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The Savanna Principle

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Why do microeconomic theories (such as decision theory and game theory) often fail to predict human behavior despite their mathematical elegance and deductive rigor? I suggest that such empirical failures stem from the theory's misconception of how the human brain functions. Drawing on evolutionary psychology, I propose the *Savanna Principle*, which posits that a hypothesis about human behavior fails to the extent that its scope conditions and assumptions are inconsistent with the ancestral environment, and its experimental corollary, that the Savanna Principle holds (and the hypothesis fails) to the extent that the conditions of the experiment resemble the ancestral environment. I suggest that the Savanna Principle and its corollary might together explain the relative empirical failure of noncooperative game theory and public choice theory, and the relative success of network exchange theory and competitive price theory tested in double auction markets in experimental economics. Copyright © 2003 John Wiley & Sons, Ltd.

Managerial and organizational theories draw heavily on other social sciences, most notably, microeconomics. Microeconomic theories (such as decision theory and game theory) are among the mathematically most elegant and rigorous theories of human behavior. Yet their precise models often fail to predict actual human behavior both in laboratory experiments and natural settings (Green and Shapiro, 1994; Thaler, 1992). For instance, noncooperative game theory predicts that rational actors always defect in Prisoner's Dilemma games (PDGs) (Nash, 1951), and cheap talk (nonenforceable threats and promises) has no effect on their choices. Yet laboratory experiments consistently show that roughly half the subjects make the 'irrational' choice to cooperate in PDGs, and cheap talk has a tremendous positive effect on the rates of cooperation (Sally, 1995). Similarly, public choice theory predicts that rational actors do not voluntarily contribute toward the production of public goods, and instead choose to free ride on others' contributions (Olson, 1965). If everyone makes the rational choice, public goods will never be provided. Yet examples of successful collective action abound in natural settings, even in the absence of material selective incentives. Obviously, something is wrong. Managerial and organizational theories are doomed to failure if microeconomic models which form their foundations fail empirically.

In this paper, I draw on the emerging field of evolutionary psychology to suggest why hypotheses about human behavior sometimes fail to make accurate predictions. I argue that the empirical failures occur because some hypotheses stipulate entities and conditions that did not exist in the ancestral environment, to which the human brain is adapted. I propose the Savanna Principle, which posits that a hypothesis about human behavior fails to the extent that its scope conditions and assumptions are inconsistent with what existed in the ancestral environment, and its experimental corollary, which states that the Savanna Principle holds (and thus the hypothesis based on conditions and assumptions that did not hold in the ancestral environment fails) to the extent that the features of the experiment resemble the ancestral environment. I use the Savanna Principle and its corollary to explain why predictions from noncooperative game theory and public choice theory often fail

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empirically, while predictions from network exchange theory in sociology and competitive price theory fare better.

I concentrate in this paper on the relative success and failure of microeconomic theories only for illustrative purposes. Their empirical success and failure are relatively easy to assess because they make such precise predictions (usually expressed as mathematical models). However, my contention is a general one; it applies to all theories of human behavior from any perspective. The Savanna Principle and its experimental corollary can suggest which hypotheses about human behavior can make accurate predictions, and why.

PRINCIPLES OF EVOLUTIONARY PSYCHOLOGY

Compared to other social scientists, economists are more open to 'evolutionary theory,' evinced, for instance, by the inception of the *Journal of Evolutionary Economics* in 1990. Most of the articles appearing in this journal, however, as well as other work by economists on 'evolutionary theory,' deal with the evolution of game strategies, institutions, organizational forms, and other nonbiological entities (Gintis, 2000; Hannan and Carroll, 1992). With the notable exceptions of Ben-Ner and Putterman (2000), Frank (1987, 1988), Hirshleifer (1988, 1998), and Rubin (2002; Rubin and Somanathan, 1998), economists on the whole have not incorporated the emerging field of evolutionary psychology (EP) and its central concern with evolved human nature. Some of the genuinely evolutionary psychological contributions to economics have been by noneconomists (Cosmides and Tooby, 1994; Rogers, 1994). Because EP is a very new field and economists are unlikely to be familiar with it, I will first explain its foundational principles before I discuss how insight from EP can help us figure out why (and which) microeconomic hypotheses fail. More comprehensive introductions to EP include Barkow, Cosmides and Tooby (1992), Buss (1999), Cartwright (2000), Ridley (1993) and Wright (1994). Markóczy (1998) provides an excellent introduction to EP's relevance and application to managerial and decision economics.

EP seeks to discover universal human nature, which is a collection of domain-specific psychological mechanisms. A psychological mechanism is an information-processing procedure or decision rules that evolution by natural and sexual selection has equipped humans to possess in order to solve a particular adaptive problem (a problem of survival or reproduction). Unlike decision rules in decision theory or game theory, however, psychological mechanisms mostly operate *behind and beneath our conscious thinking*. Evolved psychological mechanisms produce values and preferences, which rational actors then pursue within their constraints, and they also engender emotions (Ben-Ner and Putterman, 2000; Kanazawa, 2001; Rubin, 2001a).

