Evolving Economics: Synthesis

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24 April 2006

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March 2007

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Abstract

This paper reviews past experiments and visits some of the major results in the literature of behavioral-, experimental-, and neuro-economics research with the ultimatum and the dictator games. Synthesis of the findings is offered.

> "One may wonder whether Adam Smith, were he working today, would not be a neuroeconomi[st]"
>
> Aldo Rustichini 2005

Introduction

Some of the limitations of the *Homo economicus* models of game-theory are effectively illustrated by robust empirical findings from games, such as the ultimatum game, dictator game, trust game, prisoners' dilemma, and public goods games. In lab experiments, game-theoretic equilibrium outcomes are typically not achieved by the participants. Robust experimental research results suggest that there are many factors included in human decision-making that are not included in the predicted game theoretic equilibrium of decision-making. Economics and game theory are based on the assumption that people can predict the actions of others; backward induction, iterated elimination of dominated strategies, and the Nash Equilibrium (NE) require a system of beliefs about the decisions of others. These concepts are based on people understanding others' motives and beliefs (Tania Singer, Ernst Fehr 2005). This dissertation focuses on understanding two motives, generosity and stinginess, by playing two economic games: ultimatum game (UG) and dictator game (DG) in laboratory environment under the influence of two naturally occurring hormone neuropeptides, oxytocin (OT) and arginine vasopressin (AVP), which are administered to half of the subjects, leaving the other half on placebo.

In each game two anonymous subjects play one-shot games with their show-up fee, which they are dividing between themselves in some manner. The purpose and the strategy of the two games are different. In the DG, decision-maker1 (DM1) receives $10 and is told that he may send any part of that to an anonymous person in the room (DM2). DM1 may decide to send no money at all and DM2 must accept that decision. There is no further exchange, the game is over. Sub-game perfect Nash Equilibrium (SGPNE) suggests that DM1 earns $10 and DM2 $0, but in laboratory experiments the average amount sent is between $1.50 and $5 dependent upon how (blind, double-blind, known identity) and where (what country) the game is played, with the mean offers of 20% of the stash, and around 20% of the subjects send the NE of $0 (various studies summarized by (Colin Camerer 2003) pages 57-58). The UG incorporates an additional step: DM2 may reject DM1's offer, in which case neither of them earns any money. Thus, the strategy here for DM1 is to allocate "just enough" money to DM2 to have the offer accepted, in which case they both earn the amount agreed to. The Sub-Game Perfect NE in the UG is $9 to DM1 and $1 to DM2 but in laboratory experiments this is rarely achieved. Offers range between $3 or $4 and offers smaller than $3 are rejected by half of the participants; about 75% of the subjects send an even split (Werner Güth *et al.* 1982;Daniel Kahneman *et al.* 1986;Joseph Patrick Henrich *et al.* 2005;Colin F. Camerer, Richard H. Thaler 1995;Colin Camerer 2003) (pages 50-55). In the UG, DM1 needs to have some understanding of what is acceptable to offer so that DM2 will accept.

It is widely accepted that human social bonds are characterized by acts of altruism (Stephanie L. Brown, R. Michael Brown 2005;Herbert Gintis *et al.* 2003;Herbert Gintis 2002). Humans are known to benefit others at a cost to themselves in a variety of way. Reciprocal altruism is a form of altruism in which the altruist is in direct exchange with the recipient of the benefit and is expecting a reciprocation for the help provided (Robert L. Trivers 1971). This type of altruism is found in the trust game (TG), in which DM1 can send any part of his lab-given endowment to DM2. The amount sent triples en route to DM2, who can choose to send any part of the triple-stash back. The SGPNE for DM1 is to send $0 to DM2 but in lab experiments, typically 40% of the money is sent to DM2s who send back about a third of the tripled amount (Colin Camerer 2003). Another type of altruism, introduced by Richard Alexander, is indirect altruism (also called indirect reciprocity) (R. D. Alexander 1979).

In indirect altruism there is no expectation of reciprocation from the person who receives the benefit but there is from someone else in the society in the future. Indirect reciprocity involves reputation and status (Martin A. Nowak, Karl Sigmund 1998) (Martin A. Nowak, Karl Sigmund 2005) and so it provides weak support to one-shot anonymous games where reputation building is not possible. Nonetheless we find evidence of indirect reciprocity in generous offers and punishment of those whose offers are not generous enough in the UG. Vernon Smith suggested some people might just be "preprogrammed to engage naturally in acts of positive reciprocity" (page 11) (Vernon L. Smith 1998b). But this "preprogramming" does not provide an answer for "why" people make the type of other-regarding decisions they make. And finally, there is what we call pure altruism (direct altruism), in which people provide benefits to others without expectation of any future benefit to themselves. This type of altruism we find in the DG.

The UG decision might rest on different prosocial emotions from the DG, and if it does, it might be direct-reciprocity (reciprocal-altruism as per Trivers), except that here too, the games are one-shot and the individuals don't know and don't see each other. Yet as there is a direct response of the anonymous stranger by either accepting or rejecting the offer, there is a direct connection between the two players. The results of the experiments I conducted provide answers to these questions in chapter two. Rejection in the UG is also debated as one of two kinds. In one sense the rejection might be other-regarding because the rejection is costly to DM2 and it also punishes DM1 for sending an unfair offer (D. J-F. DeQuervain *et al.* 2004;John H. Kagel *et al.* 1996;Ernst Fehr, Simon Gachter 2002;Joseph Patrick Henrich *et al.* 2006). This is sometimes referred to as "second-order punishment" (Mizuho Shinada *et al.* 2004;Karthik Panchanathan, Robert Boyd 2004). In the other sense the rejection maybe purely self-regarding and is the result of spite and anger for not receiving what is considered to be fair. The results of the experiment presented in chapter two provide evidence toward which group might be right.

Results of reported laboratory experiments using economic games show that cooperation is a primary and integral part of human economic exchanges. Individuals form and maintain social bonds using sympathy and empathy and provide benefits to others through helping and generosity (Stephanie D. Preston, Frans B. M. de Waal 2002b;Joseph Patrick Henrich *et al.* 2005;Adam Smith 1892). Empathy provides the feeling or the imagination of how another person feels in response to a particular event and it helps in the understanding and predictions of others' thoughts and intentions; it is a robust process that underpins prosocial as well as antisocial behavior (Cameron Anderson, Dacher Keltner 2002;George Ainslie, Nick Haslam 2002). Generosity is part of a variety of prosocial emotions, such as altruism, reciprocity, kindness, fairness, or doing something good (Michael Lewis 2002;Margery Lucas, Laura Wagner 2005;Catherine C. Eckel, Philip J. Grossman 1998;Gary E. Bolton *et al.* 1998;Frank Fincham, Julian Barling 1978). Empathy reflects on prosocial behaviors that help form attachment between people in a society, which often leads to generosity and altruism (Stephanie D. Preston, Frans B. M. de Waal 2002b).

