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Neuroeconomics

Do economists need brains?

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A new school of economists is controversially turning to neuroscience to improve the dismal science

FOR all the undoubted wit of their neuroscience-inspired concept album, "Heavy Mental"—songs include "Mind-Body Problem" and "All in a Nut"—The Amygdaloids are unlikely to loom large in the annals of rock and roll. Yet when the history of economics is finally written, Joseph LeDoux, the New York band's singer-guitarist, may deserve at least a footnote. In 1996 Mr LeDoux, who by day is a professor of neuroscience at New York University, published a book, "The Emotional Brain: The Mysterious Underpinnings of Emotional Life", that helped to inspire what is today one of the liveliest and most controversial areas of economic research: neuroeconomics.

Illustration by Otto

In the late 1990s a generation of academic economists had their eyes opened by Mr LeDoux's and other accounts of how studies of the brain using recently developed techniques such as magnetic resonance imaging (MRI) showed that different bits of the old grey matter are associated with different sorts of emotional and decision-making activity. The amygdalas are an example. Neuroscientists have shown that these almond-shaped clusters of neurons deep inside the medial temporal lobes play a key role in the formation of emotional responses such as

fear.

These new neuroeconomists saw that it might be possible to move economics away from its simplified model of rational, self-interested, utility-maximising decision-making. Instead of hypothesising about *Homo economicus*, they could base their research on what actually goes on inside the head of *Homo sapiens*.

The dismal science had already been edging in that direction thanks to behavioural economics. Since the 1980s researchers in this branch of the discipline had used insights from psychology to develop more "realistic" models of individual decision-making, in which people often did things that were not in their best interests. But neuroeconomics had the potential, some believed, to go further and to embed economics in the chemical processes taking place in the brain.

Early successes for neuroeconomists came from using neuroscience to shed light on some of the apparent flaws in *H. economicus* noted by the behaviouralists. One much-cited example is the "ultimatum game", in which one player proposes a division of a sum of money between himself and a second player. The other player must either accept or reject the offer. If he rejects it, neither gets a penny.

According to standard economic theory, as long as the first player offers the second any money at all, his proposal will be accepted, because the second player prefers something to nothing. In experiments, however, behavioural economists found that the second player often turned down low offers—perhaps, they suggested, to punish the first player for proposing an unfair split.

Neuroeconomists have tried to explain this seemingly irrational behaviour by using an "active MRI". In MRIs used in medicine the patient simply lies still during the procedure; in active MRIs, participants are expected to answer economic questions while blood flows in the brain are scrutinised to see where activity is going on while decisions are made. They found that rejecting a low offer in the ultimatum game tended to be associated with high levels of activity in the dorsal stratium, a part of the brain that neuroscience suggests is involved in reward and punishment decisions, providing some support to the behavioural theories.

As well as the ultimatum game, neuroeconomists have focused on such issues as people's reasons for trusting one another, apparently irrational risk-taking, the relative valuation of short- and long-term costs and benefits, altruistic or charitable behaviour, and addiction. Releases of dopamine, the brain's pleasure chemical, may indicate economic utility or value, they say. There is also growing interest in new evidence from neuroscience that tentatively suggests that two conditions of the brain compete in decision-making: a cold, objective state and a hot, emotional state in which the ability to make sensible trade-offs disappears. The potential interactions between these two brain states are ideal subjects for economic modelling.

Illustration by Otto

Already, neuroeconomics is giving many economists a dopamine rush. For example, Colin Camerer of the California Institute of Technology, a leading centre of research in neuroeconomics, believes that incorporating insights from neuroscience could transform economics, by providing a much better understanding of everything from people's reactions to advertising to decisions to go on strike.

At the same time, Mr Camerer thinks economics has the potential to improve neuroscience, for instance by introducing neuroscientists to sophisticated game theory. "The neuroscientist's idea of a game is rock, paper, scissors, which is zero-sum, whereas economists have focused on strategic games that produce gains through collaboration." Herbert Gintis of the Sante Fe Institute has even higher hopes that breakthroughs in neuroscience will help bring about the integration of all the behavioural sciences—economics, psychology, anthropology, sociology, political science and biology relating to human and animal behaviour—around a common, brain-based model of how people take decisions.

Mindless criticism

However, not everyone is convinced. The fiercest attack on neuroeconomics, and indeed behavioural economics, has come from two economists at Princeton University, Faruk Gul and Wolfgang Pesendorfer. In an article in 2005, "The Case for Mindless Economics", they argued that neuroscience could not transform economics because what goes on inside the brain is irrelevant to the discipline. What matters are the decisions people take—in the jargon, their "revealed preferences"—not the process by which they reach them. For the purposes of understanding how society copes with the consequences of those decisions, the assumption of rational utility-maximisation works just fine.

