How We Think: Brain Researchers Are Using MRIs to Predict Our Decisions Before They Are Made. The Results Are Intriguing, and a Little Disturbing.

By Michael D’Antonio.

Michael D’Antonio last wrote for the magazine about an Oregon town that honored a man who as a child had been warehoused in school for the retarded and was a subject in a government experiment.

What humans possess, jokes economist Colin Camerer, "is basically a monkey brain with a good publicist." That's his conclusion from observing the results of experiments by scientists at Caltech and elsewhere, who are peering into the human brain to see how we think—and finding they can predict the decisions their subjects will make.

Scans made at an MRI (magnetic resonance imaging) lab would typically be used to map an injury or diagnose disease. But here in Pasadena, the images help scientists understand the role that emotion plays in our economic choices.

As they unravel the decision-making process, the researchers are adding to our basic knowledge about human nature. Beyond this pure science, they also are shedding light on some of the mysteries of the marketplace. Their work could aid companies that want to appeal to our emotions, as well as consumers who want to better understand and possibly control their impulses.

Here's how the Caltech research works: Camerer recruits two people to play an investment game. One player is given $10 to invest and makes all investment decisions. The other player decides how the two players split the earnings. The game lasts 10 rounds—10 sets of investments, 10 choices about dividing the money. But there is one hitch. The investor can stop investing at any moment if upset at how the money is being divided.

"If you think unemotionally, you will realize that even if someone offers you $1, that's still $1 more than you had when the game started," Camerer says. "If they won't budge, then you should just take it and be ahead by $1. But some people refuse to do that. They would rather kill the whole deal than accept something they think is unfair."

As the players make their choices, the MRI machines register the activity in their brains. Researchers at Caltech, along with others at Princeton and Baylor universities using similar games, have discovered that the choices we make when we should use cold reason are heavily influenced by the brain's emotional centers. This is especially true when players call off the deal, giving up a chance at money just to spite a greedy negotiator.

The brain images displayed on video screens often predict a decision before players push their buttons. When the MRI shows lots of activity in the prefrontal cortex, where the logical resolution of a problem would register, Camerer expects both players will leave with cash. But when he sees more action in the anterior insula—home to disgust, nausea and similar sensations—he knows the negotiation will fail.

"Basically the brain toggles between 'Yes, money is good' and 'Ugh, this guy is treating me like crap.' Things will go back and forth as the brain asks, 'What should we do? What should we
do? If the amount of activity we see builds in the insula, then you know where it’s going to go. They are going to shut the whole thing off.” He estimates that researchers predict the outcome 70% of the time.

Camerer’s quirky MRI studies are part of a new branch of science that is adding hard data to the study of decision-making and consumer behavior. Teams of economists, physicists, philosophers and physicians are discovering that even in situations when we need to be coolly detached, we are not as rational as we might hope. They are also redefining the roles played by those not-so-primitive parts of the human brain responsible for animal instinct and self-preservation.

“The publicist is the higher brain, which we use to make what we do seem like it makes sense, both to ourselves and other people.” In truth, he adds, we often rely on our emotional, primitive “lower brain” to guide through difficult decisions. In other situations people make “gut” choices that work out well.

This discovery refutes long-standing assumptions, especially about how people behave in settings such as the stock market. “A lot of traditional economists would say that feelings are the tip of the iceberg, but rational thought is what lies below, determining your choice,” Camerer explains. “Neuroscience would say that the huge part of the iceberg is the feeling.”

In the future, our important practical and moral choices could be improved by our understanding of the brain’s workings. The more we know about our monkey brains, the more likely we are to control them. But at the same time, we may be subjected to more powerful and insidious manipulation by merchandisers and propagandists who seek better ways to bypass our rational minds and appeal more directly to our primal fears and desires.

The first rule of life is basic survival. Roughly 100,000 years ago, human beings learned that banding together could provide far better security and comfort than an individual could find alone. According to prevailing theory, this social organization was so important that people developed intense emotional desires for belonging and for fairness in relationships.

The desire for fairness is likely at work when the anterior insula drives players to end Camerer’s bargaining game early, even when it means giving up a windfall. The insula fears the loss of social status that comes with accepting a raw deal. No one wants to be seen as a weakling.