To see if the decision of how much money is sent in the UG is self-regarding or other-regarding, hormones that are specific to aiding one of the behaviors or the other may be used. My experiment used two common hormones that are always present to varying levels in the human brain, one of which is known to assist in forming attachments while the other often acting in the opposite direction (in animal studies). Resent research on the neural substrates of decision-making suggests that some decision-making is hormone-dependent. By artificially stimulating human subjects with different levels of hormones that they already possess, it is possible to identify if those hormones participate in a particular decision-making and identify brain regions affecting decisions. OT is associated with prosocial behavior. OT is associated with prosocial behavior. It plays a central role in regulating positive social interactions, such as attachment and bonding and affects both social behavior and the mechanisms underlying social behavior (Karen L. Bales, C. Sue Carter 2002;R. Landgraf, I. D. Neumann 2004;D. Huber *et al.* 2005;Kerstin Uvnäs-Moberg 1998;Paul J. Zak, Ahlam Fakhar 2006;Paul J. Zak *et al.* 2005;Paul J. Zak *et al.* 2004;C. Sue Carter 1998;Kristin M. Kramer *et al.* 2005;Alison B. Wismer Fries *et al.* 2005;James P. Curley, Eric B. Keverne 2005;Eric B. Keverne, James P. Curley 2004)

Experiments have shown that manipulating OT levels in the brain influences how subjects perceive their environment (Jan Born *et al.* 2002;Michael Kosfeld *et al.* 2005b). OT seems to permit humans to overcome their anxiety of dealing with strangers in social context (Kerstin Uvnäs-Moberg 1998;Kerstin Uvnäs-Moberg, Maria Peterson 2005;Kerstin Uvnäs-Moberg *et al.* 2005). Research shows that OT crosses the blood-brain barrier after intranasal administration (Jan Born *et al.* 2002), providing a simple method for studying its affect on humans in a one-shot economic exchange with strangers in lab environment.

Humans can understand and predict the intentions, beliefs, and desires of others and have the capacity to share the feelings of others; this is referred to as empathy (Tania Singer, Ernst Fehr 2005;Jim Proctor 2005). Thus the neural processes underlying empathy are of interest in the understanding of prosocial behaviors because it is an important factor in one person's recognition of the other's need, which might render human emotions other-regarding, providing the motivational basis for other-regarding behavior (Tania Singer, Ernst Fehr 2005). Offering generous help is a component of empathy (Cameron Anderson, Dacher Keltner 2002;Michael Lewis 2002;Stephanie D. Preston, Frans B. M. de Waal 2002a). Increased OT levels may induce more empathy (Kerstin Uvnäs-Moberg, Maria Peterson 2005). OT is hypothesized to influence subjects to behave more generously in prosocial decision-making.

AVP has multiple, oftentimes conflicting, roles. AVP may enhance attachment and bonding with kin in monogamous males (aiding social recognition of conspecifics in animal experiments) (Jennifer N. Ferguson *et al.* 2002). AVP is also associated with aggressiveness with respect to kin protection and reactive aggression (C. Sue Carter 2007). Lack of OT, in some research, dysfunction of AVP receptors, have been associated with autism, a frequent human disorder with symptoms of socially withdrawn behavior (Miranda M. Lim *et al.* 2005;C. Sue Carter 2007). AVP is also control the resorption of water by the kidneys, regulates the osmotic content of blood, and at high doses increases blood pressure (WO Foye *et al.* 1995). Research also suggests that paradigms in which animals have to cope with intense stressor are controlled by both AVP and OT (Mario Engelmann *et al.* 1996).

In chapter 1 I present a historical background on research with the UG and DG with a synthesis of their findings and of the methods they used. Chapters 2 and 3 present the results of my two experiments with the UG and DG using OT (chapter 3) and AVP (chapter 3). I provide a brief conclusion with summary of findings and recommendations for future research in chapter 4.

Chapter 1

Historical Background

Most neoclassical economic models assume an agent to be maximizing to obtain the highest possible well-being (based on the expected utility theory) given available information about opportunities with constraints that are both natural and institutional. This model has become known as the *Homo economicus* model. The self-regarding Nash equilibrium predicts that in the DG a *Homo economicus* will behave self-regarding and keep all of the money, $10 in this experiment, and send nothing to the an anonymous player-partner if the game is played only once and the subjects don't have the chance to learn about the actions of the other . Thus, if such agents receive "$10 in manna from experimental heaven and [are] asked whether they would like to share some of it with a stranger," many do (Colin F. Camerer, Richard H. Thaler 1995).

However, experiments with small manna, big manna, culturally diverse experiments—including indigenous people in tribes—face-to-face, blind, double-blind, and in general, experiments in any shape or form over the past twenty years provide robust evidence that in one-shot games people don't obey the rules of the NE. The question then becomes "why not" and "what rule *do* people obey?" To answer these questions from the perspective of past research, this introduction is set out to review literature that spans over two hundred years, starting with Darwin and Adam Smith, and ending with the most recent concepts and experimental findings. Experimental interference and mistaken concepts played a key role in our developing understanding and is highlighted when necessary to advance my thought.

I chose to use the UG and DG in my experiments because they help us gain more knowledge than simply a better understanding of how people play these games. Social infrastructure, business operations, and institutions evolve uniquely to fit the particular culture of each specific society. Economic exchanges frequently involve cooperation, reciprocity, and trust that enable decision makers to plan, reduce risk, diversify food and income sources, and plan for both the short and long term. “Most anthropologists would hardly be surprised by a finding that cultural ideas about sharing and cooperation prevent participants in economics experiments from acting in their narrowly defined self-interest” (Michael Chibnik 2005) (201-206) but traditional economics has excluded hypotheses of other sciences in order to retain its simple and elegant models that seemed to work well—before experimental economics was born and pointed out that they actually do not work all that well and aren’t nearly as simple as game theory posits.

Experimental results show that human economic activity is a function of the biological and cultural makeup of each individual. These games are often used as parts of economic experiments in laboratory settings with US and other Western university students as subjects. In recent past, they have been adapted to experiments in other cultures, such as a study in 15 small-scale societies (Joseph Patrick Henrich *et al.* 2005) and others in other parts of the world (Hessel Oosterbeek *et al.* 2004;Michael Gurven 2004;Swee-Hoon Chuah *et al.* 2005;Laura Schechter 2006).

While humans behave similarly across some cultures in that they often show other-regarding behavior, the degree to which they are other-regarding seems to be culture specific. Interestingly, in nearly all cultures, there are some individuals who are selfish and leave little for DM2 in the UG. However, in nearly all cases, such acts are punished by rejection. In Henrich et al.’s study, the Au and Gnau of Papua New Guinea rejected offers even above 50% of the stash. Rejecting such generous offers sounds unreasonable but it may have a cultural foundation that is not immediately obvious to an outsider. In some societies, like the Au and Gnau villages and throughout Melanesia, accepting gifts of any kind creates a strong obligation to reciprocate at some future time. Debts accumulate, and place the receiver in a "subordinate status… As a consequence, excessively large gifts, especially unsolicited ones, will frequently be refused" (Joseph Patrick Henrich *et al.* 2005) (page 811).

Human Brain as an Economic Adaptive Mechanism

It has been suggested that evidence coming from neuroscience, the study of how the brain works, "cannot refute economic models because the latter make no assumptions and draw no conclusions about the physiology of the brain" (Faruk Gul, Wolfgang Pesendorfer 2005) (page 2). In their opinion, thus, decision-making of an individual, though is conducted by the brain as part of a higher-order processing mechanism, is separate from the mechanisms of how that decision is derived. While we certainly cannot separate the actions of the brain from the brain itself, what they suggested has some merit, once put differently. Perhaps they should have said that some economic models make no assumptions about the *environment* in which the agents make economic exchanges and that they do not make any assumption about the *context* in which those exchanges are made either. The problem has always been that of complexity because including all the factors that a real human uses to make a decision would unnecessarily clutter economic models and make their use impossible. However, if heuristics do not lead to the same result as the heuristics applied by economic models of the same decision-task, we cannot say that the models we now have are complete. The trick is to find just how much information we must include about the environment and the context such that we can predict the correct economic behavior without making the mathematics impossible.