EP is premised on two broad generalizations. The first generalization, to put it bluntly, is that there is nothing special about Homo sapiens. To put it more precisely, 'certainly we are unique, but we are not unique in being unique. Every species is unique and *evolved* its uniqueness in adaptation to its environment. Culture is the uniquely human way of adapting, but culture, too, evolved biologically' (van den Berghe 1990, p. 428). Human beings are just like other animal species (Maryanski and Turner, 1992), and all the laws of nature, in particular, the laws of evolution by natural and sexual selection, apply equally to humans as they do to other species. The second broad generalization is that there is nothing special about the brain as a human body part; it is just like the hand or the pancreas or any other body part. Just as a long history of human evolution has shaped the hand or the pancreas to perform a specific function, so has the evolution shaped the human brain to perform certain tasks (solving adaptive problems).

The second generalization leads to a very important implication of EP. Just as the basic shape and functions of the hand and the pancreas have not changed since the end of the Pleistocene epoch about 10 000 years ago, the basic functioning of the brain has not changed very much in the last 10 000 years. The human body (including the brain) evolved over millions of years during the Pleistocene epoch in the African savanna where humans lived during most of this time (Maryanski and Turner 1992, pp. 69–90). This environment—African savanna where humans lived in small bands of fifty or so related individuals as hunter-gatherers—is called the environment of evolutionary adaptedness (EEA)

(Bowlby, 1969) or ancestral environment, and *it is to the EEA that our body* (*including the brain*) *is adapted*.

EP strongly rejects the view of the human mind as *tabula rasa*, and avers instead that it is *content-rich* and *biased*. The human brain, and all of its psychological mechanisms, are adapted to the EEA and are therefore biased in favor of viewing and responding to the world as if it were still the EEA. The psychological mechanisms we possess in our brain today are still the same psychological mechanisms that we possessed in the EEA, just as our hand and pancreas are still the same as they were 10 000 years ago. It is not impossible to overcome this bias through conscious effort, but it is often difficult. This is why we still respond to sweets and fats today as if we still lived in the EEA where such high-calorie foods were rare and malnutrition was an imminent problem for survival, and we have the strong urge to consume a large quantity of sweets and fats (even though many of us can consciously overcome the urge) (Barash 1982, pp. 144–147). It is my contention that *the human brain has unconscious difficulty comprehending and dealing with entities and situations that did not exist in the EEA*.

For instance, one of the entities that we know for sure did not exist in the EEA is television. The fundamental principles of EP would therefore imply that humans have difficulty recognizing and dealing with TV. This indeed appears to be the case. People who watch certain types of TV shows are more satisfied *with their friendships*, just like they are if they have more friends or spend more time socializing with them in real life. It appears that the human brain has difficulty distinguishing between real friends and imaginary ones they see on TV, because it did not exist in the EEA (Kanazawa, 2002). It is this fundamental observation, that *our brain and its psychological mechanisms are strongly biased to view and respond to the environment as if it were still the EEA*, which leads to the Savanna Principle.

It is true, as critics of EP often point out, that the EEA, tens of thousands of years past, is not directly observable. We can make inferences about it, based both on archeological records and ethnography of contemporary hunter-gatherer societies, but it is unlikely that we will ever know all the details of the EEA. It is therefore impossible for us to draw all the implications of the above observation for our current social behavior. However, there are certain things about our ancestral life in the EEA that we know reasonably well. We know that our ancestors lived in small bands not exceeding 200 individuals; they did not live in a metropolis where everybody can be anonymous. We know that all communications between people in the EEA were direct and face-to-face; they did not have telephones, computers or even writing that allowed them to communicate without facing each other. It is my suggestion in this paper that these few facts that we know about the EEA are sufficient to use the Savanna Principle to figure out which hypotheses about human behavior are likely to fail and why.

THE SAVANNA PRINCIPLE

Because the human brain is unconsciously biased to view the environment as if it were still the EEA, any scientific theory that does not take this bias into account is unlikely to predict human behavior accurately. Stated affirmatively and straightforwardly, the Savanna Principle states that a reasonable hypothesis about human behavior succeeds to the extent that its scope conditions and assumptions are consistent with the EEA. By 'reasonable', I mean that the hypothesis is logically derived from other established principles of human behavior. Being consistent with the EEA does not *guarantee* that the hypothesis will accurately predict human behavior, but being inconsistent with the EEA will likely lead to its failure.[1] My entire discussion of the Savanna Principle in this paper stipulates a *ceteris paribus* condition, and assumes that the hypothesis in question does not fail on other grounds.

Because very few theories outside of EP posit scope conditions and assumptions that are consistent with the EEA, however, and because my focus here is microeconomic theories, none of which specifically incorporates EP, it might be more useful to state the Savanna Principle negatively, as follows:

> The Savanna Principle: A reasonable hypothesis about human behavior fails to predict it accurately to the extent that its scope conditions and assumptions are inconsistent with the EEA.

I will now use the Savanna Principle to suggest why some predictions from game theory and public choice theory fail.

