



CARPE DIEM: ADAPTATION AND DEVALUING THE FUTURE

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ABSTRACT

Organisms typically “discount the future” in their decision making, but the extent to which they do so varies across species, sexes, age classes, and circumstances. This variability has been studied by biologists, economists, psychologists, and criminologists. We argue that the conceptual framework required for an interdisciplinary synthesis of knowledge in this area is the evolutionary adaptationist analysis of reproductive effort scheduling pioneered by George Williams.

INTRODUCTION

ORGANISMS usually prefer imminent goods over more distal future goods. In psychology, this tendency to prefer the here-and-now is pejoratively called “shortsightedness,” “impulsivity,” and “inability to delay gratification,” with the misleading implication that any such preference is dysfunctional. In reality, however, some level of preference for sooner over later is generally adaptive for at least two reasons: earlier reproduction usually yields a higher intrinsic rate of increase than later reproduction, and the longer one defers benefits the greater the likelihood that they will be lost altogether.

Better labels for the phenomenon to which we refer are the value-neutral terms favored by economists: “time preference,” “intertemporal choice,” and “future discounting.” It is possible, of course, to be maladaptively present oriented and impatient, but one can also fail to discount enough. So what is the optimal rate at which future rewards should be devalued? As Williams (1957) made clear, the answer favored by natural selection depends on how quickly the expected fitness value of

deferred consumption declines, and that is largely determined by extrinsic mortality risks and the rates of senescent decline that have evolved in relation thereto. This line of thought suggests that discount rates will exhibit adaptive variation between the sexes, over the life span, and in response to circumstances that are predictive of the future.

SEX DIFFERENCES IN FUTURE DISCOUNTING

Sex differences in senescence provide a physiological example of such variation. Like other mammals, *Homo sapiens* evolved under conditions in which maternal care of young was obligatory but paternal care was not, with the result that reproductive efforts that jeopardize survival and future fitness could yield fitness for men at parameter values that would be unappealing to women. Moreover and relatedly, the reproductive success of human males is more variable than that of females—the male’s likelihood of dying childless is higher, but so too is the ceiling on his potential fitness—and so, in the words of Alexander (1979:241), “the entire life strategy of males is a higher-risk, higher-stakes

adventure than that of females.” Williams (1957:406) proposed that “the sex with the higher mortality rate . . . should undergo the more rapid senescence,” thereby, in effect, discounting the future more steeply.

Men can be shown to discount the future more steeply than women in their behavioral choices too. An experimental approach to this issue is to ask people a series of questions of the form, “Would you rather have \$ x tomorrow or \$ y after z days?” and see at which point the respondent switches from preferring a smaller, earlier reward to a larger, later one. (Informing participants that one of their choices will be selected randomly and actually paid out, whether with certainty or probabilistically, suffices to ensure sincere responses and orderly data.) In such experiments, men usually discount more than women of comparable age and social class; that is, it takes a higher interest rate to get men to choose larger, later rewards than is required to motivate such “patience” in women (e.g., Kirby and Maraković 1996). Since men have always been better able than women to gain fitness by taking the short view in reproductive effort expenditure, as well as being more likely to be disabled or killed in a given future interval, this sex difference in time preference is unsurprising.

DISCOUNTING ACROSS THE LIFE COURSE

The variability in time preference among age groups is not so readily interpreted as the sex difference. If discounting reflects the expected future trajectory of fitness prospects, then cues of an elevated risk of mortality or a downward trend in one’s capacity to exploit opportunities should make one more willing to expend reproductive effort immediately, and several studies show that such facultative responses have indeed evolved. For example, female wasps (*Leptopilina heterotoma*) accept a wider range of oviposition sites in response to both natural and experimentally manipulated cues that indicate that their future options are narrowing (Roitberg et al. 1993), and male scorpionflies (*Panorpa cognate*) lower their standards of female courtship-worthiness as the only summer that they will ever see begins to fade

(Engqvist and Sauer 2002). It is therefore somewhat puzzling that available evidence from monetary choice experiments suggests that human discount rates decline monotonically over the life course and are much lower by age seventy than in young adulthood (e.g., Green et al. 1999).

