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A Framework for the Unification the Behavioral Sciences

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Abstract: The various behavioral disciplines model human behavior in distinct and incompatible ways. Yet, recent theoretical and empirical developments have created the conditions for rendering coherent the areas of overlap of the various behavioral disciplines, as outlined in this paper. The analytical tools deployed in this task incorporate core principles from several behavioral disciplines. The proposed framework recognizes evolutionary theory, covering both genetic and cultural evolution, as the integrating principle of behavioral science. Moreover, if decision theory and game theory are broadened to encompass other-regarding preferences, they become capable of modeling all aspects of decision making, including those normally considered "psychological," "sociological" or "anthropological." The mind as a decision-making organ then becomes the organizing principle of psychology.

Keywords: Behavioral Science, Behavioral Game Theory, Evolutionary Theory, Experimental Psychology, Gene-Culture Coevolution, Rational Actor Model, Socialization

1. Introduction

The behavioral sciences include economics, biology, anthropology, sociology, psychology, and political science, as well as their subdisciplines, including neuroscience, archaeology and paleontology, and to a lesser extent, such related disciplines as history, legal studies, and philosophy.¹ These disciplines have many distinct concerns, but each includes a model of individual human behavior. These models are not only different, which is to be expected given their distinct explanatory goals, but *incompatible*. Nor can this incompatibility be accounted for by the type of causality involved (e.g., "ultimate" as opposed to "proximate" explanations). This situation is well known, but does not appear discomfoting to behavioral scientists, as there has

¹ Biology straddles the natural and behavioral sciences. We include biological models of animal (including human) behavior, as well as the physiological bases of behavior, in the behavioral sciences.

been virtually no effort to repair this condition.² In their current state, however, according to the behavioral sciences the status of true sciences is less than credible.

One of the great triumphs of Twentieth century science was the seamless integration of physics, chemistry, and astronomy, on the basis of a common model of fundamental particles and the structure of space-time. Of course, gravity and the other fundamental forces, which operate on extremely different energy scales, have yet to be reconciled, and physicists are often criticized for their seemingly endless generation of speculative models that might accomplish this. But, a similar dissatisfaction with analytical incongruence on the part of its practitioners would serve the behavioral sciences well. This paper argues that we now have the analytical and empirical basis to construct the framework for an integrated behavioral science.

The behavioral sciences all include models of individual human behavior. Therefore, these models should be compatible, and indeed, there should be a common underlying model, enriched in different ways to meet the particular needs of each discipline. Realizing this goal at present cannot be easily attained, since the various behavioral disciplines currently have *incompatible* models. Yet, recent theoretical and empirical developments have created the conditions for rendering coherent the areas of overlap of the various behavioral disciplines, as outlined in this paper. The analytical tools deployed in this task incorporate core principles from several behavioral disciplines.

The standard justification for the fragmentation of the behavioral disciplines is that each has a model of human behavior well suited to its particular object of study. However, where these objects of study *overlap*, their models must be compatible. In particular, psychology, economics, anthropology, biology, and sociology should have concordant explanations of law-abiding behavior, charitable giving, political corruption, and voting behavior, and other complex behaviors that do not fit nicely within disciplinary boundaries. They do not.

This paper sketches a framework for the unification of the behavioral sciences. Two major categories, evolution and game theory, cover *ultimate* and *proximate* causality. Under each are subcategories that relate to overlapping interests of two or more behavioral disciplines. I will argue the following points:

1. Evolutionary Perspective: Evolutionary biology underlies all behavioral disciplines because *Homo sapiens* is an evolved species whose characteristics are the product of its particular evolutionary history.

1a. Gene-culture Coevolution: The centrality of culture and complex social organization to the evolutionary success of *Homo sapiens* implies that individual fitness in humans will depend on the structure of cultural life. Since obviously culture is influenced by human genetic propensities, it follows that human cognitive, affective, and moral capacities are the product of a unique dynamic known as *gene-culture coevolution*. This coevolutionary process has endowed us with preferences that go beyond the self-regarding concerns emphasized in traditional economic and biological theory, and embrace such other-regarding values as a taste for cooperation, fairness, and retribution, the capacity to empathize, and the ability to value such constitutive

² The last serious attempt at developing an analytical framework for the unification of the behavioral sciences was Parsons and Shils (1951). A more recent call for unity is Wilson (1998), who does not supply the unifying principles.

behaviors as honesty, hard work, toleration of diversity, and loyalty to one's reference group.³

1b. Imitation and Conformist Transmission: Cultural transmission generally takes the form of *conformism*: individuals accept the dominant cultural forms, ostensibly because it is fitness-enhancing to do so (Bandura, 1977, Boyd and Richerson, 1985, Conlisk, 1988, Krueger and Funder, 2004). While adopting the beliefs, techniques, and cultural practices of successful individuals is a major mechanism of cultural transmission, there is constant cultural mutation, and individuals may adopt new cultural forms when they appear to better serve their interests (Gintis 1972, 2003a; Henrich 2001). One might expect that the analytical apparatus for understanding cultural transmission, including the evolution, diffusion, and extinction of cultural forms, might come from sociology or anthropology, the disciplines that focus on cultural life, but such is not the case. Both fields treat culture in a static manner that belies its dynamic and evolutionary character. By recognizing the common nature of genes and culture as forms of information that are transmitted intergenerationally, biology offers an accurate analytical basis for understanding cultural transmission.

1c. Internalization of Norms: In sharp contrast with other species, human preferences are *socially programmable*. Culture thus takes the form not only of information allowing superior control over nature, but also of *norms and values* that are incorporated into individual preference functions through the sociological mechanism known as *socialization* and the psychological mechanism known as the *internalization of norms*. Surprisingly, the internalization of norms, which is perhaps the most singularly characteristic feature of the human mind, and central to understanding cooperation and conflict in human society, is ignored or misrepresented in the other behavioral disciplines, anthropology aside.

2. Game Theory: The analysis of living systems includes one concept that does not occur in the non-living world, and is not analytically represented in the natural sciences. This is the notion of a *strategic interaction*, in which the behavior of agents is derived by assuming that each is choosing a *fitness-relevant response* to the actions of other agents. The study of systems in which agents choose fitness-relevant responses and in which such responses evolve dynamically, is called *evolutionary game theory*. Game theory provides a transdisciplinary conceptual basis for analyzing choice in the presence of strategic interaction. However, the classical game theoretic assumption that agents are self-regarding must be abandoned except in specific situations (e.g. anonymous market interactions), and many characteristics that classical game theorists have considered deductions from the principles of rational behavior, including the use of backward induction, are in fact not implied by rationality. Evolutionary game theory, whose equilibrium concept is that of a stable stationary point of a dynamical system, must thus replace classical game theory, which erroneously favors subgame perfection and sequentiality as equilibrium concepts.

2a. The Brain as a Decision Making Organ: In any organism with a central nervous system, the brain evolved because centralized information processing entailed enhanced decision making capacity, the fitness benefits more than offsetting its metabolic and other costs. Therefore, decision making must be the central organizing principle of psychology. This is not to say that learning (the focus of behavioral psychology) and information processing (the focus of cognitive

³ I use the terms "self-regarding" to avoid the confusion that results from using the more common term "self-interested" when the agent prefers outcomes that benefit others. For instance, if I prefer to give gifts to others, my behavior in doing so may be selfish (it may me give pleasure), but it is certainly not self-regarding. Similarly considerations apply to "other-regarding."

psychology) are not of supreme importance, but rather that principles of learning and information processing only make sense in the context of the decision making role of the brain.

2b. The Rational Actor Model: General evolutionary principles suggest that individual decision making can be modeled as optimizing a preference function subject to informational and material constraints. Natural selection leads the content of preferences to reflect biological fitness. The principle of expected utility extends this optimization to stochastic outcomes. The resulting model is called the *rational actor model* in economics, but I will generally refer to this as the *beliefs, preferences, and constraints* (BPC) model to avoid the often misleading connotations attached to the term "rational."⁴

In addition to these conceptual tools, the behavioral sciences of course share common access to the natural sciences, statistical and mathematical techniques, computer modeling, and a common scientific method.

The above principles are certainly not exhaustive; the list is quite spare, and will doubtless be expanded in the future. Note that I am not asserting that the above principles are the most important in each behavioral discipline. Rather, I am saying that they contribute to constructing a common model of human behavior from which each discipline can branch off by adding needed behavioral dimensions.

While accepting the above framework may entail substantive reworking of basic theory in a particular discipline, I expect that much research will be relatively unaffected by this reworking. For instance, a psychologist working on visual processing, or an economist working on futures markets, or an anthropologist tracking food sharing practices across social groups, or a sociologist gauging the effect of dual parenting on children's educational attainment, might gain little from knowing that a unified model of decision making underlay all the behavioral disciplines. But, I suggest that in such critical areas as the relationship between corruption and economic growth, community organization and substance abuse, taxation and public support for the welfare state, and the dynamics of criminality, researchers in one discipline are likely to benefit greatly from interacting with sister disciplines in developing valid and useful models.

In what follows, I will expand on each of the above concepts, after which I will address common objections to the beliefs, preferences, and constraints (BPC) model and game theory.

2. Evolutionary Perspective

⁴ Dialogue with behavioral scientists has convinced me of the difficulty in maintaining a sustained scientific attitude when the BPC is referred to the "rational actor model." I will continue to use the term occasionally, while generally preferring the term "BPC model." Note that "belief" applies to nonhuman species as well as human, as when we say "We led the lion troupe to believe there was a predator in the vicinity," or "we erected a mirror so that the fish believed it was being accompanied in predator inspection."

