Is *Homo economicus* extinct?

Vernon Smith, Daniel Kahneman and the Evolutionary Perspective

Abstract: The awarding in October of 2002 of the Nobel Memorial Prize in Economics[1] to Daniel Kahneman and Vernon Smith might have profound implications for the survival of *Homo economicus*, which has long occupied a privileged place in the minds of economists and decision-making theorists. The species has endured many challenges and proven quite adaptable, changing to accommodate a cascade of findings inconsistent with its original conception. *Homo economicus* now faces a potentially more serious challenge: the resurgence of *Homo sapiens*, a more coherent and biologically grounded model for human decision-making, informed by theory and data from across the scientific spectrum.

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We use the term *Homo economicus* – as others have (e. g., Thaler, 2000)– as a shorthand for the canonical model of humans as self-interested agents. The historical conception of *Homo economicus* is of a rational decision-maker with perfect information and perfectly ordered preferences. This view has proven fruitful, yielding precise and often accurate predictions of aggregate economic behavior, which yields prima facie validation of the model. However, a wealth of data, especially from the controlled setting of the laboratory, bring into question whether these assumptions reasonably reflect human thought and behavior.[2]

The work of both Kahneman and Smith played an essential role in rethinking the assumptions of classical theory. Smith, with his colleagues, for example, showed that contrary to a model of pure self-interest, people will sacrifice their own gains for others' welfare (e.g., Hoffman, McCabe, & Smith, 1996a). The *Homo economicus* approach to reconciling such observations within a rational choice framework is to add auxiliary social preferences for such things as aggregate welfare or fairness to fit the empirically observed departures from the standard model (e.g., Charness & Rabin, 2002).

Kahneman and Tversky, in turn, undermined the standard model's assumption that people's preferences are stable, by showing preference reversals that cannot be explained by any reasonable reading of standard theory. These and other challenges to the standard economic model have been met by incorporating ancillary theories and constraints (e. g., other regarding preferences, inequity aversion, risk aversion, and loss aversion): *Homo economicus'* only choice was to adapt, and she has indeed undergone considerable evolutionary change.

Is, then, *Homo economicus* becoming extinct? The answer up until now has been no, largely because there was no reasonable alternative to *Homo economicus*. But now, with evolutionary psychology providing an alternative framework that can potentially form the foundation for a satisfying and coherent theory of economic behavior, the fate of *Homo economicus* is increasingly uncertain.

Evolutionary Psychology: General Principles

Self-interest in Economics and Evolutionary Psychology

At first glance, the evolutionary perspective and the standard economic perspective seem to be quite similar, both claiming that some form of self-interest drives behavior (Economist, 1993). In broad strokes, economists posit that humans are self-interested, while evolutionary psychologists' claims rest on construing genes as selfish agents, with unidimensional "preferences" for their own replication (Dawkins, 1976/1989).[3] Although these claims have superficial similarities, they differ in important respects (Cosmides & Tooby, 1994).

In contrast to the assumption that humans are self-interested, evolutionary psychologists endorse the view that genes themselves are the unit of "selfishness." Throughout human evolutionary history, our ancestors faced a wide variety of adaptive problems, from finding food, to securing a mate and taking care of offspring. Individuals carrying genes that enabled them to solve these adaptive problems were more likely to survive and leave healthy offspring, thus increasing the frequency in the next generation of genes coding for cognitive mechanisms that generated such behaviors (Tooby &

Cosmides, 1992). Because solving these adaptive problems often involved securing benefits for oneself, individuals have cognitive mechanisms that, under a range of conditions, cause them to compute the costs and benefits to the self associated with possible outcomes and act in ways that achieve benefits for the self. This selfishness, although not a cornerstone of evolutionary theories of behavior, is consistent with the fundamental assumptions in standard economic models of human behavior.

Of course, not all behavior is transparently self-interested; at minimum, people clearly do not behave as income-maximizers: people routinely incur costs, financial or otherwise, for the benefit of others. Such other-regarding preferences are not a problem for the evolutionary view. For example, the theory of kin selection indeed predicts that people should have strong preferences for sacrificing in favor of closely related individuals (Hamilton, 1964a, 1964b).