Children are notoriously present oriented, and even after puberty, adolescents discount the future in monetary choice tests to a degree that strikes older adults as excessive. Such results are routinely interpreted as proof that the young are deficient in “self-control,” “foresight,” and the cognitive wherewithal to “postpone gratification.” Recent media coverage of research on “the teenage brain” (e.g., Wallis 2004) illustrates this prejudice: the discovery that systematic changes in neural information processing continue through the second decade of human development is taken to mean that teenagers are flawed “works in progress” who have yet to attain the relative perfection of adults. This interpretation should be doubted because every ancestor of every living person was once an adolescent, and if the “impulsivity” of the young were truly maladaptive, it would surely have been visible to selection. Unfortunately, researchers in this field seem to be scarcely more aware of the need to formulate and test adaptationist alternatives than are the reporters who have popularized their findings.

The proposition that time preference in the elderly is maladaptive because survival into old age is evolutionarily novel is initially more plausible than the dysfunctional teenager hypothesis. This argument is also weak, however. The issue is not whether selection has had a chance to act on particular age classes, but whether it has had a chance to act on facultative responsiveness to cues of diminished prowess and low residual reproductive value. Should we not expect males who are confronted with signs of declining competitive ability to become more reckless in their pursuit of one last fertilization? The logic is analogous to that by which Woyciechowski and Kozłowski (1998) predicted (and confirmed) that worker bees assume more dangerous foraging activities both as their

wings wear and in response to experimentally induced infections.

Some anecdotes suggest that more reckless competitive tactics are indeed characteristic of aging males in species such as baboons, in whom the rank and mating prospects of older males decline rather abruptly. We have not been able to find an explicit treatment of this hypothesis, however. We would expect a post-prime escalation of the willingness to fight dangerously to be even more likely in a species like the elephant seal, where paternal contributions to offspring fitness are apparently nonexistent and male reproductive efforts consist solely of the competitive pursuit of matings. But whereas an aging seal or stag who makes a last-ditch effort to defeat a rival or to force himself on an unwilling female imposes no fitness costs on his relatives, an aging man who behaves similarly might do his inclusive fitness serious harm.

Rogers (1994) has argued that the curious life-course trajectory of human time preference and risk taking can be rationalized if intergenerational resource transfers and the effects of personal reputation on the fitness prospects of family members are included in optimization models. His analysis would gain support if comparative evidence were to prove that the human life-span trajectory is truly exceptional. Sozou and Seymour (2003) take a different tack from Rogers, deriving the diminution of discounting between young adulthood and middle age from an experience-based reduction in one's subjective estimate of external mortality risks. Their analysis suggests that the human life-course pattern may not be exceptional after all, and also predicts that discount rates will bottom out in middle age and eventually increase, a prediction which runs counter to the evidence currently available (Green et al. 1999). As things stand, why it is that men whose competitive prowess and mating prospects are irreversibly on the wane become more risk-averse and not more reckless remains an important unsolved puzzle. Comparative data are especially needed.

CIRCUMSTANTIALLY CONTINGENT DISCOUNTING

Psychologists, economists, and criminologists have been more interested in comparing

discount rates between groups of people than between situations, implicitly treating time preference as a trait. For example, heroin addicts have been shown to have higher discount rates than other people (Kirby et al. 1999). Time preference should also be expected to vary within individuals as a function of their present circumstances, however, and indeed it does. Facultative responses to cues that predict the future often accomplish a de facto adjustment of discounting, as in the above-cited examples (and many others) whereby animals have been shown to expend more reproductive effort and/or to relax criteria of an acceptable reproductive opportunity as a breeding season slips away or in response to phenotypic deterioration such as wing wear. And as for heroin addicts, their discount rates increase as a function of the time that has elapsed since their last fix (Gior-dano et al. 2002).