Economics, biology and political science incorporate game theory into the core of their models of human behavior. By contrast, game theory widely evokes emotions from laughter to hostility in the other behavioral disciplines. Certainly, if one rejects the BPC model (as these disciplines characteristically do), game theory makes no sense whatever. The standard critiques of game theory in these disciplines are indeed generally based on the sorts of arguments on which the critique of the BPC model are based, to which we turn below (Section 9).

A *replicator* is a physical system capable of drawing energy and chemical building blocks from its environment to make copies of itself. Chemical crystals, such as salt, have this property, but biological replicators have the additional ability to assume a myriad of physical forms based on the highly variable sequencing of its chemical building blocks (Schrödinger called life an "aperiodic crystal" in 1943, before the structure of DNA was discovered), Biology studies the dynamics of such complex replicators using the evolutionary concepts of replication, variation, mutation, and selection (Lewontin, 1974).

Biology plays a role in the behavioral sciences much like that of physics in the natural sciences. Just as physics studies the elementary processes that underlie all natural systems, so biology studies the general characteristics of survivors of the process of natural selection. In particular, genetic replicators, the epigenetic environments to which they give rise, and the effect of these environments on gene frequencies, account for the characteristics of species, including the development of individual traits and the nature of intraspecific interaction. This does not mean, of course, that behavioral science in any sense *reduces* to biological laws. Just as one cannot deduce the character of natural systems (e.g., the principles of inorganic and organic chemistry, the structure and history of the universe, robotics, plate tectonics) from the basic laws of physics, similarly one cannot deduce the structure and dynamics of complex life forms from basic biological principles. But, just as physical principles inform model creation in the natural sciences, so must biological principles inform all the behavioral sciences.

3. The Brain as a Decision Making Organ

The fitness of an organism depends on how effectively it make choices in an uncertain and varying environment. Effective choice must be a function of the organism's state of knowledge, which consists of the information supplied by the sensory inputs that monitor the organism's internal states and its external environment. In relatively simple organisms, the choice environment is primitive and distributed in a decentralized manner over sensory inputs. But, in three separate groups of animals, the craniates (vertebrates and related creatures), arthropods (including insects, spiders, and crustaceans) and cephalopods (squid, octopuses, and other mollusks) a central nervous system with a brain (a centrally located decision making and control apparatus) evolved. The phylogenetic tree of vertebrates exhibits increasing complexity through time, and increasing metabolic and morphological costs of maintaining brain activity. There is thus no doubt but that *the brain evolved because larger and more complex brains, despite their costs, enhanced the fitness of their carriers*. Brains therefore are ineluctably structured to make on balance fitness-enhancing decisions in the face of the various constellations of sensory inputs their bearers commonly experience.

The human brain shares most of its functions with that of other vertebrate species, including the coordination of movement, maintenance of homeostatic bodily functions, memory, attention, processing of sensory inputs, and elementary learning mechanisms. The distinguishing characteristic of the human brain, however, lies in its power as a *decision making* mechanism.

Surprisingly, this basic insight is missing from psychology, which has two main branches: behavioral and cognitive. The former is preoccupied with learning mechanisms that humans share with virtually all metazoans (stimulus response and operant conditioning), while the latter defines the brain as an "information-processing organ," and generally argues that humans are relatively poor, irrational, and inconsistent decision makers. For instance, a widely used text of graduate-level readings in cognitive psychology, (Sternberg and Wagner, 1999) devotes the *ninth* of eleven chapters to "Reasoning, Judgment, and Decision Making," offering two papers, the first of which shows that human subjects generally fail simple logical inference tasks, and the second shows

that human subjects are irrationally swayed by the way a problem is verbally "framed" by the experimenter. A leading undergraduate cognitive psychology text (Goldstein, 2005) placed "Reasoning and Decision Making" the *last* of twelve chapters. This includes one paragraph describing the rational actor model, followed by many pages purporting to explain why it is wrong. Behavioral psychology generally avoids positing internal states, of which preferences and beliefs, and even some constraints (e.g. such character virtues as keeping promises), are examples. When the rational actor model is mentioned, it is summarily rejected (Herrnstein et al., 1997). Not surprisingly, in a leading behavioral psychology text (Mazur, 2002), choice is covered in the *last* of fourteen chapters, and is limited to a review of the literature on choice between concurrent reinforcement schedules and the capacity to defer gratification. Summing up a quarter century of psychological research in 1995, Paul Slovic asserted, accurately I believe, that "it is now generally recognized among psychologists that utility maximization provides only limited insight into the processes by which decisions are made." (Slovic, 1995):365 "People are not logical," psychologists are fond of saying, "they are *psychological*." Of course, in this paper I argue precisely the opposite position, *pace* the performance errors and other decision making weaknesses discovered by experimental psychologists.

Psychology could be the centerpiece of the human behavioral sciences by providing a general model of decision making that the other behavioral disciplines use and elaborate for their various purposes. The field fails to hold this position because its core theories do not take the fitness-enhancing character of the human brain, its capacity to make effective decisions in complex environments, as central.⁵

4. The Foundations of the BPC Model

For every constellation of sensory inputs, each decision taken by an organism generates a probability distribution over fitness outcomes, the expected value of which is the *fitness* associated with that decision. Since fitness is a scalar variable, for each constellation of sensory inputs, each possible action the organism might take has a specific fitness value, and organisms whose decision mechanisms are optimized for this environment will choose the available action that maximizes this value.⁶ It follows that, given the state of its sensory inputs, if an organism with an optimized brain chooses action A over action B when both are available, and chooses action B over action C when both are available, then it will also choose action A over action C when both are available. This is called *choice consistency*.

The so-called *rational actor model* was developed in the Twentieth century by John von Neumann, Leonard Savage and many others. The model appears *prima facie* to apply only when actors possess extremely strong information processing capacities. However, the model in fact depends only on choice consistency and the assumption that agents can trade off among outcomes in the sense that for any finite set of outcomes A_1, \dots, A_n , if A_1 is the least preferred and A_n the most preferred outcome, then for any A_i , $1 \leq i \leq n$ there is a probability p_i , $0 \leq p_i \leq 1$ such that the agent is indifferent between A_i and a lottery that pays A_1 with probability p_i and pays A_n with

⁵ The fact that psychology does not integrate the behavioral sciences is quite compatible, of course, with the fact that what psychologists do is of great scientific value.

⁶ This argument was presented verbally by Darwin (1872) and is implicit in the standard notion of "survival of the fittest," but formal proof is recent (Grafen 1999, 2000, 2002). The case with frequency-dependent (non-additive genetic) fitness has yet to be formally demonstrated, but the informal arguments in this case are no less strong.

probability $1-p_i$ (Kreps, 1990). Clearly, these assumptions are often extremely plausible. When applicable, the rational actor model's choice consistency assumption strongly enhances explanatory power, even in areas that have traditionally abjured the model (Coleman, 1990, Kollock, 1997, Hechter and Kanazawa, 1997).

In short, when preferences are consistent, they can be represented by a numerical function, often called a *utility function*, which the individual maximizes subject to his beliefs (including Bayesian probabilities) and constraints. Four *caveats* are in order. First, this analysis does not suggest that people consciously maximize something called "utility," or anything else. Second, the model does *not* assume that individual choices, even if they are self-referring (e.g., personal consumption) are always welfare-enhancing. Third, preferences must be stable across time to be theoretically useful, but preferences are ineluctably a function of such parameters as hunger, fear, recent social experience, while beliefs can change dramatically in response to immediate sensory experience. Finally, the BPC model does not presume that beliefs are correct or that they are updated correctly in the face of new evidence, although Bayesian assumptions concerning updating can be made part of consistency in elegant and compelling ways (Jaynes, 2003).

The rational actor model is the cornerstone of contemporary economic theory, and in the past few decades has become the cornerstone of the biological modeling of animal behavior (Real, 1991, Alcock, 1993, Real and Caraco, 1986). Economic and biological theory thus have a natural affinity: the choice consistency on which the rational actor model of economic theory depends is rendered plausible by biological evolutionary theory, and the optimization techniques pioneered by economic theorists are routinely applied and extended by biologists in modeling the behavior of a vast array of organisms.

For similar reasons, in a stochastic environment, natural selection will ensure that the brain make choices that, at least roughly, maximize expected fitness, and hence to satisfy the expected utility principle. To see this, suppose an organism must choose from action set X , where each $x \in X$ determines a lottery that pays i offspring with probability $p_i(x)$, for $i=0,1,\dots,n$. Then the expected number of offspring from this lottery is

$$\psi(x) = \sum_{j=1}^n j p_j(x).$$

Let L be a lottery on X that delivers $x_i \in X$ with probability q_i for $i=1,\dots,k$. The probability of j offspring given L is then

$$\sum_{i=1}^k q_i p_j(x_i)$$

so the expected number of offspring given L is

$$\sum_{j=1}^n j \sum_{i=1}^k q_i p_j(x_i) = \sum_{i=1}^k q_i \sum_{j=1}^n j p_j(x_i) = \sum_{i=1}^k q_i \psi(x_i),$$

which is the expected value theorem with utility function $\psi(\bullet)$. See also Cooper (1987).

There are no reported failures of the expected utility theorem in non-humans, and there are some compelling examples of its satisfaction (Real and Caraco, 1986). The difference between humans and other animals is that the latter are tested in *real life*, or in elaborate simulations of real life, whereas humans are tested in the laboratory under conditions differing radically from real life. While it is important to know how humans choose in such situations (see section 9), there is certainly no guarantee they will make the same choices in the real-life situation and in the

situation analytically generated to represent it. For instance, a heuristic that says "adopt choice behavior that appears to have benefitted others" may lead to expected fitness or utility maximization even when subjects agents are error-prone when evaluating stochastic alternatives in the laboratory.

