CORTEX VALUES

Marcello Costa says that neuroeconomics is the hot topic in brain studies, revealing that the "dismal science" may be more emotion than rationality.

The idea that hidden motivations may play a role in the economic behaviour of individuals is not new. The simplistic notion that economic behaviour can be explained on the basis that individuals behave purely as rational agents is beginning to crumble.

All aspects of behaviour are becoming legitimate subjects of brain studies (neuroscience). Growing evidence shows that it is the brain, with its fine filaments (nerves) attached to the body, which controls every aspect of human life. The brain not only is involved in the exquisite sensory and motor skills of walking, running, grasping, maintaining balance etc but is also in the ongoing "involuntary" control of fundamental bodily functions, such as intake of food, air, water and salt, while maintaining an internal constant temperature. These are all brain functions that impact on individual behaviour.

We share these functions with most humble animals, from frogs up. But more than anything else we share with mammals a significant social life, which involves individual cooperative and competitive behaviour for survival. The increasing mutual dependence for the development of offspring has been accompanied by a dramatic increase in the "social brain". Sentiments and feelings are added onto the deeper structures of instincts, aversions, fears and aggression. The rational mind appears as an icing on a complex evolutionary cake, perhaps less involved in determining human behaviour than anticipated. It is of no surprise then that the search for models of behaviour in economic systems has shifted from assumption of pure "rational" behaviour to searching for deeper psychological determinants.

Social sciences have attempted to deal with the complexities of behaviour of large numbers of individuals borrowing physico-chemical metaphors and, increasingly, their conceptual and mathematical tools. The idea that the market is controlled by simple factors of demand and supply appealed because of its simple similarity with chemical reactions coming spontaneously to equilibrium. This idea has begun to show its limitation in parallel with the realisation that even simple physical and chemical systems, when kept far from equilibrium, show remarkably unpredictable rich and varied behaviour, described in the past decades as chaotic. This led to the fertile field of non-linear dynamics (chaos theory) which now permeates every field. Economics is no exception. It is usually far from equilibrium.

A number of writers in economics have pointed to the exquisite non-linear nature of economic processes and thus the intrinsic complexity that can be generated in the real world even by only a few factors interacting in a non-linear way. Benoit Mandelbrot, the founder in 1977 of fractal geometry, the geometrical equivalent of non-linear dynamics, had already by 1963 written about the non-linearity of "the variations of certain speculative prices"[1].

Brian Arthur was among the first to point out the consequences of the non-linear nature of economic processes. His work debunked the myth that unconstrained competitive behaviour leads naturally to a balanced state of affairs[2]. Since then, a number of books have analysed the intrinsic fallacy of ignoring human psychological factors in economic models[3].

Social behaviour and economics have a common link in the history of gambling

Psychology has begun to affect economics. In 2002, Daniel Kahneman shared the Nobel Prize for Economics "for having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty". The justification by the Nobel committee pointed out that "His work has inspired a new generation of researchers in economics and finance to enrich economic theory using insights from cognitive psychology into intrinsic human motivation". The 2005 Nobel Prize for Economics went to Robert J. Aumann and Thomas C. Schelling "for having enhanced our understanding of conflict and cooperation through game-theory analysis".

Indeed the link between social behaviour, economics and brain sciences goes back to a common link embedded in the history of gambling. The relation between game theories and economic behaviour was highlighted by the mathematical physicist John von Neumann, who developed the theoretical basis of the modern computer in the 1950s. With economist Oskar Morgenstern, von Neumann wrote a book in the mid-40s entitled *Theory of Games and Economic Behaviour*.