In contrast, economic approaches need to explain why individuals do things that benefit others, and this fact forced economic models to adapt in order to explain "anomalous" findings, generally by adding new theories or constraints (e. g., inequity aversion, other-regarding preferences). On the other hand, such behaviors and preferences fall naturally out of well developed models derived from the evolutionary approach (Hamilton, 1964a, 1964b; Trivers, 1971) without recourse to ad hoc theories.

Moreover, the evolutionary approach provides an ultimate explanation for the existence of many fundamental human preferences. It is true that classical theory can be used to infer preferences from observed behaviors (Samuelson, 1948) but it can not speak to the *origins* of these preferences. Economists can (and do) claim that individuals get utility from these activities, leaving the question of the origin of tastes and preferences to the other behavioral sciences (Cosmides & Tooby, 1994; Rubin & Paul, 1979). Evolutionary psychology provides answers – or at least a way to generate possible answers – about these origins: tastes and preferences that enabled us to better solve adaptive problems were selected for during human evolutionary history.

It's Not Just the Fitness

Evolutionary psychologists do not claim that individuals simply try to maximize the number of offspring. Instead, evolutionary psychologists claim that humans have cognitive mechanisms designed to cause them to put effort toward things (proximate goals) that would have tended to increase reproductive success during our evolutionary history: gaining resources, increasing status, establishing social networks, finding mates, having sex, and investing in their children. Throughout our evolutionary history, engaging in these behaviors would have been critical to reproductive success. Although our current reproductive opportunities are far more numerous and often less costly than our reproductive opportunities in the environment in which we evolved, we cannot be expected to give up the pursuit of status, resources, social partners, and mates for the sperm bank and egg donation clinic (Burnham & Phelan, 2000).

More specifically, this perspective suggests that humans do not have one "fitness maximization system" but instead a variety of specific mechanisms designed for particular adaptive functions. A well known and generally accepted principle is that the boarder the array of tasks to which a tool – whether physical or computational – can be applied, the worse the tool will be at accomplishing each of those tasks (Tooby & Cosmides, 1992). As has been discussed at length elsewhere, only information processing systems that are designed to apply to a narrow range of problems have sufficient computational power to efficiently generate accurate solutions to these particular problems (e. g., Chomsky, 1975). Analogously, because different adaptive problems require different computations for solving them, selection favors mechanisms designed to perform specific functions. These include detecting "cheaters" in social situations (Cosmides & Tooby, 1992), evaluating prospective mates (Buss, 1994; Singh, 1993), and evaluating the risks and benefits associated with aggressive behavior (Wilson & Daly, 1993, 1997).

In the remainder of this article, we describe the ways in which the work of Smith and Kahneman undermined important components of classical economic theory and discuss how evolutionary approaches provides a paradigmatic framework that can make sense of findings considered "anomalous" on older views (e. g., Kuhn, 1996, 1962; Levati, 2002; Palfrey & Prisbrey, 1997).

Vernon Smith

Empirical Challenges to *Homo Economicus*

Homo economicus was a reasonable first guess, in light of the widespread and not completely unsuccessful application of classical theory to the real economy. However, Vernon Smith's work undermined the connection between observations of a market that was behaving in a way that matched an equilibrium analysis and the (plausible) inference that the agents in the economy were making decisions in the way implied by the theory.

Smith's early work on auctions is illustrative. In these experiments, subjects in a laboratory experiment acted as buyers and sellers in a market designed to simulate markets in the real world. Critically, participants had only very limited information about the market as a whole, i. e., a description of the rules of the game and a single price – the value (in dollars) of the object to the buyer or the seller (Smith, 1962).

In these experiments, results conformed well to those predicted by a rational expectations competitive equilibrium model. This was true under diverse parameterization of the experimental conditions, including the details of the market mechanism, and was especially true as subjects repeated play. However, underlying assumptions of classical theory were not met in these experiments, especially information conditions – subjects had knowledge of only their own values, and certainly not perfect information about other agents. However the competitive equilibrium is achieved in these experiments, it is not through the computations implied by a traditional equilibrium analysis taking place in the heads of the subjects, but through the interactions between individuals with limited information (Hayek, 1988; Smith, 1991).