In addition to the explanatory success of theories based on the rational actor model, supporting evidence from contemporary neuroscience suggests that expected utility maximization is not simply an "as if" story. In fact, the brain's neural circuitry actually makes choices by internally representing the payoffs of various alternatives as neural firing rates, and choosing a maximal such rate (Glimcher, 2003, Dorris and Glimcher, 2003, Dorris and Bayer, 2005). Neuroscientists increasingly find that an aggregate decision making process in the brain synthesizes all available information into a single, unitary value (Parker and Newsome, 1998, Schall and Thompson, 1999, Glimcher, 2003). Indeed, when animals are tested in a repeated trial setting with variable reward, dopamine neurons appear to encode the difference between the reward that an animal expected to receive and the reward that an animal actually received on a particular trial (Schultz et al., 1997, Sutton and Barto, 2000), an evaluation mechanism that enhances the environmental sensitivity of the animal's decision making system. This error-prediction mechanism has the drawback of only seeking local optima (Sugrue et al., 2005). Montague and Berns (2002) address this problem, showing that the orbitofrontal cortex and striatum contains a mechanism for more global predictions that include risk assessment and discounting of future rewards. Their data suggest a decision making model that is analogous to the famous Black-Scholes options pricing equation (Black and Scholes, 1973).

The BPC model is the most powerful analytical tool of the behavioral sciences. For most of its existence this model has been justified in terms of "revealed preferences," rather than by the identification of neural processes that generate constrained optimal outcomes. The neuroscience evidence, for the first, suggests a firmer foundation for the rational actor model.

5. Gene-Culture Coevolution

The genome encodes information that is used both to construct a new organism, to instruct the new organism how to transform sensory inputs into decision outputs (i.e., to endow the new organism with a specific preference structure), and to transmit this coded information virtually intact to the new organism. Since learning about one's environment is costly and error-prone, efficient information transmission will ensure that the genome encode all aspects of the organism's environment that are constant, or that change only very slowly through time and space. By contrast, environmental conditions that vary across generations and/or in the course of the organism's life history can be dealt with by providing the organism with the capacity to *learn*, and hence phenotypically adapt to specific environmental conditions.

There is an intermediate case that is not efficiently handled by either genetic encoding or learning. When environmental conditions are positively but imperfectly correlated across generations, each generation acquires valuable information through learning that it cannot transmit genetically to the succeeding generation, because such information is not encoded in the germ line. In the context of such environments, there is a fitness benefit to the transmission of *epigenetic* information concerning the current state of the environment. Such epigenetic information is quite common (Jablonka and Lamb, 1995), but achieves its highest and most flexible form in *cultural transmission* in humans and to a considerably lesser extent in other primates (Bonner, 1984, Richerson and Boyd, 1998). Cultural transmission takes the form of vertical (parents to children) horizontal (peer to peer), and oblique(elder to younger), as in Cavalli-Sforza and Feldman (1981), prestige (higher influencing lower status), as in Henrich and

Gil-White (2001), popularity-related as in Newman et al. (2006), and even random population-dynamic transmission, as in Shennan (1997) and Skibo and Bentley (2003).

The parallel between cultural and biological evolution goes back to Huxley (1955), Popper (1979), and James (1880).⁷ The idea of treating culture as a form of epigenetic transmission was pioneered by Richard Dawkins, who coined the term "meme" in *The Selfish Gene* (1976) to represent an integral unit of information that could be transmitted phenotypically. There quickly followed several major contributions to a biological approach to culture, all based on the notion that culture, like genes, could evolve through replication (intergenerational transmission), mutation, and selection (Lumsden and Wilson, 1981, Cavalli-Sforza and Feldman, 1982, Boyd and Richerson, 1985).

Cultural elements reproduce themselves from brain to brain and across time, mutate, and are subject to selection according to their effects on the fitness of their carriers (Parsons, 1964, Cavalli-Sforza and Feldman, 1982, Boyd and Richerson, 1985). Moreover, there are strong interactions between genetic and epigenetic elements in human evolution, ranging from basic physiology (e.g., the transformation of the organs of speech with the evolution of language) to sophisticated social emotions, including empathy, shame, guilt, and revenge-seeking (Zajonc 1980, 1984).

Because of their common informational and evolutionary character, there are strong parallels between genetic and cultural modeling (Mesoudi et al., 2006). Like biological transmission, culture is transmitted from parents to offspring, and like cultural transmission, which is transmitted horizontally to unrelated individuals, so in microbes and many plant species, genes are regularly transferred across lineage boundaries (Jablonka and Lamb, 1995, Rivera and Lake, 2004, Abbott et al., 2003). Moreover, anthropologists reconstruct the history of social groups by analyzing homologous and analogous cultural traits, much as biologists reconstruct the evolution of species by the analysis of shared characters and homologous DNA (Mace and Pagel, 1994). Indeed, the same computer programs developed by biological systematists are used by cultural anthropologists (Holden, 2002, Holden and Mace, 2003). In addition, archeologists who study cultural evolution have a similar *modus operandi* as paleobiologists who study genetic evolution (Mesoudi et al., 2006). Both attempt to reconstruct lineages of artifacts and their carriers. Like paleobiology, archaeology assumes that when analogy can be ruled out, similarity implies causal connection by inheritance (O'Brian and Lyman, 2000). Like biogeography's study of the spatial distribution of organisms (Brown and Lomolino, 1998), behavioral ecology studies the interaction of ecological, historical, and geographical factors that determine distribution of cultural forms across space and time (Smith and Winterhalder, 1992).

Perhaps the most common critique of the analogy between genetic and cultural evolution is that the gene is a well-defined, discrete, independently reproducing and mutating entity, whereas the boundaries of the unit of culture are ill-defined and overlapping. In fact, however, this view of the gene is simply outdated. Overlapping, nested, and movable genes discovered in the past 35 years, have some of the fluidity of cultural units, whereas quite often the boundaries of a cultural unit (a belief, icon, word, technique, stylistic convention) are quite delimited and specific. Similarly, alternative splicing, nuclear and messenger RNA editing, cellular protein modification and genomic imprinting, which are quite common quite undermine the standard view of the insular gene producing a single protein, and support the notion of genes having variable boundaries and having strongly context-dependent effects.

⁷ For a more extensive analysis of the parallels between cultural and genetic evolution, see Mesoudi et al. (2006). I have borrowed heavily from this paper in this section.

Dawkins added a second fundamental mechanism of epigenetic information transmission in *The Extended Phenotype* (1982), noting that organisms can directly transmit environmental artifacts to the next generation, in the form of such constructs as beaver dams, bee hives, and even social structures (e.g., mating and hunting practices). The phenomenon of a species creating an important aspect of its environment and stably transmitting this environment across generations, known as *niche construction*, is a widespread form of epigenetic transmission (Odling-Smee et al., 2003). Moreover, niche construction gives rise to what might be called a *gene-environment coevolutionary process*, since a genetically induced environmental regularity becomes the basis for genetic selection, and genetic mutations that give rise to mutant niches will survive if they are fitness enhancing for their constructors. The analysis of the reciprocal action of genes and culture is known as *gene-culture coevolution* (Lumsden and Wilson, 1981, Durham, 1991, Feldman and Zhivotovsky, 1992, Bowles and Gintis, 2003).

An excellent example of gene-environment coevolution is the honeybee, in which the origin of its eusociality doubtless lay in the high degree of relatedness fostered by haplodiploidy, but which persists in modern species despite the fact that relatedness in the hive is generally quite low, due to multiple queen matings, multiple queens, queen deaths, and the like (Gadagkar, 1991, Seeley, 1997). The social structure of the hive is transmitted epigenetically across generations, and the honeybee genome is an adaptation to the social structure laid down in the distant past.

Gene-culture coevolution in humans is a special case of gene-environment coevolution in which the environment is culturally constituted and transmitted (Feldman and Zhivotovsky, 1992). The key to the success of our species in the framework of the hunter-gatherer social structure in which we evolved is the capacity of unrelated, or only loosely related, individuals to cooperate in relatively large egalitarian groups in hunting and territorial acquisition and defense (Boehm, 2000, Richerson and Boyd, 2004). While contemporary biological and economic theory have attempted to show that such cooperation can be effected by self-regarding rational agents (Trivers, 1971, Alexander, 1987, Fudenberg et al., 1994), the conditions under which this is the case are highly implausible even for small groups (Boyd and Richerson, 1988, Gintis, 2005). Rather, the social environment of early humans was conducive to the development of prosocial traits, such as empathy, shame, pride, embarrassment, and reciprocity, without which social cooperation would be impossible.

Neuroscientific studies exhibit clearly the genetic basis for moral behavior. Brain regions involved in moral judgments and behavior include the prefrontal cortex, the orbitalfrontal cortex, and the superior temporal sulcus (Moll et al., 2005). These brain structures are virtually unique to, or most highly developed in humans and are doubtless evolutionary adaptations (Schulkin, 2000). The evolution of the human prefrontal cortex is closely tied to the emergence of human morality (Allman et al., 2002). Patients with focal damage to one or more of these areas exhibit a variety of antisocial behaviors, including the absence of embarrassment, pride and regret (Beer et al., 2003, Camille, 2004), and sociopathic behavior (Miller et al., 1997). There is a likely genetic predisposition underlying sociopathy, and sociopaths comprise 3--4% of the male population, but they account for between 33% and 80% of the population of chronic criminal offenders in the United States (Mednick et al., 1977).

It is clear from this body of empirical information that culture is directly encoded into the human brain, which of course is the central claim of gene-culture coevolutionary theory.

6. The Concept of Culture Across Disciplines

Because of the centrality of culture to the behavioral sciences, it is worth noting the divergent use of the term in distinct disciplines, and the sense in which it is used here.

Anthropology, the discipline that is most sensitive to the vast array of cultural groupings in human societies, treats culture as an expressive totality defining the life space of individuals, including symbols, language, beliefs, rituals, and values.

