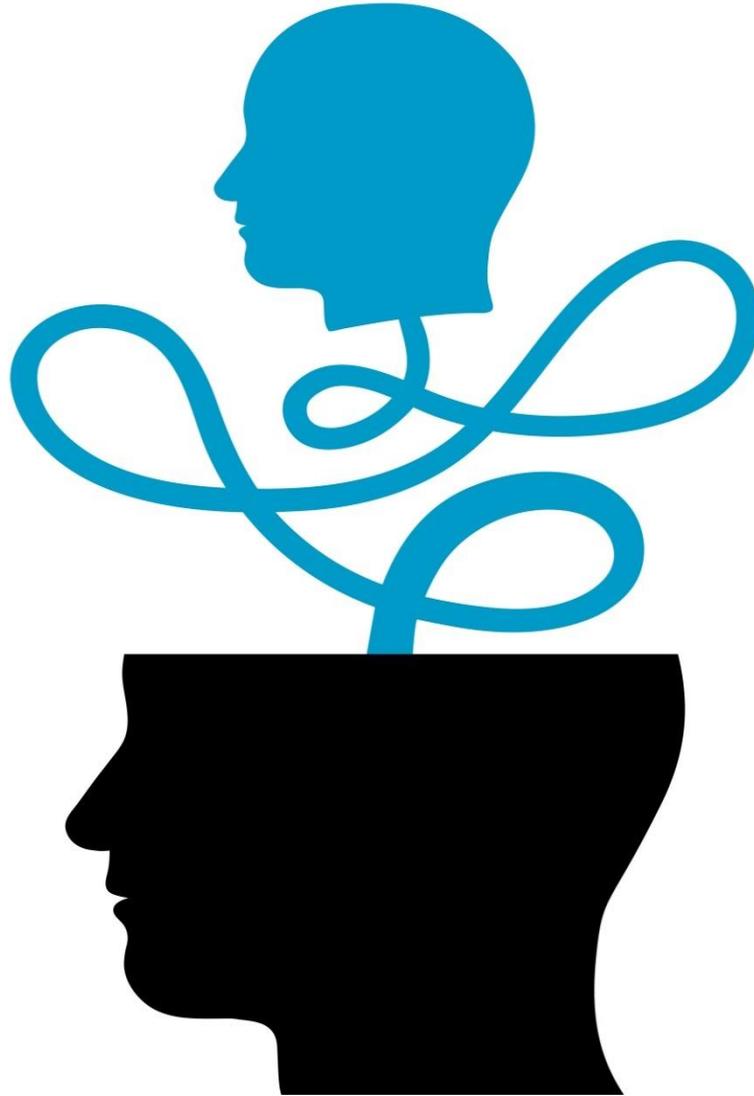


With A Little Help from Our Friends: How the Brain Processes Empathy

By Peggy Mason, Ph.D.



Editor's Note: Why are certain individuals born with a brain that is wired to help others? What daily habits or life experiences reinforce compassion but also selfishness, narcissism, and psychopathy? Social neuroscience models have assumed that people simply rely on their own emotions as a reference for empathy, but recent studies suggest neurobiological underpinnings for how the brain processes empathy. A better understanding of these processes, says the author, could lead to more social cohesion and less antisocial harm in society.

“No man is an island entire of itself.” — John Donne

John Donne’s sentiment that the self extends beyond our individual boundaries applies to virtually every animal. Mammals in particular depend on others for growth, development, effective foraging, safety, and ultimately survival. The young are born helpless and depend on their mother for nutrition, immune defense, thermoregulation, and protection from predation. If a mother (or father in some birds and a few mammals) fails to recognize that her young are cold, hungry, or exposed to danger, it’s likely that the offspring will die. A mother’s ability to react appropriately to her newborn’s needs is the difference between the newborn living and carrying on its parents’ genes or dying and reaching an evolutionary dead end.

