

# Neuroeconomics: A sceptical view<sup>1</sup>

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## Introduction

Neuroeconomics has been hailed by its advocates as affording “ground-breaking” insights into human behaviour and significant theoretical advances through conceptual trading with neuroscience. The prospect of the discovery of the proximate causes of behaviour by measuring thoughts, feelings, and hence utility is, according to neuroeconomists, within reach. Thus, neuroeconomics will permit the completion of the work of the Classical School in providing a unified theory of human behaviour, and avoiding the problems of “as if” reasoning in standard economics – so its advocates declare.

These striking claims are ultimately founded in the empirical application of a variety of neuro-imaging and neuro-pharmacological experimental techniques, including: electroencephalogram (EEG); positron emission topography (PET); (repeated) trans-cranial magnetic stimulation ((r)TMS); functional magnetic resonance imaging (fMRI); single neuron electrophysiology experiments, which attempt to establish the specialized neurons in decision making processes, and the measurement of specific neuro-hormones in blood samples.

The growth of neuroeconomics has been significant. The Society for Neuroeconomics (<http://neuroeconomics.org/>) was founded in 2005 with the purpose of fostering research on the foundations of economic behaviour through the facilitation of scholarly collaboration between economists, neural scientists and psychologists, and the “continued advancement of the field”. Considerable investment has been made in the area with dedicated neuroeconomics facilities having been established at more than a dozen, mainly US, academic institutions. This has been accompanied by a ten-fold increase in publications relating to neuroeconomics in a decade (Glimcher, 2008). It has also generated special issues of *Economics and Philosophy* and the *Journal of Economic Methodology*, and has stimulated interest from heterodox and non-mainstream economists (Davis, 2011; Herrmann-Pillath, 2009; Martins, 2011).

Glimcher (2008) traces the first attempt to combine neuroscientific data with social science to Shizgal and Conover in 1996. This was then followed by the publication of two papers in 2001 by Breitner *et al* and McCabe *et al*. Glimcher considers that the “critical insight” from these studies concerned the mapping of decision-making in the brain as a two-part system: the first is composed of the frontal cortex and basal ganglia, considered to be the sites of valuation, which are then transferred to fronto-parietal circuits that are claimed to judge and then direct the motor system for execution of the decision (see also Camerer, *et al*, 2004; Zak, 2004). These studies were based on imaging techniques, a new dimension in neuroeconomic procedures was presented by Kosfeld, *et al* (2005) who in a letter to *Nature* argued that neuropharmacological studies revealed that changes in the level of the

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<sup>1</sup> This paper draws on on-going collaborative work with Francesca Cavallaro, and Marco Novarese. The latter is based at the Centre for Cognitive Economics, Università del Piemonte Orientale, Italy. The arguments presented here do not necessarily reflect the views of my colleagues.

neuropeptide oxytocin plays a “central” role in the regulation of behaviour (see the subsequent work of Zak, 2004, 2008a, b, 2011; Vercoe and Zak, 2010).

However, the innovative application of such techniques has drawn criticisms from within standard economics, especially relating to neuroeconomic empirical procedures, sample size, data dissemination (see for example, Harrison and Ross, 2010), and indeed its relevance to mainstream economics (Gul and Pessendorfer, 2005). Harrison (2008: 41) contests that neuroeconomics is beset by “marketing hype” and that confounding evidential problems, a lack of empirical transparency, and “poor economics” will transpire to make it, “even harder for anyone to know what poses for scientific knowledge in economics and what is just story-telling”. Nonetheless, there is recognition of the potential of neuroeconomics to inform economics (for example, Bernstein, 2009; Mäki, 2010), and that any new scientific endeavour is likely to be subject to initial methodological and procedural difficulties (Mäki, 2010).

This short paper sets out to provide a brief outline of neuroeconomics, its claims, and to subject these claims to some scrutiny from a non-mainstream economic perspective. Neuroeconomics is typically presented as a fairly unified emerging approach, but this is contested here in an attempt to lend credence to the argument that neuroeconomics’ empirical basis is fundamentally underdetermined. Accordingly, the view expressed is rather sceptical as the framing of the ‘economics’ in ‘neuroeconomics’ is profoundly reductionist and incapable of providing the explanatory depth its proponents claim. The following section considers the nature of neuroeconomics; this is then followed by an outline of the main claims made by its advocates. The following two sections highlight tensions within the literature and offer some critical observations. The paper is not intended to be comprehensive nor exhaustive, but to contribute to a process of heterodox economic critical engagement.