By contrast, in biology culture is generally treated as *information*, in the form of instrumental techniques and practices, such as those used in producing necessities, fabricating tools, waging war, defending territory, maintaining health, and rearing children. We may include in this category "conventions" (e.g., standard greetings, forms of dress, rules governing the division of labor, the regulation of marriage, and rituals) that differ across groups and serve to coordinate group behavior, facilitate communication and the maintenance of shared understandings. Similarly, we may include *transcendental beliefs* (e.g., sickness is caused by angering the gods, good deeds are rewarded in the afterlife) as a form of information. A transcendental belief is the assertion of a causal relationship or a state of affairs that has a truth value, but whose truth holders either cannot or choose not to test personally (Atran, 2004). Cultural transmission in humans, in this view, is thus a process of information transmission, rendered possible by our uniquely prodigious cognitive capacities (Tomasello et al., 2005).

The predisposition of a new member to accept the dominant cultural forms of a group is called *conformist transmission* (Boyd and Richerson, 1985). Conformist transmission is fitness enhancing because, if an agent must determine the most effective of several alternative techniques or practices, and if experimentation is costly, it may be payoff-maximizing to copy others rather than incur the costs of experimenting (Boyd and Richerson, 1985, Conlisk, 1988). Conformist transmission extends to the transmission of transcendental beliefs as well. Such beliefs affirm techniques where the cost of experimentation is extremely high or infinite, and the cost of making errors is high as well. This is, in effect, Blaise Pascal's argument for the belief in God and the resolve to follow His precepts. This view of religion is supported by Boyer (2001), who models transcendental beliefs as a set of cognitive beliefs that coexist and interact with our other more mundane and testable beliefs. In this view, one conforms to transcendental beliefs because their truth value has been ascertained by others (relatives, ancestors, prophets), and are as worthy of affirmation as the techniques and practices, such as norms of personal hygiene, that one accepts on faith, without personal verification.

It is curious that sociology and anthropology clearly recognize the importance of conformist transmission, but the notion is quite absent from economic theory. For instance, in economic theory consumers maximize utility and firms maximize profits by considering only market prices and their own preference and production functions. In fact, in the face of incomplete information and the high cost of information-gathering, both consumers and firms in the first instance may simply imitate what appear to be the successful practices of others, adjust their behavior incrementally in the face of varying market conditions, and sporadically inspect alternative strategies in limited areas (Gintis, 2004).

Possibly part of the reason the BPC model is so widely rejected in some disciplines is the perception, suggested by its use in economic theory, that optimization subject to constraints and reliance on imitation and hence to conformist transmission, are analytically incompatible. In fact, the economists' distaste for optimization *via* imitation is not complete (Conlisk, 1988, Bikhchandani et al., 1992), and it is simply a doctrinal prejudice. Recognizing that imitation is an

aspect of optimization has the added attractiveness that it allows us to model cultural change in a dynamic manner: as new cultural forms displace older forms they appear to advance the goals of their bearers (Henrich, 1997, Henrich and Boyd, 1998, Henrich, 2001, Gintis, 2003a).

7. Programmable Preferences and the Sociology of Choice

Sociology, in contrast with anthropology and biology, treats culture primarily as a set of *moral values* (e.g., norms of fairness, reciprocity, justice) that are held in common by members of the community (or a stratum within the community) and are transmitted from generation to generation by the process of *socialization*. According to Durkheim (1951), the organization of society involves assigning individuals to specific *roles*, each with its own set of socially sanctioned values. A key tenet of socialization theory is that a society's values are passed from generation to generation through the *internalization of norms* (Durkheim, 1951, Benedict, 1934, Mead, 1963, Parsons, 1967, Grusec and Kuczynski, 1997, Nisbett and Cohen, 1996, Rozin et al., 1999), which is a process in which the initiated instill values into the uninitiated (usually the younger generation) through an extended series of personal interactions, relying on a complex interplay of affect and authority. Through the internalization of norms, initiates are supplied with moral values that induce them to conform to the duties and obligations of the role-positions they expect to occupy.

The contrast with anthropology and biology could hardly be more complete. *Contra* anthropology, which celebrates the irreducible heterogeneity of cultures, the moral cultures of sociology share much in common throughout the world (Brown, 1991). In virtually every society youth are pressed to internalize the value of being trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent (the Boy Scouts of America creed). In biology, values are collapsed into techniques and the machinery of internalization is unrepresented.

Internalized norms are followed not because of their epistemic truth value, but because of their moral value. In the language of the BPC (beliefs, preferences, and constraints) model, internalized norms are accepted not as instruments towards upon achieving other ends, but rather as *arguments in the preference function that the individual maximizes*, or are *self-imposed constraints*. For instance, an individual who has internalized the value of "speaking truthfully" will constrain himself to do so even in some cases where the net payoff to speaking truthfully would otherwise be negative. Internalized norms are thus *constitutive* in the sense that individuals strive to live up to them *for their own sake*. Fairness, honesty, trustworthiness, and loyalty are ends, not means, and such fundamental human emotions as shame, guilt, pride, and empathy are deployed by the well-socialized individual to reinforce these prosocial values when tempted by the immediate pleasures of such "deadly sins" as anger, avarice, gluttony, and lust.

The human responsiveness to socialization pressures represents the most powerful form of epigenetic transmission found in nature. In effect, *human preferences are programmable*, in the same sense as a digital computer can be programmed to perform a wide variety of tasks. This epigenetic flexibility in considerable part accounts for the stunning success of the species *Homo sapiens*. When people internalize a norm, the frequency of its occurrence in the population will be higher than if people follow the norm only instrumentally---i.e., when they perceive it to be in their material self-interest to do so. The increased incidence of prosocial behaviors are precisely what permits humans to cooperate effectively in groups (Gintis et al., 2005).

Given the abiding disarray in the behavioral sciences, it should not be surprising to find that

socialization/programmability has no conceptual standing outside of sociology, and most behavioral scientists subsume it under the general category of "information transmission," which is simply incoherent. Moreover, the concept is incompatible with the assumption in economic theory that preferences are self-regarding, since social values commonly involve caring about fairness, the well-being of others, and other altruistic preferences. Sociology, in turn, systematically ignores the limits to socialization (Tooby and Cosmides, 1992, Pinker, 2002) and supplies no theory of the emergence and abandonment of particular values, which in fact depend on their contribution to fitness and well-being, as economic and biological theory would suggest (Gintis 2003a,b). Moreover, there are often swift society-wide value changes that cannot be accounted for by socialization theory (Wrong, 1961, Gintis, 1975). When properly qualified, however, and appropriately related to the general theory of cultural evolution and strategic learning, socialization theory is considerably strengthened.

8. Game Theory: The Universal Lexicon of Life

In the BPC model, choices give rise to probability distributions over outcomes, the expected values of which are the payoffs to the choice from which they arose. Game theory extends this analysis to cases where there are multiple decision makers. In the language of game theory, *players* (or *agents*) are endowed with a set of available *strategies*, and have certain *information* concerning the rules of the game, the nature of the other players and their available strategies, as well as the structure of payoffs. Finally, for each combination of strategy choices by the players, the game specifies a distribution of *individual payoffs* to the players. Game theory attempts to predict the behavior of the players by assuming each maximizes its preference function subject to its information, beliefs, and constraints (Kreps, 1990).

Game theory is a logical extension of evolutionary theory. To see this, suppose there is only one replicator, deriving its nutrients and energy from non-living sources (the sun, the earth's core, amino acids produced by electrical discharge, and the like). The replicator population will then grow at a geometric rate, until it presses upon its environmental inputs. At that point, mutants that exploit the environment more efficiently will out-compete their less efficient conspecifics, and with input scarcity, mutants will emerge that "steal" from conspecifics who have amassed valuable resources. With the rapid growth of such predators, mutant prey will devise means of avoiding predation, and predators will counter with their own novel predatory capacities. In this manner, strategic interaction is born from elemental evolutionary forces. It is only a conceptually short step from this point to cooperation and competition among cells in a multi-cellular body, among conspecifics who cooperate in social production, between males and females in a sexual species, between parents and offspring, and among groups competing for territorial control.

Historically, game theory did not emerge from biological considerations, but rather from the strategic concerns of combatants in World War II (Von Neumann and Morgenstern, 1944, Poundstone, 1992). This led to the widespread caricature of game theory as applicable only to static confrontations of rational self-regarding agents possessed of formidable reasoning and information processing capacity. Developments within game theory in recent years, however, render this caricature inaccurate.

First, game theory has become the basic framework for modeling animal behavior (Maynard Smith, 1982, Alcock, 1993, Krebs and Davies, 1997), and thus has shed its static and hyper-rationalistic character, in the form of evolutionary game theory (Gintis, 2000a). Evolutionary and behavioral game theory do not require the formidable information processing capacities of classical game theory, so disciplines that recognize that cognition is scarce and

costly can make use of game-theoretic models (Young, 1998, Gintis, 2000a, Gigerenzer and Selten, 2001). Thus, agents may consider only a restricted subset of strategies (Winter, 1971, Simon, 1972), and they may use by rule-of-thumb heuristics rather than maximization techniques (Gigerenzer and Selten, 2001). Game theory is thus a generalized schema that permits the precise framing of meaningful empirical assertions, but imposes no particular structure on the predicted behavior.