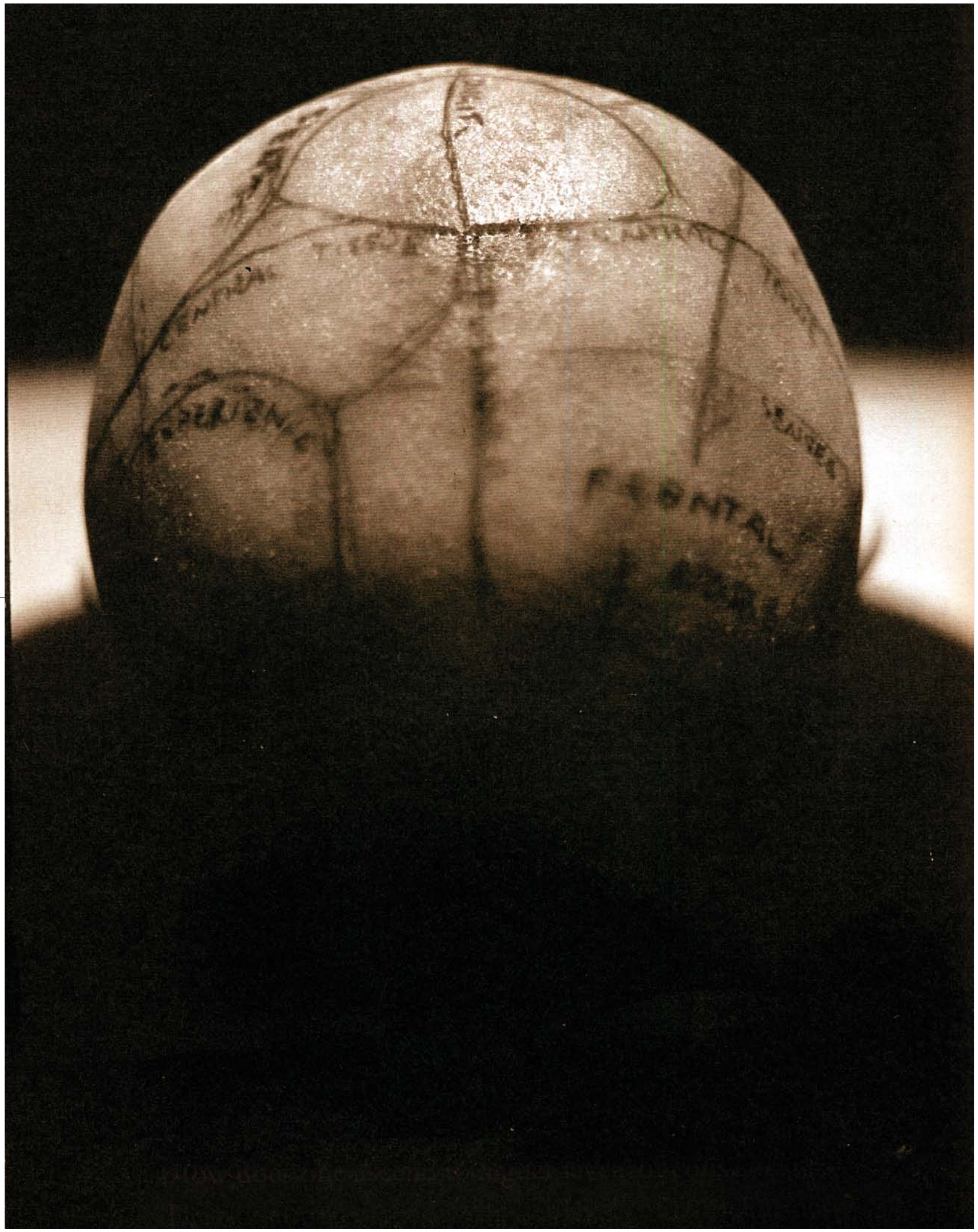
One of the best examples of such social games is the "prisoner dilemma", in which two prisoners suspected of committing a crime are offered a chance to testify against the other to gain immunity. If neither testifies against the other, both will receive a light sentence. The crucial element in this game is the introduction of temptation with the choice of acting in a more or less selfish way.

