PART 1

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NEOCLASSICAL ECONOMIC APPROACHES TO THE BRAIN

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CHAPTER

2

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Introduction: Experimental Economics and Neuroeconomics

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OUTLINE

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INTRODUCTION

p0010 There are three interdependent orders of brain/mind decision-making that I believe are essential to our understanding of the human career: first, the internal order of the mind, the *forte* of neuroscience from its inception; second, the external order of socio-economic exchange, which constitutes the reciprocity and sharing norms that characterize human sociality as a cross-cultural universal; and third, the extended order of cooperation through market institutions and technology. This is the foundation of wealth creation through specialization whose ancient emergence is manifest on a global scale.

p0020 The social brain seems to have evolved adaptive mechanisms for each of these tasks, which involve experience, memory, perception, and personal tacit knowledge, or "can do" operating skill. This theme was prominent in the reflections and observations on human sociality (sentiments, empathy) and market order, respectively, in the two works of Adam Smith (1759, 1776) and subsequently in Darwin's celebrated biological perspective on psychology as arising from "the acquirement of each mental power and capacity by gradation" in evolutionary time (Darwin, 1859: 458). That acquirement process, I believe, significantly relates to human decision-making capacity within cultural constraints – the norms and rules of engagement of the local social order, or "order without law" (Ellickson, 1991) – and the more formal rules of law that constrain decision in the extended order of market institutions.

Less obvious, but perhaps even more important to an understanding of the human enterprise, has been the process of cultural change in the norms and rules that constrain decision, and in the evolution of institutions that govern the market order. p0030

Experimental economics has been driven by the power of using controlled experiments, both in the laboratory and in the field, to illuminate the study p0040

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of these three orders of human interactive decision. Neuroeconomics adds new brain-imaging and emotion-recording technologies for extending and deepening these investigations. Consequently, it offers much promise for changing the way we think about and research brain function, decision, and human sociality. It will surely chart entirely new if unpredictable directions once the pioneers get beyond trying to find better answers to the questions they inherited from the past. Neuroeconomic achievement is most likely to be recognized for its ability to bring a new perspective and understanding to the examination of important economic questions that have been intractable or beyond the reach of traditional economics. Initially, new tools tend naturally to be applied to the old questions; however, their ultimate importance emerges when the tools change how people think about their subject matter, enable progress on previously unimaginable new questions, and lead to answers that would not have been feasible before the innovation. Neureconomics will be known by its deeds, and no one can foresee the substance of those deeds.

p0050 Neuroeconomics has this enormous nonstandard potential, but it is far too soon to judge how effective it will be in creating new pathways of comprehension.

p0060 In this spirit, I propose in this short introduction to probe those areas of economics that I believe are in most need of fresh new empirical investigation and understanding; areas where our interpretation of experimental results depends on assumptions that are difficult to test, but which may yield to neuroeconomic observations.

s0020 THE INTERNAL ORDER: REWARDS AND THE BRAIN

p0070 Neuroscience has been particularly useful in deepening our perspectives on questions related to motivation and the theory of choice – for example, does the brain encode comparisons on a relative or an absolute scale? Animal studies of choice show that they respond to pair-wise comparisons of differential rewards. It is now established that orbital frontal cortex neuron activity in monkeys enables them to discriminate between rewards that are directly related to the animals' relative (as distinct from absolute) preference among food item such a cereal, apples, and raisins (in order of increasing preference) (Tremblay and Schultz, 1999). Thus, if A is preferred to B is preferred to C, then neuronal activity is greater for A than for B when the subject is comparing A and B, and similarly for B and C when comparing B and C. But the amplitude intensity associated with B is much greater when compared to C than when it is compared to A, which is contrary to what might be expected if A, B, and C were encoded on a fixed scale of values rather than a relative scale (Tremblay and Schultz, 1999: 706).

p0080 Choice behavior, however, may relate to perception (e.g., orbital frontal response) differently from how it relates to individual utility value in problem-solving (e.g., parietal response). Glimcher (2003: 313–317) reports studies in which a monkey chooses between two options ("work or shirk") in a Nash game against a computer. The choice *behavior* of the monkey tracks changes in the Nash equilibrium prediction in response to changes in the outcome payoffs. However, neuron (LIP) firing in the parietal cortex does *not* track the changing equilibrium values, but remains steady at the relative (unchanging) realized *expected* payoffs such that the decision-maker is indifferent between the options available – i.e., the expected payoffs are the same in the comparison. These results are consistent with the hypothesis that the brain computes and maintains equilibrium while behavior responds to changes in the payoffs.

