**NEWSWEEK AUGUST 9, 2004**

**The new science of decision making. It's not as rational as you think.**

BY JERRY ADLER

Flat on my back, my eyes shrouded with LED goggles and my ears encased in headphones, I was trundled [pushed] into the maw [orifice] of an fMRT machine in a basement lab at the California Institute of Technology.

The business end of an fMRT is a giant cylindrical magnet […] with the add ability to show changes in brain activity as they happen […] In the control room next door are Steven Quartz, a Caltech neuroscientist, and Colin Camerer, an economist, who are looking inside my brain […], which was helping science explain why, despite centuries of progress in economic theory since Adam Smith, actual human beings so often refuse to behave as equations say they should.

For all its intellectual power and its empirical success as a creator of wealth, free-market economics rests on a fallacy, which economists have politely agreed among themselves to overlook. This is the belief that people apply rational calculations to economic decisions, ruling their lives by economic models. Of course, economists know that the world doesn't actually work this way; if it did, you wouldn't need a financial adviser to remind you to save for retirement. But until recently the anomalies were chalked up to the pernicious influence of emotions, emanations from the primitive regions of the brain, a kind of mental noise interfering with the pure, rational expression of economic self-interest.

The new paradigm sweeping the field, under the rubric of "**behavioral economics,**" holds that studying what people *actually* do is at least as valuable as deriving equations for what they *should* do. And when you look at human behavior, you discover, as Camerer and his collaborator George Loewenstein of Carnegie Mellon have written, that "the Platonic metaphor of the mind as a charioteer driving twin horses of reason and emotion is on the right track-except that **cognition is a smart pony, and emotion a big elephant:"** The IMRI machine enables researchers in the emerging field of neuro-economics to investigate the interplay of fear, anger, greed and altruism that are activated each time we touch that most intimate of our possessions, our wallets.

Economists have many ways of demonstrating the irrationality of their favorite experimental animal, *Homo sapiens.* One is the "ultimatum game," which involves two subjects-researchers generally recruit undergraduates, but if you're doing this at home, feel free to use your own kids. Subject A gets 10 dollar bills. He can choose to give any number of them to subject B, who can accept or reject the offer. If she accepts, they split the money as A proposed; if she rejects A's offer, both get nothing. As predicted by the theories of mathematician John Nash (subject of the movie "A Beautiful Mind"), A makes the most money by offering one dollar to B, keeping nine for himself, and B should accept it, because one dollar is better than none.

But if you ignore the equations and focus on how people actually behave, you see something different, says Jonathan D. Cohen, director of the Center for the Study of Brain, Mind and Behavior at Princeton. People playing B who receive only one or two dollars overwhelmingly reject the *offer.* Economists have no better explanation than simple spite over feeling shortchanged. This becomes clear when people play the same game against a computer. They tend to accept whatever they're offered, because why feel insulted by a machine? By the same token, most normal people playing A *offer* something close to an even split, averaging about $4. The only category of people who consistently play as game theory dictates, offering the minimum possible amount, are those who don't take into account the feelings of the other player. They are autistics.

The fMRI machine shows how all this works inside the brain. A low offer stimulates activity in the brain's insular cortex, a relatively primitive region associated with negative emotions including anger and disgust. This appears to compete with the more highly evolved prefrontal cortex, the locus of the rational impulse to take the dollar and go buy a soda with it. The more activity in the insular cortex, the more likely subjects were to reject the offer. This is a big step toward being able to see on a screen what people actually want, rather than what they say in focus groups or interviews. Would brain-scan-assisted matchmaking or employee headhunting be more efficient than the way these have been carried out until now? Or would the fMRI merely ratify the judgments of intuition? Psychologists can hardly wait to find out.

And for their part, economists can hardly contain their glee at the research horizons this opens up. "Imagine if you could go on the floor of the stock exchange and see what was

going on in traders' brains," says Camerer. "We kept hearing during the bubble that people were behaving as if they were in a delusional state. Well, were they or weren't they?" People don't save enough for their retirements because of a phenomenon known as forward discounting: they value money more in the here and now than 20 years down the road. If we could understand how this process works in the brain, says Paul Glimcher, a leading neuroscientist at New York University, we would have a head start on figuring out how to overcome it.