This "non-rational" element brings to sociology and political science and, of course, economics, a new world of emotions, such as risk-taking, trust and mistrust, retaliation, fear, reward and punishment. Aumann and Schelling addressed the problem of why some groups of individuals, organisations and countries succeed in promoting cooperation while others suffer from conflict. Their work has established game theory – or interactive decision theory – as the dominant approach to this difficult question.

And with these highly emotive, psychological dimensions, brain sciences make their entrance in economics. Hence neuroeconomics, which combines economics and psychology, to study how we make choices.tests of consumer response to commercials.

While economics, psychology and mathematics were coming together, neuroscientists since the 1800s were investigating brain mechanisms of mammalian cooperation, which underlie social activities such as caring for offspring, mating behaviour, mutual attachment and eventually trust. The parts of the brain most involved with emotions and social behaviours include the hypothalamus, the master controller of most biological regulation, and several other centres deeply embedded in the brain, such as the amygdala and the nucleus accumbens. These centres, as are all components of the brain, consist of complex networks of millions of nerve cells and are interconnected by other millions of nerve cells. Nerve cells, or neurons, communicate with one another via small chemical molecules called neurotransmitters.

In recent years one of the neurotransmit-



ters involved in these circuits was found to be a small peptide (short sequences of aminoacids) called oxytocin. This substance was already well known to be a hormone (ie circulating in the bloodstream), important in the initiation of labour and lactation. In recent years it has been found, as neuroscientist Antonio Damasio writes, that in animals oxytocin "contributes to social attachments, including male and female bonding after mating, mother and infant bonding after childbirth, and assorted sexual behaviours"[4].

Michael Kosfeld and his students in Zurich reasoned that, since oxytocin facilitates approaches between animals perhaps necessary for reproduction and caring against a natural reluctance to lower the defences, it might well also mediate similar, higher-order, attitudes in humans that we call "trust". They developed an ingenious experiment in which oxytocin or a placebo was sprayed into the noses of participants of an "economic game" with investors and trustees and real interchange of money. Their work, published in Nature earlier this year[5], showed that investors who received oxytocin exhibited more trust in anonymous trustees than investors who received the placebo. This and other studies[5] provide powerful evidence that a brain chemical transmitter actually changes economic behaviour, and is a stark reminder that we cannot ignore our deep evolutionary roots as mammals, and our biological make-up. It is also an indicator that neuroeconomics is probably here to stay.[6]

Those concerned with reducing human behaviour to simple animal behaviour should take heart at the fact that the "social brain" in humans has increased in relative size disproportionately compared with other animals. It can be said that that our brains are specialised for social cognition with the cortex, particularly the frontal lobes, interconnected with the deep centres, acting as supervisors of deep drives and emotions. This evolution of self-regulation of drives and emotions probably led to the emergence of more subtle motivations and "rational" cognitive social functions.

Perception of the surrounding social environment involves evaluating and judging trustworthiness in people. The evolutionary ancient parts of the brain, which include centres such as the orbitofrontal cortex, the insula, the amygdala, the caudate nucleus and the nucleus accumbens, are all involved in some aspect of social evaluation[6] and relevant decision making[7].

In a recent research paper on the neuroscientific bases of economic exchange, scientists visualised activity in the brain of individuals during a test involving trustors and trustees[8]. One of their main findings was that one of the deep brain centres, the caudate nucleus, becomes active as a trustee learns to reciprocate with a trustor. The activation of this brain centre is observed initially at the time decisions are revealed, but then the activation also occurs earlier, presumably in anticipation of receiving trust from another. This suggests that at first people closely monitor each other trying to "read each other's mind" to model each other's intentions, and then make shortcuts to reach a decision. This process involves mechanisms of predicting errors and associated rewards, common to many other human activities.

