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AN INSIGHT INTO NEUROECONOMICS

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Many of todays economists are no longer satisfied with economic theory and predictions based on the underlying assumption that individuals behave rationally. Previous essays in this journal attempted to overcome this assumption by supplementing economics with psychology. David Delaney and Jean Devlin now look at the exciting new area of neuro-economics which aims to improve economic understanding by analysing the workings of the human brain, thereby allowing for irrationality.

Introduction

Jean: So when is this essay due?
David: The 31st of February

People act in strange ways. We often say or do things contrary to information known to us. Economic theory views this as irrational behaviour. The concept of rationality is central to economics. Unfortunately for economic theorists, very often people, particularly David, do not think in this way. Economists have come up with many ways to augment the concept of rationality, such as subjective expected utility theory (Rustichini, 2005) and non-parametric econometrics; however the shortcomings of rationality assumptions are indicative of a larger gap in traditional economic theory – it is this gap that neuroeconomics seeks to fill.

In essence neuroeconomics is a new extension of economic theory that provides previously unavailable data - namely, neurophysiological data obtained from neuroscientific tests such as MRI scans, heart rate measures and galvanic skin response – with a view to concretely explaining the intermediate process hitherto assumed away with 'as if' modelling or assumption of algorithms. The potential of this new addition to improve economic theory should not be underestimated.

As one of the social sciences, the basic subject of economics is human behaviour, and the basic task of the economist is to establish useful predictions about these sets of actions. The traditional method in economic

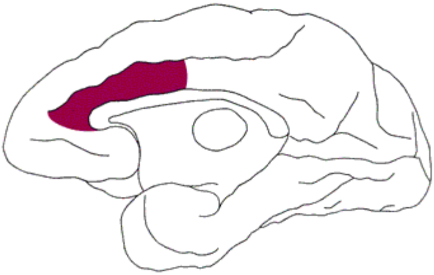
theory has been to take information such as incentives, preferences and feasibility constraints as inputs and observed behaviour as the output (ibid). They have tended not to worry themselves with the process in between. For instance, game theory relies on *'as if'* modelling of human behaviour; we don't know, for example, if firms really are profit-maximisers, but they act '*as if'* they are. The predictive capacity of economic theory (i.e. the ability to say what will happen if an individual or a society selects one course of action over another) is entrusted with complex problems - devising ways to make poor countries richer, optimising world trade - that have significant impact on the ordinary lives of its human subjects.

In this sense it is useful to draw a comparison with the medical sciences, which are also charged with finding solutions to urgent problems (Wilson, 1998). This comparison, however, shows the accomplishments of economics in a dismal light – against breakthroughs in research and new treatments for AIDS and cancer and vaccines for debilitating diseases including polio, economics has yet to come up with a formula for the optimal amount of fiscal regulation, for example, or specifying a future income distribution within and between nations (ibid). The 'laws' of economics, and of social science in general, are much more fluid than those of the natural sciences; but why is this? And how can neuroeconomics improve this capacity?

Shredder: "You have a brilliant brain, Krang."
Krang: "Of course. It's all I really am!"

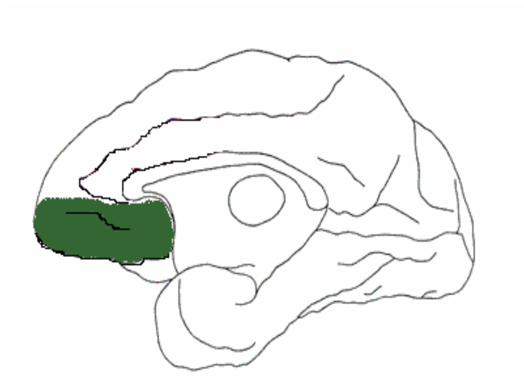
There are three main structures in the brain that neuroeconomists are interested in examining. The first, the anterior cingulated cortex, is concerned with cognitive functions, such as anticipating rewards and decision-making.

Figure 1: Anterior Cingulated Cortex



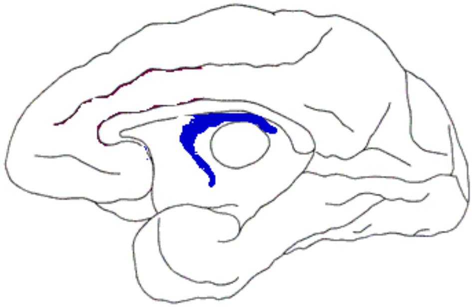
The second, the orbitofrontal cortex is involved in the decision making process, it is considered part of the limbic system and is associated with motivation. It is more active in risk takers than in introverts.

Figure 2: Orbitofrontal Cortex



The third part of the brain we are concerned with is the ventral striatum. The ventral striatum is involved in processing the likely rewards of some action and is important in how we form our beliefs.

Figure 3: Ventral Striatum



These parts of the brain are investigated by using MRI (magnetic resonance imaging) scans, which use magnetic waves and the echoes which

rebound off these structures in the brain to analyse when each particular part is being used (www.wikipedia.org). Neuroeconomists can make inferences based on the functions of each structure and the changes that occur in the brain as the challenges which are posed to individuals differ. These results allow us to make new inferences about the nature of rationality in individual decision-making. As a specific example of where assumptions about rationality have broken down, we will look at the model of consumer choice.