As far as we know, the first study to manipulate human discount rates experimentally was that by Wilson and Daly (2004). We reasoned that cues promising good returns on present efforts should inspire an effective discounting of the future and that fitness gains from mating effort increments have always had higher expected payoffs for men than for women. We therefore assessed discount rates of students both before and after an intervening photo-rating task, one version of which was chosen to induce a "mating opportunity mindset" in men. In a between-groups design, experimental subjects rated the "appeal" of photos of opposite sex people, seeing only faces that had been pre-rated as either highly attractive or unattractive; additional control subjects of both sexes rated attractive or unattractive cars. As we predicted, a significant post rating task shift in discount rates occurred only in the men who had viewed pictures of pretty women, an experience that elicited a heightened preference for smaller, earlier rewards.

We hope to see a proliferation of experimental work in this area. Any sort of present reproductive effort presumably entails a sacrifice of expected future fitness, but we have little information on how human decision processes instantiate these tradeoffs.

THE PUZZLE OF HYPERBOLIC DISCOUNTING

Experimental psychologists have described people's and other animals' choices between rewards at different delays in considerable detail, but a fuller understanding of these processes requires the infusion of evolutionary adaptationist insights. The most noteworthy conundrum concerns the shape of discount functions. Simple normative models in which future hazard risks do not change systematically suggest that discounting should follow a negative exponential function of the form $V = A e^{-kD}$, where V is the present subjective value of the delayed reward, A is its amount, D is the delay, and k is a variable discounting rate parameter fitted to the data. Research has consistently shown, however, that actual discounting is better described by a hyperbola $V = A/(1 + kD)$, such that the near future is discounted more steeply than the more distal future.

On a long timescale, one might have expected that any observed departure from exponential discounting would take precisely the opposite form because an accelerating process of senescence justifies accelerating discount rates. In the short term, hyperbolic discounting is equally difficult to rationalize. Among its consequences are predictable reversals of preference as alternative futures with different time depths draw nearer, reversals that are so predictable that people and other animals will even learn responses that function to eliminate future opportunities to change their minds (Ainslie 1974, 1992).

Why are the psychological underpinnings of time preference such as to produce these seemingly maladaptive internal struggles? Addressing this question requires that we think how decision processes might be adaptations to the structure of problems in nature. In this spirit, Kacelnik (1997) has provided a satisfying answer to the hyperbolic discounting problem by showing that the choices made in experiments that demonstrate hyperbolic discounting are exactly those that would be required to maximize rate of return while foraging or otherwise investing time in tasks with sporadic returns. The experiments that demonstrate hyperbolic discounting give

animals choices between rewards after different delays, which are followed by obligate time-outs that can make choosing the longer delay optimal and the animals' actual choices "maladaptive." But the real world offers no such choices. Instead, animals face options that have different prey encounter rates or expected rates of return, and the opportunity to resume foraging after prey capture is under the animal's own control. For this reason, animals in the lab treat a delay before reward as if it were time invested in the task, and get suboptimal returns only because of the artificiality of the lab situation. Arguably, the same applies to people who, in ancestral environments, must seldom if ever have had to make choices of the form, "x tomorrow or y after delay z," choices that were free of implications about how period z could be spent.

LETHAL COMPETITION AS FUTURE DISCOUNTING

With a larger prize for winning, and a higher probability of total reproductive failure after losing or opting out, the males of effectively polygynous species (those in which male fitness variance exceeds that of females) are selected to compete more intensely than either conspecific females or the males of strictly monogamous species. One assay of the intensity of such competition in the human animal is the incidence of homicide. Killings are extreme and infrequent consequences of competition, but they hold some advantages for researchers, including face validity as a manifestation of severe interpersonal conflict, and greater freedom from biased detection and recording than can easily be attained using other conflict measures (Daly and Wilson 1988).