### **The nature of neuroeconomics**

According to the originator of the term – Paul Zak – neuroeconomics seeks to combine the methods of neuroscience, endocrinology, psychology, and economics as a means of comprehending and explaining social decision-making<sup>2</sup>. It is the “consilience of brain and decision” (Glimcher and Rustichini, 2004). For another prominent advocate, Paul Glimcher (2008: 2):

“The goal of Neuroeconomics is to combine ... three approaches (economics, neuroscience and psychology) into a single discipline that employs constraints and insights from each level of analysis [to understand how we make decisions]”.

The overarching aspect to neuroeconomics is the relationship between the biological and social sciences. Reflections of this are evident in marketing, politics and sociology, and there has been much attention devoted to the so-called “new behavioural turn” in economics (Sent, 2004). This “turn” primarily seeks to re-engage economics with psychology (Davis, 2011; Hands, 2010; Sent, 2004) following a drift between the two over the course of the twentieth century, and as a means of advancing economic theory. Kahneman and Tversky’s (1979) article on the seeming irrationalities of decision-making under risk and subjective valuation is frequently viewed as a defining moment (see for example, Glimcher, 2008; Sent, 2004) in that

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<sup>2</sup> See Zak’s website: <http://www.neuroeconomicstudies.org/>

it prompted further investigation of the psychology of rational choice and evidence appearing contrary to the tenet of standard economic behavioural theory. This (new) behavioural literature, however, retains the rational choice tenet; seeking instead to develop variations of it (Hands, 2010; Zafirovski, 2000) in conjunction with analyses of the impact of “irrational” emotions, information asymmetries or impediments.

Following this another prominent advocate, Colin Camerer, describes neuroeconomics as:

“The use of data on brain processes to suggest new underpinnings for economic theories, which explain how much people save, why there are strikes, why the stock market fluctuates, the nature of consumer confidence and its effect on the economy, and so forth. This means that we will eventually be able to replace the simple mathematical ideas that have been used in economics with more neurally-detailed descriptions” (Camerer, 2004: *Neuroeconomics*, [http://www.hss.caltech.edu/%7Ecamerer/web\\_material/n.html](http://www.hss.caltech.edu/%7Ecamerer/web_material/n.html))

The “neurally-detailed descriptions” to which Camerer refers are applied in conjunction with a variety of game theoretic experiments, and endeavour to interrogate a host of behavioural phenomena, including: preferences, utility and rewards; co-operation, fairness, trust and altruism, and learning and strategy (for example, Camerer, *et al*, 2004, 2005; Glimcher, 2003; Glimcher *et al*, 2005; Kenning and Plassman, 2005; Vercoe and Zak, 2010; Zak, 2004, 2010).

The measurement of brain processes frequently applies experimental game theoretic techniques, in both imaging and neuro-pharmacology. Popular among those procedures is the ‘ultimatum’ game, which attempts to assess and measure co-operative behaviour between subjects, and may be decomposed into two elements – intentional and random games; the latter acting as a “control”. In the intentional game subjects are rewarded a small sum of money, typically in the region of \$10, for attending the experiment and are randomly assigned to two roles – decision maker 1, who is required to make the initial decision (the “proposer”) and decision maker 2 (the “responder”) the subsequent decision. Subjects are informed that their decisions and those of their fellow decision maker will determine how much money they will earn. Individuals are randomly paired, and pairings are anonymised – all interactions are made via a computer interface. The proposer is invited, by the computer, to make some payment out their \$10 to the responder (this could include zero). All participating subjects are informed that whatever is sent by the proposer to the responder will be tripled by the organiser. After informing the responder of the amount transferred this subject is then prompted to send an amount of their choosing, again including zero, to the first subject. Each decision is made serially and after all decisions were made subjects were paid. The second experiment consists of a random draw from an urn containing eleven balls numbered from 0 to 10. This draw held constant the amount of money received by the responder from the initiator, but importantly, removes the intentional signal from the interaction (see, for example, McCabe, *et al*, 2001; Vercoe and Zak, 2010, and Camerer, *et al*, 2005 for a survey).