Prisoner's Dilemma

In PDGs, defection strictly dominates cooperation. No matter what the other player chooses, each player is better off defecting than cooperating. Mutual defection, which is collectively the worst outcome, thus becomes a Nash equilibrium, from which neither player has any incentive to deviate unilaterally (Nash, 1951). In both one-shot and finitely repeated PDGs, mutual defection is the only Nash equilibrium. Noncooperative game theory therefore predicts that all rational players choose to defect, and mutual defection is the only possible collective outcome. Since cheap talk (nonenforceable threats and promises) does not alter the players' payoffs and payoffs are the only determinants of behavior, the theory also predicts that communication among the players has no effect on their choices.

That is not how all human subjects behave, however. In a comprehensive review of the experimental literature on PDGs, Sally (1995) concludes that roughly half (47.4%) of all subjects in 130 different experiments published in 37 studies make the 'irrational' choice to cooperate. Further, of all the factors considered by experimentalists in 35 years, cheap talk probably has the largest positive effect on cooperation. Experimental subjects are significantly more likely to cooperate when they can communicate with each other before and during the experiment, and exchange promises and threats with each other, even though such promises and threats are not enforceable by the rules of the game.

There are two anomalies here. Both what Sally (1995, pp. 70–72) calls the 'strong self-interest hypothesis' (No rational actor will ever cooperate in PDGs) and 'weak self-interest hypothesis' (Only factors that change the players' objective payoffs at the margin affect their choice) derived from noncooperative game theory fail. A large number of subjects do choose to cooperate, and cheap talk does have a positive effect on cooperation. What is wrong here?

One of the key assumptions in noncooperative game theory is that the two (or more) players of PDGs are completely anonymous. Experimentalists go to great lengths to make sure that their subjects do not meet before, during and after the experiment. The experimental design guarantees the anonymity of the subjects. It is this complete anonymity, and thus the impossibility of knowing future interactions, that partly lead to the prediction that defection is the only rational choice and that cheap talk has no effect on cooperation. For if the subjects knew the identities of each other, then there will be other considerations besides the payoffs from the game. Subjects may fear retaliation (physical or otherwise) from the other players when they defect on them or when they do not honor their promises to cooperate (however non-enforceable within the rules of the experiment). They may fear that defection or breaking promises might ruin actual or potential friendship or acquaintanceship, that it might engender 'bad feelings' between them. They may fear that their reputation might be ruined if they are perceived as selfish defectors or as someone who doesn't keep their promises. Complete anonymity between subjects guarantees that none of these considerations are relevant for their utility calculations.

However, it is likely that no such complete anonymity existed in the EEA. As our ancestor during the Pleistocene epoch, you lived in a small band of 50 to 200 individuals, where everybody knew everybody else. Further, the only way for you to communicate and interact with others in the EEA was to face them directly. There were no anonymous means to communicate or interact. So whatever choice you made in interpersonal relations was known at least to your partner, who knew who you were, if not to everyone else in the band. If you defected on Og or didn't keep your promise with him, he would likely tell everyone in the band that you were an untrustworthy cheater, probably after he beat you up first. Complete anonymity, which is an integral assumption in noncooperative game theory, probably did not exist in the EEA, and the human brain, biased to perceive the environment as if it were still the EEA, cannot quite comprehend such a thing.

Another integral assumption in noncooperative game theoretic prediction of mutual defection in one-shot PDGs is noniteration. Rules of the game in one-shot PDGs stipulate that the two or more players meet only once to make their choices (either cooperation or defection) and they will never meet again. (Complete anonymity helps guarantee it.) Noniteration is integral to the prediction of mutual defection, because Axelrod (1984) has demonstrated that mutual cooperation becomes rational and a sustainable Nash equilibrium when the same players meet repeatedly and indefinitely, and they play Tit-for-Tat or other contingent strategies.

Once again, this assumption of noniteration probably did not hold in the EEA. As our ancestor, your social world was limited to others in your band and possibly in the neighboring bands. For the most part you interacted with the same people your entire life (although occasional outmigration might have been possible). Just as you could not have complete anonymity in the EEA, you could not have a 'one-shot' interaction with anyone with no possibility of iteration. Every interaction in the EEA was likely an indefinitely repeated game. The Savanna Principle explains why a hypothesis based on the assumptions of complete anonymity and noniteration—the prediction that everyone will defect in PDGs—fails. If there were no complete anonymity or impossibility of future interactions, then cooperation and honoring promises you make in cheap talk suddenly become rational.

In a recent article, Kiyonari *et al*. (2000) present an alternative evolutionary psychological explanation for cooperation in one-shot PDGs. They argue that individuals possess 'social exchange heuristic', which compels them to play PDGs as if they were Assurance games. In PDGs, unilateral defection is preferable to mutual cooperation; in Assurance games, mutual cooperation is preferable to unilateral defection. Individuals playing Assurance games, unlike those playing the PDGs, are therefore motivated to cooperate as long as the other player also cooperates. Now what transforms the PDGs into Assurance games in the minds of many individuals? *Infinite iteration*. It is only with the infinite iteration and the use of contingent strategies such as Tit-for-Tat that PDGs are transformed into Assurance games, and mutual cooperation becomes preferable to unilateral defection. Kiyonari *et al*. (2000) argue that individuals have the social exchange heuristic which assumes that all games are infinitely iterated (and are therefore Assurance games rather than PDGs), because that was the nature of social exchange in the EEA. Their theory of social exchange heuristic and their experimental data are therefore perfectly consistent with the Savanna Principle.

