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# The Evolved Psychological Apparatus of Human Decision-Making Is One Source of Environmental Problems

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## Resource Exploitation by *Homo Sapiens*

It has become increasingly difficult to ignore or deny the fact that the Earth's biota are in crisis. The abundance and diversity of flora and fauna have been and are being diminished at an accelerating pace, both as a direct result of human exploitation and as an indirect result of habitat loss and environmental degradation (Wilson, 1992). Despite the efforts of parties with economic interests antagonistic to conservation, it is no longer possible for informed citizens to doubt the reality of these trends, nor is there reason to doubt that the diversity and abundance of species will continue to decline for some time as a result of human numbers and activities. What is controversial is what to do about it (Clark, 1991).

The accumulation and dissemination of information about the crisis and its roots in human action are clearly not all that is required to bring about an effective remedial response. Yet, according to Ridley and Low (1994), many conservationists have assumed, at least implicitly, that if people were fully informed of the problems and their causes, they would change their priorities and activities in order to conserve resources for the future, and by relying on that assumption conservationists have implicitly embraced an unrealistic model of human beings as rational collectivists. Education is not sufficient, Ridley and Low argue, because natural selection has not designed human psychology to give priority to either the common good or the distant future, but to relatively short-term gains and positional advantages in a zero-sum intraspecific competition. According to this argument, the forces that have shaped human nature over evolutionary time have been forces that favor rapid, thorough exploitation of our resource base rather than stewardship. The human animal is not exceptional in this regard: because selection is predominantly a matter of within-species differentials in reproductive success, the phenotypes that proliferate are precisely those that enable organisms to exploit resources sooner and more effectively than their competitors, especially conspecifics, and to externalize or pass on to future others the costs of that resource exploitation.

The popular notion that aboriginal people who are uncorrupted by "western" values are reverent conservationists appears to be a romantic myth. The evidence from present-day

hunting and foraging societies (Hames, 1987, 1991; Alvard and Kaplan, 1991; Alvard, 1993, 1994, Chapter 17, this volume), from ethnographic accounts of nonstate societies (Low, 1996), and from studies of human history and prehistory (Diamond, 1992; Kay, 1994) lends scant support to the idea that nonindustrialized foragers abide by a conservation ethic, nor to the proposition that greedy modern westerners are exceptional in their reluctance to subordinate their present wants to the future or to the common good. Moreover, although the conflict between human wants, on the one hand, and conservation goals, on the other, is often discussed in terms of human survivorship and comfort, human resource exploitation goes beyond these "essentials": nonindustrialized peoples, like westerners, deplete resources in ostentatious displays of resource-accruing potential and success in social competition (for industrialized societies, see Kaplan and Hill, 1985; Hawkes, 1993; and for western societies, see Frank, 1985; Ng and Wang, 1993; Howarth, 1996).

In our view, the Ridley and Low argument is overstated in the extent to which they suggest that current understanding of the natural selective process implies a "selfish" as opposed to a more collectivist evolved social psychology (Daly and Wilson, 1994). *Homo sapiens* is, after all, a social species with many psychological adaptations for social actions (e.g., Daly and Wilson, 1988; Cosmides, 1989; Simpson and Kenrick, 1997). Nevertheless, Ridley and Low's general point seems to be well taken: both theory and the available data on human behavior support the thesis that *Homo sapiens* is not by nature a conservationist, and hence that recognizing environmental problems, deploring them, and gaining a sophisticated understanding of their sources in our actions, may still not be enough to motivate the behavioral changes required to rectify them.

In this chapter, we argue for a more evolutionarily and psychologically informed model of *Homo economicus,* since economics is possibly the most relevant discipline to guide the development of incentive structures which will alleviate the current conservation crisis. This more realistic economic model will necessarily have to consider variations in human preferences and decision-making in relation to variables such as sex, age, and parental status that behavioral ecologists and other evolutionists consider fundamental. To illustrate our argument, we focus primarily on sex differences and age. The possibility that men and women "value" environmental goods somewhat differently is a topic that has hitherto received surprisingly little attention (Low and Heinen, 1993), despite an obvious selectionist rationale for predicting evolved sex differences in such domains as the subjective acceptability of various sorts of risks in the pursuit of status and resources. We also briefly discuss how a selectionist perspective on life history suggests that preferences and decision-making are also likely to have evolved to vary systematically with age.

## Toward an Evolutionarily Informed Model of *Homo Economics*

The social science with an obvious role to play in remediating the current global crisis is economics. It is economic forces that drive technological innovations with their associated risks of contamination, despoliation, and expropriation. The developing field of ecological economics (e.g., Costanza, 1991) has much to say about common pool resource use and conservation incentives, consumer practices, monetary valuation of environmental goods, and the processes and consequences of externalizing costs, including pricing costs of foregone future resource use.

Economic ways of thinking make sense to evolutionary ecologists, who for decades have

borrowed concepts like cost–benefit analysis, marginal values, investment, and profitability. Recently, the flow of ideas between these disciplines has become bidirectional. Several economists are now considering how past selection pressures have designed psychological processes underlying preferences, cooperation, and other aspects of economic transactions (e.g., Becker, 1976; Rubin and Paul, 1979; Frank, 1985, 1988; Bergstrom and Bagnoli, 1993; Samuelson, 1993; Simon, 1993; Bergstrom, 1995; Binmore et al., 1995; Mulligan, 1997; Sethi and Somanathan, 1996; Ben-Ner and Putterman, 1998; Romer, 1995), and some have begun to attend to variations in preferences and utility functions in relation to variables that evolutionists would consider central, such as sex, age, and parental and other kinship statuses (e.g., Rubin and Paul, 1979; Becker, 1981; Bergstrom, 1995; Eckel and Grossman, 1996; Mulligan, 1997). However, the dominant model of *Homo economicus* continues to be a folk psychological one in which preferences are translated into action by "rational" processes of deliberative decision-making that do not necessarily correspond to the psychological machinery that has actually evolved (Daly and Wilson, 1997).