It is probably not news that killers are overwhelmingly male, but it is less well known that their victims are too. Wherever rates are high, a large majority of homicides are cases in which a man killed another unrelated man. Moreover, these killings are transparently competitive; case reports indicate that they are usually contests over the social resources of status and face, and if not, then they are mostly robberies (i.e., competition over mate-

rial resources). Finally, it is these male non-relative cases—rather than the rarer spousal cases, infanticides, and so forth—whose incidence is most variable between times and places, justifying the use of homicide rates as an assay of local intensities of competition among men. The idea that homicide rates index the intensity of social competition also gains support from the fact that an inequitable distribution of incomes, as measured by the Gini index of income inequality, has repeatedly been found to be a much better predictor of homicide rates than mere average income (or, in most cases, any other predictor) in comparisons at spatial scales ranging from nations to neighborhoods (Daly and Wilson 2001).

As we might expect, homicide rates are at their highest among men with the least to lose: unemployed and unmarried men become embroiled in lethal competition more often than their employed and married counterparts. It is possible, of course, that these demographic statuses have no direct causal relevance to the likelihood that a man will kill or be killed, but are simply correlates of other determinants. Perhaps, for example, the kinds of men who are ill-tempered enough to enter into fatal altercations in bars are also the sorts who would never marry. In this particular case, however, we can take the analysis further. Divorced and widowed men revert to the high homicide rates seen among same-age single men (Daly and Wilson 2001), lending support to the hypothesis that being currently unmarried is a real causal determinant of the use of reckless tactics of social competition and of the implicit disregard for the future that such recklessness implies.

In our own research on homicide in Chicago neighborhoods (Wilson and Daly 1997), income inequality was, as usual, an excellent predictor of homicide rates, but we found an even better predictor: local life expectancy (with the mortality effects of homicide removed to prevent circularity). Indeed, this variable accounted for more of the variance than any other predictor in any prior study of homicide at any scale. What this suggested to us is that dangerous competitive behavior that entails an implicit disdain for the future is exacerbated by cues that one lives in the

sort of social milieu in which one's future may be cut short.

WHAT GEORGE WILLIAMS TAUGHT US ABOUT FUTURE DISCOUNTING

The expenditure of reproductive effort constitutes a sort of gamble: some expected future fitness (or "residual reproductive value:" RRV) is spent in the pursuit of a present fitness payoff. When is that gamble worth taking? Williams (1966) theorized that the "barely justified cost" of an act is: (1) directly proportional to its expected positive impact on current reproduction ("the magnitude of the threat or opportunity"); (2) directly proportional to the proportion of reproductive value that is immediately at stake; and (3) inversely proportional to the RRV that will remain if the gamble is refused. These propositions provide the framework that rationalizes the adaptationist hypotheses discussed above, with the important caveat that Williams's propositions concern the natural selective calculus that shaped the evolution of contemporary decision-making machinery and not the cost-benefit calculations which that machinery now makes. In a world with such novelties as guns, condoms, and professional police forces, violent men are probably not calibrating their choices in such a way as to maximize fitness, but their contingent responses reflect psychological adaptations nonetheless.

More recently, Williams (1997, 1999) has admonished gerontologists that their emphasis on age at death and life span is misplaced, maintaining that these statistics have no intrinsic interest but are mere byproducts of more important quantities: the scheduling of reproductive effort expenditure and the pace of senescence. Having discussed our own research findings as evidence of the "effects" of life expectancy (Wilson and Daly 1997; Daly and Wilson 2001), we feel a bit sheepish, for George's point is undeniably well taken, but we hope it is clear that the thrust of our arguments survives his critique. It is reasonable to expect that organisms will respond to cues of an uncertain future, including cues of mortality risks beyond their own behavioral control, by adjusting time preference.

What selects for patience in intertemporal choices is a high likelihood that present somatic effort can be converted to future reproduction. Thus, rather than vilifying those who discount the future as myopic or lacking in self-control, we think it is both more accurate and more fruitful to hypothesize that steep discounting characterizes those with short life expectancies, those whose likely sources of mortality are independent of their actions, and those for whom the expected fitness returns of present striving

are positively accelerated rather than exhibiting diminishing marginal returns.

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