Collective Action

Collective action purports to provide public goods. Unlike private goods, public goods, once provided, are nonexcludable (both contributors and noncontributors to their production can consume them) and have jointness of supply (consumption by some does not decrease the amount left for others to consume). Rational actors therefore have no incentive to contribute voluntarily to the provision of public goods. They can free ride on others' contributions and consume the public goods when they are provided (since free riders cannot be excluded from consumption). If everyone makes the rational decision, however, no one will contribute toward the provision of public goods, and they will never be produced (Olson, 1965). Public choice theory predicts that all rational actors free ride, and hence public goods will never be provided. This is the essence of the collective action problem. Benefits of collective bargaining and industrial action are examples of public goods relevant to managerial and organizational economics.

Contrary to theory, however, public goods are routinely provided, both in laboratory experiments and in natural settings. While the level of provision is often less than optimal, subjects do contribute their private resources toward the production of public goods in laboratory experiments (Ostrom, 1998). In natural settings, examples of successful collective action abound, from worker strikes to political protests to consumer boycotts to nationalist movements. Why do individuals participate in such collective action when the benefit (be it higher wages or political change or safe consumer goods or ethnic independence) cannot be excluded from free riders who do not participate?

An integral assumption in public choice theory is that the collective action is large, involving thousands or millions of people. The large scale of the collective action leads to two conditions: anonymity of individual choices and negligibility of each actor's contribution. Because it involves a large number of actors, each actor's choice to cooperate or defect is not known to others (this is institutionally guaranteed in some collective actions, like voting in democratic societies), and each actor's contribution makes a negligible difference to the collective outcome. Nobody knows whether you contributed or defected, and your contribution or defection makes very little difference to whether the collective action succeeds or fails.

It is likely that any collective action that took place in the EEA was small in scale (Rubin, 2001b). Thus neither consequence of large collective action (anonymity and negligibility of individual contribution) probably existed in the EEA. Whether you participated in an coordinated effort to hunt big game or collective childcare arrangement was immediately known to everyone else in the band. And your contribution made a significant difference to the collective outcome, when there were only dozens of actors at most. Whether or not the hunt became successful, and as a consequence you and your family ate animal protein that day, could crucially depend on how much effort you, personally, put into the coordinated hunting. It becomes rational to contribute to collective action when your individual share of the public goods approaches or exceeds your individual contribution toward their production, especially when others with whom you spend your entire life know whether or not you contributed. The human brain, adapted to the EEA, may still respond to many instances of collective action, however large in scale, as if they involved only dozens of people, and thus it might be rational to contribute (Rubin, 2001b).

Counterexample: Network Exchange Theory

So far I have discussed how the Savanna Principle can explain why some hypotheses about human behavior fail by not taking the EEA into account, and used noncooperative game theory and public choice theory as examples. Both theories are often tested (and at least partially disconfirmed) in laboratory experiments. Despite rigorous controls that laboratory experiments allow, hypotheses derived from these theories often prove relatively unsuccessful, consistent with the Savanna Principle.

Another theoretical perspective, network exchange theory in sociology, provides a sharp contrast. Network exchange theory originates with the work of Emerson (1962, 1972a, 1972b), and explains actors' behavior in terms of their power inherent in their positions (nodes) in exchange networks. Holding the value of resources constant, actors have more power (and can thus bring about more favorable outcomes for themselves) if they have more exchange partners who themselves have fewer alternatives. Molm (1997) and Willer (1999) provide excellent reviews of network exchange theory. Its most fruitful application to managerial and organizational theory is Burt's (1992, 2000) structural holes theory, which predicts that those in corporate organizations who occupy structural holes (network nodes that are connected to other nodes that are themselves not connected) have social capital because they can function as information brokers within the organization. His data show that employees and managers who occupy such structural holes tend to be promoted faster.

Unlike noncooperative game theory and public choice theory, hypotheses derived from network exchange theory are usually confirmed by experimental data, often very precisely, down to the decimal point. While there are minor differences in various theories within this perspective (Skvoretz and Willer, 1993), hypotheses derived from all of them are quite successful by the social science standards. Due largely to its formal models and standardized experimental procedures, network exchange theory is probably one of the very few fields in social sciences that qualifies as what Collins (1994) calls 'high-consensus, rapid-discovery' science, reminiscent of natural sciences.

Network exchange theory is similar to noncooperative game theory and public choice theory in that it conceives of the actor as rational, purposive and self-interested. It is also similar to them in its degree of formalization and its frequent use of laboratory experiments for testing hypotheses. If network exchange theory is similar to noncooperative game theory and public choice theory in its assumptions about the actor, deductive mathematical models, and preferred method of testing, why is it so much more empirically successful than them? From the perspective of the Savanna Principle, the answer may lie in the extent to which the scope conditions and assumptions of network exchange theory are consistent with conditions that prevailed in the EEA.