In studies of the relationship between the hormone oxytocin and trust and co-operation Zak (2008a), Zak and Knack (2001), and Zak *et al* (2004; 2007) employed experimental techniques mainly based on the ultimatum game. The results of these experiments consistently found nearly twice the amount of oxytocin in the blood of second responders participating in the intentional game (Zak, 2008a; Zak *et al*, 2004; Zak *et al*, 2007). The findings suggest a positive relationship between oxytocin levels and “pro-social

behaviour” via the “social signal of trust” (Zak, *et al*, 2004: 226). Zak *et al* emphasise the amount transferred in their “intentional game” provides some measure of trustworthiness in that some financial sacrifice is inherent to signalling trust and expectations of reciprocity. The authors argue that oxytocin activates the parasympathetic system which is associated with co-operative behaviour and is accordingly an important element of human physiology. Therefore, the initial trustworthy signal induces the production of oxytocin which reinforces trust and reciprocal co-operative behaviour. This they argue supports an earlier study by Zak and Knack (2001) which concluded trust, through its impact on investment and trade, was an important predictor of economic performance.

In later studies Zak *et al* (2007) and Vercoe and Zak (2010) administer oxytocin and other substances, such as arginine vasopressin and testosterone<sup>3</sup> to subjects. They argue their findings suggest subjects highly dosed with oxytocin transfer greater sums in the trust game even “controlling” for risk and attitudes to risk. Other findings include an absence of any relationship between arginine vasopressin and generosity or punishment, and no difference in the “moralistic punishment threshold” (in men) with administrations of arginine vasopressin and testosterone. From these results Vercoe and Zak (2010), and Zak (2011) develop an empathy-generosity-punishment model characterised as a “brain circuit”: Human Oxytocin Mediated Empathy (HOME), which they claim offer economics both an improved comprehension of human behaviour through experimentation with drugs to cause changes in brain activities, and by exposing economic method to inductive reasoning.

### **Neuroeconomic claims**

Based on these “groundbreaking” (and other subsequent) studies (Glimcher, 2008), neuroeconomists make several notable claims both that economics will be enriched methodologically in that greater levels of precision and explanatory depths can be provided; it renders “as if” reasoning redundant (Camerer, *et al*, 2005; Camerer, 2007). This is an aspect of conventional economic method highlighted by Fine (1999) as a key dimension to economics’ “colonising” trait. Fine argued that economics applied the “as if” notion of rationality and co-ordination “as if” by the market to the social domain, such as the family, politics and civil institutions. If Camerer, *et al* are correct in their assertion then, *prima facie*, it appears that Fine’s case is weakened. A richer psychological profile of the individual can be modelled that goes beyond the stereo-typical *homo economicus*. This also suggests that the attainment of a unified theory of behaviour is significantly closer: it is no longer any need to “sidestep” psychological detail. For example, Camerer (2007), in positively ebullient tones, argues that neuroscience enables the *direct* measurement of thoughts, feelings and hence utility. Rustichini (2005: 203-204) further notes that the more ambitious aim for neuroeconomics is: “to complete the research program that the early classics (in particular Hume and Smith) set out ... to provide a unified theory of human behaviour”. Thus, neuroeconomists claim to confound William Jevons’ (1874) classic argument that the quantification of feeling was not possible. Jevons had claimed: “Every mind is ... inscrutable to every other mind, and no common denominator of feeling seems to be possible” (1874: 85). Neuroeconomics would appear then to offer the prospect of discovering Jevons’ missing

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<sup>3</sup> Arginine vasopressin is important in maintain water balance in the body, and when released in the brain is associated with “per-reproductive” behaviour, especially in males. This may be manifest as bonding to offspring and mates and aggressive behaviour to others (especially males). The aggressive aspect is emphasised: high testosterone levels are claimed to be associated with anti-social behaviours (Vercoe and Zak, 2010).

common denominator. Indeed, further, it also claims to have discovered the “moral molecule” in oxytocin (Zak, 2008b) – the measurement of thoughts and morals appears to be in our grasp! Thus, as contract theory opened up the “black box” of the firm in microeconomics – neuroeconomics is claimed to offer comprehension of the “ultimate black box”: the brain (Camerer, 2007).