Young mammals depend on their mothers for far more than nuts-and-bolts survival. American psychologist Harry Harlow dramatically illustrated this point in the late 1950s through an experiment that involved separating monkeys from their mothers and offering two mother substitutes, one made of cloth and the other of wire.¹ Even when the wire mother was the baby’s only source of milk, the young spent ten times as much time with the cloth (nonnutritive) mother than with the wire (nutritive) mother. The experiment revealed that mammalian offspring crave a mother’s touch, which is better approximated by cloth than wire, and demonstrated that a primate mother provides her newborns with far more than nutrition. Indeed, mammals raised with adequate food, warmth, and protection but with diminished social contact became fearful, anxious adults with impaired social and parenting skills.^{2,3}

Whereas an empathic understanding by the mammalian mother of her young’s condition is critical for survival and, in turn, for evolutionary success, the utility of a social bond between individuals extends into adulthood and encompasses more than just the mother-to-offspring relationship. Darwin intuited that an individual should “extend his social instincts and sympathies to all the members of the same nation, though personally unknown to him.”⁴ If we take “nation” to mean tribe or herd or social group, Darwin is clearly stating that social cohesion, borne of mutually directed feelings, facilitates survival of the group and its constituent individuals. In essence, sociality benefits individual adult survival by providing protection and by increasing opportunities to feed, mate, and successfully raise offspring to reproductive age.

Membership in a social group brings benefits that scale with the ability of the group to work together. Thus social cohesion, more than simple sociality, most powerfully promotes survival. William James considered that “a man’s Self is the sum total of all that he CAN call his, not only his body and his psychic powers, but his ... friends...”⁵ James’s idea of an extended self depends on individuals reacting to the fortunes of others as they would if the same fortune or misfortune befell oneself. To the extent that our mood soars at a friend’s triumph as it does upon our own triumph or plummets in reaction to harm befalling a friend, that friend is part of a Jamesian extended self. Social cohesion increases as more group members consider more other group members as part of their extended selves.

To Act, or Not to Act

At the core of social cohesion among mammals is the communication of affective or emotional states between individuals. When individuals respond to others’ emotional states as if they were their own, the result is a bond, thereby building social cohesion within the larger group. The communication of affect or emotion between individuals is empathy. Defined in this way, empathy is an umbrella term that includes a large range of interactions in which an emotional or affective response is elicited by the emotional or affective state of another individual. Moreover, according to this definition, empathy is neutral in that responding to another’s affective state, mood, or emotion does not constrain the actions taken, if any, as a result. We may hope that an individual reacts with helping behavior to a member of his or her own species in distress — the social instincts and sympathies Darwin suggested. Yet, inaction and even targeted cruelty aimed at exacerbating a victim’s distress are also possible reactions.

The perception-behavior link, an automatic function that links our behavior to the behavior of another, is critical to affective communication between two individuals. Many of us are familiar with the phenomenon of adopting the physical stance of a person or people with whom we are talking; soon after one member of a group crosses his or her arms, another person does the same. Simply viewing another individual’s actions increases the probability that the viewer will perform the same actions — even if the individuals are strangers.⁶ Similarly, people in conversation with each other modify their fundamental speech frequencies to more closely match each other.⁷ These social adjustments make the actions of two interacting people more similar to each other and serve

as an affiliative signal, or a kind of social glue. Passing a person who cheerfully smiles at us makes us more likely to smile. We don't reason through this process; it just happens.

Actions are not only the readout of affect. They also influence affect — the interaction between emotions and outward expressions is two-way.⁸ In other words, just as our emotions lead to actions, our motor actions are “re-experienced” as affect. Affect and emotions are expressed through voluntary muscles responsible for posture, facial expression, breathing, and gaze, as well as autonomic processes such as a rise in heart rate or perspiring, blanching, and blushing. Facial expressions' influence upon emotional experience is particularly strong in humans. People report emotions commensurate with artificially arranged facial expressions.⁹ Feeling happy makes us smile and smiling can make us feel happy, or at least happier. When you're feeling good and laughing with friends, just try to feel angry or sad. As long as you keep your face in a smile or laugh, feeling an incongruent emotion is nearly impossible. Deriving emotion from action, often termed embodied emotion, is the essence of the Stanislavski system of method acting in which the affects that emerge from movements provide the emotive force of a performance.