It is necessary to look at human economic exchanges with a view that includes the context in which the decisions are made. This necessitates our understanding of both the external environment in which exchanges take place and also the "internal" environment, the one within the brain, because forever changing levels of hormones encourage changing moods and desires that are not necessarily explainable by linear relationships, probability theory, unchanging order of preferences between goods, and global optimum of all possible options. Physiology is the study of *all* the biological functions of living organisms. Thus, if economics is the study of exchanges that living people make, then economics is the study of human physiology as it relates to those economic exchanges—this is neuroeconomics. The physiology of the brain cannot be disconnected from the functions of the brain any more than the economic exchanges of a person can be disconnected from thinking about those actions with the use of his or her brain. The human brain is the headquarters of human actions; humans with diseases or damage to their brain show us the different economic decisions the brain can make given its internal environment. Let me visit the birth of the conflict in economic thought and why economists play games, such as the UG and the DG.

The Start of Adaptive Decision-Making

Adam Smith mentions sympathy (as "fellow-feeling"), passions and how preferences are born in the Theory of Moral Sentiments:

> Neither is it those circumstances only, which create pain or sorrow, that call forth our fellow-feeling. Whatever is the passion which arises from any object in the person principally concerned, an analogous emotion springs up, at the thought of his situation, in the breast of every attentive spectator (page 5) (Adam Smith 1892)

The above passage is often quoted in literature as the leading "passion" statement of Smith together a disclaimer like "oh well, it is in the Moral Sentiments, after all." It is less often discussed that Smith refers to passion in his other book too:

> With regard to profusion, the principle which prompts to expence, is the passion for present enjoyment; which, though sometimes violent and very difficult to be restrained, is in general only momentary and occasional (pages 281-282) (Adam Smith 1909).

In this passage, Smith indicates that people sometimes spend more than they intend to; e.g. their emotions carry them away from making purely economic decisions. Adam Smith understood that humans' utility functions might have immeasurable, thus non-maximizable, values as well.

Explorations of Decision-Making through UG and DG

The debate using these games is that human subjects don't appear to be consistent with the game theoretical predictions of choosing the optimum solution from the particular bundle; that is they are not choosing their equilibrium solution. Furthermore, there is significant variation in the way that they appear to be inconsistent, and that this variation has shown to be age and culture specific.

Choosing an equilibrium bundle is considered to be a distinguishing mental process; decision-making based on emotions and gut-feelings were reserved for the naïve and underdeveloped. Ironically, it was found that

> younger children behave more selfishly, but gradually behave more fair-mindedly [other-regarding] as they grow older, up to age 22 or so… An important exception is that about one third of autistic children and adults offer nothing in the UG (E. Hill, D. Sally 2004); …[they] behave, ironically, in accordance with the canonical model (Joseph Patrick Henrich *et al.* 2005) (page 799).

As humans grow older, they typically change from self-regarding persons to become more other-regarding. Camerer and Thaler describe fairness too as a learnt manner (Colin F. Camerer, Richard H. Thaler 1995). Indeed, Murnighan and Saxon found that notions of fairness and sharing do not appear until past third grade (J. Murnighan, Keith & Michael S. Saxon 1998). In their experiment, the most income maximizing DM2s were kindergartners (J. Keith Murnighan, Michael Scott Saxon 1998).

Even non-human primates are capable of grasping the meaning of economic exchanges; non-human primates have been playing ultimatum and dictator games—albeit their researchers did not explicitly state such claim[1].

[1] Brosnan, de Waal, and many others, tested for emotions and reasoning in non-human primates (Sarah F. Brosnan, Frans B. M. de Waal 2003;Sarah F. Brosnan, Frans B. M. de Waal 2004b;Sarah F. Brosnan, Frans B. M. de Waal 2002;Sarah F. Brosnan, Frans B. M. de Waal 2004c;Sarah F. Brosnan, Frans B. M. de Waal 2000;Sarah F. Brosnan, Frans B. M. de Waal 2004a;H Smith et al. 1998;Frans B. M. de Waal 1997). In their test of Capuchin monkey cooperation, Bosnan et al. formulated an experiment that reveals interesting similarity to humans playing UG and DG. They set up pairs of Capuchin monkeys in two cages separated by a small fence and trained them to trade work for food. Two see-through bowls were provided outside these cages. Sometimes they were filled with food for one Capuchin, sometimes for the other one, or for both. Brosnan's team attached weights to the levers so that cooperative pull was necessary; e.g., if the bowl for one Capuchin was empty but the bowl was filled for the other, the one with empty bowl had to help pull, else neither of them got any food—this is a similar composition to the UG. Not helping to pull equals rejection and both stay hungry. In particular, Brosnan and de Waal found that Capuchins would help pull more often in the cooperation trials if in the previous trial cooperation was achieved. In other words, experience with the playmate from previous social interactions (e.g. reputation) helped in the decision-making if a Capuchin was worthy of a helping pull to give her food. The expectation of reciprocity is strong in non-human primates.

Vernon Smith has studied market exchanges in his laboratory and suggested that people have both cooperative and non-cooperative skills and they use them according to the appropriate occasions (Vernon L. Smith 1998b;Vernon L. Smith 2003). He also suggested that humans use non-cooperative (self-regarding) methods when dealing in the impersonal markets, while they use the more cooperative (other-regarding) means when dealing with family, friends, and neighbors—a somewhat similar statement to calculative trust of Oliver Williamson a few years earlier (Oliver E. Williamson 1993).

Sometimes a self-regarding agent may choose to pretend to be other-regarding in order to achieve a particular goal (Colin F.Camerer, Ernst Fehr 2006a), which complicates the deciphering of what experimental subjects actually really think when they make their decisions. It is not too difficult to envision that the use of modern technology, such as functional magnetic resonance imaging (fMRI), may be used to see who is faking and who is not based on activation of the particular brain region. Perhaps "faking" is a cultural norm that all people use in economic exchanges. If so, one would expect a cultural "standard" of faking and most people would be found to fake at about the same level[2].

Reciprocity – The Nice Guys

Brosnan and de Waal found the rate of acceptance of Capuchins having to give a helping hand to be 39% (Sarah F. Brosnan, Frans B. M. de Waal 2000), somewhat lower than the acceptance rate of human-sharing in UG (close to 100% in the UG). In the same experiment, Brosnan and de Waal found that Capuchins share their food in what they called "facilitated taking," in which when only one Capuchin received food from the cooperative pull, she moved close to the separating fence, let food pieces fall to the floor, and allowed the other Capuchin to reach over and take it through the fence. This I find similar to the DG, in which DM1 receives all the money (food in the case of the Capuchin) and may decide to share some with someone in the room (this means giving in DG and allowing to take in Capuchin experiments). Note, however, that in the case of the Capuchins, each participating female knew each other whereas the experiments with humans are usually blind, multi-gender, and typically one-shot.

[2] Most studies that published their results in the evaluation whether the perception of fairness is enough report that, indeed, the perceived fairness payment (when the DM2 is uninformed of the true value of the money DM1 has to split), on average, is below the informed payment and the offer that is perceived to be fair is accepted. But no study to this date analyzed whether *everyone* fakes fairness when the opportunity arises or if only some of the people do. See (Colin F. Camerer, Richard H. Thaler 1995;Michael Mitzkewitz, Rosemarie Nagel 1993;John H. Kagel *et al.* 1996;Rachel T. A. Croson 1996) for further details.

Adam Smith's statements about emotional decision-making were overlooked for many years. In neoclassical economic theories human behavior was simplified and reduced to contractual interactions between agents that traded goods based on highest probability, lowest cost, and rigid orderability of preferences. The transition back toward Adam Smith's emotional agent started with Dawkins, Axelrod, and Trivers in the mid to late 70's.