Smith's later work (see the edited volumes Smith, 1991; Smith, 2000a) extended the experimental work on auctions to other kinds of markets and institutions. One of the many important messages to emerge from this corpus of research was the critical role played by institutions (Smith, 1994). The mechanisms that subjects interact with in experiments have important effects on the behavior of those subjects. This is in large part because, not surprisingly, people respond to their perceptions of incentives, if not always in ways predicted by standard theory (see below). A significant contribution of Smith and his collaborators' work was to catalogue subjects' responses to various economic environments and institutions.

For example, Hoffman, McCabe, and Smith (1996a) illuminated an important aspect of bargaining psychology that is not captured by classical theory. They used an

Ultimatum Game, in which one subject (the Proposer) offers a second player (the Responder) $X out of a total of $M. The second player can either accept, receiving $X, or decline, in which case both get $0. HMS found that if player 1 earns the role of Proposer (as opposed to being chosen at random), Responders are, under some conditions, willing to accept smaller offers. This is just one piece of a large set of data which add richness to our understanding of human economic decision making by taking psychology seriously – in this case, a psychology of "entitlement."

In the context of the present chapter, it is worth pointing out that the wealth of evidence generated by Smith led him and some of his collaborators toward evolutionary psychology as a source for new theoretical insights.

<u>Evolutionary Perspectives on Smith's work</u>

<u>Cooperation.</u> Recent work by Smith and his colleagues, especially Kevin McCabe (e. g., Hoffman, McCabe, Shachat, & Smith, 1994; E. Hoffman, McCabe, & Smith, 1996a, 1996b; Kurzban, McCabe, & Smith, 2001), extended research programs showing that in laboratory settings, people behave in ways that seem to suggest prosocial motivations (Guth, Schmittberger, & Schwarze, 1982). Hoffman, McCabe and Smith (1998) focused on findings that players in numerous experiments using Prisoner's Dilemma and Public Goods games were far more cooperative than predicted by standard theory. The authors presented an argument that an explanation for the existence of cooperation is the result of a history of selection for "certain cognitive abilities that predispose many people toward reciprocity" (p. 655; see also Gintis, Bowles, Boyd, & Fehr, 2003).

Similar results suggesting preferences beyond simple self-interest have been obtained with other games as well. Smith's explanation for this is, in some sense, to say that in the laboratory you can take the person out of the social world, but not the reverse. That is to say, people enter experiments as social creatures with adaptations for a social world and experiences in it. In discussing why lab results don't match predictions of classical theory, Smith (2000b) suggests: "What may be wrong is the very idea that instances of human decision interaction can be construed as without a history or a future" (p. 80).

Responding to incentives: it's not just the money. An important contribution of Smith's was to detail the ways in which subjects in the laboratory responded to economic incentives. No one seriously doubts that they do, but Smith's work systematically examined how people responded to different institutions – different rules of the game – a body of research with obviously important implications for the real world, in particular questions surrounding how to structure markets to generate economic efficiency. (For a collection of relevant papers see Smith, 1991; Smith, 2000a.)

Impersonal and Personal Exchange

The juxtaposition of two seemingly contradictory patterns of findings from the laboratory, that 1) in some experiments people closely follow their financial self-interest in a way that bears out predictions drawn from classical theory and that 2) in other experiments people are considerably more prosocial than non-cooperative game theory would suggest led Smith to a distinction that he highlighted in his Nobel address: Impersonal versus Personal Exchange. As Smith puts it, when experiments are run to test the standard model: "[A]lthough the test results tend to be confirming in impersonal market exchange, the results are famously and recalcitrantly mixed in 'personal exchange,' notably in a great variety of two-person extensive form games where some half of the people attempt and frequently succeed when risking cooperation, even when anonymously paired" (p. 505).

Impersonal exchange refers to the familiar relatively anonymous transactions with money in markets with which we are all familiar. As the name suggests, this type of interaction is with individuals with whom we have little history and quite possibly little future, and, indeed, they may not be individuals at all, but rather faceless firms. In this context, people seem to be performing computations that allow them to follow their money-maximizing self-interest, whether or not these computations are the ones implied by classical theory. Critically, under conditions of impersonal exchange, *Homo economicus* is a reasonably predictive model.