Second, evolutionary game theory has become key to understanding the most fundamental principles of evolutionary biology. Throughout much of the Twentieth century, classical population biology did not employ a game-theoretic framework (Fisher, 1930, Haldane, 1932, Wright, 1931). However, Moran (1964) showed that Fisher's Fundamental Theorem, which states that as long as there is positive genetic variance in a population, fitness increases over time, is false when more than one genetic locus is involved. Eshel and Feldman (1984) identified the problem with the population genetic model in its abstraction from mutation. But how do we attach a fitness value to a mutant? Eshel and Feldman (1984) suggested that payoffs be modeled game-theoretically on the phenotypic level, and a mutant gene be associated with a strategy in the resulting game. With this assumption, they showed that under some restrictive conditions, Fisher's Fundamental Theorem could be restored. Their results were generalized by Liberman (1988), Hammerstein and Selten (1994), Hammerstein (1996), Eshel et al. (1998) and others.

Third, the most natural setting for biological and social dynamics is game theoretic. Replicators (genetic and/or cultural) endow copies of themselves with a repertoire of strategic responses to environmental conditions, including information concerning the conditions under which each is to be deployed in response to character and density of competing replicators. Genetic replicators have been well understood since the rediscovery of Mendel's laws in the early 20th century. Cultural transmission also apparently occurs at the neuronal level in the brain, in part through the action of *mirror neurons* (Williams et al., 2001, Rizzolatti et al., 2002, Meltzoff and Decety, 2003). Mutations include replacement of strategies by modified strategies, and the "survival of the fittest" dynamic (formally called a *replicator dynamic*) ensures that replicators with more successful strategies replace those with less successful (Taylor and Jonker, 1978).

Fourth, behavioral game theorists now widely recognize that in many social interactions, agents are not self-regarding, but rather often care about the payoffs to and intentions of other players, and will sacrifice to uphold personal standards of honesty and decency. (Fehr and Gächter, 2002, Wood, 2003, Gintis et al., 2005, Gneezy, 2005). Moreover, human actors care about power, self-esteem, and behaving morally (Gintis, 2003b, Bowles and Gintis, 2003, Wood, 2003). Because the rational actor model treats action as instrumental towards achieving rewards, it is often inferred that action itself cannot have reward value. This is an unwarranted inference. For instance, the rational actor model can be used to explain collective action (Olson, 1965), since agents may place positive value on the process of acquisition (for instance, "fighting for one's rights"), and can value punishing those who refuse to join in the collective action (Moore, Jr., 1978, Wood, 2003). Indeed, contemporary experimental work indicates that one can apply standard choice theory, including the derivation of demand curves, plotting concave indifference curves, and finding price elasticities, for such preferences as charitable giving and punitive retribution (Andreoni and Miller, 2002).

As a result of its maturation of game theory over the past quarter century, game theory is well positioned to serve as a bridge across the behavioral sciences, providing both a lexicon for communicating across fields with divergent and incompatible conceptual systems, and a theoretical tool for formulating a model of human choice that can serve all the behavioral disciplines.

9. Some Misconceptions Concerning the BPC Model and Game Theory

Many behavioral scientists (including virtually all outside of economics, biology, and political science) reject the BPC model and game theory on the basis of one or more of the following arguments (the list may not be complete, and I invite the reader to suggest additional entries). In each case, I shall indicate why the objection is not compelling.

9.1. Individuals are only Boundedly Rational

Perhaps the most pervasive critique of the BPC model is that put forward by Herbert Simon (1982), holding that because information processing is costly and humans have finite information processing capacity, individuals *satisfice* rather than *maximize*, and hence are only *boundedly rational*. There is much substance to this view, including the importance of including information processing costs and limited information in modeling choice behavior and recognizing that the decision on how much information to collect depends on unanalyzed subjective priors at some level (Winter, 1971, Heiner, 1983). Indeed, from basic information theory and the Second Law of Thermodynamics we can show that *all rationality is bounded*. However, the popular message taken from Simon's work is that we should reject the BPC model. For instance, the mathematical psychologist D. H. Krantz (1991) asserts, "The normative assumption that individuals *should maximize some quantity* may be wrong...People do and should act as *problem solvers*, not *maximizers*." This is incorrect. As we have seen, as long as individuals have consistent preferences, they can be modeled as maximizing an objective function subject to constraints.

Of course, if there is a single objective (e.g., solve the problem with a given degree of acceptability), then the information contained in knowledge of preference consistency can be ignored. But, once the degree of acceptability is treated as endogenous, multiple objectives compete (e.g., cost and accuracy), and the BPC model cannot be ignored. This point is lost on even such capable researchers as Gigerenzer and Selten (2001), who reject the "optimization subject to constraints" method on the grounds that individuals do not in fact solve optimization problems. However, just as the billiards players do not solve differential equations in choosing their shots, so decision-makers do not solve Lagrangian equations, even though in both cases we may use such optimization models to describe their behavior.

9.2. Decision Makers are not Consistent

It is widely argued that in many situations of extreme importance choice consistency fails, so preferences are not maximized. These cases include time inconsistency, in which individuals have very high short-term discount rates and much lower long-term discount rates (Herrnstein, 1961, Ainslie, 1975, Laibson, 1997). As a result, people lack the will-power to sacrifice present pleasures for future well-being. This leads to such well-known behavioral problems as unsafe sex, crime, substance abuse, procrastination, under-saving, and obesity. It is thus held that these phenomena of great public policy importance are irrational and cannot be treated with the BPC model.

When the choice space for time preference consists of pairs of the form (reward, delay until reward materializes), then preferences are indeed time inconsistent. The long-term discount rate can be estimated empirically at about 3% per year (Huang and Litzenger, 1988, Rogers, 1994),

but short-term discount rates are often an order of magnitude or more greater than this (Laibson, 1997), and animal studies find rates are several orders of magnitude higher (Stephens et al., 2002). Consonant with these findings, sociological theory stresses that *impulse control*---learning to favor long-term over short-term gains---is a major component in the socialization of youth (Power and Chabieski, 1986, Grusec and Kuczynski, 1997).

However, suppose we expand the choice space to consist of triples of the form (reward, current time, time when reward accrues), so that for instance $(\pi_1, t_1, s_1) > (\pi_2, t_2, s_2)$ means that at the individual prefers to be at time t_1 facing a reward π_1 delivered at time s_1 to being at time t_2 facing a reward π_2 delivered at time s_2 . Then the observed behavior of individuals with discount rates that decline with the delay become choice consistent, and there are two simple models that are roughly consistent with the available evidence (and differ only marginally with one another): hyperbolic and quasi-hyperbolic discounting (Fishburn and Rubinstein, 1982, Ainslie and Haslam, 1992, Ahlbrecht and Weber, 1995, Laibson, 1997). The resulting BPC models allow for sophisticated and compelling economic analyses of policy alternatives (Laibson et al., 2004).

Other observed instances of *prima facie* choice inconsistency can be handled in a similar fashion. For instance, in experimental settings, individuals exhibit *status quo* bias, loss aversion, and regret, all of which imply inconsistent choices (Kahneman and Tversky, 1979, Sugden, 1993). In each case, however, choices become consistent by a simple redefinition of the appropriate choice space. Kahneman and Tversky's "prospect theory," which models *status quo* bias and loss aversion, is precisely of this form. Gintis (2006) has shown that this phenomenon has an evolutionary basis in territoriality in animals and pre-institutional property rights in humans.

There remains perhaps the most widely recognized example of inconsistency, that of preference reversal in the choice of lotteries. Lichtenstein and Slovic (1971) were the first to find that in many cases, individuals who prefer lottery A to lottery B are nevertheless willing to take less money for A than for B. Reporting this to economists several years later, Grether and Plott (1979) assert "A body of data and theory has been developed...[that] are simply inconsistent with preference theory... (p. 623). These preference reversals were explained several years later by Tversky et al. (1990) as a bias toward the higher probability of winning in lottery choice and toward the higher the maximum amount of winnings in monetary valuation. If this were true for lotteries in general it might compromise the BPC model.⁸ However, the phenomenon has been documented only when the lottery pairs A and B are so close in expected value that one needs a calculator (or a quick mind) to determine which would be preferred by an expected value maximizer. For instance, in Grether and Plott (1979) the average difference between expected values of comparison pairs was 2.51% (calculated from Table 2, p. 629). The corresponding figure for Tversky et al. (1990) was 13.01%. When the choices are so close to indifference, it is not surprising that inappropriate cues are relied upon to determine choice.

Another source of inconsistency is that observed preferences may not lead to the well-being, or even the immediate pleasure, of the decision maker. For instance, fatty foods and tobacco injure health yet are highly prized, addicts often they get no pleasure from consuming their drug of choice, but are driven by an inner compulsion to consume, and individuals with obsessive-

⁸ I say "might" because in real life individuals generally do not choose among lotteries by observing or contemplating probabilities and their associated payoffs, but by imitating the behavior of others who appear to be successful in their daily pursuits. In frequently repeated lotteries, the law of large numbers ensures that the higher expected value lottery will increase in popularity by imitation without any calculation by participants.

compulsive disorders repeatedly perform actions that they know are irrational and harmful. More generally, behaviors resulting from excessively high short-term discount rates, discussed above, are likely to lead to a divergence of choice and welfare.

However, the BPC model is not based on the premise that choices are highly correlated with welfare. Drug addiction, unsafe sex, unhealthy diet, and other individually welfare-reducing behaviors can be analyzed with the BPC model, although in such cases preferences and welfare may diverge. I have argued that we can expect the BPC to hold because, on an evolutionary time scale, brain characteristics will be selected according to their capacity to contribute to the fitness of their bearers. But, fitness cannot be equated with well-being in any creature, and in the case of humans, we live in an environment so dramatically different from that in which our preference predispositions evolved that it seems to be miraculous that we are as capable as we are of achieving high levels of individual well-being. For instance, in virtually all known cases, fertility increases with per capital material wealth in a society up to a certain point, and then decreases. This is known as the *demographic transition*, and accounts for our capacity to take out increased technological power in the form of consumption and leisure rather than increased numbers of offspring (Borgerhoff Mulder, 1998). No other known creature behaves in this fashion. Thus, our preference predispositions have not "caught up" with our current environment and, especially given the demographic transition and our excessive present-orientation, they may never catch up (Elster, 1979, Akerlof, 1991, O'Donoghue and Rabin, 2001).