Eeny, meeny, miny, mo

Consumer choice is based on the idea of revealed preference. This says that the best indicator we have of a person's preferences is to look at the choices they have made. The General Axiom of Revealed Preference (GARP) states that if an allocation X is revealed preferred to Y, then Y is never strictly directly revealed preferred to X. That is, X is never strictly within the budget set of Y. When a choice is made, GARP attributes choice preferences to this which rationalize this behaviour. GARP is a necessary and sufficient condition for data to be consistent with utility maximisation. At an aggregate level neither Varian (1993) nor Swoffard & Whitney (1987) found there to be any violation of GARP using non-parametric tests[1]. At a micro level, however, results were quite different. In experimental settings, subjects were asked to choose a position on a budget set between two goods. These results were then analysed, and if the results for different budget sets were found to be completely random, then the null hypothesis (i.e. the assumption) of GARP could be rejected. Mattei, in a microanalysis of GARP, observed that between 30% and 50% of results taken from Swiss consumer panel data rejected the null of rational preferences. In his study Mattei comments "we find a considerable number of violations of the revealed preference axioms, which contradicts the neo-classical theory of the consumer maximising utility subject to a budget constraint. We should therefore, pay closer attention to the limits of this theory as a description of how people actually behave" (Mattei, 2000:487).

What neuroscience is finding is that our intuitive understanding of the way preferences are formed is flawed. Neo-classical economics only looks at preferences in terms of the observed choices at the end of the decision process. It analyses the choice one makes by assuming the existence of one common indifference curve for all possible beliefs that we have. For example, whether I believe that the stock market will go up or go down, my maximisation problem will be the same. In reality, if the stock market goes down, this may come as a surprise to me, hence my indifference curve in this case will be flatter to allow for a different trade-off between risk and return. In contrast, if the stock market went up in value I would be more willing to take on extra risk. Neoclassical economics neglects this possible flexibility of preference curves. Neuroeconomics is changing this, by suggesting that preferences can be divided into different types of beliefs which we hold about the probability of different outcomes. This should allow us to model different indifference curves based on the probability of different outcomes occurring.

"I believe I can fly!" - Anonymous

Using neurological techniques Camerer and Bhatt (2005) have shown that they can separate the different types of beliefs that people have and the choices to which these correspond. They analyse two separate types of beliefs: 1st order or self-referential beliefs, and 2nd order beliefs or beliefs about what one thinks other people think they will choose. Equilibrium in

[1] non-parametric tests allow econometricians to analyse data when specific assumptions underlying the formulation of that data is unknown

this case is defined as the correlation between these types of beliefs and the final choice that the individual makes. Equilibrium therefore conforms to the neoclassical opinion that beliefs can be analysed based on the observed choice which an individual makes. Disequilibrium provides more interesting results and ones related to the real world in which decisions are made under uncertainty - uncertainty regarding the effects of an action, but also the actions which other individuals will take. This type of disequilibrium is modelled by allowing some individuals a set length of time in choosing their action while others must make split second decisions.

It has been shown that when making decisions concerning themselves, individuals are less concentrated on forming beliefs about their current situation; rather, they concern themselves with choosing an action. Interestingly, when it comes to considering the possible action of other players in the game, there is a great deal of neural activity in the ventral striatum. This shows that when thinking about the other person the player is analysing the likely rewards of their own action, given the other player's likely action; i.e. it is crucial to how we figure out our reaction. This type of inference has wide ranging applicability to economics. For instance we can analyse economic changes that will have effects on increasing disequilibrium in the decision making process, or increasing the correlation between the choices which we make and the beliefs preceding this action. It will allow us to specify the type of information needed to increase the speed at which we are able to make 'rational decisions' and increase our own welfare.

Conclusion

In summary, the application of neurophysiological techniques to measure and test economic behaviour is an increasingly popular method of investigating the empirical formation of beliefs and choices, the knowledge of which is crucial to understanding, and ultimately, predicting human economic behaviour. The exposition of one such application, to consumer choice models, is an example of the promise that neuroeconomics holds towards this end. However, that is not to dismiss the substantial advances made by neoclassical theory. It provides very powerful explanations of some economic phenomena – for instance, the Federal Reserve Board in the USA has successfully prevented major recession or depression from occurring through careful manipulation of monetary policy. However, it is biased in its fulfilment of the principles scientists lay down for scientific theories, and this bias leads to two major weaknesses that this essay has pointed out. The first is its obsession with universality. The stringency with which neoclassical economics upholds the principles of parsimony[2] and generality[3] makes for universal laws that must necessarily cover all possible economic arrangements (Wilson, 1998). This is not only unrealistic given the innate traits of human behaviour, but as Rustichini (2005) points out, the axiomatic system employed means that economic theorists must, from the beginning, specify behaviour in *all* possible choices – in effect, they must provide the answer before they can ask the question.

The second weakness stems from the hermetic character of economic theory – it examines economic behaviour in a vacuum, sealed off from the myriad complexities of human behaviour. *Homo economicus* exists because of this a priori consequence where economic action has become independent of reality. These weaknesses hinder the incorporation of the two other principles of scientific theory. Consilience - having units and processes that conform to solidly verifiable knowledge in other disciplines – is the major stumbling block of economic theory, and up to the emergence of neuroeconomics, the discipline has more or less made no attempts to seriously consider what other disciplines reveal about the exact nature and sources of individual behaviour. This is the major impediment to the achieving the fourth principle, predictiveness. As we have argued, it is at this point that neuroeconomics has entered the discipline in an attempt to bridge the gap and ultimately improve the accuracy of economic predictions by focussing on the most basic (neurophysiological) level at which human decision-making can be measured – what happens in the brain.

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[2] the fewer units and processes used to account for a phenomenon, the better

[3] the greater the range of phenomena covered by the model the more likely it is to be true

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