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MIRROR NEURONS

Are We Ethical by Nature?

CHRISTIAN KEYSERS

Shared Circuits: How You Invade My Brain

In the 1990s, a pivotal discovery was made by the Italian neuroscientists Giacomo Rizzolatti, Vittorio Gallese, Leonardo Fogassi, and their colleagues at the University of Parma, where they were investigating how the brain controls our actions. Using very thin electrodes, they measured the activity of single neurons in a region of the monkey brain called the premotor cortex. This region contains neurons that are active while the monkey grasps or manipulates objects. Some of these neurons, for instance, are active when the monkey grasps a peanut, others while the monkey breaks the peanut's shell. It is the activity of these neurons that triggers the monkey's movements. Humans also have a premotor cortex, and if a surgeon stimulates this region while a patient is undergoing surgery, the patient reports feeling the urge to perform certain actions. The premotor cortex is a key element of our voluntary

actions and of our personal control over our own bodies—a stronghold of our free will.

The surprise came when one of the experimenters grasped a peanut to give it to the monkey. The very same neuron that had responded when the monkey grasped a peanut also responded when the monkey simply saw someone else perform the same action. At first, Rizzolatti et al. did not believe their own finding. How could a brain region involved in voluntary actions respond while someone else's actions were simply watched? What finally convinced them was a remarkable congruence: neurons involved in performing a particular action (e.g., grasping) would respond to the sight only of that particular action. This could not be coincidence.

The experimenters later showed that even the *sound* of someone else's actions would activate neurons involved in executing those particular actions, and it became increasingly clear that the monkey's brain could transform the actions of the experimenters into motor programs that the monkey would use to perform the same actions.

We call such neurons *mirror neurons*, because through them the motor activity in the brain of the monkey mirrors the actions of others.

A number of experiments have shown that humans have a similar system. Motor representations of our own actions are activated whenever we see the actions of other people, animals, or even robots.

If motor representations of our actions are activated while viewing those of others, why don't we always overtly imitate other people? The answer is that while we're observing the actions of others, a neural gate seems to block the output of our

motor areas, keeping our bodies from imitating the movements we are seeing. Behind this gate, our brain can covertly share the actions of the people around us. We no longer only see the movements of others, we also feel their movements inside us, as if we were doing the same thing they were. If we are in the starting blocks of a race, for instance, the false start of a competitor automatically almost triggers our own. When we see people dance, we often cannot help but feel our own bodies moving. Our motor system is thought of as the seat of our free will, but each time I witness your movements, you permeate this stronghold. Your acts become mine, and my acts become yours.

This phenomenon is not restricted to physical movement. When someone taps my shoulder, say, my somatosensory cortex makes me feel the sensation. But simply seeing someone else being tapped activates the same area of my brain. If I cut my finger, my cingulate cortex and anterior insula will register the pain—and these areas also become active if I see you cut your finger. The vicarious representations are not quite as strong as those produced when we experience our own sensations, but we nevertheless feel a milder version of what the other person feels. I feel a sensation something like pain in my finger when I see you cut yours. My own shoulder itches as I watch a tarantula crawl across James Bond's shoulder in *Dr. No*.

Moreover, our emotions seem to obey a similar rule. When I smell a foul odor, for example, my insula produces a feeling of disgust. The very same region is active when I see an expression of disgust on your face; it is as if I were experiencing your disgust. These shared neural activations go hand in hand with our individual subjective experience: who has never felt his or her

mood improve at the sound of someone else laughing, or felt sadness when a friend cries? The emotions of others are contagious because our brain activates our own emotions at the sight of them.

These brain circuits can keep us from seeing other individuals as something "out there." Indeed, we are able to feel their actions, sensations, and emotions inside us, as if we were in their shoes. Others have become us.

Shared Circuits Allow Us to Learn from Others

What are these shared circuits good for? Humans owe their success to their ability to cooperate with and learn from one another. Hunting is a good example: given spears and coordination, humans can bring down buffalo or woolly mammoths. While the media often glorify the genius of individuals and Nobel Prizes are given to the inventors of new ideas, most useful things (such as spears) are the result of thousands of years of slow technological improvement—of learning from a more experienced teacher and then adding one's own innovation and teaching it to the next generation.

Somehow our brains must be able to learn from others. This process is far from trivial. To learn to make a spear, for instance, we have to convert the sight of someone else's manipulations into something very different—the nerve impulses required to move our own hands in similar fashion. Mirror neurons appear to have solved this difficult task: each time we see an action, they transform this sight into the motor commands necessary to replicate the action. While we watch an expert perform a series

of action components, one after another, until a spear is made, our brain activates similar action components in the same order, composing the novel sequence of spear-making from the familiar movements of picking up a stone, sharpening it, picking up a stick, and tying the stone to the stick.