His studies have also highlighted differences in the ways that male and female brains seek agreement. The MRI shows that men and women use the same brain structures when they play the negotiation game. However, after it is over, male and female minds follow different paths.

“Men seem to shut down once the decision is made,” he observes. “In women, the process continues, and the caudate, which is a sort of error-checking center, continues to work as if it’s considering whether the right choice was made. There is also more activity in the parts of the brain that relate to social worry, as if someone is wondering, ‘How is the other person going to react to what has happened here?’ ”
Scientists at Baylor found similar results when they considered the brain’s production of dopamine, which is associated with pleasant feelings, in games in which a player must win another’s trust. Women produced significant increases in dopamine when they gained the confidence of other participants. Men in the study showed no similar increase. What explains the difference? Perhaps ancient females were more responsible for creating cohesion in social groups. Maybe males had to accept their status among other males, and fall in line, to avoid being cast out.

Whatever the explanation, these studies suggest practical insights into how emotions affect our lives. Camerer suggests that in important negotiations, over, say, a new job, it might be wise to acknowledge the power of emotion, and delay making a decision until feelings cool.

But that’s not as easy as it sounds, because the human hunger for fairness is, apparently, a primal urge. In an experiment at Emory University, scientists trained female monkeys to trade tokens for food. When some monkeys saw that a monkey received a better treat for her tokens—a sweet grape instead of cucumber slice—they would disrupt the bargaining. Sometimes the resentful monkeys would pay the token but refuse the cucumber. Sometimes the cucumber was thrown on the floor. The more unfair the trade, the more a monkey would display disgust.

As they looked for an explanation, the Emory group settled on the social organization that helps the capuchins survive in the wild. Fairness that reinforces relationships would make capuchin groups function better. Although capuchins are distant cousins, we humans are nevertheless just another species of social primate, and as such, we try hard to achieve fairness. Without it, our communities would break down.

The experiments with monkeys and MRI technology have largely evolved from the clinical observations in the 1990s by a single neurologist, Antonio Damasio of the University of Iowa. By studying people who suffered damage to parts of the brain, Damasio found that feelings can be a shortcut message system, drawing on our lifetime of experiences to prod us in a direction before the slower process of reasoning produces an answer. Fear, delight, dread and other emotions arise as what Damasio terms “somatic markers” that grab our attention. They are often felt as a physical sensation—that hollow feeling in the pit of the stomach that signals dread based on our many experiences. They help whittle down the range of choices we face when making a decision.

Good illustrations of this process abound in daily life. Did you jump checkout lines at the supermarket because the cashier in your line seemed too chatty? Why do we give erratic drivers on the freeway extra room to merge? Why do we go back and doublecheck whether we locked our front doors?

To back up his hypothesis, Damasio showed how people who suffered damage to the feeling centers of the brain—areas such as the amygdala and prefrontal cortices, which are near the brain stem—found it difficult, if not impossible, to make even the simplest choices. Without access to somatic markers, setting the time for a doctor’s appointment or choosing a restaurant for dinner became a torturous process.
In one study, Damasio showed how the lower-level parts of the brain can affect us in powerful ways without our even knowing it. Damasio turned to a man he called “David,” who had lost the ability to recall anything he was exposed to, even if it had happened less than a minute earlier. On numerous occasions, three different men visited David. One treated him with consistent kindness, one was emotionally neutral, and a third was always unpleasant. David’s injury was so profound that after the men left his sight, he couldn’t recall anything about them. But when he was later asked to choose from photographs the man who might be a friend, he always picked the nice guy. He couldn’t explain the choice, except to say it was based on a feeling.

David and the other patients who have appeared in Damasio’s books, including “Looking for Spinoza,” illustrate the idea that the feeling sections of the brain and the higher-level “thinking” parts perform a never-ending dance of chemical and electrical signals that produce judgments about all sorts of things. One region of the brain is not necessarily superior to the other. Indeed, in his writings, Damasio has shown great respect for our ability to feel, noting that the most coldly calculating among us are sociopaths who lack the feelings that keep the rest of us from committing violence. For example, emotionally detached serial killer Gary Ridgway, responsible for at least 48 murders in the Puget Sound area, described killing as a “career.”