The links between perception and action and between action and affect set up a cascade whereby one person's perception by another's actions ultimately results in the first person feeling the second one's mood. This cascade results in matching affects.¹⁰ The affect the viewer experiences is vicarious in nature, “caught” from the other individual. The process by which one individual catches the affect or emotion of another is called “emotional contagion,” and it is a fundamental building block of more complex forms of empathy.

Aid and Abetment

Emotional contagion is required but not sufficient to elicit empathically motivated helping. In humans, personal distress must be suppressed in order to move from emotional contagion to helping, to choose action over immobility and panic. High levels of personal distress are detrimental to helping.¹¹ Suppressing personal distress allows someone to focus on the other over the self and leads to empathic concern, an other-oriented emotional response elicited by and congruent with the welfare of an individual in distress. The response's congruence with the welfare of the other

precludes antisocial actions so that the action taken by someone feeling empathic concern is always prosocial in nature.

By helping a distressed individual, a helper resolves not only the distressed individual's predicament but also his or her own uncomfortable affective state, providing an internal reward.¹² Thus, helping dissipates the distress of both the helper and the beneficiary. That the helper benefits does not diminish the prosocial action or its effect. The empathy-helping connection is so effective precisely because "empathy gives individuals an emotional stake in the welfare of others."

What Nonhumans Reveal

Empathy is an internal experience. The feeling of empathy may drive behavior such as a facial expression. In humans, empathy may even drive speech. Nonhuman animals, however, do not have the control over, and variety of, facial expressions that humans possess. Therefore, probing a nonhuman animal for the internal feeling of empathy has proved challenging.

Researchers have taken two basic approaches. One has been to test for emotional contagion. A typical experiment using rodents tests the influence of one rodent's expression of either fear or pain on another rodent's behavior. The second approach asks whether, given the opportunity, animals will engage in prosocial behavior, such as sharing food (in primates) or working for the relief of another from foot shock or confinement (in rodents). Mounting evidence suggests that emotional contagion and prosocial behavior are present in nonhuman primates and rodents and likely are widespread among mammals.

Preverbal humans and nonhuman primates show prosocial behavior. For example, a useful paradigm to test for helping behavior is to place an object out of the reach of an experimenter but within reach of the test subject. The subject watches the experimenter try to reach for the object unsuccessfully. The question is whether the subject will hand the object to the experimenter even though the subject gains no reward by doing so. In one study using this paradigm, chimps handed the object to the experimenter in about 40 percent of the trials; human infants helped in about 60 percent of trials.¹³ The proportions of children (60 percent) and chimps (50 percent) that helped at least once in ten trials were similar. The subsets of children and chimps that had helped were then

tested on the same task but with physical obstacles placed between them and the object, adding to the cost of helping. Just over half of the subjects of both species helped even when helping required significant effort.

Since emotional contagion is automatic, from perception to action to embodied emotional cascade, it is not surprising that chimps and other primates also appear to experience empathy.¹² Moreover, because the pathways involved in linking perception to action to embodied emotional cascade are shared across mammals and the perception-action model for empathy does not depend on conscious deliberation or higher cognition, there is no reason to expect that empathy and prosocial behavior are exclusive to primates.^{12, 14} Indeed, emotional contagion has been documented in a number of mammalian species, including rodents.¹⁵ A mouse that views another mouse experiencing foot shock, for example, shows fear by freezing in place.¹⁶ In another example, pairs of mice that receive a noxious stimulus show more pain behavior than a single mouse that receives the same noxious stimulus; this finding has been interpreted as emotional contagion of pain.¹⁷

Overcome by Caring

Several years ago, we designed a behavioral helping test for rats.¹⁸ In this test, one rat is restrained in a plastic tube located in the center of an arena while a second rat is free to roam in the arena. The restrainer door can be opened only from the outside — only by the free rat. Within a few sessions, most rats begin to open the door consistently, releasing the other rat. By the final session, most rats open the restrainer door within just minutes. The fact that rats opened the restrainer door repeatedly and consistently is remarkable in light of rats' strong preference to remain close to walls and avoid open areas. The motivation to approach the trapped rat in the arena center evidently is sufficient to overcome rats' natural avoidance of open space.