The single most important predictor of behavior in network exchange theory is power. Actors who find themselves in certain structural locations in networks have more power than those in other structural locations. When more powerful actors interact with less powerful actors, the former can obtain outcomes that are more favorable to them than to the latter. Actors' structural power is inversely determined by their dependence on others, and dependence is in turn determined inversely by the number of potential exchange partners and directly by the value they place on the resources that their exchange partners possess (Emerson, 1962). Actors are more dependent on their exchange partners to the extent that they have fewer alternative exchange partners (fewer network ties to others) and that they place greater value on the resources that their exchange partners hold. The more dependent the actors are on others, the less power they have over them. These are the basic principles of network exchange theory.

Note that none of these assumptions appear inconsistent with the EEA. Our ancestors most probably exchanged resources with each other. Some had more exchange partners (more network ties to others) than others, and as a consequence were less dependent on and exercised more power over others. Unlike noncooperative game theory or public choice theory, hypotheses derived from network exchange theory do not presume complete anonymity among actors or a large group size. If they required complete anonymity among actors, then they would have to predict that actors do not exercise power over others in face-to-face interactions. They would not predict, for instance, that the most popular girl in high school (who can get many dates) can get more out of her dates than the least popular girl (who can get few dates), or that a job candidate with many offers can extract a more favorable contract than one with few offers. However, these predictions are perfectly consistent with network exchange theory. None of the French or American corporate managers Burt (2000) studies are anonymous to each other within their firms.

One of the network exchange theories that Skvoretz and Willer (1993) test is Bienenstock and Bonacich's (1992) core theory based on cooperative game theory. In stark contrast to noncooperative game theory, which explains strategic choices of individuals, cooperative game theory (Kahan and Rapoport, 1984) models coalition formation. Within cooperative game theory, all agreements are enforceable and anonymity is not necessary, reflecting the conditions that probably prevailed in the EEA more accurately than noncooperative game theory. The Savanna Principle can therefore explain why cooperative game theory makes more accurate empirical predictions about human behavior than noncooperative game theory.

None of the integral scope conditions and assumptions of network exchange theory are inconsistent with what prevailed in the EEA. Hypotheses derived from network exchange theory would probably have been successful in the EEA, while those derived from noncooperative game theory and public choice theory would not have been. Perhaps the strongest indication for this is that *network exchange theory has been tested and supported with nonhuman primate species* (Maryanski, 1987; Maryanski and Ishii-Kuntz, 1991). It is therefore likely that scope conditions and assumptions of network exchange theory held true even before the EEA in the evolutionary history of primates, before our ancestors were human.

Counterexample: Competitive Price Theory in Double Auction Markets

Another theory that is even more empirically successful than network exchange theory is competitive price theory tested in double auction markets in experimental economics (Smith, 1962, 1964). In a typical double auction experimental market, there are several sellers and buyers. Each seller has a certain units of commodity to sell on the market, and each buyer has a certain units of the same commodity to buy. The cost of each unit of the commodity can vary between the sellers, and the value of each unit of the commodity can vary between the buyers. When an auction period begins, each seller posts an 'ask' (asking price), and each buyer posts a bid. Sellers successively lower their asks, and buyers successively raise their bids, until there's a match between an ask from a seller and a bid from a buyer, at which point they enter a binding contract. The auction period ends either when the sellers sell all the units they want to sell, or the buyers buy all the units they want to buy.

Double auction markets function so well that their mean efficiency in various experiments range from 95 to 100% (Davis and Holt, 1993, p. 136, Table 3.4; Holt, 1995, p. 371, Table 5.2). In other words, 95–100% of theoretically possible surplus is actually extracted by buyers and sellers in double auction experimental markets. In fact, double auction markets are so efficient that they serve as benchmarks against which the performance of all other market institutions is evaluated.

Why are double auction markets so efficient? Competitive price theory, which these experimental markets are designed to test, rests only on a few fundamental economic concepts: Demand, supply, value, and cost. These four parameters are sufficient to compute the competitive price for any market. None of these concepts were absent in the EEA, and thus violate the Savanna Principle. Even in the EEA, some goods were in greater demand (food) than others (flowers). Some goods were in greater supply (berries in season) than others (berries out of season). Some goods had inherently greater value to people (sharp spears) than others (dull spears). Some goods were inherently more costly to produce (meat of large game) than others (meat of small game). In their economic exchange, our ancestors would have demanded or offered more for inherently more valuable or costly goods than for inherently less valuable or costly goods, and they would have demanded or offered more for goods in greater demand or in shorter supply. Our ancestors would have made as good subjects for double auction experimental markets (once they overcome the language barrier) as sophomores at California Institute of Technology or the University of Arizona.

It is important to note that, while double auction markets in experimental economics (like experiments testing network exchange theory) are often conducted via computers and thus participants in these experiments remain anonymous, *neither computerized* (*indirect, non-face-to-face*) *communication nor anonymity is an integral assumption of competitive price theory* (just like they are not for network exchange theory). In fact, early double auction markets were conducted face-to-face (in what is now known as the 'oral' double auctions), and *they were slightly more efficient than the computerized markets with the same parameters* (Williams, 1980). Prices are also more variable and volatile in computerized double auction markets than in their oral counterparts (Davis and Holt, 1993, pp. 135–141; Williams, 1980).