9.3. Addiction Contradicts the BPC Model

Substance abuse is of great contemporary social importance and appears most clearly to violate the notion of rational behavior. Substance abusers are often exhibited as prime examples of time inconsistency and the discrepancy between choice and well-being, but as discussed above, these characteristics do not invalidate the use of the BPC model. More telling, perhaps, is the fact that even draconian increases in the penalties for illicit substance use do not lead to the abandonment of illegal substances. In the United States, for instance, the "war on drugs" has continued for several decades and, despite the dramatic increase in the prison population, has not effectively curbed the illicit behavior. Since the hallmark of the rational actor model is that individuals trade off among desired goals, the lack of responsiveness of substance abuse to dramatically increased penalties has led many researchers to reject the BPC model out of hand.

The target of much of the criticism of the rational actor approach to substance abuse is the work of economist Gary Becker and his associates, and in particular, the seminal paper Becker and Murphy (1988). Many aspects of the Becker-Murphy "rational addiction" model are difficult to fault, however, and subsequent empirical research has strongly validated the notion that illicit drugs respond to market forces much as any marketed good or service. For instance Saffer and Chaloupka (1999) estimated the price elasticities of heroin and cocaine using a sample of 49,802 individuals from the National Household Survey of Drug Abuse. The price elasticity for heroin and cocaine were about 1.70 and 0.96, respectively, which are quite high. Using these figures, the authors estimate that the lower prices flowing from the legalization of these drugs would lead to an increase of about 100% and 50% increase in the quantities of heroin and cocaine consumed, respectively.

How does this square with the observation that draconian punishments do not squelch the demand altogether? Gruber and Koszegi (2001) explain this by presenting evidence that drug users exhibit the commitment and self-control problems that are typical of time-inconsistent agents, for whom the possible future penalties have highly attenuated deterrent value in the

present. Nevertheless, allowing for this attenuated value, sophisticated economic analysis, of the sort developed by Becker et al. (1994) can be deployed for policy purposes. Moreover, this analytical and quantitative analysis harmonizes with the finding that, along with raising the price of cigarettes, the most effective way to reduce the incidence of smoking is to raise its immediate personal costs, for instance through social stigma, smoking bans in public buildings, stress upon the externalities associated with second-hand smoke, and the like (Brigden and De Beyer, 2003).

9.4. Positing Exotic Tastes Explains Nothing

Broadening the rational actor model beyond its traditional form in neoclassical economics runs the risk of developing unverifiable and *post hoc* theories, as our ability to theorize outpaces our ability to test theories. Indeed, the folklore among economists dating back at least to Becker and Stigler (1977) is that "you can always explain any bizarre behavior by assuming sufficiently exotic preferences."

This critique was telling before researchers had the capability of actually measuring preferences and testing the cogency of models with nonstandard preferences (i.e., preferences over things other than marketable commodities, forms of labor, and leisure). However, behavioral game theory now provides the methodological instruments for devising experimental techniques that allow us to estimate preferences with some degree of accuracy, (Gintis, 2000a, Camerer, 2003). Moreover, we often find that the appropriate experimental design variations can generate novel data allowing us to distinguish among models that are equally powerful in explaining the existing data (Tversky and Kahneman, 1981, Kiyonari et al., 2000). Finally, since behavioral game-theoretic predictions can be systematically tested, the results can be replicated by different laboratories (Plott 1979, V. Smith 1982, Sally, 1995), and models with very few nonstandard preference parameters, examples of which are provided in Section 10 below, can be used to explain a variety of observed choice behavior,

9.5. Decisions are Sensitive to Framing Bias

The BPC model assumes that individuals have stable preferences and beliefs that are functions of the individual's personality and current needs. Yet, in many cases laboratory experiments show that individuals can be induced to make choices over payoffs based on subtle or obvious cues that ostensibly do not affect the value of the payoffs to the decision maker. For instance, if a subject's partner in an experimental game is described as a "competitor" or an "opponent," or the game itself is described as a "bargaining game," subjects may make very different choices from a situation where the partner is described as a "teammate", or the game is described as a community participation game. Similarly, a subject in a bargaining game may reject an offer if made by his bargaining partner, but accept the same offer if made by the random draw of a computer (Blount, 1995) on behalf of the proposer.

Sensitive to this critique, experimenters in the early years of behavioral game theory attempted to minimize the possibility of framing effects by rendering as abstract and unemotive as possible the language in which a decision problem or strategic interaction was described. It is now widely recognized that it is in fact impossible to avoid framing effects, because abstraction and lack of real-world reference is itself a frame rather than an absence thereof. A more productive way to deal with framing is to make the frame a part of the specification of the experiment itself, and vary the frame systematically to discover the effect of the frame on the choices of the subjects, and by inference, on their beliefs and preferences.

We do not have a complete model of framing, but we do know enough to know that its existence does not undermine the BPC model. If subjects care only about the "official" payoffs in a game, and if framing does not affect the beliefs of the subjects as to what other subjects will do, then framing could not affect behavior in the BPC framework. But, subjects generally do care about fairness, reciprocity, and justice as well as the game's official payoffs, and when confronted with a novel social setting in the laboratory, subjects must first decide what moral values to apply to the situation by *mapping the game onto some sphere of everyday life* to which they are accustomed. The verbal and other cues provided by experimenters are the clues that subjects use to "locate" the interaction in their social space, so that moral principles can be properly applied to the novel situation. Moreover, such framing instruments as calling subjects "partners" rather than "opponents" in describing the game can increase cooperation because strong reciprocators (Gintis, 2000b), who prefer to cooperate if others do the same, may increase their prior as to the probability that others will cooperate (see section 10), given the "partner" as opposed to the "opponent" cue. In sum, framing is in fact an ineluctable part of the BPC model, properly construed.

9.6. People are Faulty Logicians

The BPC model permits us to infer the beliefs and preferences of agents from their choices under varying constraints. Such inferences are valid, however, only if individuals can intelligently vary their behavior in response to novel conditions. While it is common for behavioral scientists who reject the BPC model to explain an observed behavior as due to error or confusion on the part of the agent, the BPC model is less tolerant of such explanations if agents are reasonably well-informed and the choice setting reasonable transparent and easily analyzable.

Evidence from experimental psychology over the past forty years has cast doubt on the capacity of individuals to reason sufficiently accurately to warrant the BPC presumption of subject intelligence. For instance, in one well-known experiment performed by Tversky and Kahneman (1983), a young woman Linda is described as politically active in college and highly intelligent, and the subject is asked which of the following two statements is more likely: "Linda is a bank teller" or "Linda is a bank teller and is active in the feminist movement." Many subjects rate the second statement more likely, despite the fact that elementary probability theory asserts that if p implies q , then p cannot be more likely than q . Since the second statement implies the first, it cannot be more likely than the first.

I personally know many people (though not scientists) who give this "incorrect" answer, and I never have observed these individuals making simple logical errors in daily life. Indeed, in the literature on the "Linda problem" several alternatives to faulty reasoning have been offered. One highly compelling alternative is based on the notion that in normal conversation, a listener assumes that any information provided by the speaker is relevant to the speaker's message (Grice, 1975). Applied to this case, the norms of conversation lead the subject to believe that the experimenter wants Linda's politically active past to be taken adequately into account (Hilton, 1995, Wetherick, 1995). Moreover, the meaning of such terms as "more likely" or "higher probability" are vigorously disputed even in the theoretical literature, and hence are likely to have a different meaning for the average subject and for the expert. For instance, if I were given two piles of identity folders and ask to search through them to find the one belonging to Linda, and one of the piles was "all bank tellers" while the other was "all bank tellers who are active in the feminist movement," I would surely look through the second (doubtless much smaller) pile first, even though I am well aware that there is a "higher probability" that the folder is in the first pile

rather than the second.

More generally, subjects may appear irrational because basic terms have different meanings in propositional logic and in everyday logical inference. For instance, "if p then q " is true in formal logic except when p is true and q is false. In everyday usage "if p then q " may be interpreted as a material implication, in which there is something about p that cause q to be the case. In particular, in material logic " p implies q " means " p is true and this situation causes q to be true." Thus, "if France is in Africa, then Paris is in Europe" is true in propositional logic, but false as a material implication. Part of the problem is also that individuals without extensive academic training simply lack the expertise to follow complex chains of logic, so psychology experiments often exhibit a high level of *performance error* (Cohen 1981; see section 11). For instance, suppose Pat and Kim live in a certain town where all men have beards and all women wear dresses. Then the following can be shown to be true in propositional logic: "Either if Pat is a man then Kim wears a dress or if Kim is a woman, then Pat has a beard." It is quite hard to see why this is formally, true, and it is not true if the implications are material. Finally, the logical meaning of "if p then q " can be context dependent. For instance, "if you eat dinner (p), you may go out to play (q)" formally means "you may go out to play (q) only if you eat dinner (p)."

We may apply this insight to an important strand of experimental psychology that purports to have shown that subjects systematically deviate from simple principles of logical reasoning. In a widely replicated study, Wason (1966) showed subjects cards each of which had a "1" or "2" on one side and "A" or "B" on the other, and stated the following rule: a card with a vowel on one side must have an odd number on the other. The experimenter then showed each subject four cards, one showing "1", one showing "2", one showing "A", and one showing "B", and asked the subject which cards must be turned over to check whether the rule was followed. Typically, only about 15% of college students point out the correct cards ("A" and "2"). Subsequent research showed that when the problem is posed in more concrete terms, such as "any person drinking beer must over eighteen," the correct response rate increases considerably (Stanovich, 1999, Shafir and LeBoeuf, 2002). This accords with the observation that most individuals do not appear to have difficulty making and understanding logical arguments in everyday life.