The rats' helping actions are remarkable for another reason. We would expect that emotional contagion would lead the free rat to experience at least some of the distress felt by the trapped rat. The most common reaction of a rat to personal distress is freezing or immobility such as that which occurs in response to foot shock. Yet rats in the helping test do not freeze. Instead they act intentionally to open the restrainer door.¹⁸ This behavior suggests that the helper rat recognizes

that its distress is vicarious in origin. In other words, the rat is able to attribute personally felt distress to the trapped rat's condition and distinguish that from its own condition. Such recognition of the distinction between self and other is unexpected in a rat.

The helping behavior test is not the first scientific demonstration of helping, but it is the first tractable paradigm for studying prosocial behavior in a mammal. Already, the test has been used to demonstrate that helping is socially selective.¹⁹ Rats help a stranger rat but only if that rat is from a familiar strain. In other words, an albino rat that has never before seen a black-hooded rat will not help it. However, an albino rat that has lived with a black-hooded rat will open the restrainer door for black-hooded strangers. Remarkably, albino rats raised since birth with black-hooded rats do not help other albino rats, although they do help black-hooded strangers. This suggests that rats do not inherit genetic instructions to help others of their own kind. Instead, they learn which individuals to help from their social environment. The test result tells us that environmental experiences trump genetics when it comes to targeting helping, resolving one piece of the nature-nurture debate. Moreover, because the fostering-from-birth experiment is easy to perform in rodents but would be impossible in most other mammals, this result shows the power of an experimental model for prosocial behavior in rodents.

The finding that rats help strangers of a familiar type but not strangers of an unfamiliar kind may appear, at first glance, to suggest a biological basis for a social bias, a kind of "strainism." However, the results are more consistent with a biological basis for "groupism" through social experience. Humans readily form strong affiliations to groups that are based on "minimal-group" criteria such as an arbitrary assignment to one of two meaningless markers (e.g. red or blue wrist bands).²⁰ The finding that rats raised without experience with their own strain do not help strangers of their own strain demonstrates that group affiliation, with respect to helping, is fluid, based on experience, and not genetically determined.

Motivation to Help

We still need to understand more about the rat's motivation to help another in distress and to discover the underlying brain mechanisms that support helping behavior. While the motivation for prosocial behavior looks like empathic concern, a rat may open a restrainer door for other reasons.

One commonly raised possibility is that the rat finds some part of the trapped rat's behavior so aversive that it opens the door to terminate this aversive experience.

Since rats do not open restrainer doors for rats from unfamiliar strains, including strangers from their own strain if they were fostered with a different one, escaping aversion is a possible but unlikely motivation for door-opening in the helping behavior test.¹⁹ Nonetheless, empathic concern must start with an individual showing distress. Because an individual's demonstration of distress is as critical to empathic concern as another's noticing and responding to that distress, biology has left little to chance. Crying works—babies and others get attention when they need help. Facial expressions and posture also work because they are universal, with commonalities across populations and across species. Conversely, in the absence of an individual displaying distress, nonhuman animals and young humans are never moved to “help.” Some degree of attention-getting distress is necessary to elicit empathic concern.

A second common theory is that rats may be motivated by a desire to interact socially with the trapped rat. Social reward is a fundamental underpinning of social behavior, and all rodent behavior involving more than one individual is, at the very least, influenced by social reward. Rats will opt to be together when given the opportunity. Using a modification of the helping behavior test in which rats were repeatedly retrapped, a free rat that could not release the trapped rat opted for physical proximity.²¹ In contrast, when given the chance, rats continue to open the door for a trapped cagemate even when subsequent interactions are prevented.¹⁸ This finding suggests that the opportunity to play or interact with the trapped rat is not a requirement for prosocial behavior.