Computerized and oral double auction markets function more or less the same because the equilibrium price predicted by competitive price theory depends only on demand, supply, value and cost. If computerized communication and anonymity were integral to auction markets, then one would have to predict that computerized, anonymous auctions like eBay would perform differently than face-to-face, nonanonymous auctions like Sotheby's. Disregarding for the moment that eBay typically deals with an entirely different class of commodities than Sotheby's, competitive price theory nonetheless predicts that both auction markets would reach the same equilibrium price equally efficiently.[2]

This is in stark contrast to noncooperative game theory and public choice theory, for which anonymity (created by their computerized experiments) *is* an integral theoretical assumption. Participants in face-to-face PDGs are predicted to behave differently than those in anonymous PDGs. And they do. Participants in face-to-face PDGs and similar games often experience extreme rage toward defectors and threaten them with physical violence (Bonacich, 1976, pp. 206–208; Ostrom *et al*., 1992). That is why anonymity is necessary. It is unlikely that participants in Sotherby's auction would threaten someone who just outbid them with physical violence if the auction was otherwise fair. The Savanna Principle predicts empirical failure only when the theory's integral scope conditions or assumptions are inconsistent with the EEA. It can therefore explain why network exchange theory and competitive price theory perform so much better empirically than noncooperative game theory and public choice theory.

Finally, a critic might argue that an alternative explanation for the success of network exchange theory and competitive price theory is the 'disciplinary' power of competition.[3] In situations modeled by these theories, unlike those modeled by noncooperative game theory and public choice theory, some individuals are routinely excluded from exchange. An actor who offers less to a potential exchange partner than someone else will not be chosen for the exchange. A buyer who bids less than another buyer will not win the bid. In order not to be excluded, individuals must modify their behavior continuously until it nears efficiency predicted by theory; in other words, competition, and the possibility of exclusion, 'disciplines' the actors' behavior until it is optimal, regardless of their cognitive processes and what their brain can or cannot recognize (as the Savanna Principle posits).

While this alternative perspective can explain why network exchange theory and competitive price theory succeed in predicting human behavior precisely, it cannot explain why noncooperative game theory and public choice theory fail. In contrast, the Savanna Principle can simultaneously explain why (and which) theory succeeds empirically, and why (and which) one fails. The Savanna Principle is also consistent with the fact that it doesn't seem to take much 'discipline' for inexperienced participants to reach equilibrium prices. In Smith and William's (1983) experiment, for instance, inexperienced participants reach 94.8% efficiency only after two trading periods and 100% efficiency after five. It is highly doubtful that inexperienced participants in experimental markets can reach efficiency so quickly unless their brain is already equipped with the concepts of demand, supply, value and cost.

THE EXPERIMENTAL COROLLARY

Finally, I would like to propose an Experimental Corollary to the Savanna Principle, which predicts the extent to which the Savanna Principle holds in experimental (and other empirical) tests. Once again, put affirmatively and straightforwardly, the Experimental Corollary to the Savanna Principe stipulates that the Savanna Principle holds, and reasonable hypotheses about human behavior based on scope conditions and assumptions consistent with the EEA succeed, to the extent that the features of the experiment resemble the EEA. However, since my focus here is microeconomic theories, which are not consistent with the EEA most of the time, and since I have stated the Savanna Principle negatively above, it might help to restate the Experimental Corollary in a similarly negative fashion, assuming that the hypotheses in question are not consistent with the EEA.

> The Experimental Corollary: The Savanna Principle holds, and reasonable hypotheses about human behavior based on scope conditions and assumptions inconsistent with the EEA fail, to the extent that the features of the experiment resemble the EEA.

This is because any feature of the experiment that resembles the EEA will further reinforce (albeit completely unconsciously) the human brain's bias toward perceiving and responding to the environment as if it were still the EEA. When this innate bias is reinforced by the features of the experiment, then any hypothesis that is inconsistent with the EEA will fail even more than it would if the experiment did not reinforce this bias, and as a consequence the Savanna Principle (stated negatively) will hold even stronger.

While some features of modern business organizations, such as their large size, bureaucratic relations, and electronic means of communication, do not resemble the EEA, others, such as status hierarchies (Waldron, 1998) or the copresence of men and women (Browne, 2002) do. Thus the Experimental Corollary does not unequivocally tell us whether modern corporations provide good sites for testing microeconomic hypotheses. It all depends on *which features* of modern corporations become part of the context of empirical testing.

I will examine the effects of visibility and computerized cheap talk on cooperation in PDGs in order to illustrate the Experimental Corollary.

Visibility

Some laboratory experiments have demonstrated that players are more likely to cooperate with each other when they can see each other in PDGs, even though they cannot otherwise communicate (Wichman, 1970). Sally's (1995) meta-analysis shows that visibility has a strong positive effect on cooperation at least for repeated games. Once again, a factor that does not alter players' payoffs influence the rates of cooperation, and the positive effect of visibility is therefore a mystery. Since noncooperative game theory predicts mutual defection in PDGs, this means that the hypothesis fails even more, and the Savanna Principle holds even stronger, when the players can see each other.