Specifically, for Camerer *et al*, neuroeconomics potentially makes two types of contributions to economics – incremental and radical. In the former, standard models are supplemented by the addition of variables with greater empirical support, thereby resonating with Kahneman and Tversky’s approach. For instance, Camerer *et al* note how the neurobiology of addiction constrains the utility from the future consumption of other commodities and the impact of environmental cues on demand. The radical contribution offers a more direct challenge to the benefit-cost calculus of *homo economicus* by emphasising emotionally-based behaviour as an “automatic” process.

Camerer *et al* stress two neuroscientific findings that could have profound implications for the calculative rational persona of *homo economicus*: First, the human brain implements “automatic” processes more quickly than conscious deliberation or calculation, where these processes have emerged to address problems of “evolutionary importance rather than respect logical dicta” (Camerer, *et al*, 2005: 11). Second, human behaviour is strongly influenced by emotions; the “affective” system. For Camerer, *et al* (2004) this challenges conventional conceptions of the ubiquity of cost-benefit decisions and analysis, Bayesian updating, time preference assumptions, and therefore central aspects of game theory. Nevertheless, the authors are reluctant to endorse a “radical” approach.

Camerer, *et al*’s (2004, 2005) neural architecture draws from cognitive localisation theories: different parts of the brain are primarily, but not exclusively, responsible for specific functions. For instance, the amygdala is associated with “positive and negative emotions” (see also Zak, 2004); the hippocampus with long-term memory; the cingulate cortex with attention and error detection, and the olfactory cortex with smell, and so forth. Camerer *et al* present the notion of the brain as two competing systems: the “affective”, reflects emotions, and the “cognitive”, referring to rational thought. There are echoes of this in Zak’s work (for example, 2008a, b, 2011). Zak identifies the emotional-moral processes in behaviour, associating these with Adam Smith’s *Theory of Moral Sentiments*, and contrasts this with rational deliberation, redolent of the behaviour (self-regarding) identified in Smith’s *Wealth of Nations*. He, however, dilutes the oppositional dimension of self (rational) and other regarding (emotional-moral) behaviours arguing that the two are not mutually exclusive and the dominance of one may be context dependent.

Zak (2008b) makes some remarkable claims on the basis of his (and others’) work in this area. He notes that exchange is predicated on particular “character values”, such as honesty, fairness, trust, and reliability, and argues strongly that markets are moral in that they both rely upon and promote such character values by punishing transgressors. Reducing transaction costs through “social behaviour” promotes social capital: a potent virtuous cycle is predicted by Zak. With reference to game theoretic experiments, Zak challenges standard agency theory in arguing that employee autonomy does not imply shirking. He goes further in contesting (2008b: *xiv*):

“Because of genetic heterogeneity, the claimed equal sharing of resources [he associates with ‘socialism’] triggered a race-to-the-bottom in work effort [in the former

‘socialist’ economies] – my genes are little, if at all, helped by extra effort, so why bother. The design of market economies, then, is congruent with our evolved genetic predispositions”.

### **Internal tensions?**

The foregoing, however, masks the evolution of neuroeconomics along potentially divergent paths, from Camerer *et al.*'s variation of “behavioural economics in the scanner” (Harrison and Ross, 2010) a possible challenge to rational choice, to Glimcher's (2003) variation, which Ross (2005) has termed “neurocellular economics”, supportive of rational choice. Zak's (2004; 2008b) neuropharmacological approach, which presents markets as sites of morality, offers a further dimension.

Given this, there may be doubts over the coherence of neuroeconomics that may undermine claims to present a unified theory of behaviour. Fumagalli (2010), for instance, outlines a “labyrinth” and “panoply” of differences (see also Harrison and Ross, 2010). By contrast, Vromen (2008) considers fracture points as exaggerated with neuroeconomics possessing a fixed reference point: rational choice. Nonetheless, potentially significant differences appear to be evident at two levels – neural architecture and departures from utility maximisation.

Ross's (2005) “neurocellular economics” theorises brains as distributed information-processing networks.

He considers the (mammalian) brain controls behaviour through learning about associations between reward predictors and categories of actions, and hence in this way brains and markets are claimed to share an important property – they are parallel processors of information and valuations. Ross believes the brain network can be readily modelled by constrained maximisation game theoretic experiments and simulations (see Glimcher, 2003).

