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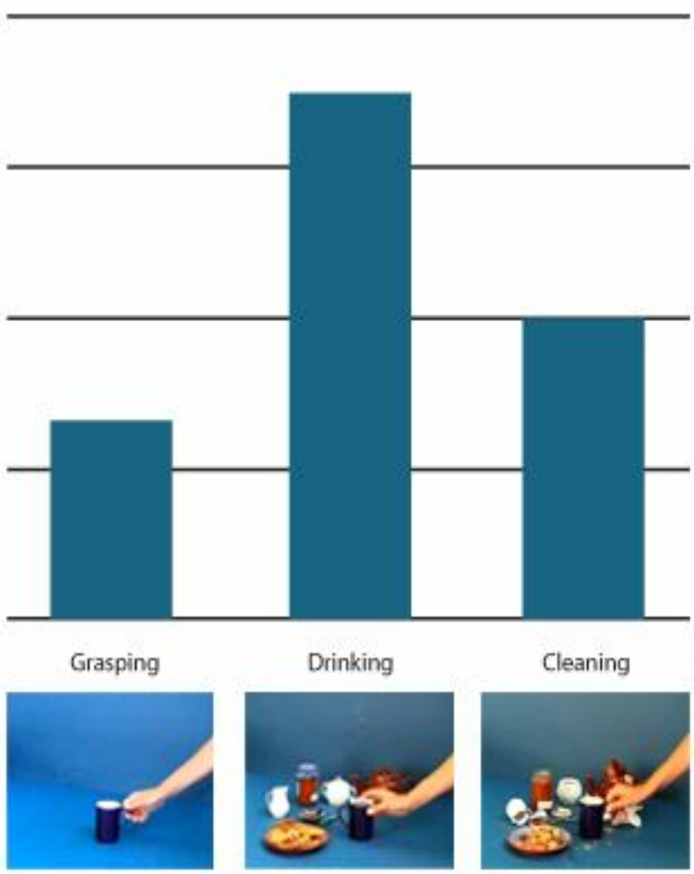
Creation Date: **16 Nov 2008** | Review Date: **20 Feb 2013**

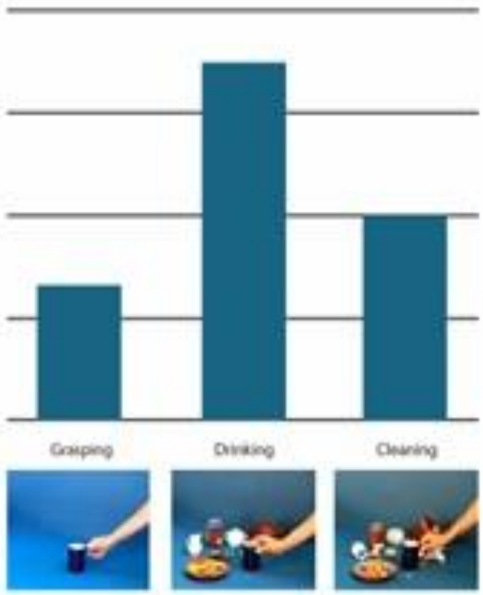
Mirror Neurons

You see a stranger stub her toe and you immediately flinch in sympathy, or you notice a friend wrinkle up his face in disgust while tasting some food and suddenly your own stomach recoils at the thought of eating. This ability to instinctively and immediately understand what other people are experiencing has long baffled neuroscientists, but recent research now suggests a fascinating



explanation: brain cells called mirror neurons.

Observing the same action, such as grasping a cup, in different contexts elicits different levels of mirror neuron activity in one area of the brain that belongs to the mirror neuron system (right posterior inferior frontal gyrus). This finding shows that the mirror neuron system does more than code the observed action ("that's a grasp"). It also codes the intention behind the action ("that's a grasp to drink" or "that's a grasp to clear the table").
Adapted with permission from Marco Iacoboni, UCLA School of Medicine.



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In the early 1990s, Italian researchers made an astonishing and quite unexpected discovery. They had implanted electrodes in the brains of several macaque monkeys to study the animals' brain activity during different motor actions, including the clutching of food. One day, as a researcher reached for his own food, he noticed neurons begin to fire in the monkeys' premotor cortex—the same area that showed activity when the animals made a similar hand movement. How could this be happening when the monkeys were sitting still and merely watching him?

During the ensuing two decades, this serendipitous discovery of mirror neurons—a special class of brain cells that fire not only when an individual performs an action, but also when the individual observes someone else make the same movement—has radically altered the way we think about our brains and ourselves, particularly our social selves.

Before the discovery of mirror neurons, scientists generally believed that our brains use logical thought processes to interpret and predict other people's actions. Now, however, many have come to believe that we understand others not by thinking, but by feeling. For mirror neurons appear to let us "simulate" not just other people's actions, but the intentions and emotions behind those actions. When you see someone smile, for example, your mirror neurons for smiling fire up, too, creating a sensation in your own mind of the feeling associated with smiling. You don't have to think about what the other person intends by smiling. You experience the meaning immediately and effortlessly.

Mirror neuron research, therefore, is helping scientists reinterpret the neurological underpinning of social interactions. These studies are leading to:

- New insight into how and why we develop empathy for others.
- More knowledge about autism, schizophrenia, and other brain disorders characterized by poor social interactions.
- A new theory about the evolution of language.
- New therapies for helping stroke victims regain lost movement.

Direct evidence of individual mirror neurons continues to come from research involving macaque monkeys implanted with electrodes. Building on research in animals, researchers have conducted brain imaging studies that reveal a possible mirror neuron "system" in humans, as well. Several key findings have been made. One is that mirror neurons appear to allow us to determine other people's intentions as well as their actions. For example, one area of the mirror neuron system exhibits greater activation in our brains when we observe someone picking up a cup to have a drink than when we watch the same person picking it up to clear it from a table.

The mirror neuron system also appears to allow us to decode (receive and interpret) facial expressions. Whether we are observing a specific expression or making it ourselves (a frown of disgust, for example) the same regions of our brain become activated. And the better we are at interpreting facial expressions, the more active our mirror neuron system.

These findings suggest that the mirror neuron system plays a key role in our ability to empathize and socialize with others, for we communicate our emotions mostly through facial expressions. And, indeed, studies have found that people with autism—a disorder characterized, in part, by problems during social interactions—appear to have a dysfunctional mirror neuron system. The more severe the symptoms of autism, the less active the mirror neuron system seems to be. Studies have demonstrated that children with autism have difficulties understanding the intention of others on the basis of the action they observe. In order to decide what others are doing, they rely on object meaning or the context in which the action is performed. To them, a cup means "drinking" even when others would intuit that the intention is to clear it from the table. Attempts are now being made to use imitative behavior to try to counter this deficit. Similar imitative training techniques are also being explored to rehabilitate people whose motor skills have been damaged by a stroke or other brain injury.

Among other intriguing mirror neuron research is the discovery that complex hand gestures activate the same brain circuits as the complex tongue and lip movements used in making sentences. Some scientists believe these findings suggest that spoken language evolved from hand gestures.

Do mirror neurons form the basis of communication and empathy? That has yet to be determined. But research into this intricate and pervasive neural system is providing fascinating new insight into the mechanisms by which we acquire social skills and communicate our innermost feelings and intentions to others.

Further Reading

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About the Author

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Susan Perry is a Minnesota-based medical and science writer with a special interest in neuroscience. A former writer and editor for Time-Life Books, she has been contributing educational and other materials to the Society for Neuroscience for almost two decades.