Traditional economic analysis has assumed not only that actors are rational utility maximizers, but also that there is a unitary currency of utility in which all "goods" can be valued. (See Sunstein, 1994, for a critique of the assumption of a unitary currency of utility.) These assumptions make the application of economic decision theory to the behavior of nonhuman animals seem metaphorical. But the application of cost–benefit models to *Homo sapiens* is really no less metaphorical. All complex animals confront the problem of how to value seemingly incommensurate goods in a common "currency." How many prospective calories will cover the predation risk cost of foraging activity *X*? Is mating opportunity *Y* sufficiently valuable to warrant accepting prospective injury risk *Z* by competing for it? From this comparative perspective, the real innovation in the invention of money was not that it reduces disparate utilities to one, but that it facilitates otherwise difficult reciprocal exchange. Money permits the elaboration of economic transactions by eliminating the necessity that one party trust the other to reciprocate in future, as well as by enabling exchanges in which the "buyer" does not otherwise have a commodity presently desired by the "seller." Unfortunately, this fungibility of assets in modern economic systems increases the appeal of destructive resource exploitation because exploiters can take their profits and invest elsewhere.

Some readers may protest that the costs, benefits, and trade-offs that we invoke in explaining risky decision-making by animals are only statistical characterizations of the natural selective past, whereas for human actors prospective costs and benefits are actually calculated and considered and hence are proximate determinants of behavioral choices. Perhaps so, but the model of decision makers as conscious and rational deliberators is, in fact, just as problematic when applied to people as when applied to kangaroo rats or starlings. Experimental psychologists have shown that people do not have the sort of privileged insight into the determinants of their own decisions that rational actor models presume and that the sense of having engaged in conscious deliberation and reasoned choice is largely illusory and after the fact (e.g., Nisbett and Wilson, 1977; Nisbett and Ross, 1980; Kahneman et al., 1982; Marcus, 1986). Although there are controversies about how best to characterize the psychological processes that produce human choice behavior, the evidence is unequivocally contrary to the assumption that people engage in the sort of simple rational calculus of utility maximization customarily attributed to *Homo economicus* (e.g., Kahneman and Tversky, 1979, 1984; Nisbett and Ross, 1980; Loewenstein and Thaler, 1989; Shafir, 1993; Gigerenzer and Hoffrage, 1995; Cosmides and Tooby, 1996; Hoffman et al., 1996).

Consider, for example, the classic demonstration by Kahneman and Tversky (1979) that people weigh alternatives very differently when exactly the same end states are framed as gains versus losses. Most people prefer a sure $1500 gain over letting a coin toss determine whether they would get $1000 or $2000, and this "risk aversion" is not hard to rationalize: it apparently reflects the diminishing marginal utility of money, presumably because each successive dollar's incremental effect on our expected well-being really is smaller than the last. (The difference between being penniless or a millionaire is much greater than the additional impact of a second million.) However, if people are presented with exactly the same alternative outcomes framed as an initial award of $2000 followed by a choice between relinquishing $500 or taking a 50% chance on being obliged to relinquish $1000, most switch to "risk acceptance" (preferring the gamble). This is very much harder to rationalize in terms of the curvilinear utility of money. Losing any ground whatever from a state already attained apparently has a strong negative emotional valence.

How are the mental processes that produce such apparent inconsistencies of preference to be understood? Adaptationist thinking suggests several testable hypotheses. One is that voluntarily relinquishing prior gains has evolved to be aversive in the specific context of social bargaining because in ancestral environments, to relinquish prior gains was to advertise weakness, inviting future demands for additional concessions. Another hypothesis is that people may be averse to alternatives that take more time or require more steps, ultimately because delay and complexity have entailed risk of defection or duplicity. Even those decision theorists who have been critical of the assumption that people are rational utilitarians with full conscious knowledge of their own preferences (e.g., Kahneman and Tversky, 1984; Loewenstein and Thaler, 1989; Shafir, 1993; Knetsch, 1995) and who have thus attempted to model the psychological processes that produce these "irrational" effects have yet to consider such possibilities. In addition to its value as a cautionary tale against simple rational-actor models, Kahneman and Tversky's gain–loss framing effect is potentially interesting with respect to decisions about how to pitch conservation efforts to the public: the emotional appeal of a campaign to avoid the loss of what we already possess may be more powerful than the appeal of promised gains through remediation.

Another area in which economic analysis might benefit from considering how the evolved human psyche works is in efforts to attach prices to nonmarket resources. Certain "goods," such as air, have not ordinarily been monopolizable, exchangeable, or partible, and have not traditionally been treated as property, nor even thought of as resources. Other "goods," such as the tranquility or beauty of a setting, are clearly threatened by various sorts of economic exploitation and must somehow be valued in decisions about whether the gains from that exploitation are sufficient to offset the losses in these nonmarket resources. Armed with a unitary currency (money) and the conception of human decision-makers as capable of articulating veridical, rational preferences, economists interested in placing values on nonmarket goods have invented the "contingent valuation method" (CVM; e.g., Carson and Mitchell, 1993; Goodwin et al., 1993; Willis and Garrod, 1993; Cummings and Harrison, 1994; Smith, 1994; Heyde, 1995).

In a CVM study, a sample of people are asked how much they would be willing to pay to retain or attain some benefit. Ideally, respondents in a CVM study are given sufficient relevant information to permit a meaningful answer to some question such as how much would you be willing to pay in order to engage in a recreational activity $X$ at place $Y$ under conditions $Z$ on a total of $N$ days in the next year, or what is the maximum additional amount that you would pay before deciding that $X$ is too expensive (e.g., Cummings et al., 1986; Carson and Mitchell, 1993). Critics of this method have been alarmed by the growing use

of CVM studies in policy making and in legal decisions concerning compensation and have decried the presumption that it is appropriate or even possible to place dollar values on such goods as human health, aesthetic worth, or species survival (e.g., Sunstein, 1994; Heyde, 1995). Moreover, when CVM survey data are used to determine the damages to be paid by environmental despoilers, as they have been and are being used, then the incentive structures for decision makers planning environmentally hazardous endeavors may become such that damaging even the recreational resources of the wealthy will be more costly (and hence more to be avoided) than damaging resources that are crucial to the lives and health of much larger numbers of people of lesser means (see also Boyce, 1994).