Richard Dawkins titled chapter 12 of his book "Nice Guys Finish First," (Richard Dawkins 1976) (1999 edition) which was his translation of the turn of events brought to light by Robert Axelrod in three competitions for a "best" Prisoners Dilemma (PD) game solution in evolutionary terms—meaning the one that provided the most stable solution (Robert Axelrod, William D. Hamilton 1981;Robert Axelrod, Douglas Dion 1988). The PD game is simple; two computer "characters" (paired subjects equivalent) receive two cards: "cooperate" and "defect." Four combinations exist: either both cooperate, both defect, or one cooperates and the other defects with an asymmetrical payoff structure. Dawkins discusses this game from an evolutionary perspective and quoted American biologist Garrett Hardin who said "nice guys finish last" in order to emphasize what may have been called "selfish genery" that is befit to be a member of the classical economics theories of self-regarding actors. In Darwinian sense, "a nice guy is an individual that assists other members of its species, at its own expense, to pass their genes on to the next generation. Nice guys, then, seem bound to decrease in numbers: niceness dies a Darwinian death" (Dawkins, page 10). The classical economic theory's self-regarding maximizing individuals thus suit the Darwinian evolutionary image. But in Axelrod's competition, actually the "nice guy" finished first!

Dawkins explains why this "nice guy" could survive evolution (in contrast of the "Darwinian death"), which conceptualizes what is to have become the UG. He introduces *Grudgers*, a group within a type of bird, that helped each other in an altruistic way, but

> refused to help—bore a grudge against—individuals that had previously refused to help them. Grudgers came to dominate the population because they passed on more genes to future generations than either Suckers (who helped others indiscriminately, and were exploited) or Cheats (who tried to exploit everybody and ended up doing each other down). The story of Grudgers illustrates an important general principle, which Robert Trivers called 'reciprocal altruism' (Dawkins, page 202).

Reciprocal altruism is discussed in economics but has been assumed to only be participant in kin groups; hence it was troubling to think that people acted altruistically in the UG with non-kin. However, the *Grudgers* tell us a different story about altruism; they tell us that the *Grudgers* ended up dominating the population. What this means is that behaving altruistically can change the population from cheaters and defeaters into cooperators within a few generations. Camerer et al. (Colin F. Camerer, Ernst Fehr 2006) and Fehr et al. (Ernst Fehr *et al.* 2000) introduce concepts that are akin to this population domination by the "nice guys." These concepts suggest that individuals with sharing motive can turn individuals with non-sharing motive into sharing types. The tools are the proper identifications and use of "strategic complements" and "strategic substitutes," albeit with one caveat: in Camerer et al., the transformation is strategic and temporary, whereas in the *Grudgers*, it becomes genetic and permanent, pending genetic mutations on the long run.

At this point little can be said about possible methods of changing an entire population generation toward becoming more sharing types, particularly if we use our abilities to put on a new face as the environment necessitates it. Changing to become other-regarding, in the case of strategic complementarity, is not only temporary but also a "fake." This should present a serious problem in our understanding of human behavior because we cannot know for sure when the subjects play genuine and when opportunistic or fake. However, a large share of strong reciprocators in the population can be part of an evolutionarily stable situation, suggesting that those who "fake it" might be forced to convert (Robert. Boyd *et al.* 2003;R. Sethi, E. Somanathan 2003;Samuel Bowles, Herbert Gintis 2006). Some of the questions I would like to ask are as follows: What are the modifiable elements that change the behavior of the people? Does what is prevalent today in our society (as far as experiments can tell) provide an evolutionary stable system (ESS)? For example, which provides ESS: genuine fairness or faking fairness or the mixture of the two? What are the underlying biological functions that drive us toward or away from an ESS? Can we modify these biological functions without destroying ESS?

Economic decision-making doesn't happen in a vacuum. To see the decision-making environment, it is helpful to first look at what it takes to program economic decision-making into computers that mimic human decision-making in a risky environment. When Axelrod set up the model for the evolution of human cooperation, he listed several requirements for the simulation steps, of which two are described here: (1) *specification of an environment* in which the PD can be operated, and (2) specification of the *genetics* (history), including the way in which information on the emulated chromosome is translated into a strategy for the simulated individual (Robert Axelrod 1981). Axelrod wanted to develop a PD game that was based on survival mechanisms, not unlike that of Dawkins' theories on the gene (Richard Dawkins 1976). Axelrod also showed that increasing the number of players increases the difficulty of maintaining cooperation, and that having one player defect after a number of cooperating periods, increases the likelihood of the population reaching a certain threshold at which defection dominates.

The UG and DG

The UG was introduced in 1963, (L. E. Fouraker, S. Siegel 1963), and first used as part of an economic experiment by Güth *et al.* to analyze bargaining behavior (Werner Güth *et al.* 1982). Güth and his team described that by game theory, the UG is considered to be a game of one person on each end where each person is playing a game alone. But this assessment is incorrect because “all that player *i* has to do is to make a choice which is good for himself” (page 368), and the same for player *j.* However, if player *i* chooses his best maximizing solution and passes little or nothing to player *j*, in the UG player *j* has veto rights. If *j* is unsatisfied with the share of the pie, he can reject the deal, thereby cancelling the deal for player *i* as well; they both end up empty handed. Thus the two players are playing dependently on one another.

Güth found that players gave more money to stranger than would have been predicted by to game theory. Even more surprisingly, the receiving players used their veto rights even when some money was given to them. In one experiment players played both roles, the role of the sender and the receiver. Güth compared the amount of what each player maximally offered as DM1 and what the same player would minimally have accepted as DM2. The inconsistency, Güth thought, was attributed to the players’ knowledge that they will play both roles. “Knowing to be player1 in one game and player2 in another game might have caused some subjects to care for a fair bargaining result” (380).

With Axelrod and Güth’s publications showing that something other than monetary utility-maximization was driving economic decision-making in the laboratory, many experiments commenced; some with mistaken concepts that gave confused results and were based on unsound theoretical principles. Binmore et al. set out to test this "anomalous" economic decision-making of the players in one-shot UG. They designed the experiment such that each person played both DM1 and DM2 roles repeatedly against the same individual (K. Binmore *et al.* 1985). What they found was identical to what Güth et al found in 1982 and they warned about the validity of Güth's statement against the predictive power of game theory in the one-shot games. In proof that Güth's comment was inappropriate, they played what they called one-shot games, which had two stages. In stage one the players played a standard UG with 100 pence (monetary unit) and divided it in any way. In the second stage, the same two subjects (in anonymity) were paired but with only 25 pence and DM2 made the first offer. Only the opening offer of DM2 was recorded and compared with the first stage game. Thus what Binmore et al., played were sequentially repeated games with learning effects rather than one-shot games. Neelin et al., in repeating Binmore's experiment with three-shot games, found that the results of the two-shot games did not hold in three-shot games (Janet Neelin *et al.* 1988).

Some experiments that claimed to prove that human make their decisions based on the expected utility theory's axioms placed the experiment itself on the basis of the thenceforth assumed utility theory, and set out to look for the very thing it assumed. A classic example of this is Rubistein's UG experiment in 1982 (Ariel Rubistein 1982). This experiment he called an "ultimatum-type" game between two players. In the first step, DM1 proposes and if DM2 accepts the game ends with the payout. If DM2 does not accept, he may *make an offer* and the game goes on for *several rounds*, until DM2 accepts. The assumption is that both parties behave according the expected utility theory and that all its axioms are met. Clearly such bargaining shares little with one-shot games in which cooperation between anonymous strangers is the object of study. Another critical unrealistic assumption is that all players have complete information about the *preferences* of others. The game Rubinstein used was a sequential *centipede* game with full knowledge at each nod of the opponent's step. Thaler critiqued by writing "when a Recipient declines a positive offer, he signals that his utility function has non-monetary arguments" (Richard H. Thaler 1988) (197).