As I have repeatedly pointed out in this paper, any and all interactions and exchange relations in the EEA were most likely direct and face-to-face. Our ancestors could always see each other when they interacted. Relative to the typical experimental procedure on PDGs where the two (or more) players are isolated from each other in their own booths or rooms during the experiment, the condition of visibility, where they can see each other, resemble the EEA more. The Experimental Corollary of the Savanna Principle can therefore potentially explain why the rates of cooperation are higher when the players can see each other.

Computerized Cheap Talk

As I discussed above, cheap talk (communication and exchange of nonenforceable promises and threats) before and during the PDGs significantly increases the rates of cooperation. And I have suggested a potential explanation for this phenomenon in terms of the Savanna Principle above. There are necessary qualifications to this observation, however. When the experimental subjects have cheap talk by exchanging messages through computer terminals, without facing each other directly, the increase in cooperation is not as great as if the communication was face-to-face (Isaac and Walker, 1988; Sell and Wilson, 1991) or is sometimes completely nonexistent (Palfrey and Rosenthal, 1988). In other words, one of the most robust (if unexplainable within noncooperative game theory) findings in the PDG literature does not occur (or occurs to a far lesser extent) when the communication and cheap talk happen via computers. Since noncooperative game theory predicts mutual defection throughout, this means that the Savanna Principle (stated negatively), predicting the failure of the hypotheses, holds less with computerized cheap talk.

One of the very few things that we can be absolutely sure about is that there was no computerized (or otherwise nondirect) means of communication in the EEA. Thus this feature of the laboratory experiment does *not* resemble the EEA. Such feature does not reinforce the innate bias of the human brain to perceive and respond to the environment as if it were still the EEA, and therefore weakens the Savanna Principle. While Ostrom (1998, pp. 9–14) provides an alternative explanation for the null or weakened effect of computerized cheap talk on cooperation, it is significant to note that her explanation also relies on insight from evolutionary psychology. The Experimental Corollary of the Savanna Principle can also explain why computerized double auction markets seem to function slightly worse than oral double auction market, producing slightly lower efficiency levels and much greater price variability (Williams, 1980).

EMPIRICAL IMPLICATIONS FOR HITHERTO UNOBSERVED PHENOMENA

Critics might argue, rightly, that I have so far used the Savanna Principle only to account for already known phenomena (although such a criticism—that my explanation is 'ad hoc'—precipiprecipitously loses force when I apply the same simple principle to explain multiple empirical anomalies in divergent domains, as I have done above). In anticipation of such criticisms, I will provide at least one empirical prediction for a (to my knowledge) hitherto unobserved phenomenon.

In the last section, I present the curious fact that, while cheap talk dramatically increases cooperation among players of PDGs (itself a vexing finding from the perspective of pure noncooperative game theory), it does not increase cooperation when players engage in cheap talk via computers. I then explain the entire observed empirical pattern (why cheap talk increases cooperation in face-to-face interactions but not through computers) in terms of the Savanna Principle.

I can use the fact that the human brain cannot recognize computers to our advantage, in order to 'restore' the higher rate of cooperation by cheap talk. Because there were no artificial images of any kind (such as pictures and videos) in the EEA, the only way our ancestors could see someone visually was through face-to-face interactions. Of course, this is no longer true today; we can see very realistic electronic images of others on TV and computer monitors, and this is probably why people who watch TV shows appear to confuse TV characters with their own friends (Kanazawa, 2002).

If our brain cannot tell the difference between real people and their realistic electronic images, then computerized cheap talk should still function to increase cooperation *if the players can see and hear each other in real time*. Today, with the use of web cams, microphones and camcorders, individuals can engage in computerized interactions while being able to see and hear each other realistically and without time delay. The Savanna Principle would lead me to predict that computerized cheap talk via web cams and microphones would increase cooperation as much as cheap talk exchanged in face-to-face interactions (as long as the images transmitted from the web cams are not 'choppy' as often happens with slow modem connections and videophones, or otherwise unrealistic). To the best of my knowledge, no one has ever conducted an experiment on PDGs where subjects could exchange cheap talk via web cams and microphones. I encourage my critics to prove me wrong by testing this specific empirical hypothesis.

RECOMMENDATIONS FOR BUSINESS AND MANAGEMENT

Finally, what practical implications does my Savanna Principle have for business and management science? While the Savanna Principle is a purely theoretical and abstract proposition, can it offer some suggestions for the efficient management of businesses and corporations?

While I have consistently stated and used the Savanna Principle above in terms of what the human brain *cannot* recognize or deal with (i.e. entities and situations that did not exist in the EEA), its obverse should also be true. The obverse of the Savanna Principle would lead me to predict that the human brain *can* very easily and readily recognize entities and situations that *did* exist in the EEA because, more than likely, such recognition is genetically hardwired.

What would be such entities whose recognitions would be hardwired in the human brain? What existed in the EEA that still exists today? If you look around, you would realize that the answer to these questions is: Virtually nothing. Among the very few exceptions, among the very few entities in our life today that existed in the EEA, are: Sexes (the distinction between males and females), ages (the distinction between young and old), and hierarchies. With respect to these three entities that still exist today, the Savanna Principle would suggest the following recommendations to managers and business owners, no matter how politically incorrect they may be.