Personal exchange, in contrast, refers to transactions with known others, or, more generally to transactions that take place within a context that is construed socially. When the experimental context is constructed to cue participants to the social aspects of the task – for example, by reducing one's sense of anonymity (Hoffman, McCabe, & Smith, 1996) – participants cooperate at rates well above that predicted by traditional theory.

Taken together, the results of experiments in these differing environments suggest that *Homo economicus* – in the sense of a set of cognitive mechanisms that are capable of calculating how to pursue one's financial interest – is one aspect of human cognition. However, *Homo economicus* appears only under certain conditions, especially ones in which there are few cues that one is embedded in a social world. This resonates with evolutionary views that take human cognition to be a set of functionally specific modules that are dynamically activated depending on proximate cues (Tooby & Cosmides, 1990), and, more specifically, the view that humans have a number of distinct modes of social interaction depending on the context (Fiske, 1992).

Daniel Kahneman

Empirical Challenges to *Homo economicus*

While Vernon Smith's work challenged the assumptions of *Homo economicus* from inside the discipline of economics, psychologists Daniel Kahneman and Amos Tversky, his collaborator, used the methods of experimental psychology to challenge traditional notions of human rationality from the outside. Kahneman and Tversky are best known for their work that chipped away at a cornerstone of classical approaches to decision making, expected utility theory. Expected utility theory assumes that individuals have preferences over choices based on the value of the outcomes and the probability of the outcomes obtaining (von Neumann & Morgenstern, 1944). Kahneman and Tversky's prospect theory illustrates several other factors that can affect the valuation of an outcome.

In their early work, Kahneman and Tversky described the two central aspects of prospect theory: the non-linearity of decision-weights and loss aversion (Kahneman & Tversky, 1979/2000). The non-linearity of decision-weights describes how the perceived value of an outcome does not increase linearly as its probability increases, as standard theory would suggest. Instead, individuals tend to undervalue outcomes that are close to certain (but not 100% certain) and overvalue extremely unlikely outcomes (Kahneman & Tversky, 1992/2000). For example, a 99% chance of getting a $2,000 Christmas bonus would be valued at less than the $1,980 expected value, simply because it is not entirely certain. Also, playing the lottery, which clearly has a negative expected value, might be explained if players are overvaluing the unlikely possibility of a win, as predicted by prospect theory.

Loss aversion refers to the asymmetric value functions individuals have for losses and gains. A loss tends to carry with it a greater decrease in perceived value than the increase in value that comes with an equivalent gain, i. e., “losses loom larger than gains.” In other words, people seem to dislike losing $10 more than they like winning $10. Tennis great Jimmy Connors captured the notion of loss aversion when he said, "I hate to lose more than I love to win”(Wall Street Journal, 2004).

In later work, Kahneman and Tversky expanded the notion of loss aversion, applying it to economic exchanges (Kahneman & Tversky, 1991/2000). Kahneman and Tversky convincingly showed that human behavior violates one of the assumptions of standard models of decision-making: “that preferences do not depend on current assets” (p. 143). According to the standard model, the amount of money an individual is willing to pay (WTP) for a good should be the same as the amount that individual is willing to accept (WTA) for giving up the good. If I am willing to accept no less than $8 to give up a university mug, I should be willing to pay $8 for that mug if I do not have it. However, individuals are often willing to pay less to get an item – a university mug, among many other things (Kahneman & Tversky, 1991/2000) – than they are willing to accept to give it up.

Kahneman and Tversky used prospect theory to explain this disparity, by arguing that people don’t think of spending money as incurring a loss, but do perceive losing goods as incurring a loss (see Kahneman, 1991/2000). That is, the loss aversion entailed by prospect theory increases the magnitude of the perceived loss of the item, raising the minimum amount an individual would be willing to accept (WTA) to give that item up, which leads to the difference between WTA and WTP.

Kahneman and Tversky also showed that under some conditions, individuals display inconsistent preferences (Kahneman & Tversky, 1984). In their experiments, Kahneman and Tversky showed that framing an option as a cost versus framing it as an uncompensated loss can affect whether that option is chosen. For example, one of their questions asks the respondent to choose between two options for combating a disease that is expected to kill 600 people. When presented with the following options, most individuals (72%) choose the risk-averse option (program A)

A: 200 people will be saved

B: There is a one-third probability that 600 people will be saved and two-thirds probability that no people will be saved.