But the problems with the CVM are not limited to the questionable justness of its policy applications. There are good reasons to doubt that people are capable of giving meaningful, valid answers to CVM questions (e.g., Fischoff, 1991; Kahneman and Knetsch, 1992; Kahneman et al., 1993; Cummings and Harrison, 1994; Guagnano et al., 1994; Binger et al., 1995; Gregory et al., 1995; Loewenstein and Adler, 1995). Answers to CVM questions regularly violate the expectation that increments in the quantity of a good will increase its subjective value, for example, as may be illustrated by Kahneman's (1986) demonstration that different groups of people attached almost the same average dollar value in extra taxes to preserving the fish stocks of lakes in a small area of the province of Ontario as they were willing to pay for all the lakes in Ontario. Professed willingness to pay is also apt to be greatly exaggerated until respondents are reminded of the many possible demands on their limited means. For example, Hamilton, Ontario, residents who were asked how much they would be willing to pay to improve boating conditions in the local harbor gave a mean answer that was 30-fold higher if this was the first such CVM question in the interview than if it was the second (Dupont, 1996).

Being asked to put a price on certain environmental goods may be so out of the normal context in which a preference would be elicited that it is impossible to give a meaningful response. Indeed, it is questionable whether the sorts of preferences that the CVM obliges interviewees to articulate even exist prior to the questioning or are instead constructed in ways affected not only by the stable attributes of the respondent (as the CVM assumes), but also by the circumstances of the interview and the contextual framing of the task (Fischoff, 1991; Boyce et al., 1992; Kahneman and Knetsch, 1992; Irwin et al., 1993; Baron and Greene, 1996). Ajzen et al. (1996), for example, showed that respondents who had been "primed" by the inclusion of do-gooder bromides (e.g., "It's better to give than to receive") in an ostensibly unrelated word-unscrambling task committed almost twice as much to a public good from which they would derive no personal benefit as did respondents who had unscrambled only neutral control sentences.

It is also questionable whether even cooperative respondents are able to predict what they would really do or pay if the situation ceased to be hypothetical (Bohm, 1994; Loewenstein and Adler, 1995), and it is even more questionable whether they have conscious access to the determinants of their choices. Nevertheless, CVM researchers ask people to articulate just these things and accept the answers at face value. When Kahneman and Knetsch (1992) proposed, for example, that professions of willingness to pay for environmental protection or remediation might represent "the purchase of moral satisfaction" rather than the specific environmental benefit's value to the respondent, several CVM researchers announced that they had disconfirmed this hypothesis by showing that respondents who were instructed to choose "the reason" for their choice of dollar values from a menu mainly picked something else (e.g., Loomis et al., 1993; MacDonald and McKenney, 1996).

If we are going to price nonmarket goods in making tough decisions among alternatives

that all have negative aspects, as it seems we must, then we need to move beyond these simplistic conceptions of decision makers as rational and decision criteria as consciously accessible. Recent efforts (e.g., Gigerenzer et al., 1988, 1991; Cosmides, 1989; Gigerenzer and Hoffrage, 1995; Cosmides and Tooby, 1996; Wang, 1996) have begun to incorporate evolutionary psychological models into explanations for the seemingly irrational aspects of the ways in which people process information and order their priorities. Success in this endeavor partly depends on correctly hypothesizing the nature of the adaptive problems that emotional reactions and other psychological processes were designed to solve in order to clarify the functional organization of complex psychological phenomena involved in decision-making under uncertainty, risk-taking, discounting the future, collective action, cooperating in use of common pool resources, and many other aspects of decision-making relevant to conservation of resources, species, and habitats.

## Risk as Variance of Expected Payoffs

An adaptationist perspective on human psychology and action could contribute to understanding of several aspects of the contemporary ecological crisis. The need to elucidate the psychological adaptations of most direct and remediable relevance to the continuing population explosion is one obvious example. Another area in which evolutionary theorizing has already contributed is in identifying the circumstances under which the restraint of selfish consumption in cooperative ventures is realizable and those under which opportunities for "cheating" make cooperation unstable (Axelrod, 1984; Cosmides and Tooby, 1989; Boone, 1992; Hawkes, 1992). But in addition to the much-discussed problems entailed by the natural selective advantages enjoyed by the most prolific and selfish phenotypes, the ways in which selection has shaped such subtle specifics as time preferences, social comparison processes, and sex differences may also have important implications for conservation and environmental remediation efforts. If we are to mitigate the ills caused by human reluctance to reduce resource accumulation and consumption, for example, it seems important to elucidate the precise ways in which human decision-making discounts the future and how this discounting responds to uncertainty, both in ontogeny and in facultative responsiveness to variable aspects of one's immediate situation. The perceived costs of giving up present consumption depend on one's material circumstances, but little is known about subjective valuations and perceptions of uncertainties as a function of material and social circumstances.

Experimental studies of nonhuman animal foraging decisions have established the ecological validity of a risk-preference model based on variance of expected payoffs. Rather than simply maximizing the expected (mean) return in some desired commodity such as food, animals should be, and demonstrably are, sensitive to variance as well (Real and Caraco, 1986). Whereas seed-eating birds generally prefer to forage in low variance microhabitats as compared to ones with a similar expected yield but greater variability, for example, they switch to preferring the high variance option when their body weight or blood sugar is so low as to predict that they will starve unless they can find food at a higher than average rate (Caraco et al., 1980). Although the high variance option increases the bird's chances of getting exceptionally little, a merely average yield is really no better, and the starving birds accept the risk of finding even less in exchange for at least some chance of finding enough to survive. Such experiments have produced essentially similar results in several species of seed-eating birds (Caraco and Lima, 1985; Barkan, 1990), as well as in rats (Kagel et al., 1986; Hastjarjo et al., 1990).

It may be possible to understand risk acceptance by human explorers, adventurers, and warriors in analogous terms. Even taking dangerous risks to unlawfully acquire the resources of others might be perceived as a more attractive option when safer, lawful means of acquiring material wealth yield a pittance, although the expected mean return from a life of robbery may be no higher and the expected life span shorter. Interestingly, variations in robbery and homicide rates between places are better explained by variance in income than by absolute values of poverty (e.g., Hsieh and Pugh, 1993).

There is also experimental evidence that human decision-making is sensitive to variance as well as to expected returns. Psychologists and economists, using various hypothetical lottery or decision-making dilemmas, have documented that people's choices among bets of similar expected value are affected by the distribution of rewards and probabilities (e.g., Lopes, 1987, 1993). They are also influenced by whether numerically equivalent outcomes are portrayed as gains or losses as discussed above (Kahneman and Tversky, 1979). The underlying psychological dimension governing these choices among alternative, uncertain outcomes has been conceptualized as one ranging from "risk-averse" to "risk-seeking" (or "risk-prone" or "risk-accepting"). In the experimental nonhuman studies described above, the starving below-weight animal preferring the high variance option would be deemed risk-seeking. Diversity in risk aversion or risk seeking could be mediated psychologically by either variation in the subjective utilities of the outcomes or variation in perceptions of the probabilities associated with each outcome or both (Real, 1987).