The sharing of others' emotions is an important element in this process. Virtually all animals learn based on trial and error. When we share the actions and emotions of others, this ancient mechanism becomes social learning. If we see someone taste an unfamiliar fruit and look pleased, our brain will share the action and the positive consequence as if we ourselves had eaten the fruit and enjoyed it. If we see the person expressing disgust, we will share this negative experience. Our vicarious trial-and-error learning mechanisms tell us that eating that particular fruit is either a good or a bad idea, providing us with all the benefits of learning without the risk of being poisoned.

These brain circuits thus blur the bright line between your experiences and mine. Our experiences fuse into the joint pool of knowledge that we call culture. With the advent of language, books, and television, this sharing becomes global, allowing us to exchange experience across time and space.

Shared Circuits Create an Ethical Instinct

Often we are more than passive observers; many of our decisions affect other people. Imagine I am one of two starving individuals and I find a piece of food. Shall I eat it all, or shall I share it?

From an individualistic point of view, eating it all seems the

most rational decision. It saves me from starvation, and the only disadvantage is that the other person might die—but that is not my problem, is it? If I share the food, I may hope that the other person will feel obliged to return the favor later on—but who knows, he might not.

Because of these shared circuits, though, the equation is different. Since the same brain areas are active whether we are feeling our own pain or witnessing that of others, this means that the vicarious sharing of others' feelings is not an abstract consideration but a toned-down equivalent of our own. If I eat all the food, I will not only witness but also share my companion's suffering, whereas if I divide the food I will share his joy and thankfulness. My decision is no longer guided only by my hunger but also by the real pain and pleasure my companion's pain and pleasure will give me.

What's more, although the strength of these brain mechanisms varies from person to person and also depends on the circumstances, all individuals show some degree of sharing. It is thus reasonable to assume that other people will also take my suffering into account while deciding whether or not to share food with me. Indeed, experiments performed in a wide variety of societies show that, in most places in the world, people will tend to share the wealth with others instead of keeping it all for themselves.

The circuits allowing us to share knowledge with others therefore have another profound implication for human nature: they lay the foundation for an *intuitive altruism*. Most cultures have what is called an ethical Golden Rule. Christianity, for instance, urges, "Therefore all things whatsoever ye would that men should do to you, do ye even so to them: for this

is the law and the prophets" (Matthew 7:12), while Islam holds, "Not one of you truly believes until he wishes for others what he wishes for himself" (Muhammad, 13th Hadith of Nawawi). I believe that the brain mechanisms that make us share the pain and joy of others are the neural bases that intuitively predispose us according to this maxim. Our brain is ethical by design.

This is not to say that humans are incapable of hurting one another. Indeed, if our personal interest is in direct conflict with that of others, our desire for benefits might outweigh our empathy. Unfortunately, human ingenuity has designed methods to reduce empathy in those circumstances where it fails to serve our purpose. In the military, the distance that separates the generals from the human suffering their armies cause minimizes their empathy and favors self-interested decisions. At the same time, the chain of command strips moral responsibility from the soldiers who do directly witness the suffering. In such a way, empathy can be bypassed in the service of efficiency. The development of weapons that kill at a distance has a similar effect. Insights into the biology of our empathy help us realize the risk of such distancing and point us toward ways to build the natural mechanisms of empathy into our institutions.

Humans are the result of evolution, and evolution favors individuals who will leave more offspring, not altruistic individuals who forget their own interests in the service of others. At first, a brain that forces us to share the emotions of others seems at odds with survival of the fittest. Humans, however, are social animals. Imagine a family whose members can share the actions, sensations, and emotions of other family members. And imagine a family without this ability. In the latter, brothers will steal from one another, cheat one another, and learn very little from one

another. The family with strong sharing will respect one another's needs, learn from and collaborate with one another. In the face of hardship, this capacity for cooperation will prove essential for hunting, gathering, and child care—and this family will therefore leave more offspring. As individuals, we may pay the price of shared misery because of our ability to empathize, but we reap all the benefits that our culture and a stable society bestow. Mirror neurons—and their gift of insight into the emotions of others—enable us to manipulate other individuals but also prompt us to use this understanding for good and not for evil. It is heartening to realize that there is something inside us that makes us truly care about other individuals as if they were part of our extended self.

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