p0090 These studies appear to have parallel significance for humans. In prospect theory, the evaluation of a gamble depends not on the total asset position but marginally on the opportunity cost, gain or loss, relative to a person's baseline current asset position. Moreover, as noted by Adam Smith (1759; 1982: 213), the effect of a loss looms larger than the effect of the gain – a robust phenomenon empirically established by Kahneman and Tversky (1979). Similarly, Mellers *et al*. (1999) found that the emotional response to a gamble's outcome depends on the perceived value and likelihood of the outcome, but also on the foregone outcome. It feels better (less bad) to receive $0 from a gamble when you forgo +$10 than when you forgo +$90. Opportunity cost comparisons for decision are supported by our emotional circuitry, and that support is commonly below our conscious awareness.

p0100 The human brain acquired its reward reinforcement system for food, drink, ornaments, and other items of cultural value long before money was discovered as a mechanism for facilitating exchange. Consequently, our brains appear to have adapted to money, as an object of value, or "pleasure," by simply treating it like another "commodity," latching on to the older receptors and reinforcement circuitry (Thut *et al*., 1997; Schultz, 2000, 2002). To the brain, money is like food, ornaments, and recreational drugs, and only indirectly signals utility derived from its use. However, this interpretation is conditional on an external context in which the exchange value of money is stable. We need to learn how the brain adapts when the context changes: How

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do our brains monitor and intervene to modify this reinforcement when money is inflated by monetary authorities, sometimes eroding to worthlessness?

p0110 Money is a social contrivance, and in its exchange value to the individual we see human sociality at work; we accept fiat money only so long as we have confidence that others will accept it from us. We also see sociality at work in individual decision based on observing and learning from the experience of others. Hence, individual decision modeled as a game against nature does not imply social isolation.

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THE SOCIAL ORDER

p0120 These considerations leave unanswered questions regarding how to interpret behavior in social interactions as observed in a variety of two-person experimental games.

p0130 Thus, in extensive-form trust games played anonymously only once, people cooperate more than is predicted by game theory based on the hypotheses that people choose according to dominance criteria, perceive single-play games as events isolated from all other social interactions, and always apply backward induction to analyze decisions. Is cooperation motivated by altruism (social preferences), by the personal reward that emanates from relationship-building (goodwill) in exchange, or by failure to backward induct? (See Chapter 15 of this volume; McCabe and Smith, 2001; Johnson *et al.*, 2002.) Many experiments have sought to explore or reduce this confounding (see Smith, 2008: 237–244, 257–264, 275–280, for summaries and references).

p0140 Repeated games are modeled by assuming that individual i with current utility u_i chooses strategy s_i in a stage game to maximize $(1 - d)u_i(s) + d\,V_i(H(s))$, where $s = (s_1, \ldots s_i, \ldots s_n)$, d is a discount factor, n is the number of players, H is the history of play, and $d\,V_i(H)$ is i's endogenous subjective discounted value of continuation (Sobel, 2005). Hence, the continuation value perceived by i may easily make it in her interest to forgo high current utility from domination because it reduces the value she achieves in the future. An open question is how individuals perceive V_i. We ordinarily think that our procedures for implementing single play should yield $V_i = 0$, and the choice is the dominant immediate payoff from s_i. But is this assumption defensible?

p0150 In a trust game (with $n = 2$), a cooperative response by the second player has been discovered to depend on the opportunity cost to the first player of choosing to offer the prospect of cooperation. Second movers defect twice as often when they see that the first player has no option but to pass to the second versus seeing the sure-thing payoff given up by the first in order to enable cooperation and a greater reward for both (McCabe *et al.*, 2003). Thus, defection in favor of payoff dominance is much reduced when the circumstances suggest intentional action at a cost to the first player in facilitating cooperative gains from the exchange. Moreover, fMRI data confirm that circuitry for detecting intentions is indeed activated in trust games (McCabe *et al.*, 2001). Knowing that you did something costly for me may increase my unconscious motivation to reciprocate your action, to implicitly recognize a relationship, as in day-to-day socializing. Hence, forgoing $u(s_i)$ is part of H in a sequential move single-play game, and the players need not be oblivious to this "history" if they share common cultural experiences.