Arguably, Ross's analytical entry point is the notion of multiple selves: individuals are collections of sub-individual optimising neurons that symbiotically interact in co-ordination games (Davis, 2011). Thus, a person is the result of both *intra* and *inter* personal (evolutionary) games; they are “sculpted” and “re-sculpted” over time with language playing a prominent role (Ross, 2005). Ross (2005: 248) argues that neuroscience instructs us that neurons and neural structures demonstrate the property of servosystematicity, which in essence refers to the ability to maintain themselves as relatively autonomous entities. After all, arguably the starting point of neuroscientific approaches is the segmented brain structure. Thus, for Ross agency resides in the optimising neuron.

This is also the case with Glimcher (2003), who rejects the competing systems frame of Camerer *et al.* In this Glimcher acknowledges the influence of the computer scientist David Marr. In modelling neurobiological architecture Marr considered that the most obvious entry point was to pose the question as to what a particular architecture was attempting to accomplish. Thus, (mainstream) economics permits the specification of the computational goal – (expected) utility maximisation – of the brain as it furnishes the benchmark for survival and reproductive success in human and non-human species. Indeed, in using experimental analysis of monkeys' choice behaviour and the behaviour of individual parietal neurons Glimcher (2003) offers the prospect of a *literal* application of the rational choice model. *Utility*

*maximisation occurs at the neural level and hence throughout the brain.* Pace Camerer *et al*, Glimcher and his colleagues contest that there is no evidence to substantiate the case for two “independent” systems – emotional or irrational and rational – within the brain. Indeed, in his book, *Decisions, Uncertainty, and the Brain*, Glimcher (2003) makes no reference to emotions.

Thus, the rationality debate within neuroeconomics is partly derived from seemingly divergent ontological positions regarding the structure of the brain. For instance, Camerer *et al*'s dualistic systemic view of the brain's structure adopts a localisation position that there are distinct decision-making modules within anatomical regions of the brain arising from differing evolutionary origins (see also, Zak, 2011). Contrastingly, Glimcher promotes a monistic ontology; conceiving a unitary neural structure, which is shaped by evolution in a fashion that promotes a unified behavioural pattern tailored to maximise reproductive success given environmental conditions.

An example of how the foregoing can lead to divergent interpretations of the same results is provided by experiments into the production of dopamine in monkeys in response to a reward, conducted by a team led by the neuroscientist Wolfram Schultz, and cited by both Camerer and Glimcher (Camerer, *et al*, 2005; Glimcher, 2003 and Glimcher *et al*, 2005). The experiment involved the measurement of neural activity in monkeys sitting passively in a quiet environment to establish the baseline resting state of neuron firing. “Quite” thirsty monkeys in the same environment and condition were then subjected to a “tone” followed by a “squirt” of juice directly into their mouths. No difference was observed in neural activity (of dopamine neurons), which Glimcher *et al* describe as *prima facie* “a curious result” given that the fruit juice is “reinforcing to thirsty monkeys” (Glimcher *et al*, 2005: 242). Without warning the magnitude of the juice (or reward) was increased substantially. In response there was a “dramatic increase” in neural activity. The continuance of this increased rate of reward through subsequent rounds led to a diminishing rate of neural activity until it eventually returned to the initial restive state. Additionally, when the tone sounded and was not accompanied by juice the firing rate of neurons diminished. From this the authors concluded that the neuron “seemed” to encode the difference between the expected and actual rewards incorporating any sustained change into modified expectations, which correspondingly, according to Glimcher, demonstrates the innate ability to value.

Camerer *et al* (2005) offer a differing interpretation of the same experiment. They highlight homeostasis: the process by which the body adjusts to external stimuli – such as sweating in relatively warm conditions – to maintain a “set-point”. Homeostasis can also, however, involve conscious and deliberate actions, such as putting on a coat when feeling cool. Thus, returning to the “set-point” or “equilibrium” engenders some feeling of satisfaction. On this basis Camerer *et al* (2005: 27) argue that the standard economic approach of utility maximisation “starts in the middle of the neuroscience account”. They argue that pleasure should not be viewed as the goal of human behaviour, but as a homeostatic “cue”, or signal. Homeostatic systems are sensitive to changes in stimuli as opposed to their levels. Hence, Camerer *et al* interpret the results of the Schultz monkey experiments also in terms of expectations, but not in the literal application of Glimcher *et al*. Somewhat ironically, Camerer *et al* employ the “as if” clause, thus: “When the juice was expected from the tone, but was not delivered, the neurons fired at a very low rate, *as if* expressing disappointment” (Camerer, *et al*, 2005: 28, emphasis added). For Camerer *et al* homeostasis is important in explaining sensitivities to change and, for instance, how happiness levels may be sensitive to changes in, as opposed to levels of, income.