By using technology in the study of the mind, and then writing about it in a provocative and popular way, Damasio inspired a surge of new science that is producing answers to questions once believed to be beyond answers. “For people interested in emotion and decision-making, he fired the starting gun,” Camerer says.

The race begun by Damasio is, in part, a competition to determine the roles and influence of various parts of the brain. As this work has progressed, researchers have come to refer to the limbic system as the lower brain because it resembles similar structures in less advanced animals. In situations where the lower brain dominates, one could argue that we behave instinctually. Similarly, reasoning, logic and analysis depend on the cortex and its subdivisions. It is this higher brain that gives us conscious thought, takes in new information and performs the intellectual tasks that distinguish humans from the rest of Earth’s creatures.

Though we like to think we can make choices based on objective facts, in truth the decisions are almost always bound up with feelings. Fear, for example, is most likely at work whenever we make decisions that seem to set aside reason in favor of avoiding pain.

Economist David Romer of UC Berkeley cites as an example the assumption among football coaches that it is almost always better to punt the ball on fourth down than to try for a first down. After studying 700 games, Romer is certain the odds favor going for it. But few coaches do because failure to gain the needed yards gives an advantage to their opponents, and thus is often seen as reckless. "They are afraid of risk and drawn by the illusion of having control over what’s going to happen," Romer explains.

The aversion to that risk can be exceptionally strong if the coach has experienced an embarrassing defeat—and howling derision from fans.
Psychologists at UCLA reported biological evidence of the emotional power of rejection in October. Matthew Lieberman and his colleagues used MRI to monitor the brains of students playing a game of catch called “cyberball” with images on a monitor. When the other “players” excluded them, their social rejection activated the same brain regions as physical pain. This occurred even when players were told that the rejection was not intentional, but rather the result of a malfunctioning computer.

The UCLA researchers theorize that the pain of rejection is harbored in the same old-brain place as physical pain, because social connections were a matter of life and death to our ancient ancestors. “It would have been be a signal for us to reestablish social bonds before harm came to us,” Lieberman says. “It may be vestigial, but it still serves us when we are very young and dependent on others for survival.”

Knowing that our lower brains crave fairness, but fear pain and rejection, could help us in many ways. The most obvious could be in arenas where factual information abounds, but feelings often lead us astray. Economist Romer points to stock market investors, who swim in a sea of data but are subject to the dangerous pull of market psychology. How else to explain why Martha Stewart broke the law to save a relatively small sum by trading on insider information?

Doctors and families facing tough medical decisions, where the experiences of thousands of patients can be weighed and analyzed, might also benefit. “The truth is, an analytical model can sometimes beat the best judgment of an experienced doctor,” Romer says.

A compelling example of how life-and-death choices can be shaped illogically by the emotional brain is offered by Joshua Greene, a postdoctoral fellow at Princeton. Greene and his colleagues rolled people into an MRI machine to see how their brains worked on moral judgments that we might assume are guided almost entirely by intellect. While the scanner displayed the biology of their thoughts on computer screens, subjects were presented with two hypothetical problems. First, they were told that a speeding train was about to kill five people. They could be saved if a switch was thrown, diverting the locomotive to a spur, where it would run over just one person. In the second problem, a similar scenario was described, but the five people could be saved if the subject pushed someone off a bridge in front of the train.

The two problems involve the same trade—one life for five—and have the same consequences. But the majority of subjects saw them quite differently. Most said that they would throw the switch that promised to send one person to his death while sparing five others. But when it came to shoving someone off a bridge and into the path of the speeding train, to save just as many lives, the majority refused.

This pattern didn’t startle Greene—philosophers have been puzzled by it. The brains of those people who lay in the MRI devices offered a solution. When confronted with the idea of shoving another person to his death, the brain’s emotional centers became more active. When technology distanced the subjects from the actions that caused another’s death—in the first scenario they would only have to move a lever—their emotional centers showed less activity and they could decide how to act.
By refusing to act personally and directly to save lives, people may be demonstrating what Greene calls “the byproduct of a Stone Age neurological structure” that programs us to avoid killing. This is why a choice sometimes feels good—like an absolute truth—when it may be morally wrong.