More Than a Feeling

Not all humans show empathy or express helping behavior. We aren't alone: About 25 percent of the rats that we have tested in standard conditions do not exhibit helping behavior. The predominant reason for not helping appears to be an excessive amount of personal anxiety. Similarly, bonobo apes who show more anxiety (measured by how much they scratch themselves) and take longer to recover from a stressful event show less consolation behavior toward other bonobos in distress.²² This finding dovetails beautifully with research in humans suggesting that in order to use empathy for helping or caring, an individual must overcome personal distress, a

process typically termed self- or down-regulation. People with a specific genetic variation who show greater social anxiety also demonstrate less helping behavior.²³ This finding suggests that rather than lacking empathy, many individuals who do not help may be unable to suppress the anxiety associated with catching another's feeling of distress.

In professions that involve repeated exposure to human suffering, such as medicine, strong down-regulation is highly adaptive in counteracting the development of burnout. Physicians have a down-regulated response to noxious events that are common in medical practice. For example, an image of a needle stick evokes a lower assessment of pain intensity and unpleasantness by physicians than controls.²⁴ Finally, human psychopaths appear to lack empathy and exhibit a callous disregard for others' suffering. Whether psychopathic individuals exist in other mammalian species is an unanswered question.

Researchers are beginning to elucidate the brain circuits that support empathy and empathic concern. A particularly instructive approach has been to compare brain activation in humans, using functional magnetic resonance imaging (fMRI), to compare when an emotion is experienced by the self versus when it is experienced by another. When one person views another in pain, the activated brain areas are similar and overlapping, but not identical, to those activated by a personal experience of pain.²⁵ The overlapping regions of activation evoked by self- and other-pain can breed confusion so that an individual experiences another's distress as their own. Conflation of the distress originating with the self and the other may explain why vicarious distress can be as immobilizing as personal distress. It appears that the prefrontal cortex allows us to make the distinction between ourselves and others by promoting down-regulation.²⁵ For example, the medial and dorsolateral prefrontal cortex was activated as physician acupuncturists viewed images of needle insertions, an activation that was not observed in control subjects.²⁶ Moreover, the degree of activation in the prefrontal cortex was inversely correlated to the ratings of pain intensity made by the subjects so that those with the greatest prefrontal activation judged the needle insertions with the lowest pain ratings.

These studies show that viewing others' pain engages ascending affective pathways, while top-down regulation arising from the prefrontal cortex is critical to stemming personal distress so that

empathy can serve as a call for action. Nonhuman animals are likely to employ similar brain circuits. Indeed, fear contagion in mice appears to require the anterior cingulate cortex as well.^{16, 25} A full elucidation of the similarities and differences in brain circuits involved in empathy and down-regulation between humans and other mammals is an exciting challenge for the future.

Bio

Peggy Mason, Ph.D., is a professor of neurobiology at the University of Chicago and the author of *Medical Neurobiology* (Oxford University Press, 2011). Dr. Mason offers an open online course, "Understanding the Brain: The Neurobiology of Everyday Life," through Coursera (<https://www.coursera.org/course/neurobio>). She also maintains a blog at <http://thebrainissocool.com/>. For more than 20 years, Dr. Mason's research was focused on the cellular mechanisms of pain modulation. In the last several years, she has turned her energies to the biology of empathy and prosocial behavior. Originally from the Washington, D.C., area, Dr. Mason received her bachelor of arts degree in biology in 1983 and her Ph.D. in neuroscience in 1987, both from Harvard University. After postdoctoral work at the University of California-San Francisco, she joined the faculty at the University of Chicago in 1992. A lively discussion of her empathic helping work can be found at reddit.com/r/science/comments/23o5w4/science_ama_series_hi_im_peggy_mason_i_study.

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