Gneezy et al. had a very similar experiment to Rubistein in1982. They experimented with what they called a "reverse ultimatum game" with a variety of conditions, such as deadlines and the number of responders participating, in repeated games of 25 (Uri Gneezy *et al.* 2003). They hypothesized that the addition of a deadline would shift the sub-game perfect equilibrium prediction from one extreme to the other in terms of which bargainer is predicted to gain all but a fraction of the available money, which is did, showing that the person with the bargaining control power takes home more. In their game, if DM2 rejected the offer, DM1 was allowed to make *another offer*. They called the game a "reverse" ultimatum game because it was DM1 doing the bargaining until DM2 accepted. However, similarly to Rubinstein in 1982, Gneezy et al. also applied a centipede game, but in which update was actual rather than Bayesian; each player received specific answer rather than a risky social cue. Gneezy et al., found significant learning effects over the 25 game-periods and that no matter which way the game was set up, the majority of the proposers still offered "fair" amounts rather than the SGPNE.

Hoffman and Spitzer, while testing the Coase Theorem in two- and three-person bargains, ended up drawing a conclusion for one-shot games, like UG and DG, but the game had complex rules, and there was this ever-present arbitrator to implement the decision (Elizabeth Hoffman, Matthew L. Spitzer 1982). Harrison suggested that the reason why DM2s reject offers is that the opportunity cost of "misbehavior" in these experiments is small and thus the anomalies may not be anomalies at all but reflect a "theoretically consistent behavior under conditions where misbehavior is virtually costless"(Glenn W. Harrison 1992) (page 1426). However, so long as the stakes are small for both gain and loss, if the players find any kind of behavior costless, then I would think that the reverse is also true: there cannot be any benefits to being upset about not receiving enough share of the pie. The showing of "feeling insulted" by rejecting the offer, however small the offer may be, shows that DM2s receive some non-monetary utility large enough.

The influence of stake-size has been heavily investigated. Dickinson suggested that bargainers take advantage of information asymmetries (David L. Dickinson 2000). He hypothesized that as the size of the pie gets arbitrarily large, DM2s will be less likely to reject a smaller offer since the monetary penalty for doing so grows increasingly large. He set up an experiment to test information asymmetry in action and the kindness theory (kindness theory is a function Rabin developed that he called "kindness function," which measures how kind one player is to another (Matthew Rabin 1993)). Dickinson did so by changing the size of the available stash (from $1 to $15) and by telling only DM1 what DM2 did in the previous round and he played repeated games for five rounds but with different partners in each round. DM1s were given on "a piece of paper what [DM2] was offered, what the pie size was, and they were also told whether or not [DM2] accepted or rejected the offer" (David L. Dickinson 2000). Furthermore, he was comparing if stake-size changed the rejection percentage. He reports his results as having found statistically significant means but the significance powers are rather mild (p-range 0.08 to 0.43, with one exception, the $7 stash was significantly different at $p = 0.02$ – page 165). However, in my view, the DM1's offer was not a response for the changing size of the pie but for the history of previous response by DM2, in other words, Dickinson tested the effect of *reputation* on UG transactions; he replaced ambiguity with a known probability distribution. Yet even then, his results were rather mild.

Cameron ran a field experiment in Indonesia in 1994 in which she raised the stakes to represent substantial earnings (for example, she offered $100 stake where the per capita gross domestic product was US$670) and she found that stake size had no effect on the percentage of money DM1 sent to DM2, or the percent that DM2 rejected; as found Carpenter et al., in their experiment where they tested both the UG and the DG (Jeffrey Carpenter *et al.* 2005;Lisa A. Cameron 1999). However, Cameron found that in imaginary (hypothetical) games, DM2s were much more likely to reject than in real games (Lisa A. Cameron 1999).

Eckel and Grossman recruited two groups of players: volunteer subjects in the usual way and pseudo-volunteer subjects (class-time students), all participating in a DG experiment with a *charity* as the recipient (Catherine C. Eckel, Philip J. Grossman 2000). The experiment was meant to test for social signal differences between volunteers and pseudo-volunteers in the typical economic exchange scenario using DG. The unintended interference was provided by the subjects being asked if they would be willing to participate "voluntarily" in a game (asked in class by the authors, who were professors in these classes) – henceforth called the "pseudo volunteers," the charity that was chosen by the authors (professor's favorite?), and by the pseudo-volunteers' knowledge that they have the "option" to donate to the professor's charity (Catherine C. Eckel, Philip J. Grossman 2000). As there is no risk or ambiguity involved in offering a donation to a charity, no applicable social signal was exchanged, only personal preference, and because the professor's image was hovering in the pseudo-volunteers mind when making their decisions, they showed skewed preference toward "sharing". Eckel and Grossman thus found that volunteer subjects (those with no connection to the class, and hence, a grade from the faculty) were significantly more likely to offer zero to the charity than pseudo-volunteers and that almost 29% of the pseudo-volunteer gave *everything* to the charity, while only 5% of the true volunteers did.

Even as late as 2005, we still find misunderstandings about human nature and human behavior in economic experiments. For example, Bardsley noted that people don't seem to make anonymous donations to strangers and decided to set up an experiment to test whether DG truly measure social preferences or if they measure something else (Nicholas Bardsley 2005). He hypothesized that if giving money was equivalent to *taking money* (as it is true in mathematics), then the game reflected true social preference. He wanted to measure the difference between what players would offer to give and what they would take. However, he did not find any difference because subjects, knowing that in one experiment they will give and in the other take, did not offer much in the first place in the giving part. Furthermore, in one version of the game the subjects had to choose between giving some positive amounts (from £0 - £4) or take £2 from the show-up fee earned by the opposing players—and results suggest that many did take but not all. In order to get stronger results, he simulated 10,000 experiments and using nonparametric techniques, he was able then top reject the null hypothesis at 5% level. Hence, what Bardsley actually tested was a player taking the endowment from one player (negative) versus a player giving something from his endowment by choice (positive) to the other.

However, giving is an altruistic act while taking is a *punishing* act. Adding and subtracting in human terms have strikingly different utilities associated with them; one provides reward and the other punishes in terms of endowment. Thaler showed that an item of endowed value is greater than the value of the same item not yet owned (R. Thaler 1980).

My final example of mistaken views is Rustichini's comment, who suggests that

> the task of an economist is to establish useful predictions on which human behavior will follow given certain incentives, preferences, and feasibility constraints. This set of parameters, that is available to the economist analyzing the situation, defines the input, and the behavior is the output (Aldo Rustichini 2005) (page 203).

Rustichini is missing the most important element in the definition of the input and the output. Where is the giant processing machine, the brain? Rustichini suggests that inputs are given by external conditions (incentives and constraints) and internal ones (preferences) that combined provide the variables for processing, of which the *output* becomes the human *behavior*. Put differently, if Rustichini's comments were true, similarly to any factory machinery or computer used as processors, so long as the inputs are the same, one would predictably always get the same output. This suggests that the *processor* does not add additional input variables, which is certainly true in the case of computers. However, each person has a very unique processor sitting atop his or her neck and each of these processors provides additional inputs (hormones) into the model based on a mixture of physiological constraints. In fact, this is precisely what laboratory experiments with economic games are trying to capture.

The researchers provide the same instructions and the same money to each participant—thus the controllable external variables are the same. Not only do experimenters want to see the end result (the outcome) of how much money is exchanging hands, but the behavioral constraints as well by analyzing blood hormonal levels or imaging the brain at the time of decision-making or adding neuropeptides to analyze how modified internal environment of the individual affects how much money is exchanging hands. In the case of humans, it is the behavior and not the input that modifies the output. If the brain did not provide input, how would adding neuropeptides modify the outcome? Yet adding neuropeptides does modify the outcome! See a great study about nasally administering OT into human subjects and what that does to their behavior in terms of modifying the output they offer (Michael Kosfeld *et al.* 2005a) and also see the next chapter in which I use OT to induce a more generous behavior in the UG.