However, when individuals are asked to choose between logically identical options that are framed differently, most individuals (78%) choose the more risky option (program D) (Kahneman & Tversky, 1984).

C: 400 people will die.

D: There is a one-third probability that nobody will die and a two-thirds probability that 600 people will die.

Although the first and second sets of choices are identical in real terms, they differ with respect to the framing of the two options. In the first version, the deaths are framed as an uncompensated loss, implying a reference state in which everybody dies of the disease ("…people will be saved"). The second version frames the deaths as a loss, implying a reference state in which nobody dies ("…people will die").

Evolutionary Perspectives on Kahneman's Work

Although Kahneman and Tversky's prospect theory was not designed as a model of ecological decision making, there are clear parallels between the preferences described by prospect theory and the kinds of behaviors that are rational for organisms in variable or risky ecological circumstances.

Loss/gain asymmetry. The asymmetry between losses and gains, which is a centerpiece of prospect theory, can be easily reconciled with evolutionary theory. For any organism, marginal losses are more fitness relevant than marginal gains because gains and losses are asymmetrical with respect to their effect on expected fitness. When an organism realizes a gain, it can increase its energy store, which usually increases the length of time it will live. However, when an organism realizes a loss, it may cause that organism to die or become more susceptible to death. So, everything else being equal, under broadly plausible assumptions about fitness functions, organisms should be designed to be more concerned with avoiding losses than with realizing gains because of this asymmetry (Stephens & Krebs, 1986).

Note that the marginally decreasing nature of the utility function also makes sense from an evolutionary perspective. If an individual is close to death, an increase in their energy reserves is much more valuable than the same amount of increase would be if that organism had much more energy to begin with.

FIGURE 1 ABOUT HERE

Prospect theory acknowledges that the variability and probability of a given outcome can influence the value ascribed to it to a greater extent than predicted by an expected value computation. Accordingly, an outcome with a less than certain chance of occurring, say a .95 probability of getting $100, could be subjectively valued at $80, rather than the $95 expected value. In evolutionary terms, optimal foraging theory suggests that sensitivity to probability and variability is quite rational (Stephens & Krebs, 1986). If an organism has a .95 probability of acquiring the large prey item that will sustain it and a .05 chance of getting nothing that day (and therefore dying), the organism should not value this option equivalently to a sure bet at getting a prey item that is .95 the size of the large prey. Because every organism always faces the threat of death (or decreased fecundity) when it does not acquire enough resources (Caraco, 1983; Caraco & Lima, 1987), a less than certain gain can be worth much less than its expected value. The same reasoning applies for variable outcomes. If organisms have a threshold of energy they need in order to survive, a variable option that entails the possibility of going below that threshold is worth less than an option with an equivalent expected value but no chance of going below that threshold (Caraco, 1983; Caraco & Lima, 1987).

In short, optimal foraging theory, a framework derived from an evolutionary analysis, which has already proven fruitful for understanding decision making in non-human animals, provides a potentially unifying perspective on the ultimate origins of the preferences reflected by prospect theory (Caraco & Lima, 1987). It is true that Kahneman and Tversky (1984) did not require the evolutionary analysis to develop their theory – their ingenious empirical efforts were sufficient. But optimal foraging theory links economic decision making in this domain with a proven productive theoretical background and, importantly, suggests new directions of inquiry (e. g., Rode, Cosmides, Hell & Tooby., 1999). This changes loss aversion from an empirically derived ad hoc add-on into a comprehensible component of a more seamless conceptual structure.

Relative well-being. Classical economic theory, sensibly, holds that utility increases as wealth and consumption increase. Similarly, evolved organisms' motivational systems should be designed to find it rewarding to have more of those things that contribute to growth, health, and reproductive success. However, a particular good can have different value, depending on the consumption history of the individual: the first doughnut tastes better than the fifth. A well designed motivational system should clearly be designed to take into account diminishing returns – a hungry organism should be more motivated to acquire calories than a sated one.