“In some settings, emotions can be a very blunt instrument for decision-making,” Greene says. “They can be triggered by certain things, and they can wash away the important subtleties of certain issues. The point is that emotions are an important part of how we make choices.”

The Princeton research could have a profound effect on the way ethics, morality, and even religious tenets are taught in the future. On a practical level, patients, families and doctors could also consider the Greene group’s work as they make painful choices about treatments and the quality of life. In such settings, moral choices that just “feel right” may be balanced with hard science that says those feelings aren’t enough.

While he doesn’t think the Columbine High School massacre of 1999 could have been averted, UCLA’s Lieberman believes talking through emotional pain might help short-circuit the aggressive reactions of troubled, uncommunicative kids. “If you think about what happened at Columbine, you have two individuals who were abused and socially rejected again and again,” Lieberman says. These experiences might have been ameliorated by an appeal to the killers’ higher brains.

“There are far more connections made from the rational part of the brain down than there are coming up from the emotional areas,” Lieberman says. “There is a lot of top-down control. A number of studies have shown this. Putting negative emotional experience into words disrupts the response” of the lower brain.

The prospect of using neuroscience to make us wiser and safer in the ways that Lieberman and the others describe makes their work seem exciting. But other potential uses for their theories and technologies give a thoughtful person pause. For example, Camerer says that one day doctors may be able to measure a child’s potential for making bad, impulsive, even criminal choices. Would they be declared dangerous and subjected to controls before they do anything harmful?

Closer at hand is the possibility that corporations could use neuroscience to develop ad campaigns that appeal subtly to our lower brains. Of course, many companies already do this in unsuitable ways. Beautiful faces and bodies are placed next to tubs of Coors beer because they evoke pleasure in the minds of many viewers. Mouthwash commercials provoke our fear of social isolation. The difference is that MRI imaging of consumers’ brains can help them develop emotion-based marketing that is supercharged. Cars, electronic gadgets and even household products could be designed, packaged and marketed to completely bypass reason.

If the idea of scientifically calibrated lower-brain consumer products and advertising don’t bother you, consider politics. Romer hopes that as people come to understand the influences of emotion, we will be inclined to seek out experts and information to help us compensate for
our biases. But isn’t it just as likely that political candidates and parties will learn to exploit our limbic systems to gain power?

Camerer says we all can appreciate the nuanced dance of reason and emotion every day in our own lives. To demonstrate, he recently met me for lunch at Jerry’s Famous Deli in West Hollywood, where the menu offers what seems like a thousand items, and that’s before you look at the drinks and desserts.

In another era, an economist such as Camerer would have scanned all the diners in the red vinyl booths and predicted that they would make rational choices based on the value of different items, their dietary needs and their level of hunger. For decades this kind of analysis was accepted wisdom among economists. Indeed, as a doctoral candidate at the University of Chicago, Camerer was surrounded by professors whose faith in the reasoning consumer was unshakable. They taught him that individuals make decisions, including basic purchases, as adept players in the free market.

But Camerer is no longer convinced. “Most of the people here decided what to eat based on the feelings they experience when they think about certain foods.” He then challenges me to judge who is right, the traditional economists or the neuroscientists, by considering my own choices.

In front of me was a plate of fried kreplach, a cholesterol-laden dietary disaster introduced to me years ago by a friend at this very restaurant. I had been thinking about him, and the kreplach, as I walked into Jerry’s. Beside the little dumplings was half of a pastrami sandwich, just like the ones I share with my wife whenever we eat at a deli. Both dishes appealed to my heart, not my need for nutritional value.

Camerer smiled broadly as I confessed to the emotion behind my meal.

Last year Camerer was offered a job on the East Coast. Emotionally, he wasn’t ready. “So my cortex formed a rationalization. I was getting married at the time and I just decided that I couldn’t handle one more big change in my life.” Was it the best option from a professional perspective? Camerer can’t be absolutely certain. “But it felt right and it still does.”

Just like kreplach and pastrami.