However, Vromen (2008) contests that the differences represented by Camerer and Glimcher are more illusory than real. Vromen observes that Glimcher's approach relates to computations at the neural level and not the level of the mind. The two are ontologically distinct. Vromen notes Glimcher's argument in no way implies that neural activity is initiated in a deliberative fashion – it is effortless and proceeds in a highly mechanical manner (Glimcher and Rustichini, 2004): expected utility maximisation is the default mode arising from evolution.

As noted, Camerer, *et al*, and Zak define rationality as a deliberative process and note that most behaviour is non-deliberative, and on this basis deduce that it is non-rational in the standard economics sense. For Vromen it is this difference in the definition of "rationality" that leads to the apparent divergences. Indeed, he considers that Glimcher's neural level computations are equivalent to Camerer's affect-driven or automatic (and hence Zak's allusion to the emotional-moral dimension of behaviour). All are effortless and do not involve any deliberation. From this both camps indicate anomalies between "actual behaviour" and the standard rational choice model.

Yet all may not be as it seems. The stratified ontological properties Vromen refers to may be less than watertight. For instance, Zafirovski (2000) usefully distinguishes between 'first and second-class axioms' of rational choice theory. First-order approaches emphasise hyper-rationality or perfect rationality and are 'hard' and 'thin.' Second-order models are characterised by quasi, pseudo, or imperfect rationality and are 'soft' and 'thick.' The two differ in terms of their teleological definitions – in identifying actors' ends and motives – with first-order models demonstrating utilitarianist agnosticism. In the first order, actors' ends are not specified beyond utility maximization. Following Zafirovski's delineation, *pace* Vromen, Glimcher's neural level computations are not equivalent to Camerer *et al*'s affect-driven behaviour, but manifestations of different classes of rationality. Arguably, Camerer *et al*'s and Zak's positions are most appropriately represented as second order, given the roles ascribed to the "affective system" and emotions, whereas Glimcher, *et al*'s defence suggests a first order orientation. Again, if this is indeed the case then there are grounds for questioning neuroeconomists' contention of presenting a unified theory of behaviour.

### **Other reasons to be sceptical**

The divergent interpretations also suggest that neuroeconomics may be subject to weak underdetermination<sup>4</sup> concerning the saliency of first and second order rational choice. There may also be a case for articulating the first order position, as in Ross's and Glimcher's models, in terms of the strong variant of underdetermination, which implies that utility maximisation is unfalsifiable (McMaster, *et al*, 2011).

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<sup>4</sup> Underdetermination is associated with the Duhem-Quine thesis. In the weak form – associated with the French physicist, Pierre Duhem – hypothesis testing is subject to a profound weakness: following from the conjoinment of hypotheses, auxiliary assumptions, and *ceteris paribus* clauses, it is not possible to test an isolated hypothesis. Any one of the conjoined hypotheses/assumptions/*ceteris paribus* clauses may be responsible for any test results. In effect, empirical models lack sufficient data for the unequivocal realisation of an interpretation: data can be subject to a variety of interpretations, and are hence underdetermined. The stronger version, associated with Quine, suggests that any hypothesis or description can be rendered unfalsifiable through changes in conjoined auxiliary assumptions.



More specifically, a key assumption in neuroeconomic experimentation, derived for neuroscientific procedure, is subtraction. Imaging techniques apply the “subtraction” method to identify the location of neural activity. Subtraction is based on the measurement of brain activity during a task in the experimental context followed by the elimination of the focus activity during a control task, which is considered to provide a baseline of neural activity (Klein, 2010; Uttal, 2001; Zak, 2004). For example, experimental games in neuroeconomics apply subtraction in order to delineate between intentionality and randomness (see for example, Camerer, *et al*, 2005; Zak, *et al*, 2004). The baseline is the provision of monetary rewards to subjects in the absence of choice (randomness). The subtraction thus attempts to remove that element of neural activity derived from receiving, or anticipating the receipt of, the monetary reward, and then allows access to measure the separable effect induced by the process of choice. The selection of the control task is of considerable importance in establishing the robustness of the experimental process.