9.7. People are Poor Statistical Decision Makers

Just as the rational actor model began to take hold in the mid-Twentieth century, vigorous empirical objections began to surface. The first was Allais (1953), who exhibited cases where subjects exhibited clear choice inconsistency in choosing among simple lotteries (a lottery is a probability distribution over a finite set of monetary outcomes). It has been shown that Allais' examples can be explained by regret theory (Bell, 1982, Loomes and Sugden, 1982), which can be represented by consistent choices over pairs of lotteries (Sugden, 1993).

Close behind Allais came the famous Ellsberg Paradox (Ellsberg, 1961), which can be shown to violate the most basic axioms of choice under uncertainty. Consider two urns. Urn A has 51 red balls and 49 white balls. Urn B also has 100 red and white balls, but the fraction of red balls is unknown. One ball is chosen from each urn but remains hidden from sight. Subjects are asked to choose in two situations. First, a subject can choose the ball from urn A or urn B, and if the ball is red, the subject wins \$10. In the second situation, two new balls are drawn from the urns, with replacement, the subject can choose the ball from urn A or urn B, and if the ball is white, the subject wins \$10. Many subjects choose the ball from urn A in both cases. This obviously violates the expected utility principle, no matter what probability the subject places on the probability the ball from urn B is white.

It is easy to see why unsophisticated subjects make this obvious error: urn B seems to be *riskier* than urn A, because we know the probabilities in A but not B. It takes a relatively sophisticated probabilistic argument---one that no human being ever made or could have made (to our knowledge) prior to the modern era---to see that in fact in this case uncertainty does not lead to increased risk. Indeed, most intelligent subjects who make the Ellsberg error will be convinced, when presented with the logical analysis, to modify their choices without modifying their preferences. In cases like this, we speak of *performance error*, whereas in cases such as the Allais Paradox, even the most highly sophisticated subject will need change his choice unless convinced to change his preference ordering.

Numerous experiments document clearly that many people have beliefs concerning probabilistic events that are without scientific foundation, and which will most likely lead them to sustain losses if acted upon. For instance, virtually every enthusiast believes that athletes in competitive sports run "hot and cold," although this has never been substantiated empirically. In basketball, when a player has a "hot hand," he is preferentially allowed to shoot again, and when he has a "cold hand," he is often taken out of the game. I have yet to meet a basketball fan who does not believe in the phenomenon of the hot hand. Yet, Gilovich et al. (1985) have shown on the basis of a thorough statistical analysis using professional basketball data, that the hot hand does not exist.⁹ This is but one instance of the general rule that our brains often lead us to perceive a pattern when faced with purely random data. In the same vein, I have talked to professional stock traders who believe, on the basis of direct observation of stock volatility, that stocks follow certain laws of inertia and elasticity that simply cannot be found through a statistical analysis of the data. Another example of this type is the "gambler's fallacy," which is that in a fair game, after a run of exceptionally bad luck (e.g., a series of ten incorrect guesses in a row in a coin flip game), a run of good luck is likely to follow. Those who believe this cannot be dissuaded by scientific evidence. Many who believe in the "law of small numbers," which says that a small sample from a large population will have the same distribution of characteristics as the population (Tversky and Kahneman, 1971), simply cannot be dissuaded either by logical reasoning or presentation of empirical evidence.

We are indebted to Daniel Kahneman, Amos Tversky, and their colleagues for a long series of brilliant papers, beginning in the early 1970's, documenting the various errors intelligent subjects commit in dealing with probabilistic decision making. Subjects systematically underweight base rate information in favor of salient and personal examples, they reverse lottery choices when the same lottery is described emphasizing probabilities rather than monetary payoffs, when described in term of losses from a high baseline as opposed to gains from a low baseline, they treat proactive decisions differently from passive decisions even when the outcomes are exactly the same, and when outcomes are described in terms of probabilities as opposed to frequencies (Kahneman et al., 1982, Kahneman and Tversky, 2000).

Like many other behavioral scientists, I consider these findings of decisive importance for understanding human decision making and for formulating effective social policy mechanisms where complex statistical decisions must be made. Unlike many others, I do not consider these findings a threat to the BPC model (Gigerenzer and Selten, 2001). They are simply performance errors in the form of incorrect beliefs as to how payoffs can be maximized.¹⁰

⁹ I once presented this evidence to graduating seniors in economics and psychology at Columbia University, towards the end of a course that developed and used quite sophisticated probabilistic modeling. Many indicated in their essays that they did not believe the data.

¹⁰ In a careful review of the field, Shafir and LeBoeuf (2002) reject the performance error interpretation of

Statistical decision theory did not exist until this century. Before the contributions of Bernoulli, Savage, von Neumann and other experts, no creature on Earth knew how to value a lottery. It takes years of study to feel at home with the laws of probability. Moreover, it is costly, in terms of time and effort, to apply these laws even if we know them. Of course, if the stakes are high enough, it is worthwhile to go to the effort, or engage an expert who will do it for you. But generally, as Kahneman and Tversky suggest, we apply a set of heuristics that more or less get the job done (Gigerenzer and Selten, 2001). Among the most prominent heuristics is simply *imitation*: decide what class of phenomenon is involved, find out what people "normally do" in that situation, and do it. If there is some mechanism leading to the survival and growth of relatively successful behaviors and if the problem in question recurs with sufficient regularity, the choice-theoretic solution will describe the winner of a dynamic social process of trial, error, and replication through imitation.

9.8. Game Theory Misunderstands Rationality

Game theory predicts that rational agents will play Nash equilibria. Since my proposed framework includes both game theory and rational agents, I must address that fact that in important cases, the game theoretic prediction is ostensibly falsified by the empirical evidence. The majority of examples of this kind arise from the assumption that agents are self-regarding, which can be dropped without violating the principles of game theory. Game theory also offers solutions to problems of cooperation and coordination which are never found in real life, but in this case, the reason is that the game theorists assume perfect information, the absence of errors, the use of solution concepts that lack plausible dynamical stability properties, or other artifices without which the proposed solution would not work (Gintis, 2005). However, in many cases, rational agents simply do not play Nash equilibria at all under plausible conditions.

Consider, for instance, the centipede game, depicted in Figure 1 (Rosenthal, 1981, Binmore, 1987). It is easy to show that this game has only one Nash payoff structure, in which player one defects on round one. However, when people actually play this game, they generally cooperate until the last few rounds (McKelvey and Palfrey, 1992). Game theorists are quick to call such cooperation "irrational." For instance, Reinhard Selten (himself a strong supporter of "bounded rationality") considers any move other than immediate defection a "failure to behave according to one's rational insights" (Selten, 1993):133. This opinion is due to the fact that this is the unique Nash equilibrium to the game, it does not involve the use of mixed strategies, and it can be derived from backward induction. However, as the professional literature makes abundantly clear, it is simply not true that rational agents must use backward induction. Rather, the most that rationality can ensure is *rationalizability* (Bernheim, 1984, Pearce, 1984), which in the case of the centipede game includes any pair of actions, except for cooperation on a player's final move.

Another way to approach this issue is to begin by simply endowing each player with a BPC structure, and defining the "type" of a player to be the round on which he would first defect, assuming this round is reached. The belief system of each player is then a subjective probability

these results, calling this a "trivialization" of the findings. They come to this conclusion by asserting that performance errors must be randomly distributed, whereas the errors found in the literature are systematic and reproducible. These authors, however, are mistaken in believing that performance errors must be random. Ignoring base rates in evaluating probabilities or finding risk in the Ellsberg two urn problems are surely performance errors, but the errors are quite systematic. Similarly, folk intuitions concerning probability theory lead to highly reproducible results, although incorrect.

distribution over the type of his opponent. It is clear that if each player maximizes his payoff subject to this probability distribution, almost any pair of actions can result. This is the correct solution to the problem, not the Nash equilibrium. Of course, one could argue that both players must have the same subjective probability distribution, in which case there is only one equilibrium, the Nash equilibrium. But, it is hardly plausible to assume two players have the same subjective probability distribution over the types of their opponents without giving a mechanism that would produce this result.¹¹ In a famous paper Nobel prize winning economist John Harsanyi (1967) argued that common priors follow from the assumption that agents are rational, but this argument depends on a notion of rationality that goes far beyond choice consistency, and has not received empirical support (Kurz, 1997).

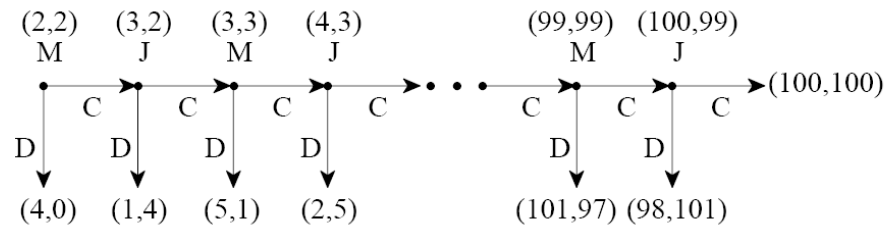


Figure 1. The Hundred Round Centipede Game

In real world applications of game theory, I conclude, we must have plausible grounds for believing that the equilibrium concept used is appropriate. In the examples given in next section, we restrict ourselves to games that are sufficiently simple that the sorts of anomalies discussed above are not present, and the Nash equilibrium criterion is appropriate.

