How the Mind Reads Other Minds

Understanding what others are thinking is a human exclusive. Now researchers are tracking how the brain performs this feat and speculating about how it evolved.

Imagine a boy sitting on a couch about to unwrap a chocolate bar. His mother announces that she’s taking him to soccer practice. He tucks the chocolate under the couch for safekeeping and leaves. A few minutes later, his sister comes into the room in search of her teddy bear. When she looks under the couch she is surprised to find an unopened chocolate bar, which she then hides behind a bookshelf. When her brother comes home, drooling for chocolate, where will he look?

This may not seem like a difficult question: It’s glaringly obvious that the boy will look under the couch. But to get the right answer, you have to perform an extraordinary mental feat: understand the boy’s intentions and beliefs—regardless of their accuracy—and use that information to predict his action. And the skill doesn’t come easily: Until the age of 5 or so, children answer that the boy will look behind the bookshelf, where they know the chocolate bar to be.

Of all the species on Earth, only humans possess what researchers call a “theory of mind”—the ability to infer what others are thinking. “It is extremely critical, because it underlies teaching, deception, propaganda, all these sorts of things,” says Christopher Frith of University College London. “To get an idea from one brain into another, that’s a deeply mysterious thing we do.”

It has been 25 years since scientists first began to seriously investigate this ability to read minds. Today psychologists can chart its development, and they link it to children’s acquisition of language and appropriate social behavior. Neuroscientists have tried for a decade to pinpoint the regions of the brain required for a theory of mind, and their results are now converging on a distinct network.

This work may ultimately reveal how the brain’s social wiring evolved. On a more practical level, it is also allowing researchers to pinpoint some of the neurological signs of autism, in which a breakdown in theory of mind makes it difficult to understand other people’s emotions and motives. Researchers hope that they will be able to translate these discoveries into more accurate diagnoses of autism and point to more effective treatments.

Mind reading takes shape

The psychologists David Premack and Guy Woodruff, who first coined the term “theory of mind,” believed that chimpanzees and perhaps other primates could read intentions. Subsequent research has shown that primates are remarkably sophisticated in their relationships: They can deceive, form alliances, and bear grudges for days. Chimpanzees can even tell what another chimpanzee can and cannot see. But after decades of studies, no one has found indisputable signs that chimps or other nonhuman primates have a theory of mind.

Humans aren’t born with a full-blown theory of mind. Children from cultures around the world acquire the skill at roughly the same age, and after reaching the same developmental milestones, which has led many psychologists to conclude that the theory of mind is a specific adaptation separate from general-purpose intelligence. “There might be a dedicated brain system,” says Frith. Researchers are still working out how theory of mind develops in the brain. “The exciting thing that’s going to happen in the next few years is scanning children doing [theory-of-mind] tasks at different stages,” says Frith.

Autism provides more evidence that theory of mind is somewhat independent of other skills. Autistic people do poorly on problems like the chocolate bar test. One powerful demonstration uses animations of geometrical shapes in motion. Nonautistic people easily recognize when these shapes are acting like people—when two triangles coax a circle out of a square, for example. But even highly intelligent autistic people can’t distinguish intentional movements from random collisions. Autism, some researchers theorize, is a selective deficit of theory of mind.

Specialized circuitry for reading people’s minds hints that this ability played an important role in human evolution. According to Paul Bloom, a psychologist at Yale University in New Haven, Connecticut, the evolution of language would have been impossible without it. “Our species has come to possess this powerful theory of mind, and once you possess that, you are then capable of understanding people referring to things,” says Bloom. His research suggests that theory of mind makes learning words a fast, efficient process because children can quickly recognize what their parents are trying to teach them.

Minds in the brain

In the mid-1990s, researchers using brain-imaging technology began searching for the biological basis of theory of mind. The premise was simple: Scan people while they perform mental tasks differing only in that one demands the use of theory of mind. In an early study, Frith and his colleagues had subjects read stories. The subjects then answered questions about the stories while in a brain scanner. Only some of the stories demanded that the subjects think about the beliefs and intentions of the characters.

Many other teams conducted similar experiments, and each revealed a constellation of active brain regions. Unfortunately, the constellations were not identical from one experiment to the next. Part of the trouble was that theory of mind is hard to isolate from other mental tasks. Another problem was that the experiments didn’t demand mind readings on real minds—only on pictures or stories.