Importantly, subtraction methods are predicated on a linear, unidirectional systemic model of the brain. This assumes that neural activities are separable; brain activity is additive, i.e. the exercise of additional tasks involves additional brain function (Klein, 2010; Sidtis, *et al*, 2003; Uttal, 2001); the difference between subtracted recordings is the only source of significance; the components of cognitive function are “true”, and the subtracted activity is irrelevant. Brook and Mandik (2007); Coltheart (2006); Damasio (2006); Hardcastle and Stewart (2002); Klein (2010), and Uttal (2001), for example, argue that consensus in the literature beyond localisation studies indicates that the brain and nervous system is a highly complex, non-linear system with extensive feedback loops. Damasio (2006: 93) observes:

“It is appropriate to say that signals in the stream (of neural connections) move both forward and backward. Instead of a forward-moving stream, one finds loops of feedforward *and* feedback projections, which can create a perpetual recurrence” (original emphasis).

Thus, an important source of potential underdetermination rests on the auxiliary assumptions underpinning a key neuroeconomic empirical procedure and model of the brain (McMaster, *et al*, 2011). At best, this warrants caution in the interpretation of neuroeconomic findings.

This is augmented further by the seemingly limited account of the social dimension afforded by neuroeconomics. This is manifest in several ways, three of which are elaborated here.

In Zak and colleagues’ series of experiments, some, *prima facie*, interesting results are attained with reference to the positive association between oxytocin and levels of co-operation and trust. Yet, whilst this study relates to social relations and interactions little discussion is devoted to the social dimension. Zak *et al* do not explicitly define trust, tacitly their account appears to incite co-operation either as a manifestation of trust or a pre-requisite of trust, or *vice versa*. The elasticity of the concept of trust; its innate, conscious, unconscious and institutional properties are conflated and presumed to be measurable.

In effect, trust demonstrates stratified properties emergent from both human biology and social construction. Baier (1986: 235), for example, conveys this:

“When I trust another, I depend on her good will toward me. I need neither acknowledge this reliance nor believe that she has either invited or acknowledged such trust since there is such a thing as unconscious trust, as unwanted trust, as forced receipt of trust, and as trust which the trusted is unaware of”.

Thus, to consciously trust implies that there is some diminution in behavioural uncertainty (Nooteboom, 2002; Zucker, 1986). Parties orient behaviour on the basis of the expectations of the behaviour of others, and their motivations. Moreover, an agent may judge to interact with other agents on the basis of past experience. This engages with degrees of *entrustment*. Concisely, not only is the identity of the individual that is trusted of paramount importance, so is the question – what is to be trusted to them? The extent of any entrustment is influenced by shared values and loyalty (see, for example, Simon, 1991; Zucker, 1986).

At no point in their discussions do Zak *et al* make any reference to the social construction of trust; its learned or instinctive qualities; its fragility, nor its manifestations. Instead, as demonstrated in Vercoe and Zak (2010), the approach tends to the binary – administered or not-administered (a particular drug) leading to high trust-low trust interpretations to accommodate the measurability framing of modelling (or model closure).

Then there are Zak’s (2008b) and Ross’s (2005) invocations of the market. As noted, Zak makes the claim that markets are moral and promote morality through the enhancement of the “moral molecule”, oxytocin. This is all the more remarkable given the on-going financial crisis that commenced in 2007. Moreover, following DeMartino’s (2011a; 2011b) insightful analysis of ethics and the economics profession, Zak’s allusion seems to be founded on a “maxi-max” position, predicated on utilitarian and perhaps utopian perspectives that relegate individual autonomy and the ethical imperative of professionals exercising care, “to avoid preventable harm” (DeMartino, 2011a: 151). The maxi-max principle emphasises selection on the (consequentialist) basis of superiority of outcome relative to other possible courses of action. It does not, however, adequately account for uncertainty or deontology (DeMartino, 2011a). Given DeMartino’s argument, Zak’s references appear both naïve and crude.