Such reward processes appear to involve some of these brain centres, including the nucleus accumbens and the chemical transmitter dopamine. Naturally reward mechanisms are heavily involved in addictive behaviours, including taking drugs of dependence, addiction gambling, risk-taking behaviours, etc. Is it possible that some form of such addictive behaviours occurs also in the highest spheres of economic behaviour? Similarly, self and social psychological punishing mechanisms involve brain mechanisms that are almost certainly also involved in economic behaviour.

Is the mixing of neuroscience with economics yet another a fad in a post-modernist society?

Interestingly, there is a flurry of activity, with several groups, both in academic and private institutions, portraying themselves as "experts" in this new field. A number of centres dedicated to neuroeconomics already exist. Academics and economists are flocking to international conferences organised under newly formed societies on neuroeconomics. A superb collection of articles in this field, presented at the Second Conference on NeuroEconomics (ConNEcs) in Muenster, Germany, in May 2004, has been published recently.9 Several courses in neuroeconomics are offered by credible academic institutions.

The subject is beginning to attract the interest of the popular press, ranging from the now almost classic cover article of the October 2002 Money Magazine by Jason Zweig entitled "Are You Wired for Wealth?", to a recent Catalyst program entitled "Trust", broadcast last October on ABC TV with Mark Horstman interviewing some of the major players in the field.

Neuroeconomic research raises predictable ethical concerns of why should "brain scientists" be allowed to influence views of what is normal or abnormal, and thus desirable and undesirable economic behaviour. Will, for instance, future bank managers, economic advisers and politicians involved in determining economic policies be evaluated by neuroscience-based tests as to their suitability for the job? Will they be tested for their psychophysical suitability to be economic operators as prospective commercial pilots are tested before flying?

From a more ominous perspective, will knowledge of the deeper mechanisms of economic behaviour be used to profit private organisations against individual rights? Such strategies based on psychological findings are already being applied, with psychologists involved in marketing or simply in studying ways of facilitating specific choices in supermarkets on the basis of disposition, colours, catchy phrases, etc.

Modern neuroscience brings a deeper understanding and with it a greater potential power of influencing choices. For example the program of a workshop on neuroeconomics held at Stanford University aimed to understand how psycho and pharmaco-therapies can normalise deranged affective circuits and to decompose how affective circuitry modulates decision-making and economic behaviour.

Will future bankers be evaluated by neuroscience tests on their suitability?

Are these things to come? The new field of "neuromarketing" claims to "investigate product branding, preference, and purchase decisions via 'neuroscientific' techniques". Will neuroscientists be involved in developing more effective means, including perhaps drugs, to increase trust, to augment reward systems and to influence economic decisions and acquire personal preferences? Not surprisingly, there are already companies looking into using brain studies to supplement or replace traditional tests of consumer response to commercials.

Equally unsurprising is the development of a "Neuroethics Project" to focus public attention on trends in pharmacology and neuro-technology that have an impact on individual rights of "freedom of mind". With this project, the Centre for Cognitive Liberty & Ethics (CCLE) seeks to educate and foster public debate in relation to emerging neurotechnologies and drugs, and to encourage social policies that respect and protect the full potential of the human intellect.

The fusion of the fields of neuroscience and economics will have long-lasting implications for society. But perhaps history should teach and reassure us that, behind excessive expectations and fears of new developments, there is probably always a lasting legacy of increased awareness of ourselves, awareness that is likely to give society a better chance to make intelligent choices. A good dose of healthy scepticism may help. ■

References

1 Mandelbrodt, B. The variations of certain speculative prices, The Journal of Business 35, 394-419, 1977.

2 Arthur, B. Competing technologies, increasing returns and lock-in by historic events, Economic Journal, 99, 116-131, 1989.

3 Sence, P. M. (1992), The Fifth Discipline; The Art & Practice of the Learning Organisation, Random House; Diamond, M. A. (1993), The Unconscious Life of Organizations; Interpreting Organizational Identity, Quorum Books; Ormerod, P. (1994), Death of Economics, Faber and Faber; Davies, G. (2004), Economia; New Economic Systems to empower people and support the Living World, ABC Books; Ball, P. (2004), Critical Mass; How one thing leads to another, Arrow Books.

