas one population of neurons responds to observed movements and another to executed movements.

Two recent studies have addressed this issue using different functional MRI (fMRI) approaches, with different results. In both studies participants were scanned while they performed a number of hand movements and then watched either the same or different hand movements on a screen.

Chong *et al.* made use of the phenomenon of fMRI adaptation, which reflects the decrease in a neuronal population's response to a stimulus upon repeated exposure to that stimulus. The authors set out to determine whether such adaptation occurs in responses to the observation of an action that had recently been executed. Using 60 different hand movements as stimuli, they found that an area in the inferior parietal lobe, the right supramarginal gyrus, showed such fMRI adaptation. This suggests that neuronal populations in this region are selective for particular hand movements regardless of whether they are executed or observed, and thus that the right supramarginal gyrus might contain mirror neurons.

In a second study, Dinstein *et al.* focused on a nearby region of the parietal lobe, the anterior intraparietal sulcus (aIPS). As had been previously shown, the overall fMRI response in the aIPS to the observation of a particular hand movement did not differ from the response to the execution of that movement. However, a pattern-classification analysis revealed that observing and performing a movement resulted in distinct voxel-by-voxel patterns of activity in the aIPS, suggesting that the majority of responding neurons were not mirror neurons, but rather two discrete subpopulations of visual and motor neurons. This indicates that possible mirror neurons in the human aIPS form a minority of the neurons that respond during movement execution and observation, or that they exhibit a 'promiscuous' nature so as to generate different activity patterns during observation and execution of the same movement.

These two studies might seem to reach opposing conclusions and thus do not resolve the question of whether humans, like monkeys, have mirror neurons in the parietal lobe. However, there are several differences between the studies that have to be taken into account, including the precise cortical location of the reported effects and the use of quite different methodologies with different underlying assumptions.

Much has been speculated about the possible significance of a human mirror system, and it has been proposed that abnormalities in the system might be involved in various disorders, including autism. However, these two studies show that more research is needed to establish with certainty whether the human brain indeed contains cells with these remarkable characteristics.

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ORIGINAL RESEARCH PAPERS
Chong, T. T.–J. *et al.* fMRI adaptation reveals mirror neurons in human inferior parietal cortex. *Curr. Biol.* **18**, 1576–1580 (2008) | Dinstein, I. *et al.* Executed and observed movements have different distributed representations in human aIPS. *J. Neurosci.* **28**, 11231–11239 (2008)