The same cannot be said of Ross, who presents a more sophisticated and elegant argumentation. Nonetheless, Ross’s market-brain analogy – both, according to Ross, are processors of information and valuations – is perhaps over-egged. It acts to de-emphasise the power of institutions. The market merely facilitates the agency of other entities; there is no hint of conditioning. This contrasts with recent institutionalist-oriented accounts, which emphasise the centrality of language to social organisation and activity (Hodgson, 2003; Searle, 2005; ironically see also Ross, 2005, for a neoclassical perspective). In short, the argument places language as the fundamental institution predicating all other institutions through its recursive and communicative qualities, which are key to organizing, partly through language’s property of conveying rights and obligations in the reproductive capacities of institutions. Language therefore goes beyond symbolism; it invokes power in the shaping of social relations. Neuroeconomics’ neglect for these dimensions of language limits its analysis; there is no explicit recognition of social conditioning on the responses of their subjects (see also, Herrman-Pillath, 2009; Martins, 2011)<sup>5</sup>.

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<sup>5</sup> This may also reveal a further philosophical (and ontological) problem with Ross’s, and Glimcher’s, utility maximising neurons. Vromen (2008) convincingly argues that this conferral of agency is subject to a mereological fallacy: imbuing a property only attributable to the whole upon a part.

The social dimension further queries the saliency of Camerer, *et al*'s neural architecture in its delineation between two autonomous and competing systems (the "affective" and the "cognitive"), noted above. As Martins (2011) argues, Antonio Damasio's (2006) work on "somatic markers" accents the critical role emotions have in influencing the decision-making process; far from a separable or conflicting 'system' emotions are integral to rational decision-making. Actions and behaviour – how the brain selects mechanisms in framing behaviour and values on types of actions – depend upon emotions (see also Elster, 1998; Herrmann-Pillath, 2009; Twomey, 1998; Wolozin, 2005). Damasio identifies layers of emotion – primary (fear, anger, sadness, etc) and secondary (sympathy, compassion, envy, etc) – where primary are shared by all humans; they are an element of human neurobiology, whereas secondary are partially derived from primary emotions and also socially constructed. This resonates with Thorstein Veblen's advocacy of a stratified mind – conscious deliberation, habit, and instinct (Twomey, 1998)<sup>6</sup>.

Veblen's engagement with psychology over one hundred years ago seems remarkably prescient given recent neuroscientific endeavours. Veblen's emphasis on habit and a stratified conception of the mind provides a compelling analytical entry point in appreciating the intimate and complex relationship between habits, emotions and institutions. Again, by partly enabling, constraining and constituting the individual, institutions also influence human emotions, and *vice versa* (Wolozin, 2005). Yet whilst Camerer *et al* explicitly recognise emotions via their conceptualisation of an affective system they do not key into social referents and embeddedness and treat emotion as conceptually oppositional to cognition; there is much work suggesting otherwise.

Given the foregoing, I believe there is a case to question the veracity of neuroeconomics' epistemic claims. This, however, is not the same as saying that there is no value in neuroscience and neuroscientific referents for the study of economics and other social sciences. My scepticism lies in the framing of the 'economics' in 'neuroeconomics'; a framing that appears, perhaps unsurprisingly, to relegate the social and therefore generates lacuna as opposed to addressing them. It is not possible to characterise the human mind without appeal to language, and that language belongs to a linguistic community and accordingly embeds the individual into the social (see Davis, 2011; Dupré, 2005), but neuroeconomics appears if not ignore this then to treat it as a mere triviality. Vercoe and Zak (2010: 143) refer to Veblen's proposition that economics should be an evolutionary science and advocate the construction of "inductive models that are problem driven, rather than imagination driven (as in deduction)". It is a great pity Vercoe and Zak's reference to Veblen is so partial; further reading would have revealed the centrality of the social dimension to Veblen's work and to the comprehension of human behaviour.

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<sup>6</sup> Veblen drew from the nineteenth century psychologist William James (see for instance, Wolozin, 2005). James is cited with approval by Damasio (2006: 129) when he states: "William James, whose insights on the human mind have been rivalled only by Shakespeare's and Freud's, produced a truly startling hypothesis on the nature of emotion and feeling".

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