4 Damasio, A. Brain Trust, Nature, 435, 571-572, 2005

5 Kosfeld, M. et al. E. Oxytocin increases trust in humans, Nature 435, 673–676, 2005; Zak PJ, et al. Oxytocin is associated with human trustworthiness. Horm Behav. Aug 16, 2005; Zak PJ.Trust: A temporary human attachment facilitated by oxytocin. Behav Brain Sci. 28(3):368-369, 2005.

6 Glimcher PW, Rustichini A, Neuroeconomics: the consilience of brain and decision. Science. 15;306, 447-52, 2004; Terry Burnham & Jay Phelan. Mean Genes: From Sex to Money to Food: Taming our Primal Instincts. Perseus 2005; Paul Glimcher. Decisions, Uncertainty, and the Brain: The Science of Neuroeconomics. MIT Press, 2003; Colin F Camerer. Behavioural game theory; Experiments on strategic interaction. Princeton University Press, 2003.

7 Adolph R. Cognitive Neuroscience of Human Social Behaviour. Nature Reviews, 4, 165-178, 2003; Schultz W. Neural coding of basic reward terms of animal learning theory, game theory, microeconomics and behavioural ecology. Curr Opin Neurobiol. 14(2):139-47, 2004.

8 Brooks King-Casas, et al. Getting to know you: reputation and trust in a two-person economic exchange. Science, 308, 78-83, 2005.

9 Brain Research Bulletin, 67, 341-442, Edited by P. Kenning, et al. 2005

Marcello Costa is a member of the Australian Academy of Science and MSD Professor of Neurophysiology in the Department of Human Physiology and Centre of Neuroscience, School of Medicine, Flinder University

SOME CENTRES AND LABORATORIES ON NEUROECONOMICS

- A neuroeconomics lab has been established at Stanford University
- New York University: The Center for Neuroeconomics.
- University of Muenster, Germany: The ConNEcs collaboration have performed important research in their joint marketing neurology group.
- An academic and commercial workgroup on neuroeconomics at the University of Bonn Medical Centre, Germany on NeuroCognition
- A neuroeconomics study group has formed at Hong Kong University (HKUST).
- George Mason University also has a neuroeconomics lab
- At Claremont Graduate University there is a center for neuroeconomics sciences
- The Neuro-Economy Department was established at the University of Münster
- The George Mason's Interdisciplinary Center for Economic Science includes neuroeconomics.
- Center for Neuroeconomics Studies exists at Claremont Graduate University, Claremont, CA

SOCIETIES AND CONFERENCES ON NEUROECONOMICS

- A conference on neurobehavioural economics was held in 1997 at Carnegie-Mellon University
- A conference on neural economics was held at Princeton University in December 2000
- The first academic conference entitled "Neuroeconomics" was held at the University of Minnesota in October of 2002
- The 3rd annual meeting on neuroeconomics organised by the Society for Neuroeconomics was held on Hiawah Island, USA in 2004
- A neuroeconomics conference was held in Charleston, SC. in 2004.
- The 2nd ConNEcs Annual Conference on Neuroeconomics" in Muenster in 2004.
- The Society for Neuroeconomics was incorporated in 2005 and promotes the research and dissemination of knowledge in neuroeconomics
- Aneuroeconomics conference was held on Kiawah Island Resort, South Carolina, USA in 2005
- The 3rd ConNEcs Annual Conference on Neuroeconomics is planned for May 2006 in Muenster, Germany.

COURSES IN NEUROECONOMICS

- Stanford University's Psychology and Economics Departments organises neuroeconomics workshops
- The California Institute of Technology and New York University offers a course in Neuroeconomics
- George Mason University offers a neuroeconomics course
- Caltech University offers a course syllabus with readings for the course on "Neural Foundations of Social Science".