### Sex Differences in Risk Acceptance and Resource Use?

Consideration of the ways in which sexual selection differentially affects the sexes suggests that women and men confronted by uncertainty might have different subjective utilities or subjective probabilities and that these psychological determinants of risk acceptance or aversion might also vary in relation to life-history variables and cues indicative of expected success in intrasexual competition. Psychologists studying risk acceptance have documented sex differences and age effects but have focused mainly on stable individual differences (e.g., Trimpop, 1994; Zuckerman, 1994) and have scarcely addressed how risk preferences may be affected by social and material cues of one's life prospects and by one's relative social and material success.

The rationale for anticipating sex differences in the way people value and exploit the environment, as well as differences in willingness to risk damaging one's health, is an argument that has been applied to other aspects of risk taking and to sexually differentiated adaptations for intrasexual competition (e.g., Wilson and Daly, 1985, 1993). Its premise is that ancestral males were subject to more intense sexual selection (the component of selection due to differential access to mates) than were ancestral females, with resultant effects on various sexually differentiated attributes.

Successful reproduction, in *Homo* as in most mammals, has always required a long-term commitment on the part of a female, but not necessarily on the part of a male. Female fitness has been limited mainly by access to material resources and by the time and energy demands of each offspring, whereas the fitness of males, the sex with lesser parental investment, is much more affected by the number of mates (Trivers, 1972; Clutton-Brock, 1991). It follows that the expected fitness payoffs of increments in "mating effort" (by which term we encompass both courtship and intrasexual competition over potential mates) diminish much more rapidly for females than for males, and it is presumably for this reason that such effort constitutes a larger proportion of total reproductive effort for men than for

women. One hypothesis inspired by these considerations is that men may find rapid resource accrual, resource display, and immediate resource use somewhat more appealing than women and that men may be more inclined to disparage risks and discount the future in their decisions about acquiring and expending resources (Low and Heinen, 1993).

Following Bateman (1948), Williams (1966), and Trivers (1972), sex differences in the variance in reproductive success are widely considered indicative of sex differences in intrasexual competition. Relatively high variance generally entails both a bigger prize for winning and a greater likelihood of failure, both of which may exacerbate competitive effort and risk acceptance. Bigger prizes warrant bigger bets, and a high probability of total reproductive failure means an absence of selection against even life-threatening escalations of competitive effort on the part of those who perceive their present and probable future standing to be relatively low. Although it is worth cautioning that fitness variance represents only the potential for selection and that variations in fitness could in principle be nonselective (Sutherland, 1985), intrasexual fitness variance appears to be a good proxy of the intensity of sexual selection because it is a good predictor of the elaboration of otherwise costly sexually selected adaptations. In comparative studies, sex differences in such attributes as weaponry for intraspecific combat are apparently highly correlated with the degree of effective polygamy of the breeding system—that is, with sex differences in fitness variance (e.g., Clutton-Brock et al., 1980). It is also worth cautioning that there can be other evolutionary explanations for sex differences in risk acceptance besides the Bateman–Williams–Trivers theory of sexual selection (see, for example, Regelmann and Curio, 1986), but this theory currently appears to be the one of greatest relevance to mammals in general and humans in particular.

All evidence suggests that the human animal is and long has been an effectively polygynous species, albeit to a lesser degree than many other mammalian species. Successful men can sire more children than any one woman could bear, consigning other men to childlessness, and this conversion of success into reproductive advantage is ubiquitous across cultures (Betzig, 1985). Of course, great disparities in status and power are likely to be evolutionary novelties, no older than agriculture, but even among relatively egalitarian foraging peoples, who make their living much as most of our human ancestors did, male fitness variance consistently exceeds female fitness variance (Howell, 1979; Hewlett, 1988; Hill and Hurtado, 1995). Moreover, in addition to the evidence of sex differences in the variance of marital and reproductive success in contemporary and historically recent societies, human morphology and physiology manifest a suite of sex differences consistent with the proposition that our history of sexual selection has been mildly polygynous: size dimorphism with males the larger sex, sexual bimaturism with males later maturing, and sex differential senescence with males senescing faster (Harcourt et al., 1981; Møller, 1988).

If the fitness of our male ancestors was more strongly status dependent than that of our female ancestors, as seems likely, then from the perspective of sexual selection theory, men may be expected to be more sensitive than women to cues of their status relative to their rivals. If intrasexual competition among men has largely depended on acquisition of resources (both material and social), which were converted into reproductive opportunities, and if there has been a history of high variance in the distribution of resources and reproductive opportunities, then the masculine psyche is likely to have evolved to accept greater risk in its efforts to acquire, display, and consume resources, especially when accepting a small payoff has little or no more value than no payoff, as, for example, when a small payoff leaves a poor man still unmarriageable. This argument treats risk as variance in the magnitude of payoffs for a given course of action. In life-threatening circumstances people of-

ten take the riskier (higher variance) course of action. But people also take great risks when present circumstances are perceived as "dead ends." For example, history reveals that successful explorers, warriors, and adventurers have often been men who had few alternative prospects for attaining material and social success. Later-born sons of aristocratic families were the explorers and conquerors of Portuguese colonial expansion, for example, while inheritance of the estate and noble status went to first-born stay-at-home sons (Boone, 1988). Similarly, later-born sons and other men with poor prospects have been the ones who risked emigration among more humble folk, too (e.g., Clarke, 1993), a choice which sometimes paid off handsomely, as in European colonial expansion, but must surely have more often led to an early death.

### Sex Difference in Disdain for Health Risks?

One of the many domains within which men manifest greater risk acceptance than women is in health monitoring and preventive health care. Apparently, the average number of physician contacts per year is greater for males than females before puberty, but between 15 and 45 years of age, women visit physicians almost twice as often as men (Woodwell, 1997), even after one has accounted for birth-related visits and sex differences in rates of accident and illness. We hypothesize that men will also disregard the health hazards of various environmental contaminants more than women. And if men are relatively insensitive to the risks that they themselves incur, it seems likely that they will also be relatively insensitive to the risks that their activities entail for other people and for other fauna and flora.