In addition, some types of motivational systems will be designed to vary not as a function of some absolute metric (satiety), but rather in comparison with relevant social others. For example, if mates are evaluated on the basis of some comparison among candidates, then selection might favor a mechanism that motivates behavior with the goal of achieving *relative* superiority along that dimension, rather than against some objective metric (Price, Cosmides, & Tooby, 2002).

There is considerable support for the idea that people's happiness and satisfaction is computed in this way. While it is true that there is a positive correlation internationally between income and happiness (or "subjective well-being"), this relationship is neither straightforward nor monotonic, and large national increases in wealth do not cause correspondingly sizable increases in happiness (Diener & Oishi, 2000). This is somewhat of a puzzle on standard approaches to utility.

State Dependence. The impact of a given change in welfare depends on an organism's current state; a small gain to an organism that has large energy reserves might represent a large gain to a starving organism. Consistent with this, people indeed respond to risks to changes in welfare as a function of their current financial or nutritive state (Rode et al., 1999). In the context of prospect theory, this suggests that there should be some variation in the shape of individuals' curves. For example, a starving animal or a poor person is likely to have a more steeply sloped curve for gains since a morsel of food or dollar has greater (perceived) value, while a sated organism or rich person would have a shallower curve for gains because the marginal value of those gains is small. Somewhat less obviously, the loss portion of the curve is likely to be less steeply sloped for a hungry animal or poor individual because a small loss is likely to kill or ruin that individual, and further losses are irrelevant after that point. For a sated animal or for a rich person, the curve is likely to be steeply sloped curve over a greater range of losses since there is more to lose before all is lost.

Individuals with differently shaped curves will value the same risky opportunity in different ways. A rich individual might value a risky option less because the perceived value of the potential loss associated with the risk is much greater than the perceived value of the potential gain. However, a poorer individual might be more willing to undertake that risk because the value of the potential gain is greater than the value of the possible loss.

Data suggest that humans do behave in such a way: Wilson and Daly (1997) found that rates of homicide and early pregnancy are higher in areas of lower socioeconomic status and lower life expectancy. They claim that this difference in willingness to undertake risks is adaptive because individuals with lower life expectancies should be more willing to engage in risky behaviors (such as violence) that might raise status, thereby increasing reproductive success. One interpretation of this finding is that individuals who perceive themselves to be poorly off may have a curve with a steeper slope for gains and shallower slope for losses, which makes them more likely to engage in risky behaviors such as violence and sex (Wilson & Daly, 1993, 1997).

The foregoing raises the possibility that the differently shaped curves for organisms in different states can be profitably thought of as the *same* prospect theory curve with reference points above (in the case of a sated individual) and below (in the case of a hungry individual) the origin. Whether state dependence is conceptualized as differently shaped curves or changing reference points along a single curve, individuals value outcomes differently, and therefore behave differently, depending on their current subjective well-being.

The Resurgence of *Homo sapiens*

Tastes and Preferences

Although tastes and preferences are central to economic decision making, the question of the origins of tastes and preferences is of little interest to many economists. Evolutionary psychology, on the other hand, is critically concerned with and has conceptual tools to address the origins of preferences (Cosmides & Tooby, 1994): our literal taste for fat is because of the adaptiveness of consuming fat in our evolutionary history, we like finding attractive partners because that increased our reproductive success, and we care about our children because their survival meant the survival of our genes. Similar arguments can be made for other sorts of tastes and proximate goals, such as helping kin (Daly, Salmon, & Wilson, 1997), developing positive social relationships (Leary & Baumeister, 2000), and striving for prestige (Henrich & Gil-White, 2001).

One of the ways in which our tastes and preferences helped us survive during our evolutionary history was by attracting us to fitness-relevant elements of the environment. As Thornhill (1998) put it: "beauty experiences are unconsciously realized avenues to high fitness in human evolutionary history. Ugliness defines just the reverse" (p. 544). In the case of food, our ancestors lived in a world in which fat and sugar were much scarcer than it is today. Passing up an opportunity to eat meat or high sugar items (which were then mostly fruits) could have made the difference between starving or surviving the winter. Because of the nutritional value of animal fat, genes that coded for a preference for consuming animal fat were selected. In modern environments, this taste leads to unfortunate outcomes. Consuming meat and high sugar foods (which are now candy bars and the like) can make the difference between an early heart attack and surviving to see one's grandchildren. The evolutionary approach predicts tastes for proximate goals (fatty and sugary foods), not ultimate survival and reproductive success (Burnham & Phelan, 2000).