But today's neuroeconomists are not the first dismal scientists to dream of peering inside the human brain. In 1881, a few years after William Jevons argued that the functioning of the brain's black box would not be known, Francis Edgeworth proposed the creation of a "hedonimeter", which would measure the utility that each individual gained from his decisions. "From moment to moment the hedonimeter varies; the delicate index now flickering with the flutter of the passions, now steadied by intellectual activity, low sunk whole hours in the neighbourhood of zero, or momentarily springing up towards infinity," he wrote, poetically for an economist.

This is "equivalent to neuroeconomics' brain scan," notes David Colander, an economist at Middlebury College in Vermont, in an article last year in the *Journal of Economic Perspectives*, "Edgeworth's Hedonimeter and the Quest to Measure Utility". Later economists such as Irving Fisher, Frank Ramsey (who proposed a utility-measuring machine called a "psychogalvanometer") and Friedrich von Hayek would discuss the role of the complex inner workings of the brain. Hayek cited early advances in neuroscience to explain why each individual has a unique perspective on the world.

The reason why economists in the late 19th century and much of the 20th put the rational utility-maximising individual at the heart of their models was not that they thought that economics should avoid looking into the brain, but because they lacked the technical means to do so, says Mr Colander. "Economics became a deductive science because we didn't have the tools to gather information inductively. Now, better statistical tools and neuroscience are opening up the possibility that economics can become an abductive science that combines elements of deductive and inductive reasoning."

The big question now is whether the tools of neuroscience will allow economics to fulfil Edgeworth's vision—or, if that is too much to ask, at least to be grounded in the physical reality of the brain. Studies in the first decade of neuroeconomics relied heavily on active MRI scans. Economists' initial excitement at being able to enliven their seminars with pictures of parts of the brain lighting up in response to different experiments (so much more interesting than the usual equations) has led to a recognition of the limits of MRIs. "Curiosity about neuroscience among economists has outstripped what we have to say, for now," admits Mr Camerer.

A standard MRI identifies activity in too large a section of the brain to support much more than loose correlations. "Blood flow is an indirect measure of what goes on in the head, a blunt instrument," concedes Kevin McCabe, a neuroeconomist at George Mason University. Increasingly, neuroscientists are looking for clearer answers by analysing individual neurons, which is possible only with invasive techniques—such as sticking a needle into the brain. For economists, this "involves risks that clearly outweigh the benefits," admits Mr McCabe. Most invasive brain research is carried out on rats and monkeys which, though they have similar dopamine-based incentive systems, lack the decision-making sophistication of most humans.

One new technique being used by some neuroeconomists is transcranial magnetic stimulation, in which a coil held next to the head issues a low-level magnetic pulse that temporarily disrupts activity in a certain part of the brain, to see if that changes the subject's preferences—for example, for a particular food and how much he is willing to pay for it. However, this tool, too, has only limited applicability, as it cannot get at the central temporal node of the brain where much basic reward activity takes place.

Still, Mr Camerer is confident that neuroeconomics will deliver its first big breakthroughs within five years.

Likewise, Mr McCabe sees growing sophistication in neuroeconomic research. For the past four years, a group of leading neuroeconomists and neuroscientists has met to refine questions about the brain and economic behaviour. Researchers trained in both neuroscience and economics are entering the field. They are asking more sophisticated questions than the first generation "spots on brains" experiments, says Mr McCabe, such as "how these spots would change with different economic variables." He expects that within a few years neuroeconomics will have uncovered enough about the interactions between what goes on in people's brains and the outside world to start to shape the public-policy agenda—though it is too early to say how.

The success of neuroeconomics need not mean that behavioural economics will inevitably triumph over an economics based on rationality. Indeed, many behavioural economists are extremely pessimistic about the chances that brain studies will deliver any useful insights, points out Mr Camerer with regret.

However, Daniel Kahneman, a Princeton University psychologist who in 2002 won the Nobel prize in economics for his contribution to behavioural economics, is an enthusiastic supporter of the new field. "In many areas of economics, it will dominate, because it works," says Mr Kahneman.

Even so, "we are nowhere near the demise of traditional neoclassical economics," he argues. Instead, insights from brain studies may enable orthodox economists to develop a richer definition of rationality. "These traditional economists may be more impressed by brain evidence than evidence from psychology," he says; "when you talk about biology either in an evolutionary or physical sense, you feel they have greater comfort levels than when you start to talk about psychology."

In this respect, Mr Kahneman's Princeton colleagues and neuroscience-bashers may be making a mistake in bundling behavioural economics—soft mind science—and neuroeconomics—hard biology—together. "It is far easier to argue for mindless economics than for brainless economics," he says.