One way to test these ideas is to ask people how they would behave in hypothetical dilemmas. As an example of this approach, we asked 173 introductory psychology students (90 women and 83 men) at McMaster University in Hamilton, Ontario, to consider the following hypothetical situation and then answer questions as if the situation applied to them.

> Imagine that you presently live in a mid-sized southern Ontario city of 300,000 people, where you were born and where most of your family and friends still reside. You have been looking for work and you suddenly find yourself with two job offers to choose between.
>
> If you accept Baylor & Wilson's offer of employment at $30,000 per annum, you can continue to live and work in your home town. If you accept Smithers and Company's offer of $35,000 [$50,000] instead, you will be relocated to a city of 600,000 people in another province. From what you've heard, this city sounds like an interesting and beautiful place to live, but air pollution levels and respiratory disease rates are twice [ten times] what they are in the city where you now live.
>
> Which offer do you accept?
>
> Baylor & Wilson _____ Smithers & Company _____

The alternatives in square brackets were presented to distinct sets of subjects, making a 2x2x2 between-groups experimental design: male versus female subjects x the magnitude of the incentive to move ($5000 versus $20,000 higher salary) x the magnitude of the deterrent costs in air quality and attendant health hazard (2-fold versus 10-fold).

Although all subjects were university students, at the same life stage and almost unanimously unmarried and childless, women and men responded somewhat differently to the experimental variables (Fig. 18-1). As we predicted on the basis of the arguments above, men were attracted by an extra financial incentive more than were women, although not significantly so. More striking, and statistically significant, was the differential response to en-

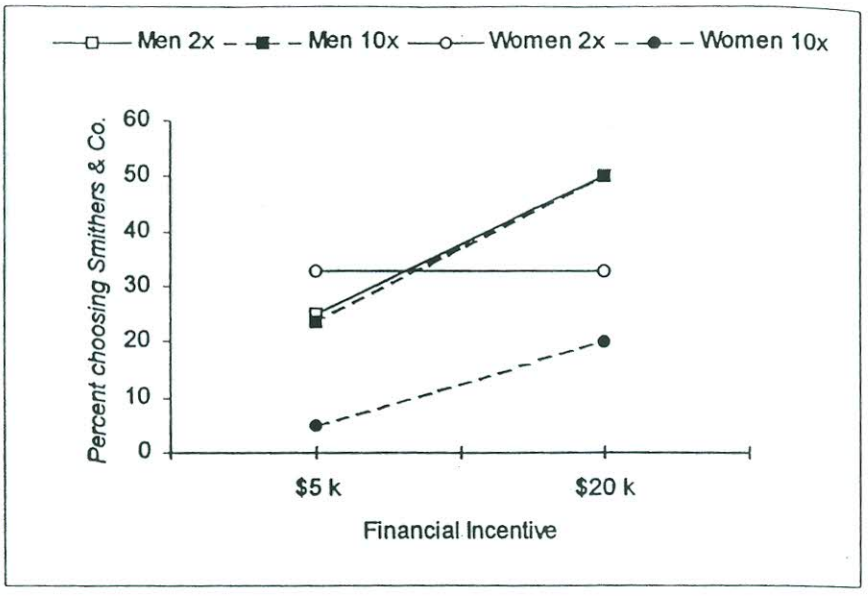


Figure 18-1 Percentage of men and women choosing the job at Smithers & Company, which would entail moving far away, either a $5,000 or $20,000 incentive above the hometown job, and either a 2 times or 10 times greater risk of respiratory problems than that of the hometown. Women were significantly more deterred by the health risk than males ($p$ = .03 by logit loglinear analysis). The tendency for men to be more attracted by a financial incentive was not significant ($p$ = .14).

vironmental risk: women were substantially deterred by higher costs in air quality and health hazards, but men were completely unaffected by this variable, choosing identically regardless of whether the stated costs were 2-fold or 10-fold. Other evidence also indicates that women may be more concerned about environmental health hazards than men (e.g., Flynn et al., 1994; Sachs, 1996, 1997). In a previous study involving a similar dilemma (but no variation of financial incentives and health risks), Wilson et al. (1996) found that men were significantly more likely than women to say they would accept a promotion "which would significantly boost your career" but would require moving to a city where the respiratory health risk was 10% higher than that of the hometown. In this earlier version, there were many parents among the subjects, and 41% of those who were parents said they would accept the promotion, compared to 81% of those without children, a difference that remained significant when the age of respondents was controlled.

Earlier in this chapter, we criticized "contingent valuation" studies for asking people how much they would be willing to pay for a particular benefit and taking their answers at face value, and we must acknowledge that the results we report here may have similar validity problems. Unlike CVM studies of nonmarket goods, however, we have asked people to consider a situation that is likely to be a common experience of most people: deciding to take one job rather than another, with benefits and costs associated with both. In principle, data from people's actual decisions between different employment opportunities can be compared with our results (as sometimes can be done and sometimes has been done in val-

idating CVM results with "revealed preference" analyses of what people have actually paid for different goods or benefits; Smith, 1994; Carson et al., 1996). We attach no significance to the specific percentages of men and women choosing the Smith & Co. employment opportunity, but only to the sex difference in the impacts of an imagined financial incentive and an imagined health hazard. The apparently greater willingness of men than of women to treat health hazards as acceptable costs of opportunities for financial benefit should be further tested with real-world data on choices among different job opportunities.

### Sex Difference in Disregard of Environmental Degradation?

In addition to the expectation that men are more likely than women to disdain personal health risks in their pursuit of economic and status advantages, we hypothesize that men are more likely than women to disregard or downplay environmental degradation. Support for this proposition already exists (e.g., Mohai, 1992; Sachs, 1997), but the possibility that it is a reflection of the male's psyche's greater prioritizing of present profits as a result of differential histories of sexual selection has not been articulated or explored.

The rate at which one "discounts the future" is the rate at which the subjective value of future consumption diminishes relative to the alternative of present consumption (or, the "interest rate" required to motivate foregoing consumption). If *A* discounts the future more steeply than *B*, then *A* will value a given present reward relative to expected future rewards more highly than *B* and will be less tolerant of what psychologists call "delay of gratification." Hence, variable willingness to engage in nonsustainable modes of resource exploitation such as clearcutting or otherwise expending one's capital may be construed, at least in part, as variation in the rates at which decision makers discount the future.