Great Experiments

There have been some truly ingenious experiments as well as there were lots of oppositions to the games and experimenting techniques. Vernon Smith suggested that "subjects *experience* the choices of others and then choose based on what they have learned to accept" (Vernon L. Smith 1998b) (page 110; emphasis added). But not all experiments offer the chance of experiencing the decisions of others. In particular, experiments that want to learn the influence of hormones do not provide feedback because it would contaminate the results by measuring reactive emotions rather than the affect of the neuropeptide itself. Smith argued that the experimental procedures themselves constitute unintended contaminants. He further suggested that

> the idea that one should randomize effects that are not controlled comes from biology, where you randomize treatments among plots of land to prevent differences in soil quality from being attributed accidentally to the treatments. But human subjects are not plots of land, and the method of assignment may not have a neutral effect on behavior… results call into question the interpretation of data from the large literature in bilateral bargaining that is characterized by a first-mover, or other asymmetric advantage, randomly assigned… the question is whether inducing fair behavior is the appropriate way to frame the test of a bargaining theory that assumes self-interested agents whose interests conflict, as with management and labor. Now, if one were to replicate all the asymmetric bargaining experiments, assigning privileged rights only to those who earned them, and still observe fair outcomes, then this would call into question the relevance of the theory" (Vernon L. Smith 1998a) (112-113).

Smith makes a good point. As the reader will see in chapter 3, I describe such possible contamination by randomizing the order in which the games were played. It is well documented that some games, the trust game in particular, makes the subjects release OT (Paul J. Zak *et al.*

2004). Such OT release can override the effects of other hormones—in this case AVP—cancelling out the desired effect.

Schotter et al. designed an experiment to test what Smith suggested: mimic a "true" market under survival pressures and see if agents still defy the theory (Andrew Schotter *et al.* 1996). His team introduced property rights in two-stage-survival UG and DG, in which proposers were competing with each other in offering higher amounts to the same one responder. Whoever was able to have his offer accepted, entered stage two as "property right owner." As property owners, the money they kept for themselves in the second game (second stage) was higher; "demand behavior changes substantially as we move from the one-stage to the two-stage experiments" and DM2s rejected less often the smaller amounts offered in the second stage (Schotter et al., 1996, page 44).

To address the first-mover-advantage question, Weber et al. set up an experiment to see if first movers would demand different dollar amount from when the same players moved second (Roberto A Weber *et al.* 2004). They found that minimal acceptable offers (MinAccept) of DM2s became lower when they knew that they were going to move second, and were higher when they knew that they were first-movers. They suggested that the timing result points to an interpretation on fairness that is incomplete. If only distaste for unfairness drives the response of DM2, their minimum acceptable offer amount should not change based on the knowledge of who moves first. Within the fairness framework, the answer they suggest is that a low offer appears to be fairer when a person is DM1 and moves first than when that same player is DM2 and moves second. But this answer suggests that fairness is based on who has access to exercise advantage (Weber, page 40).

Kahneman et al. wanted to get a better understanding of how consumers react to the model of profit-seeking firms by considering the newly discovered preferences that people have for being treated fairly (Daniel Kahneman *et al.* 1986). They set up an experiment in which two individuals played the DG. The dictator was called "fair," if he offered half of the play-money or "unfair" if he took more than half. A third individual then had to choose with whom she would split a certain dollar amount (knowing the history of previous exchanges). Would she split a larger amount with an unfair player or a smaller amount with a fair player? The majority of the third players chose to split the smaller amount in order to share with the fair player, albeit at a cost to themselves.

Aumann suggested that even though people reject in UG because they are insulted, the models still consider this insult exogenous (Robert J. Aumann 1986). He recalled Axelrod et al.'s experiment with the PD game and how it is usually "a crazy type, that wins out – takes over the game, so to speak… there is only one crazy type, who always plays tit-for-tat, no matter what the other player does; and it turns out that the rational type must imitate the crazy type, he must also play tit-for-tat." Axelrod's team already had a theory why crazy types win (Robert Axelrod, William D. Hamilton 1981;Robert Axelrod 1981;Robert Axelrod, Douglas Dion 1988). But new theories have emerged providing different theories about who these "crazy types" are and why they win. Fehr and Tyran (Ernst Fehr, Jean-Robert Tyran 2005), and Camerer and Fehr (Colin F. Camerer, Ernst Fehr 2006) suggested that "strategic complementarity"[3] is participating in these games, which means that it takes only a small number of individuals to play other-regarding before that may lead to large deviations from aggregate predictions of NE models, whereas under

[3] "I do as you do"

strategic substitutability[4] the opposite is true, a minority of self-regarding agents may suffice to generate aggregate outcomes consistent with the predictions of NE game-theoretical models.

The process of why Aumann's "crazy types win" is detailed by Camerer and Fehr as follows: what happens if a strong reciprocator faces a self-regarding player and both players know each other's preferences? [Note: there is a bit of a problem here with "knowing" the other person's preferences but I will let it go at this time for the sake of making a point]. In a simultaneous game, the existence of the self-regarding player will induce the reciprocator to behave non-cooperatively as well. If the exchange is structured sequentially, however, with the self-regarding player starting first, an exchange will take place because the self-regarding player knows that the reciprocating player will only respond to a reasonable offer (Colin F.Camerer, Ernst Fehr 2006b) (page 47).

Preferences, Beliefs, and Environmental Factors

I would like to return to my note about knowing the preferences of others above in Camerer's and Fehr's explanation. Obviously they placed the framework of the "old" *Homo economicus* model as grounds for explaining a phenomenon that otherwise has no known answer (so far) in this literature review—the reader may suggest that telepathy may exists under these circumstance. Assume for a moment that you, the reader of this article, and I suddenly find ourselves engaged in playing a game of DG or UG, anonymously. Would I, under any circumstances, know your preferences without actually knowing you? Would you know mine? Certainly, I may postulate that given that you are reading my article, you and I share at least one thing in common: we both know what this article is about; this gives you some shared history of me. This may allow us to form beliefs about one another's expectation but those are just *beliefs*

[4] "if you go right I go left"

(some based on reputation) and *not* actual knowledge of preferences. In the lab where experiments are conducted, hundreds of students converge from the same university in a room to play the games. Obviously they share some beliefs—otherwise they would not be students in the same institution. In general every university lab experiment is biased by the homogeneity of the population from which a group of convenience is selected for experiments. Random selection must be ignored and the subjects are not independent because they all share at least two systemic bias: 1) same university and 2) they all are volunteers, which by definition distinguishes them from those who don't volunteer. However, as these errors are systemic across the board in all experiments, perhaps we all start from a plateau that is different from a study of true independent observations but since all laboratory experiments have them, this systemic error can be ignored.

"Cultural traits like values, ambitions, and lifestyles influence economic behavior and thereby economic conditions [see on this subject (Paul J. Zak, Stephen Knack 2001)]. Economic conditions exert selective pressure on the cultural traits" (Selten, page 90). "Mechanisms of cultural evolution are shaped by biological evolution and competitive processes involve learning and imitation" (Selten, pages 92, 101). Thus Selten also noticed the mimicking behavior necessary for successful societies. Henrich and team found in their experiments in 15 small-scale societies that there were distinct group-differences in notions of fairness (Joseph Patrick Henrich *et al.* 2005). They also found that the level of market integration of a society influences differences in notions of fairness and punishment. They found that the selfishness axiom accurately predicts DM2 behavior in some societies but not university students in lab experiment. They also found that few or none of the subjects in these small-scale societies offered zero in DG. They further write that "cultural evolution and its products have undoubtedly influenced the human genotype… The relationship between culture-gene coevolutionary theory and the preferences, beliefs, and constraints approach is straightforward, although rarely illuminated" (Henrich, page 812).