10. Experimental Game Theory and Other-regarding Preferences

Contemporary biological theory maintains that cooperation can be sustained based by *inclusive fitness*, or cooperation among kin (Hamilton, 1963) by and individual self-interest in the form of *reciprocal altruism* (Trivers, 1971). Reciprocal altruism occurs when an agent helps another agent, at a fitness cost to itself, with the expectation that the beneficiary will return the favor in a future period. The explanatory power of inclusive fitness theory and reciprocal altruism convinced a generation of biologists that what appears to be altruism---personal sacrifice on behalf of others---is really just long-run genetic self-interest. Combined with a vigorous critique of group selection (Williams, 1966, Dawkins, 1976, Maynard Smith, 1976), a generation of biologists became convinced that true altruism---one organism sacrificing fitness on behalf of the fitness of an unrelated other---was virtually unknown, even in the case of *Homo sapiens*.

The selfish nature of human nature was touted as a central implication of rigorous biological modeling. In *The Selfish Gene* (1976), for instance, Richard Dawkins asserts that "We are survival machines---robot vehicles blindly programmed to preserve the selfish molecules known as genes....Let us try to teach generosity and altruism, because we are born selfish." Similarly, in *The Biology of Moral Systems* (1987, p. 3), R. D. Alexander asserts, "ethics, morality, human

¹¹ One could posit that the "type" of a player must include his probability distribution over the types of other players, but even such arcane assumptions do not solve the problem.

conduct, and the human psyche are to be understood only if societies are seen as collections of individuals seeking their own self-interest." More poetically, Michael Ghiselin (1974) writes: "No hint of genuine charity ameliorates our vision of society, once sentimentalism has been laid aside. What passes for cooperation turns out to be a mixture of opportunism and exploitation.... Scratch an altruist, and watch a hypocrite bleed."

In economics, the notion that enlightened self-interest allows agents to cooperate in large groups goes back to Bernard Mandeville's "private vices, public virtues" (1724[1705]) and Adam Smith's "invisible hand" (1776[1759]). Full analytical development of this idea awaited the Twentieth century development of general equilibrium theory (Arrow and Debreu, 1954, Arrow and Hahn, 1971) and the theory of repeated games (Axelrod and Hamilton, 1981, Fudenberg and Maskin, 1986). So powerful in economic theory is the notion that cooperation among self-regarding agents is possible that it is hard to find even a single critic of the notion in the literature, even among those that are otherwise quite harsh in their evaluation of neoclassical economics.

By contrast, sociological, anthropological, and social psychological theory generally explain that human cooperation is predicated upon affiliative behaviors among group members, each of whom is prepared to sacrifice a modicum of personal well-being to advance the collective goals of the group. The vicious attack on "sociobiology" (Seeger, 2001) and the widespread rejection of the bare-bones *Homo economicus* in the "soft" social sciences (Etzioni, 1985, Hirsch et al., 1990, DiMaggio, 1994) is due in part to this clash of basic explanatory principles.

Behavioral game theory assumes the BPC model of choice, and subjects individuals to strategic settings, such that their behavior reveals their underlying preferences. This controlled setting allows us to adjudicate between these contrasting models. One behavioral regularity that has been found thereby is *strong reciprocity*, which is a predisposition to cooperate with others, and to punish those who violate the norms of cooperation, at personal cost, even when it is implausible to expect that these costs will be repaid. Strong reciprocity is other-regarding, as a strong reciprocator's behavior reflects a preference to cooperate with other cooperators and to punish non-cooperators, even when these actions are personally costly.

The result of the laboratory and field research on strong reciprocity is that humans indeed often behave in ways that have traditionally been affirmed in sociological theory and denied in biology and economics (Ostrom et al., 1992, Andreoni, 1995, Fehr et al., 1997, Fehr et al., 1998, Gächter and Fehr, 1999, Fehr and Gächter, 2000, Fehr and Gächter, 2002, Henrich et al., 2005). Moreover, it is probable that this other-regarding behavior is a prerequisite for cooperation in large groups of non-kin, since the theoretical models of cooperation in large groups of self-regarding non-kin in biology and economics do not apply to some important and frequently observed forms of human cooperation (Boyd and Richerson, 1992, Gintis, 2005).

Another form of prosocial behavior conflicting with the maximization of personal material gain is that of maintaining such *character virtues* as honesty and promise-keeping, even when there is no chance of being penalized for unvirtuous behavior. An example of such behavior is reported by Gneezy (2005), who studied 450 undergraduate participants who paired off to play the following game. One subject was randomly assigned to be player 1, who was shown two available payoffs, say A:(5,6) that pays 5 to player 1 and 6 to player 2, while B:(6,15) that pays 6 to player 1 and 15 to player 2. Player 1 then passed a message to player 2 saying that either A or B would give player 2 a higher payoff. Player 2, who was not allowed to see the payoffs, then chose A or B, then either believing or not believing player 1's message. For this particular pair of payoffs, only 17% of player 1's lied. If the payoff to option is changed to B:(6,6), so player 2 gets only 6 instead of 15, then 36% of player 1's lied, and if the payoffs were A:(5,15) and B:(15,5),

then fully 52% of player 1's lied. Assuming that player 2's tended to follow the advice of player 1 (which they did), this shows that many subjects are willing to sacrifice material gain to avoid lying in a one-shot, anonymous interaction, and their willingness increases with the cost to themselves, and decreases with the cost to player 2. Similar results were found by Boles et al. (2000) and Charness and Dufwenberg (2004). Gunnthorsdottir et al. (2002) and Burks et al. (2003) have shown that a social-psychological measure of "Machiavellianism" predicts which subjects are likely to be trustworthy and trusting, although their results are not completely compatible.

11. The Role of Beliefs in the BPC Model

In its simplest formulation, individuals have consistent preferences over lotteries, and hence there are preferences and constraints, but no beliefs (Savage, 1954). In the real world, however, the probabilities of various outcomes in a lottery are rarely objectively known, and hence must generally be subjectively constructed as part of an individual's belief system. Anscombe and Aumann (1963) extended the Savage model to preferences over bundles consisting of "states of the world" and payoff bundles, and showed that if certain consistency axioms hold, the individual could be modeled as maximizing subject to a set of subjective probabilities over states. Were these axioms universally plausible, beliefs could be derived in the same way as are preferences. However, at least one of these axioms, the so-called *state-independence axiom*, which states that preferences over payoffs are independent of the states in which they occur, is generally not plausible.

It follows that beliefs are the underdeveloped member of the BPC trilogy. There is no compelling analytical theory of how a rational agent acquires and updates beliefs, although there are many partial theories (Kuhn, 1962, Polya, 1990, Boyer, 2001, Jaynes, 2003).

Beliefs enter the decision process in several potential ways. First, individuals may not have perfect knowledge concerning how their choices affect their welfare. This is most likely to be the case in an unfamiliar setting, of which the experimental laboratory is often a perfect example. In such cases, when forced to choose, individuals "construct" their preferences on the spot by forming beliefs based on whatever partial information is present at the time of choice (Slovic, 1995). Understanding this process of belief formation is a demanding research task.

Second, often the actual actions $a \in A$ available to an individual will differ from the actual payoffs $\pi \in \Pi$ that appear in the individual's preference function. The mapping $\beta: A \rightarrow \Pi$ the individual deploys to maximize payoff is a belief system concerning objective reality, and can diverge more or less strongly from the correct mapping $\beta^*: A \rightarrow \Pi$. For instance, a gambler may want to maximize expected winnings, but may believe in the erroneous Law of Small Numbers (Rabin, 2002). Errors of this type include the *performance errors* discussed in section 9.

Third, there is considerable evidence that beliefs directly affect well-being, so individuals may alter their beliefs as part of their optimization program. Self-serving beliefs, unrealistic expectations, and projection of one's own preferences on others are important examples. The trade-off here is that erroneous beliefs may add to well-being, but acting on these beliefs may lower other payoffs (Bodner and Prelec, 2002, Benabou and Tirole, 2002).

The fact that beliefs are instrumental to decision-making suggests the BPC model as a conducive framework for developing a cogent theory of belief formation and change.

12. Conclusion

Each of the behavioral disciplines contributes strongly to understanding human behavior. Taken separately and at face value, however, they offer partial, conflicting, and incompatible models. >From a scientific point of view, it is scandalous that this situation was tolerated throughout most of the Twentieth Century. Fortunately, there is currently a strong current of unification based on both mathematical models and common methodological principles for gathering empirical data on human behavior and human nature.

The true power of each discipline's contribution to knowledge will only appear when suitably qualified and deepened by the contribution of the others. For instance, the economist's model of rational choice behavior must be qualified by a biological appreciation that preference consistency is the result of strong evolutionary forces, and where such forces are absent, consistency will be imperfect. Moreover, *a prioristic* notions that preferences are purely self-regarding, in either the short or long run, must be abandoned. These are the key tenets of behavioral economics. Second, the sociologist's notion of internalization of norms is generally rejected by the other behavioral disciplines because the ease with which diverse values can be internalized depends on human nature (Tooby and Cosmides, 1992, Pinker, 2002), and the rate at which values are acquired and abandoned depends on their contribution to fitness and well-being (Gintis, 2003b, Gintis, 2003a). Finally, there are often rapid society-wide value changes that cannot be accounted for by socialization theory (Wrong, 1961, Gintis, 1975). When properly qualified, however, and appropriately related to the general theory of cultural evolution and strategic learning, the socialization theory is considerably strengthened.

Disciplinary boundaries in the behavioral sciences have been determined historically, rather than conforming to some consistent scientific logic. Perhaps for the first time, we are in a position to rectify this situation. We must recognize evolutionary theory (covering both genetic and cultural evolution) as the integrating principle of behavioral science. Moreover, if the beliefs, preferences and constraints (aka rational actor) model is broadened to encompass other-regarding preferences, game theory becomes capable of modeling all aspects of decision making, including those normally considered "sociological" or "anthropological," which in turn is most naturally the central organizing principle of psychology.

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