Do men discount the future more steeply than women in the specific realm of conservation decisions? Wilson et al. (1996, p. 154) asked another set of 104 McMaster University people (36 men and 68 women ranging in age from 17 to 24) to consider the following dilemma:

> Imagine you are farming a tract of land. Your father, like his father before him, lived off the profits from the farm without taking additional wage work elsewhere. You were fortunate to earn a scholarship to university to study agriculture, and now that you have inherited the farm you are considering changing the techniques of farming to be more specific and business-like. Prior to inheriting the farm you had a successful career as a broker specializing in agricultural commodities. [After your wife died suddenly, you've decided to leave that job to return to the farm. Your two children are delighted about the prospect of living on the farm.] Presently, you are pondering whether to follow one course of action (Plan A) or another (Plan B).
> Plan A: Convert the farm entirely to hybrid corn production for livestock feed. Corn is extremely profitable to grow, but it requires heavy chemical fertilization which over time will percolate into the water table with a very high probability that the land will not be usable in 60 years without heavy chemical supplements.
> Plan B: Convert the farm entirely to hay for livestock feed. Hay in good years can bring a good market price, but generally hay yields a modest profit. On the other hand, hay production does not diminish the quality of the soil and chemical supplements are not needed.
> Which plan did you choose? A or B? _____

Men were significantly more likely to choose the soil-degrading option (39% of men and 16% of women, fig. 18-2). In order to determine whether these "decision makers" were uti-

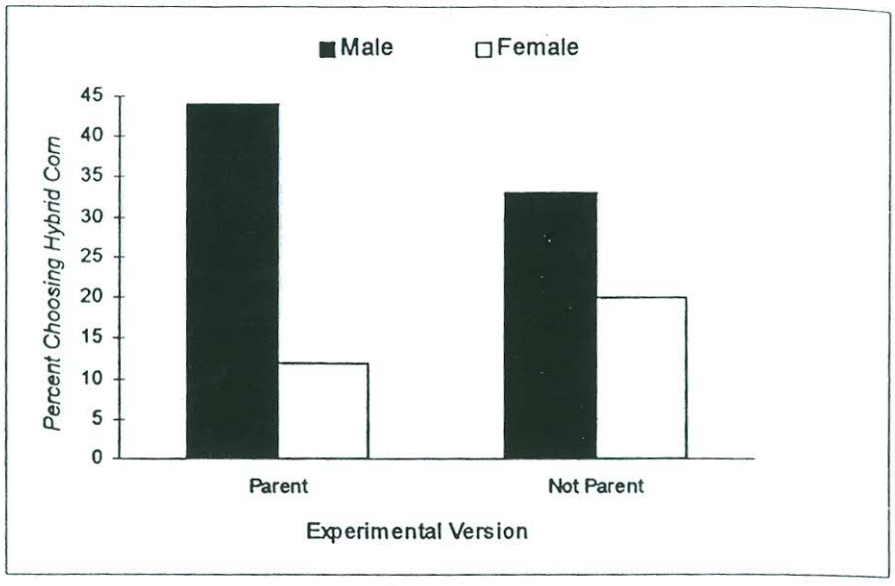


Figure 18-2 Percentage of men and women choosing the soil-degrading option (plan A: hybrid corn) according to the experimental version of the hypothetical dilemma they considered (being a widowed parent of two children, versus parental status unmentioned). Men were significantly more likely to choose the soil-degrading option ($\chi^2 = 6.6, p < .01$), but neither parental status ($p = .91$) nor the interaction of sex of the subject by parental status ($p = .27$) was significant by logit loglinear analysis.

lizing sound economic logic, we asked them to rate their agreement (on seven-point Likert scales) with propositions that might reflect the reasoning behind their choices. As expected, the proposition that "because you can always invest the profits from farming in other economic ventures including other farmland, you should weight profit over damage to the land" was endorsed significantly more strongly ($p < .0001$) by those who chose corn than by those who chose hay, but there was no significant effect of sex of subject.

In this scenario, one factor that might be expected to influence decisions that may have long-term negative effects on the quality of your farm is whether your children are likely to continue farming. This was the rationale for adding the two bracketed sentences ["After your wife died . . ."] for half the subjects. We had anticipated that parental status would increase the likelihood that subjects of both sexes would be deterred from planting corn due to the possible long-term costs, but inclusion of this sentence did not result in any detectable difference in the choice of crops (fig. 18-2). Perhaps imagining that one has children cannot evoke the mindset of actual parenthood. (In this sample, only four people were married and only two had children.) Another possibility is that some subjects interpreted the existence of children as a source of increased demand for imminent cash flow. (And it may be relevant that the experiment was conducted in a region where it has become the norm that farmland is retained only until suburban real estate developers are prepared to pay the farmer's asking price.)

We also anticipate that the percentage of people choosing corn versus hay might vary

with expertise or other characteristics of the sample, so, for example, economics majors rather than psychology majors may be more likely to choose corn, and conservation biology majors may be more likely to choose hay than our sample of psychology majors. However, we predict that, in general, a sex difference in choice will remain; departures from this expectation may reveal interesting insights into the determinants of decision-making relevant to conservation efforts.

What other factors might we expect to influence the steepness of discounting functions? If we assume that there is an evolved, facultative decision process behind such discounting, then obvious candidates are life expectancy and other sources of variable, subjective probability that one will retain control of the resources in question in the future. Wilson and Herrnstein (1985) have argued, on the basis of diverse evidence, that men who engage in predatory violence and other risky criminal activity have different "time horizons" than law-abiding men, weighing the near future relatively heavily against the long term. What these authors failed to note is that facultative adjustment of one's personal time horizons could be an adaptive response to predictive information about one's prospects for longevity (Daly and Wilson, 1990; Rogers, 1991, 1994; Hawkes, 1992; Gardner, 1993; Wilson and Daly, 1997) and the stability of one's social order and ownership rights.