Fairness in One-Shot Blinded Games?

The question of whether *fairness* drives the unexpected human behavior in UG was asked by many. *Fairness* is defined as sacrificing self-gains "to change the distribution of material outcomes among others, sometimes rewarding those who act prosocially and punishing those who do not" (Joseph Patrick Henrich *et al.* 2005) (page 797). Forsythe et al. tested if the fairness hypothesis can explain the result of Güth's experiment (Robert Forsythe *et al.* 1994b;Robert Forsythe *et al.* 1994a). They hypothesized that if the results of the UG and the DG are the same, fairness is the explanation. However, as they did not find this to be the case, they concluded that fairness can only be one factor that determines the money offered by DM1 in UG. Nowak *et al.* developed an evolutionary approach to the UG (M. A. Nowak *et al.* 2000). They suggested that fairness will evolve if DM1 can obtain some information on what deals DM2 has accepted in the past, similarly to the hypothesis of Dickinson (David L. Dickinson 2000). They believed that the evolution of fairness, similarly to the evolution of cooperation, is linked to reputation and is driven by a mechanism that is similar to genetic evolutionary forces. Like Dawkins' *Grudgers,* future generations of individuals leave their offspring in proportion to their "total payoff," which in this case is "success rate," and each new generation only deals with those who have been accepted by DM2s in previous encounters. This process can readily lead to the evolution of fairness in repeated games where reputation matters. Why fairness evolves without explicit reputation, as is the case in one-shot blinded games, remains to be solved by those experiments that can measure emotional responses more directly, such as the two experiments that follow this chapter.

The dictator game by its nature removes incentives for strategic behavior. The assumption is that if players still act fairly in DGs, they must have a taste for fairness, which was introduced earlier as sacrificing self-gains in order to change the distribution of material outcomes among others to benefit those who act prosocially and punish those who do not (Michael P. Haselhuhn, Barbara A. Mellers 2005). Haselhuhn and Mellers modified the UG and DG such that DM1s are also asked to imagine the pleasure they would feel with each possible payoff—payments were paid according to the actual games and not based on the imagined possible payoffs. They were told to rank-order their preferences over all possible offers, and to draw inferences about the emotions DM2 might feel. Their statistics shows that 25% of DM1s thought they did not derive pleasure from fairness, 65% some pleasure, and 10% significant pleasure (Haselhuhn). They also found that preference-orders differed from pleasure-orders. Most DM1s made fair offers in the UG, but cooperation appeared to be strategic rather than emotional. However, there were 10% of DM1s who derived greater pleasure from fair payoffs than from larger payoffs (Haselhuhn, page 29). In the DG, 55% of dictators derived no pleasure from fairness, and 15% felt significant pleasure from fairness. Those dictators who received pleasure from fairness, tended to make fair offers even when they had no strategic reason to do so.

Saad and Gill (Gad Saad, Tripat Gill 2001) and Eckel and Grossman (Catherine C. Eckel, Philip J. Grossman 1996) found that in the UG, female allocators were more concerned about fairness when making offers than males, while males made more generous offers when pitted against a female than a male. White females made equal offers independently of the sex of the recipient. They also suggested an evolutionary explanation for fairness; "male allocators are altruistic towards female recipients and competitive with male recipients is construed as a manifestation of social rules, which evolve from the male predisposition to use resources for attracting mates" (Saad and Gill, page 171). Takahashi observed that there was a negative correlation between interpersonal trust and social stress-induced cortisol elevation in DM2s in UG under stress, indicating that subjects with high levels of interpersonal trust showed reduced social stress (Taiki Takahashi 2005). "Collectively, interpersonal trust might possibly enhance social cooperation via better social memory due to lowered acute social stress actions during a face-to-face social interaction, which would result in high levels of an economic growth" (Taiki Takahashi 2005) (page 4).

Environmental Cues: Cultural Heuristics

I have frequently mentioned throughout this essay that players have beliefs rather than actual updates of the preferences of others. One clever experiment calls attention to cues that hang in the general environment without even our conscience observation. Blythe et al. set up an experiment that shows just how such social cues may enter into comprehension without the players' knowledge (Philip W. Blythe *et al.* 1999). Their goal was the opposite of what one may expect; they wanted to see if complex social cues can tell the story about the *intentions* of the individuals while playing certain games. The games were played by volunteers on the computer with imaginary little creatures. On screen two bugs: one blue and the other red. Each player played 6 types of games: red bug *plays* with blue bug, red bug *courts* blue bug, blue bug acts *being courted*, blue bug *courts* red bug and red acts *courted*, red bug *pursues* blue bug who is trying to *evade*, the same with bug color change, and lastly the two bugs are *fighting*. In each of these games, the human volunteer controlling the specific bug is given a list of "to do's" but otherwise "acts out" the feeling according to his or her best interpretation of what "courting" or "fighting" means. For example, to court, the bug "owner" volunteer was told to move the bug to court the other bug by interacting with it in any way that it might find interesting, exciting, or enticing. The owner of the courted bug was instructed to move the bug to show interest or disinterest, and to elicit further displays in any way desired (page 266).

Since the bugs were computer images, their movements could easily be digitized and recorded on a time-series model 3D graph—the bugs themselves were reduced to directionless dots. Blythe *et al.* averaged the motion images of the many trials and displayed the aggregate image of the six motion types. Next they invited new volunteers who were not familiar with the game and replayed in front of them only the time-correct motion graphs of dots (no bugs were seen). The job of the volunteers was to identify which type of the six the particular bug-aggregate-motions they were looking at. The uninitiated were able to predict the motion-intents of the bug on the screen with about 50% accuracy based on the graphs alone—random guessing is expected to be correct 18% of the time, so 50% is well above randomness. When Blyth's team removed one of the two bugs and showed, again, to uninitiated players, but this time the bug-aggregate-motions of only one of the two bugs, the recognition of the motion was reduced to approximately 30% but still did not disappear.

What this experiment clearly demonstrates is that social cues "in the air" can continuously reaffirm or modify a person's belief in the type of environment. In the laboratory, there is plenty of opportunity for receiving such social cues. One of them, I already mentioned, is that the volunteers come from the same institution. Another is that as they come for the experiments, they line up to provide their student identifications; sometimes the line is long and there is ample opportunity to look and feel who is in the crowd. Although once the UG or DG starts in the lab, the volunteers do not specifically know whom they play with, they certainly know the "average makeup" of the people in the room. They can, thus, estimate if they are in an environment where acting according to the rules of strategic complementarity or strategic substitutability would offer the highest payoff.

Reciprocity can be based on experience from the past by having repeated interaction but they can "also be based on the knowledge that the members of the interacting group are 'alike'" (Ernst Fehr, Bettina Rockenbach 2004). In an experiment by Gachter and Thoni, subjects were ranked with respect to their contribution in a one-shot PG game and then sorted into groups of individuals with similar ranks (S. Gachter, C. Thoni 2005). Cooperation in the "alike" groups of like-minded people was found to be significantly higher than in random group composition—supporting significantly that lab environment, which is made up of individuals that are members of an "alike" group, might provide economic choices that reflect the norms of that "in-group."