More recent experiments have tried to overcome these limits. Working with Frith and other researchers at University College London, Helen Gallagher put together an experiment based on the game of “rock, scissors, paper.” In each round, two players simultaneously choose one object. Rock beats scissors, scissors beat paper, and paper beats rock. Gallagher’s subjects lay in a brain scanner and played the game on a computer screen. In some cases, they were told they...
were playing against a computer; in other cases, they thought their opponent was a person. In fact, the researchers generated a random sequence of choices. The only difference lay in the attitude of the subjects: As the researchers confirmed in interviews after the study, when subjects thought they were playing against a person, they tried to figure out their opponent’s strategy.

In the brain of the participant, the chief difference between playing against a computer or a supposed human lies in one small region, a patch of neurons above the eyes known as the anterior paracingulate cortex, the researchers reported last year in Neurorimage. The paracingulate turned up in older studies of theory of mind as well. It may be responsible for the central task: separating your own mind from someone else’s. “It’s being able to recognize that someone has a different perspective than you do,” says Gallagher, who is now at Glasgow Caledonian University. She notes that the adjacent region of the brain acts as a conflict monitor, sensing when the brain’s predictions about how the world works don’t match up with reality. The paracingulate may make a similar distinction between our own beliefs and intentions and those of other people.

As important as the paracingulate may be, however, it can’t create a theory of mind by itself. “You have to draw on other abilities and skills in other parts of your brain,” says Gallagher. Two such regions tend to turn up in theory-of-mind experiments. One is the temporal pole, located near the ear. It’s crucial for recalling memories, suggesting that subjects need to dredge up past experiences to help figure out what other people must be thinking.

The other region, known as the superior temporal sulcus, lies high up on each side of the brain. Like the temporal pole, neuroscientists have found it at work in many experiments not focused on theory of mind. It is, essentially, a sensor of biological motion. The sight of a moving car won’t activate its neurons, but a moving hand will. It is particularly sensitive to the movement of eyes and lips. It’s possible that the paracingulate gyrus depends on interpretations about body language made by the superior or temporal sulcus in order to work out what’s going on inside another person’s head.

Other parts of the brain may eventually be initiated into this inner circle of the theory of mind, but not without debate. Simon Baron-Cohen of the University of Cambridge, for example, believes that an almond-shaped structure known as the amygdala should be recognized as part of the network. The amygdala has long been recognized as a key player in the emotional life of the brain. Baron-Cohen has found that the amygdala becomes active when subjects look at pictures of eyes to answer questions about the depicted person’s feelings and intentions. Theory of mind comes into play, Baron-Cohen says, when “you’re trying to find out if [a stranger is] friendly or aggressive.”

A few other studies have revealed the amygdala at work as well. Robert Schultz of Yale University and his colleagues showed people animations of “intentional” geometrical objects, as they reported in the 28 February issue of Philosophical Transactions of the Royal Society of London. They found that only the shapes that were moving as though they were pursuing goals triggered a theory-of-mind network—one that included the amygdala. In the brains of autistic people, none of the films activated this network.

Gallagher plays down the role of the amygdala, however, pointing out that it fails to become active in most tests of theory of mind. She suspects it plays an indirect role, primarily during development. As children mature, she suggests, the amygdala guides their theory of mind to situations that are socially relevant. However, earlier this year in Neuropsychologia, Baron-Cohen and his colleagues reported that people who sustain damage to the amygdala in middle age—long after their theory-of-mind network has been wired together—do worse on theory-of-mind tests than do people with undamaged brains. In other words, it seems adults still rely on the amygdala to read minds.

An evolving theory
Determining the neural building blocks of the theory of mind may help researchers figure out how it evolved in our ancestors. The brain regions identified so far all have counterparts in the brains of other primates. It seems that the pieces of the mind-reading network were probably all in place in the brains of early hominids. Perhaps all that was required to create a theory of mind was to network them in the right way. “My personal view is that it all comes from trying to predict what some other animal is going to do next,” says Frith. “It just happens that the best way to predict what people are going to do next is understanding mental states.”

A theory of mind may even have evolved before people could understand their own minds. That at least is the opinion of Francesca Happé, who works with Frith at University College London. She points out that the brain networks underlying self-awareness and an awareness of others are intermingled. “People have struggled to find an evolutionary explanation for self-awareness, whereas the evolutionary value of theory of mind is clear,” says Happé. Perhaps a human ancestor “could track the intentions of others but wasn’t at all self-reflective.” However it evolved, theories about theory of mind will likely keep researchers’ minds occupied for years.

Image not available for online use.

What are you thinking? The anterior paracingulate cortex is activated by tasks that call upon a subject’s theory of mind.

Carl Zimmer is the author of Evolution: The Triumph of an Idea.