Much of the social science literature on discounting and time horizons treats tolerance of delayed gratification as a proxy for intelligence. We see this as an anthropomorphic stance predicated on the claim that the capacity to plan far ahead and adjust present behavior to long-term future expectancies is a hallmark of complex cognitive capacity in which the human animal is unmatched. From an evolutionary adaptationist perspective, however, discounting and delay of gratification represent essentially the same issue as that addressed by Fisher (1930) and all subsequent life-history theorists: how is the future optimally weighted in deciding present allocations of effort (e.g., Roitberg et al., 1992; Clinton and LeBoeuf, 1993). The answers depend on the expected present and future reproductive payoffs associated with each alternative, expectations that may vary facultatively in response to available cues, and these issues are as germane to nonhuman animals (and plants) as to sophisticated cognizers. From this perspective, what selects for willingness to delay gratification is a high likelihood that present somatic effort can be converted to future reproduction. Thus, rather than reflecting stupidity, short time horizons are likely to characterize those with short life expectancies, those whose sources of mortality are not strongly or predictably dependent on their actions, and those for whom the expected fitness returns of present striving are positively accelerated rather than exhibiting diminishing marginal returns.

How human beings and other animals discount the future has been described in considerable detail by experimental psychologists, but a fuller understanding of these processes awaits the infusion of evolutionary adaptationist insights (Bateson and Kacelnik, 1996; Benson and Stephens, 1996; Kacelnik and Bateson, 1996; McNamara, 1996). The most noteworthy conundrum concerns the shape of discount functions, which are often, perhaps typically, hyperbolic rather than "rationally" exponential (Kirby and Herrnstein, 1995; Green and Myerson, 1996). The puzzling thing about hyperbolic discount functions is that they engender predictable reversals of preference between alternative futures with different time depths and hence predictable regret of what will become bad decisions in retrospect (e.g., Hoch and Loewenstein, 1991; Roelofsma, 1996). Suppose, for example, that a large reward two weeks hence is preferable to a smaller reward one week hence. If future discounting is hyperbolic, then as time passes the appeal of the more imminent reward rises more steeply than that of the more distant, until it may come to be preferred when almost at hand. One consequence is that people and other animals may even invest effort in erect-

ing impediments to their own anticipated future lack of "self-control" or capacity to delay gratification (Kirby and Herrnstein, 1995). Understanding why the psychological underpinnings of time preference have evolved to produce such seemingly maladaptive internal struggles and why the evolved human psyche defies normative economic theory by discounting different utility domains at different rates (Chapman, 1996) may provide important clues for understanding why "waste" and inefficiency are so hard to eradicate. (See Kacelnik, 1997, for a possible adaptationist explanation for hyperbolic discounting).

## Life-Stage Patterns of Risk Preference: Young Men as the Most Risk-Accepting Demographic Group

One may also hypothesize that sexually differentiated valuations of natural resources may be especially conspicuous in those life stages in which males have been selected to compete for reproductive opportunities most intensely. By this reasoning, the life-stage in which laying claim to resources and expending rather than conserving them should be most attractive is that in which such behavior would have had the greatest expected fitness payoff for our ancestors. There is reason to believe that that lifestage for men is and has long been young adulthood (Daly and Wilson, 1990). Once men are husbands, they have something to lose in intrasexual competition, and once they are fathers, concern for their offspring's well-being may result in alterations of their valuations of the environment, especially if the resources would be those of recurring value from one generation to the next, such as land or water rights. Remarkably, however, effects of parenthood on environmental attitudes and behavior are virtually unstudied.

Several lines of evidence about life-span development support the idea that young men constitute a demographic class specialized by a history of selection for maximal competitive effort and risk-taking. Young men appear to be psychologically specialized to embrace danger and confrontational competition (e.g., Gove, 1985; Jonah, 1986, Lyng, 1990, 1993; Bell and Bell, 1993).

Risk of death as a result of external causes (accidents, homicides, and suicides) is greater in men than in women and is maximally sexually differentiated in young adulthood, both in the modern west (Wilson and Daly, 1985, 1993; Holinger, 1987; Daly and Wilson, 1990), and in nonstate, foraging societies more like those in which we evolved (Hewlett, 1988; Hill and Hurtado, 1995). The fact that men senesce faster and die younger than women even when they are protected from external sources of mortality suggests that these sex differences in mortality have prevailed long enough and persistently enough that male physiology has evolved to discount the future more steeply than female physiology. In the case of homicides, young men are not only the principal victims but also the principal perpetrators; indeed, men's likelihood of killing is much more peaked in young adulthood than is the risk of being killed (Daly and Wilson, 1988, 1990). All of these facts can be interpreted as reflections of an evolved life span schedule of risk proneness.

An alternative to this hypothesis, however, is that age patterns reflect responses to changes in relevant circumstances that happen to be correlated with age. Mated status, for example, would be expected to inspire a reduction in dangerous risk-taking because access to mates is a principal issue inspiring competition, and married men have more to lose than their single counterparts. Marital status is indeed related to the probability of committing a lethal act of competitive violence, but age effects remain conspicuous when married and unmarried men are examined separately (Daly and Wilson, 1990). Similarly, men are most

likely to be economically disadvantaged in young adulthood, and poverty, too, is a risk factor in intrasexual competitive homicide, but young adulthood and unemployment status are again separable risk factors for homicide (Daly and Wilson, 1990).

Dangerous acts are adaptive choices if the positive fitness consequences are large enough and probable enough to offset the costs (Daly and Wilson, 1988). Disdain of danger to oneself is especially to be expected where available risk-averse alternatives are likely to produce a fitness of zero: if opting out of dangerous competition maximizes longevity but never permits the accrual of sufficient resources to reproduce, then selection will favor opting in (Rubin and Paul, 1979; Enquist and Leimar, 1990).

From a psychological point of view, it is interesting to inquire how age- and sex-specific variations in effective risk-proneness are instantiated in perceptual and/or decision processes. As we noted above, one possible form of psychological mediation entails flexible time horizons or discount rates. Other psychological processes with the effect of promoting risk-taking can also be envisaged. One could become more risk prone as a result of one or more of the following: intensified desire for the fruits of success, intensified fear of the stigma of nonparticipation, finding the adrenalin rush of danger pleasurable in itself, underestimating objective dangers, overestimating one's competence, or ceasing to care whether one lives or dies. As drivers, for example, young men both underestimate objective risks and overestimate their own skills in comparison to older drivers (Finn and Bragg, 1986; Matthews and Moran, 1986; Brown and Groeger, 1988; Trimpop, 1994). There is also some evidence that the pleasure derived from skilled encounters with danger diminishes with age (Gove, 1985; Lyng, 1990, 1993). In general, sensation-seeking inclinations, as measured by preferences for thrilling, dangerous activities, are higher in men than in women and decrease with age in a pattern quite like that of violent crime perpetration (Zuckerman, 1994).