Framing and *Machs*

Hoffman et al. conducted several interesting experiments testing fairness with a variety of framing approaches. In their 1996 experiment, using DG, they tested the theory that framing might have a lot to do with the appearance of fairness in the game (Elizabeth Hoffman *et al.* 1996). In most cases at that time, the experiments were conducted under observation, rather than blindly from everyone, including the experimenters. They conducted their experiment double-blind and requested that the dictators place their offer to the recipient into an envelope, place the envelope in a box, from which the experimenters took them, counted the money and passed them on to the recipients. They found that "there was a pronounced tendency for those leaving no money to seal their envelope, and for those leaving positive amounts of money to not seal their envelopes." They concluded that other-regarding behavior varies with context based on opportunity costs (Elizabeth Hoffman *et al.* 1996). With respect to framing, they suggested that subjects bring their ongoing experience of the world with them into the laboratory, and the instructional language used can associate a subject's decision with past experience. For example, "suggesting that the task is to 'divide' the $10 may imply that the objective is to *share* the money with someone, who, though anonymous, is socially relatively near to the decision-maker" (Hoffman, 1996, page 655). Bolton et al. agrees with Hoffman et al., suggesting that in comparing their data with that of previous studies, they also find differences in the results of the games based on the differences in written directions (Gary E. Bolton *et al.* 1998;Elizabeth Hoffman *et al.* 1999).

Carpenter et al., had players fill out a personality scale called the *Mach* scale (first developed in (R. Christie, F. Geis 1970)), which consists of 20 statements drawn from Machiavelli's The Prince to which subjects agree or disagree (Jeffrey Carpenter *et al.* 2005). Those who tend to agree with the statements are the high *Machs* and the others the low *Machs*. They included the *Mach* scale to control for "variations in predispositions toward engaging in manipulative behaviors." In previous work, (H.-D. Meyer 1992) found evidence suggesting that high *Machs* accept low offers and reciprocate less (A. Gunnthorsdottir *et al.* 2002). Burks et al. found that high *Machs* were also less trusting, sending less and rejecting higher amounts (S. Burks *et al.* 2003). McCabe et al., however found that Christie and Geis's Machiavellianism scale (Mach-IV) is not a good predictive tool to measure the trust of subjects in the trust game (Kevin McCabe *et al.* 2002).

As there is substantial debate over why humans use costly punishment, Xiao and Houser tested experimentally if constraints on *emotion expression* would increase, decrease, or keep the same, the use of costly punishment (Erte Xiao, Daniel Houser 2005). They found that rejection of unfair offers was significantly less frequent when DM2s could convey their feelings to DM1s concurrently with their decisions. Their data supports the view that punishment might be used to express the negative emotions players feel when they are treated unfairly.

fMRI

Sanfey et al. noted that the magnitude of activation in the bilateral anterior insula, dorsolateral prefrontal cortex (DLPFC), and anterior cingulate cortex (ACC) (using fMRI) were significantly greater for unfair offers from human partners then from computer partners (A. G. Sanfey *et al.* 2003). They also found the magnitude of activation to be significantly greater in both sides of the insula for unfair offers from human partners than to both unfair offers from computer partners and low control offers. The insula is associated with the feeling of negative emotions. For example, Singer et al., found in an fMRI experiment that the insula is associated with the feeling of pain of a loved one (Tania Singer *et al.* 2004) and Wager et al., found that the insula is also able to partake in placebo-effects of suggestions of investigation (Tor D. Wager *et al.* 2004). They suggest that these activations were not solely a function of the amount of money offered but rather they were sensitive to the context, the *perceived* unfair treatment from another human. Regions of "bilateral anterior insula demonstrated sensitivity to the degree of unfairness of an offer, exhibiting significantly greater activation for a $9:$1 offer than an $8:$2 offer from a human partner" (A. G. Sanfey et al. 2003 page 1756).

Sanfey et al.'s findings are in conflict with the results of Rilling et al., (James K. Rilling *et al.* 2004) who used fMRI for experimenting with UG and PD games, using human and computer partners. In Rilling's team's experiments of UG, the scanned participants were always in the role of DM2. Unfair offers by humans were rejected at a significantly higher rate than the same offers by computers, as was also found by Sanfey et al. in 2003 (A. G. Sanfey *et al.* 2003). However, Rilling et al. found that while playing the with computer partners, they got different results for playing UG or prisoner's dilemma (PD). While playing the UG, computer partners did not activate the same regions in the brain as did playing with real people. In other words, the scanned participants' brain actively distinguished between playing with a computer or a person. Each participant in the scanner knew the identity of the other player, even when the other player was a computer—there was no deception. In spite of knowing that the scanned partner was playing against a computer, when playing the PD game, playing with computer partners elicited the same brain activation in the scanned DM2 than when playing with a real human partner.

Put differently, in PD game, the brain is not able to distinguish between playing against a computer or a person, even when all facts are clearly stated to the scanned participant. Several areas, including right dorsolateral prefrontal cortex and right parietal lobe were activated in both cases. Event-related plots for both of these regions of interests (ROIs) reveal an increase in activation in response to the partner's face (could be computer "face" in case of a computerized partner) that remain elevated until the game outcome is revealed, at which time there is a secondary increase—in other words, when image is seen, there is an expectation until the offer is revealed. Rilling et al. found that there was a notable discrepancy between the UG and the PD games in the ability of computer partners to elicit activation in areas also activated by human partners. They suggest that this difference may relate to the varying "responsiveness" of the two computer strategies. In the UG game, the computer did not respond to participant choices; it simply made the participant an offer. But in the PD game, the computer responded to a choice by the participant and gave the impression that the computer's decision was contingent on the human participant's choice. Mutual cooperation and the punishment of defectors activate reward related neural circuits, suggesting that evolution has endowed humans with mechanisms to render altruistic behavior psychologically and physiologically rewarding (Ernst Fehr, Bettina Rockenbach 2004).

The results of recent years' experiences provide support for the hypothesis that neural representations of emotional states guide human decision-making. Sanfey found that the anterior insula scales *monotonically* to the degree of unfairness felt by the participant, reflecting the emotional response to the offer (A. G. Sanfey *et al.* 2003). Unfair offers were also associated with increased activity in the anterior cingulate cortex. Areas of anterior insula—maybe representing the emotional reaction to unfairness— and the dorsolateral prefrontal cortex (DLPFC)—maybe representing the cognitive part for earning money—represent areas for decision-making in UG. Other recent neuroeconomics studies that scan subjects' brains while they are making decisions in interactive economic experiments also provide interesting results on the neural foundations of reciprocity (K. McCabe *et al.* 2001;J. K. Rilling *et al.* 2002;R. Adolphs 2003;A. G. Sanfey *et al.* 2003;D. J-F. DeQuervain *et al.* 2004). These studies support the hypothesis that neural representations of emotional states guide human decision-making and that subjects derive specific rewards from mutual cooperation and the punishment of norm violators.

Learning effects form expectation and adaptation in brain cells. For example, drug addiction is a form of learning effect, called "incentive learning," where if the neurons' expectation of the upcoming drug is not met, withdrawal follows. During "withdrawal, rats with previous experience of heroin in withdrawal initiated drug-seeking with a shorter latency, and showed more completed cycles of drug-seeking compared to either saline controls or control groups without experience" (D. M. Hutcheson *et al.* 2001) page 944. Thus learning-effects modify behavior and in many lab experiments with humans, such learning effects may be substantial but has been difficult to capture.

It is clearly evident from this review that we have come a long way from the self-regarding and measurably wealth-maximizing *Homo economicus* models and are making strong advances in the understanding of economic exchange from a behavioral and physiological perspective. The reader most certainly has noticed how two games, the UG and the DG, originally used to measure the accuracy of game-theoretic predictions, have metamorphosed into a means to explain evolutionary forces, hormonal stress responses, sexually dimorphic emotions, and now the neural representations of emotional states!

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