1. *Do not treat men and women identically and interchangeably*. An incredibly ingenious recent experiment (Kurzban *et al.* 2001) convincingly demonstrates that, unlike race categories, sex and age categories are genetically hardwired in the human brain. This finding makes perfect sense from the perspective of the Savanna Principle because the sex and age distinctions have always existed in identical forms throughout the human evolutionary history, while what constitutes an ingroup (whose members are to be favored) and an outgroup (whose members are to be disfavored) depended on what constituted a deme (an endogamous group) in the local society (Whitmeyer, 1997). Thus, while ethnocentrism is probably hardwired, what constitutes an ethnic group is not.

It should therefore be very difficult, if not virtually impossible, for the human brain to treat men and women identically and interchangeably, as difficult as it is for us to believe that sugar is distasteful and rotten meat is delicious. The current law that requires that employers and employees treat men and women identically and interchangeably goes against the core of human nature, and, just like anything else that goes against human nature, it is likely to fail. Besides, it makes no sense to treat men and women identically and interchangeably because ample empirical evidence incontrovertibly demonstrates that men and women are inherently and biologically different, and that the sex differences in behavior and outcomes probably result from such biological differences in preferences and dispositions, not from employer discrimination (Browne, 2002).

2. *Do not treat the young and the old identically and interchangeably*. Because age categories, like the sex categories, are genetically hardwired and cannot therefore be 'erased' (Kurzban *et al.*, 2001), any law that requires that employers and employees treat the young and the old identically and interchangeably also goes against the core of human nature and is bound to fail. The obverse of the Savanna Principle would therefore recommend that employers not ignore the age differences and that they not require their employees to do so either.

Once again, the identical and interchangeable treatment of the young and the old would make no scientific (and thus economic and management) sense since age, like sex, is an important determinant of preferences, predispositions and behavior. Just as 'sex discrimination' is not necessary to explain sex differences in behavior and outcomes, 'age discrimination' is not necessary to explain age differences in behavior and outcomes. Evidence shows that young, unmarried men are responsible for an overwhelming majority of productivity in such widely divergent fields as music, art, literature and science (Kanazawa, 2000; Miller, 1999). Young, unmarried men are intensely competitive and driven to attain a higher status whenever and wherever they find a status hierarchy, no matter now trivial, meaningless or even illegal (Wilson and Daly, 1985). It appears that employers and managers ought to take advantage of such extra energy in the pursuit of corporate goals.

The extreme competitiveness of young men, which leads to their enormous productivity, is a double-edged sword, however.[4] Their competitiveness manifests itself in their risk-taking behavior (Wilson and Daly, 1985), which is often essential for success in new economic ventures but can be fatal for more routine management decisions with much at stake. For the same evolutionary developmental reasons that make young men competitive and risk-taking, older men are more conservative and risk-averse, because older men who became our ancestors and from whom we inherit our psychological mechanisms, had achieved high statuses by their late adulthood, which they could potentially lose if they continued to be competitive and take risks (Kanazawa and Still, 2000; Kanazawa, 2001, pp. 1151–1153). Thus, while young men are better suited for leading new ventures into uncertain territories, older men and women, who are even more risk-averse than older men (Campbell, 2002), are probably better for routine decision-making.

CONCLUSION

Despite their mathematical elegance and deductive rigor, microeconomic theories (such as decision theory and game theory) often fail to predict actual human behavior both in laboratory experiments and natural settings. Evolutionary psychology provides a potential answer to this mystery. EP contends that the human brain is biased and content-rich, rather than *tabula rasa*, and that it is biased to perceive and respond to the environment as if it were still the EEA, in which it evolved and to which it is adapted. The Savanna Principle takes this observation into account and explains why some otherwise reasonable hypotheses about human behavior succeed empirically and why others fail, in terms of the extent to which their scope conditions and assumptions are consistent with the EEA. The Experimental Corollary to the Savanna Principle predicts the extent to which the features of the experimental tests influence the operation of the Savanna Principle. I have explained how the Savanna Principle and its Experimental Corollary can together explain the relative empirical failure of noncooperative game theory and public choice theory (which depend on scope conditions and assumptions which did not hold true in the EEA) and the relative empirical success of network exchange theory in sociology and competitive price theory (which do not depend on such scope conditions and assumptions). I reiterate the point, however, that, while I concentrate on microeconomic theories in this paper, the Savanna Principle and its Experimental Corollary are general in that they can predict the extent to which any reasonable hypothesis about human behavior from any theoretical perspective accurately predicts human behavior, as long as all of the scope conditions and assumptions necessary for its derivation are clearly stated.

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NOTES

1. I thank Denise L. Anthony for pointing this out to me.
2. While anonymity is not essential for auction markets, reputation is. Sotheby's is not likely to invite just anyone off the street into its auction gallery and accept her personal check, and participants in eBay are not likely to transact with someone with a reputation for cheating. That is why eBay provides members' reputation scores on its site, while preserving their anonymity through computerized transaction via anonymous handles. The genius behind eBay's success is eliminating what is not necessary for efficient auction (face-to-face transactions) while preserving what is (reputation).
3. I thank Toshio Yamagishi for pointing out this alternative explanation to me.
4. I thank the Editor for pointing this out to me.

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