Time/Energy Constraints

The evolutionary approach highlights the fact that our ancestors – like all other living organisms – had only limited time and energy to engage in a wide variety of fitness-enhancing activities, and therefore had to make trade-offs between one activity and another, for example, how much time to invest in finding a mate versus finding food, or whether to invest in having offspring immediately or invest in increasing status so future offspring might have a better chance at survival and reproduction.

This process itself, allocating time and energy to decision-making, represents an important adaptive task. Collecting information relevant to a question and determining the correct weighting of that information can take an arbitrarily large amount of time and mental resources. Standard economic approaches were unconcerned with computational limitations, implicitly assuming that time and mental resources were unlimited and costless.

Simon (1955) introduced the idea that computation was itself a limited resource, stating that humans exhibit "bounded rationality," or rationality within certain computational constraints. Both Kahneman and Smith extended these ideas in important ways. Smith & Walker (1993), for example, developed a framework designed to take into account payoffs to the subject beyond the monetary, including the cost of making the decision itself. Kahneman and Tversky (1979/2000, 1984) showed that humans use decision rules that are based on neither perfect information nor straightforward cost/benefit evaluation.

Both of these research programs laid foundations for extremely productive lines of research that have been taken up by others who have extended and clarified these issues. Gigerenzer and his colleagues (Gigerenzer, 2000; Gigerenzer & Selton, 2001; Gigerenzer, Todd, & The ABC Research Group, 1999) have strengthened the connections between bounded rationality and evolution/ecology to develop precisely formulated models that make sense in the context of an organism with biological constraints. They have developed the idea that humans are 'ecologically rational,' making judgments that are "fast and frugal," arriving at good decisions using only very limited information (Gigerenzer et al., 1999). Other researchers are similarly engaged in productive research programs that take seriously the idea that human decision makers have limited time and cognitive resources to bring to bear on any given problem (e. g., Gabaix & Laibson, 2003).

Emotions

Another aspect of human behavior that is informed by the evolutionary perspective is that of emotions. Historically, emotions have been seen as impediments to rationality, getting in the way of good decision-making. However, it has become clear that emotions play a central, indeed critical, role in decision-making. Emotions imbue situations with an affective valence that is essential for responding appropriately to opportunities and weighing choices. Damasio (1995) refers to this as a "somatic marker," a physiological response that carries affective information relevant to a situation. Individuals whose emotional capacities have been damaged by brain injuries seem to lack this anticipatory response. Damasio and his collaborators (Bechara, Damasio, Damasio, & Lee, 1999) have shown that these patients persist in choosing cards from a deck with more risk and lower expected return, while normals developed an anticipatory psychological response and learned to avoid the inferior deck. In a sense, the patients who lacked the emotional response were behaving less rationally than the individuals whose emotional systems were in tact.

This view resonates with that of other functionally oriented researchers (Frank, 1988; Ketelaar & Todd, in press; J. Tooby & Cosmides, 1990) who have discussed the evolutionary significance of emotions. According to evolutionary psychologists Tooby & Cosmides (1990), emotions function to coordinate physiological and psychological responses to fitness relevant situations, focusing attention on important aspects of the environment and guiding the organism to adaptively correct responses. Emotions are obviously important for responding to the social environment as well. Ketelaar and Au have shown that the emotion of guilt seems to have an important function in motivating commitment (Ketelaar & Au, 2003).

Hence, emotions are more of an aid to decision-making than an obstacle to be overcome. Without them we would be unable to attend to relevant stimuli, properly respond to risky situations, or feel emotions such as guilt that facilitate the formation and maintenance of social relationships. The evolutionary significance of emotions is transparent; they help us respond to danger effectively and facilitate the social relationships that influence our reproductive success.