Many other experiments report results consistent with relationship-building in single-play stage games, suggesting that we have failed to implement the key conceptual discontinuity in game theory between single and repeat play. For example: p0160

1. In dictator games, altruistic behavior substantially increases when people are informed that a second undefined task will follow the first. This discovery shows how strongly people can be oriented unconsciously to modify their behavior if there is any inadvertent futurity in the context (Smith, 2008: 237–244). o0010
2. Double-blind protocols affect behavior in single-play dictator and trust games, establishing that people are more cooperative when third parties can know their decisions – a condition that we would expect to be important in reputation-building only when there is repeat interaction. o0020
3. People are more cooperative when the "equivalent" stage game is played in extensive rather than abstract strategic form. The latter is rare in everyday life, but is very convenient for proving theorems. The extensive form triggers an increase in cooperative behavior consistent with the discussion above, although own and other payoffs are identical in the comparisons (see Smith, 2008: 264–267, 274–275, for a summary and references). o0030

As experimentalists, we have all become comfortable with our well-practiced tool kits for implementing and rewarding subjects in single-play games. But are experimental results affected by an "other people's money" (OPM) problem when the experimenter gift-endows the subjects up front? Cherry *et al.* (2002) show that dictator-game altruism all but disappears (97% of the subjects give nothing) under double-blind p0200

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conditions when subjects are first required to earn their own endowments. Oxoby and Spraggon (2008) vary these protocols and report that 100% of their dictators give nothing. These results raise fundamental questions concerning the effect of OPM on observed social behavior in the laboratory.

p0210 If cooperation derives from social preferences, the neuroeconomic question is: how is the encoding of payoff to self and to other affected by the circumstances under which the resources are acquired? Yes, we know that the "same" general OFC area is activated by own and other rewards (see Chapters 15 and 20 in this volume), but how do those activations network with other brain areas and respond to differential sources of reward monies?

p0220 Hence there is the prospect that neuroeconomics can help to disentangle confounding interpretations of behavior in trust and other two-person games. But in this task we need continually to re-examine and challenge our implicit suppositions to avoid painting ourselves into a confirmatory corner. In summary:

- u0010 How are brain computation processes affected by *who* provides the money or *how* people acquired the stakes – the OPM problem?
- u0020 When people cooperate, which game theoretic hypothesis do we reject: payoff dominance independent of circumstances, or our procedures for implementing the abstract concept of a single-play game? If the former, we modify preferences; if the latter, we have to rethink the sharp distinction in theory between single-play games and goodwill-building in repeat interaction. Either or both may be manifestations of the social brain.
- u0030 How does relationship building differ between people who do and those who do not naturally apply backward induction to the analysis of decisions?
- u0040 What accounts for the behavioral non-equivalence between the extensive and normal form of a game?

p0270 In the absence of a deeper examination of these questions, we cannot (1) distinguish between exchange and preference interpretations of human sociality; (2) understand why context is so important in determining cooperative behavior; (3) understand how cooperation is affected by repeat play across the same or different games, under different subject matching protocols.

s0040 THE MARKET ORDER

p0280 Hundreds of market experiments have demonstrated the remarkable ability of unsophisticated subjects to discover equilibrium states, and to track exogenous changes in these states over time in repeat interaction with small numbers under private information. Yet the mental processes that explicate this skill are unavailable to those who demonstrate the ability, are inadequately modeled, and understood only as empirical phenomena. For example it is well documented that individual incentives and the rules of market institutions matter in determining the speed and completeness of equilibrium convergence, but it is unknown how the brain's decision algorithms create these dynamic outcomes.

Can neuroeconomics contribute to an understand- p0290
ing of how uncomprehending individual brains connect with each other through rules to solve the market equilibrium problem and in this process create wealth through specialization? Lab experiments, betting markets, many information markets, and some futures markets demonstrate how effective people are at efficiently aggregating dispersed information.

We also have the puzzle that, under both the p0300
explicit property right rules of the market order and the mutual consent reciprocity norms of the social order, the individual must give in order to receive in exchange. However, this insight is not part of the individual's perception. The individual, who perceives social as well as self-betterment through cooperation in personal exchange with others, does not naturally see the same mechanism operating in impersonal market settings. Yet individuals in concert with others create both the norms of personal exchange and the institutions of market exchange.

In closing, it is evident that there is mystery aplenty p0310
across the spectrum of individual, social, and market decision to challenge the discovery techniques of neuroeconimcs. However, to meet that challenge I believe we must be open to the exploration of assumptions that underpin theory and experiment. I am optimistic about this prospect and how it may contribute to future understanding.

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