Youths are especially unlikely to seek medical assistance or other health-enhancing preventive measures (Millstein, 1989; Adams et al., 1995), and young men are the demographic group most willing to take risks with drugs and intoxicants and to risk contracting sexually transmitted diseases (Irwin, 1993; Millstein, 1993). Relative disdain for their own lives can also be inferred from the fact that men's suicide rates maximally surpass women's in young adulthood (Holinger, 1987; Gardner, 1993).

In this context, it may be worth noting that the data in fig. 18-1 and 18-2 were collected almost entirely from young adults, in whom risk acceptance and sex differences therein may be most pronounced. However, the subjects were also people with good economic prospects and life expectancies, and these factors should have diminished risk acceptance. Because of their demographic uniformity, these samples were unsuitable for assessing the possibility of differential responses according to age, marital, and parental status. Whether this artificial technique is suitable for exploring life-span developmental changes and differences between economic classes and other life circumstances remains to be seen.

It is clear that the most risk-prone demographic classes accept risk in diverse domains, and it seems likely that the same association would hold in comparing individuals within demographic categories. But the degree to which risk proneness is domain general is still largely an open question. Zuckerman (1994) has argued that sensation-seeking is a stable personality characteristic: a domain-general mindset which is highly correlated with individual differences in neuron membrane physiology, and he has developed a "sensation-seeking scale," on which men score significantly higher than women, and both sexes (but especially men) score highest in young adulthood. We asked subjects who participated in the hypothetical job choice dilemma (fig. 18-1) to complete Zuckerman's "thrill and adventure

seeking" scale, and we, too, found a significant sex difference (average score for males was 7.6 and for females 6.1; $t = 3.54$, df $= 119$, $p < .001$). However, sensation-seeking scores were not associated with subjects' choice responses to the dilemma, and we are currently conducting research aimed at assessing the degree to which risk acceptance is consistent within individuals across different contexts and alternative operationalizations of risk.

Rogers (1994, 1997) has brought evolutionary reasoning to bear on the issue of optimal age-specific rates of future discounting, given the age-specific mortality and fertility schedules of human populations. His analysis suggests that people of both sexes should have evolved to have the shortest time horizons and to be maximally risk accepting in young adulthood. More specifically, his theoretical curve of age-specific optimal discount rates looks much like the human life-span trajectory of reckless risk proneness that may be inferred from data on accidental death rates and homicide perpetration. The claim that optimal discount rates decline as one ages may seem paradoxical, given the argument that indicators of a short or uncertain expected future life span should be cues favoring risk acceptance. The factors responsible for Rogers' counterintuitive result are certain peculiarities of human life history and sociality, namely, gradually diminishing fertility long before death and a shifting allocation of familially controlled resources between personal reproductive efforts and descendants' reproductive efforts.

Economists such as Norgaard and Howarth (1991) and Common (1995) consider it a conceptual error to extend the concept of future discounting beyond the individual actor's reasonably expected life span and argue that conserving resources for future generations is an issue of resource allocation and equity, instead. But to behavioral ecologists, one's descendants are an extension of one's self, and organisms may be expected to have evolved to act in ways that will promote their fitness both before and after their deaths. Thus, appropriate modeling of the factors affecting optimal discount rates requires consideration of the psychology of human kinship and lineage investment (Rogers, 1991; Kaplan, 1996).

## Conclusions and Recommendations

We believe that effective solutions to environmental and conservation problems require a sophisticated understanding of their sources in human desires and actions. Answering this challenge will surely require an integration of conceptual and empirical contributions from several disciplines. Our thesis has been that the use of the Darwinian/Hamiltonian selectionist paradigm of behavioral ecology as metatheory for psychology and economics may constitute one particularly promising route toward productive interdisciplinary synthesis.

A strength of bringing this behavioral ecological perspective to bear on the study of human decision-making that impacts conservation and environmental degradation is that it has drawn attention to the likelihood of variations with respect to sex, life stage, parenthood, social status, inequity, and life expectancy cues, and unites these variables in a theoretical framework capable of generating predictions. This perspective has also contributed to the growing realization that research and education are insufficient to stem the tide of environmental degradation without sophisticated attention to modifying incentive structures, as argued by Ridley and Low (1994). And as we argued in criticizing some CVM studies, thinking evolutionarily draws attention to the fact that the functional organization of the human mind is not designed to produce accurate introspections, but rather to produce effectively reproductive action in ancestral environments, an understanding that sensitizes the researcher to the potential pitfalls of opinion polling.

A weakness is that the individualistic focus of evolutionary psychologists and behavioral ecologists has yet to shed much light on political processes, especially in state-level societies with complex governmental and other institutions, with the result that the implications drawn from evolutionists' insights are still likely to be rather far removed from practical policy recommendations.

The suggestion that our evolved "human nature" is a source of environmental exploitation and degradation is not a claim that nothing can be done, but a warning that effective conservation and remediation strategies will have to incorporate an understanding of relevant evolved psychological processes in order to modify human action.

## Summary

The serious reduction in abundance and diversity of the earth's flora and fauna is a fact, but what can be done about it remains controversial. We argue that the use of the Darwinian/Hamiltonian selectionist paradigm of behavioral ecology as metatheory for psychology and economics offers a promising route to a sophisticated understanding of human desires and actions which are the sources of and solutions to conservation problems.

Our critique of the "contingent valuation method" widely used by economists centers on the point that the functional organization of the human mind is not designed to produce accurate introspections but rather to produce effectively reproductive action in ancestral environments.

A strength of the behavioral ecological perspective in developing hypotheses relevant to exploitation and despoliation is that it has drawn attention to the likelihood of variations in human decision-making with respect to sex, life stage, parenthood, social status, inequity, and life expectancy cues. In two experimental studies concerning sex differences in hypothetical decisions, men were significantly more likely than women to prefer a crop with higher profit but higher risk of soil degradation, and the men were more willing to treat personal health hazards as acceptable costs of opportunities for financial benefits.

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