Conclusion

Smith, Kahneman and their colleagues amassed a tremendous amount of evidence that first threatened, then endangered *Homo economicus*. Instead of a simple model of human behavior based on rationality and perfect information, *Homo economicus* became an amalgam of various sub-models and constraints that explain deviations from straightforward rationality. In this paper, we sought to answer the questions: *Why* is it that humans so often depart from the reasoning, decision making, and behavior of *Homo economicus*? *When* should we expect human behavior to be consistent with the predicted behavior of *Homo economicus*? *Where* should we look for the ultimate explanation for our species' actual preferences?

Evolutionary psychology and experimental economics share more than a skeptical view of *Homo economicus*; they also share the common goal of creating a realistic model of human behavior. Evolutionary psychology can help provide a framework for experimental economists to understand behaviors observed in the laboratory and in the real world, as well as an account of the origins of preferences. Experimental economists have provided a wealth of evidence with which adaptationist hypotheses about cognitive design can be built.

The evolutionary view sheds light on the ultimate reasons for behavior surrounding trust and reciprocity (Hoffman et al., 1996b), and gives potential insights into people's asymmetrical valuations of equivalent sized losses and gains (Kahneman & Tversky, 1991/2000). More generally, evolutionary psychology is potentially valuable to economics because it can help economists better understand the ultimate reasons for the cognitive mechanisms underlying economic choices, or even, as in the case of Prospect Theory, the shape of a particular value function.

The marriage of theory from evolutionary psychology and methods from cognitive science and experimental economics has already borne empirical fruit (Hoffman et al., 1996b; Ketelaar & Au, 2003; Kurzban et al., 2001). The emerging field of "neuroeconomics" (Glimcher, 2003; McCabe, 2003), for example, owes much to the increasing connections between economics and cognitive psychology that have been forged during the past two decades, many of which to a greater or lesser degree are descended from research by Smith and his colleagues. Reciprocally, the tools of experimental economics can help evolutionary psychologists test hypotheses focal to their theoretical interests, including kin-directed altruism (Unur & Peters, 2003), how individuals balance their interests against those of their group, people's desire for punishment, intertemporal choices, and so on.

So, is *Homo economicus* extinct? Not exactly. In hindsight, *Homo economicus* is a species that could never have evolved in the first place. *Homo economicus* tried to survive by adding auxiliary theories into an ultimately unsalvageable model. The model of human decision making envisioned by early rational choice theorists violates what is known about human behavior in the laboratory on the one hand, and what is known about the products of evolution by natural selection on the other. It is true that a wealth of evidence suggests that *Homo economicus* is a reasonable model for human behavior, but only under very particular conditions, such as impersonal exchange. But the correct model of human decision making requires acknowledging that our actual species, *Homo sapiens*, is an amalgam of *Homo reciprocans*, *Homo prospectus*, *Homo nepotismis*, and no doubt many other interesting subcomponents. *Homo economicus* can be expected to live on in *Homo sapiens* as well, showing herself only when no one is watching.

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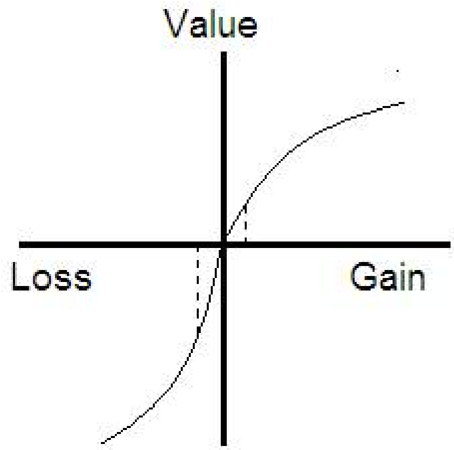

Figure 1. This graph shows a hypothetical value function based on prospect theory (adapted from Kahneman and Tversky, 1984). Note that the value of a loss is larger than the value of an equivalent gain (dotted lines).

Footnotes

[1] Technically the Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel, established in 1968.

[2] In his Prize Lecture, Smith (2002) was quick to point out that another Smith (Adam) had long ago argued (Smith, 1759) that "individuals were mischaracterized by the metaphor, 'economic man'" (p. 2).

[3] We use teleological language for discursive economy, confident that this language can be paid out in terms of purely physical causality (see Dawkins, 1976).