Mirror neurons

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Just over 20 years ago, an Italian team reported findings on macaques showing the existence of a "surprising new class" of neurons in a particular region of the premotor cortex of the macaque brain (1). These neurons were active not only when the macaque performed an action—like grabbing an object—but also when the macaque watched the same action being performed by a person or another monkey. The researchers named these neurons "mirror neurons" and proposed that they provide the basis for what became known as "action understanding" in macaques, allowing them to interpret the intentions or goals of the person or monkey whose actions they are observing.

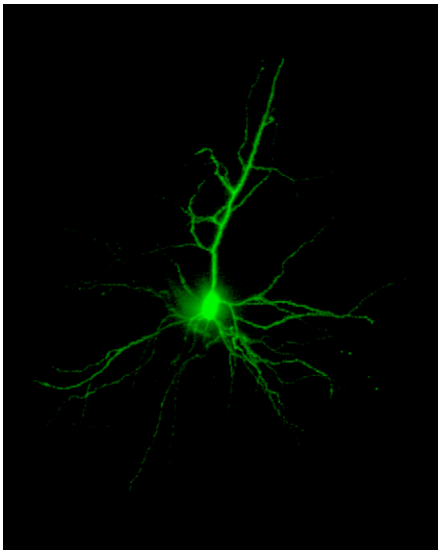
The findings launched a new field of study within neuroscience. Researchers were quick to look for mirror neurons in humans. The direct, invasive methods used to observe them in macaques cannot be used for studying the human brain, but other evidence supports their existence. "Although the function of mirror neurons is highly debatable, I would be very surprised if something like mirror neurons didn't exist in humans," says Greg Hickok of the University of California, Irvine. Indeed, researchers have since published papers arguing that mirror-like systems in humans underlie experiences from speech to emotions to pain to music (2–5). For example, the same brain regions that fired when people smelled something disgusting also were active when people saw someone else making a disgusted face (3). The implication of this system is that, cognitively speaking, we are putting ourselves in another's shoes as we observe an action.

The only other animal besides macaques and humans where mirror neurons have been found is in songbirds, says Vittorio Gallese of the University of Parma, Italy, one of the authors of the paper that first reported the neurons' existence (1), but he believes it is only for lack of looking.

Although there may be little doubt that these neurons exist, researchers differ considerably in their interpretation of what they do (6). Some say that the neurons are necessary to understand the meaning of others' behaviors. Others believe that they instead play a more straightforward role, helping us to learn motor tasks or to choose our own actions, or that we use mirror neurons to help predict the actions we are observing, without assigning a goal to them. For example, when others' actions don't jibe with what we expect, we take particular notice and engage other areas to try to explain them.

Nobody disagrees that our brains have a way of simulating what others are doing or predicting others' actions and intentions, says James Kilner of University College London. The question is, how much of this ability is embodied in mirror neurons in the motor system versus in other areas of the brain? If indeed mirror neurons are important for understanding others' behavior, that raises the question of whether people with motor problems therefore interpret the social world differently, or even whether there is a basis in the motor system for social disorders, Kilner says.

Indeed, one area of great interest—and of additional controversy—is whether mirror neurons play a role in disorders like autism and schizophrenia. If autism, one hallmark of which is a difficulty in relating to others, is related to malfunctioning mirror neurons in the motor system that lead to impairments in understanding the meanings of others' actions, then perhaps motor therapies could be helpful in improving the social skills of individuals on the autism spectrum (7).



An example of a mirror neuron. Image courtesy of Richard Cole, Wadsworth Center, New York State Department of Health, Advanced Light Microscopy and Image Analysis Core.

1 di Pellegrino G, Fadiga L, Fogassi L, Gallese V, Rizzolatti G (1992) Understanding motor events: A neurophysiological study. *Exp Brain Res* 91(1):176–180.
2 Watkins KE, Strafella AP, Paus T (2003) Seeing and hearing speech excites the motor system involved in speech production. *Neuropsychologia* 41(8):989–994.
3 Wicker B, et al. (2003) Both of us disgusted in *My* insula: The common neural basis of seeing and feeling disgust. *Neuron* 40(3): 655–664.
4 Singer T, et al. (2004) Empathy for pain involves the affective but not sensory components of pain. *Science* 303(5661):1157–1162.
5 Molnar-Szakacs I, Overy K (2006) Music and mirror neurons: From motion to 'e'motion. *Soc Cogn Affect Neurosci* 1(3):235–241.
6 Gallese V, et al. (2011) Mirror neuron forum. *Perspect Psychol Sci* 6(4):369–407.
7 Cattaneo L, et al. (2007) Impairment of actions chains in autism and its possible role in intention understanding. *Proc Natl Acad Sci USA* 104(45):17825–17830.