Much of Glimcher's work is with monkeys, which can be implanted (safely and painlessly, he stresses) with electrodes that can detect in real time the firing of a single neuron. By contrast, the fMRI only indirectly tracks brain function by measuring blood flow. This is an imprecise indicator both spatially - it deals with regions of hundreds of thousands of neurons - and temporally, since it lags several seconds behind the neural activity it reflects. Monkeys, obviously, don't save for their retirements, and you couldn't expect them to grasp the rules of the ultimatum game. But they do have a rudimentary concept of economic choice, and researchers have discovered a medium of exchange - Berry Berry fruit drink - that can usefully stand in for money in a monkey's mental life.

To illustrate how monkeys make economic decisions, Glimcher's former colleague Michael Platt, now at Duke, has investigated how they value status within their troop. Male monkeys have a distinct dominance hierarchy, and Platt has found they will give up a considerable quantity of fruit juice for the chance just to look at a picture of a higher-ranking individual. This is consistent with field observations, Platt says, which have found that social primates spend a lot of time just keeping track of the highest-ranking troop member. It isn't known exactly why monkeys do this, but the finding might help

explain the behavior of human beings who pay $1,000 just to sit in a hotel ballroom with the president. You can draw whatever conclusion you choose from Platt's finding that there is no quantity of juice sufficient to get a male monkey to look away from the hindquarters of a female in estrus.

Glimcher is trying to piece together the building blocks of economic choice in the brain, starting at the most basic level of a single neuron. In weighing options - a gamble on a roulette wheel, say, or the purchase of a bond economists invoke the concept of expected value." It is the potential payoff of a given course of action, multiplied by the chance of

collecting it. Hence the expected value of flipping a coin to win $1 is 50 cents. A more sophisticated mathematical function called "expected utility" takes into account most people's inborn aversion to risk, and appears to more accurately reflect how people actually make these choices. Tossing a coin for $10 million or getting a guaranteed $5 million both have the same expected value, but a different expected utility - and most people who aren't already millionaires would take the sure thing. (Or so economists believe. No one has come up with the funding to test the hypothesis.) In his monkey research, Glimcher has isolated individual neurons that fire in response to the expectation of getting a drink of juice. By manipulating the odds of getting the drink and the size of the drink, he has shown that the rate at which these neurons fire is proportionate to the expected utility of the juice payoff. The implication is electrifying, especially to economists: an abstract, mathematically derived formula appears to be literally hard-wired into the primate brain.

**A**ND THAT, IN TURN, IS A STEP toward the holy grail of marketing: being able to figure out how people will make choices that haven't been offered yet. The same tools that can answer deep questions about primate behavior can also be used to get people to sign up for more cell-phone minutes than there actually are in a month. A handful of researchers in the United States and Europe are already using fMRIs to test how product brands are represented in the brain. The goal of every consumer marketer is to have people "identify" with a brand, to develop the kind of loyalty that goes far beyond a utilitarian preference for, say, one kind of pickup truck over another. Emory University psychologist Clint Kilts scanned subjects as they looked at a variety of products, from cars to soft drinks, and found that this sense of brand identification elicited a strong response in the medial prefrontal cortex. This is the brain area associated with what psychologists call the "sense of self", one's self-constructed identity. His insights are now being offered to the corporations of the world through the BrightHouse Neurostrategies Group in Atlanta, a pioneer in the emerging field of neuromarketing. "There's a pretty big gap in our understanding of consumers, which neuroscience can help close," says Justine Meaux, a researcher at BrightHouse. But - well aware of the Orwellian implications of this work - she hastens to add that "there's no 'buy button' out there to be found. We're

not going to subvert free will. This isn't about screwing the consumer:”

Glimcher has thought about these questions, too. Based on his research into choice and preference, he says, "If a corporation came here and said, `We want to be able to tell the lowest salary a candidate will accept for a job,' I wouldn't do it. But given six months or a year, I think it would be possible:' Of course, he admits, you couldn't scan people's brains, practically or ethically, without their knowing it. So they would have to voluntarily submit to an fMRI scan. Would they? Well, Glimcher says, "how badly do you want the job?"

Inside the scanner at Caltech, I played a version of what economists call the "investment game:" Quartz, in the next room, watched images of my brain while I manipulated a thumb switch and studied choices on fiber-optic goggles. At the same time his collaborator Read Montague was overseeing a subject inside a similar machine in his laboratory at Baylor University. The game is played thus: at the start of each of 10 rounds, I am given an imaginary stake of $10. I can keep it all, or "invest" some or all of it with my opposite number at Baylor. Anything I invest gets tripled, and the other player then has the option of returning any portion of that amount back to me. If I keep $5 and invest $5, the other player has $15 to divide between us. He can keep it all and send me nothing if he chooses, but since in this version of the game we play for 10 rounds - there are also one - round variations - he obviously has an incentive to keep my trust. This game investigates one of the hottest topics in behavioral economics: interpersonal trust. Observing that some societies are consistently richer than others, social scientists have invoked such ingenious explanations as "the Protestant ethic" (of working and saving for the future) or "the resource curse" (when an élite controls a valuable natural resource, such as oil, and has no incentive to encourage political and economic modernization). One of the newest explanations is "trust," which varies widely between societies and is strongly correlated with economic growth, says Paul Zak, an economist at Claremont Graduate University. Trust encourages savings and investment, and reduces the "transaction cost" of investigating the people you do business with. But, compared with well-studied behaviors such as aggression, relatively little is known about the biological basis for trust. (Zak's own research is not on brain function directly, but on oxytocin, a hormone that seems to promote trust. It is usually studied in relation not to the stock

market but to lovemaking and breast-feeding.)

"If we knew what creates trust and could intervene to encourage it, we could do a lot of good for the world," says Camerer. Hence the investment game. Because the participants have no outside force to keep them honest, it represents an unusually pure test of interpersonal trust in a laboratory setting. And I was determined to ace it! I didn't get a seat on the subway to work for 39 consecutive days last year by trusting the other passengers to leave one for me.

My approach, it turns out, is consistent with some of the findings coming out of Quartz and Montague's research. The cingulate cortex, which processes both emotions and abstract thinking, becomes especially active after one player betrays the other by cutting back on how much he shares as if the brain, or at least this crucial part of it, is "hypertuned" to detect betrayal. Quartz has also seen intriguing differences between men and women in the scanner. Men's brains tend to shut down after they've made their decision, awaiting a reply from the other subject. But women don't relax so easily; they show continued activity in at least three areas-the ventral striatum (the brain's center for anticipating rewards), the ventral medial prefrontal cortex (which is involved with planning and organizing) and the caudate nucleus (a checking and monitoring region, sometimes associated with obsessive-compulsive disorder). Women, says Quartz, seem to obsess more over whether they did the right thing-and how the other subject will react to them.

There's one other intriguing discovery coming out of this work, which has even the scientists baffled: with approximately 85 percent accuracy, the subjects, separated by the distance from Los Angeles to Texas, can guess whether they're playing against a man or a woman. They appear to be picking up on subtle clues in the interactions that the scientists themselves haven't identified.

So here was my strategy. In total defiance of the social norms that should incline me toward cooperation and trust, I pursued the single-minded goal of amassing as many points as possible. Recognizing that the more I invested the more money there would be for both of us to split, on each round I sent all $10 to my counterpart, who routinely returned $16 (of $30) to me-just enough over half to keep me going.

That is, until the ninth round, when, I calculated, the other subject could come out

ahead by keeping the whole $30. So I got there first: I "invested" zero. I did the same on the last round and cleared a hypothetical $148 ($16 times eight rounds, plus $10 times two rounds) to her (or his) $112 ($14 times eight rounds). And I pulled off one more coup: I figured out, correctly as it happened, that I was playing against a woman. I reasoned that a man would have been just as competitive as I am, and guessed that I was going to betray him on the ninth round-so he would have kept all $30 to himself on the eighth round. (At least, most of the ones I know would have.) Out of such insights, scientists are constructing a model for some of the most intricate and sophisticated decisions a fully evolved human being can face in the modem world. And maybe, in some small way, if Camerer and his colleagues are right, making the world a more trusting and cooperative-and peaceful-place.

With MARY CARMICHAEL