PATIENCE IN A FORAGING-HORTICULTURAL SOCIETY: A TEST OF COMPETING HYPOTHESES[1]

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Patience, or the ability to delay gratification, matters in the behavioral and medical sciences and in public policy because it correlates with a wide range of desirable outcomes. For instance, patience correlates positively with income, wealth, conservation of natural resources, health, and savings and negatively with crime and drug addiction. Anthropologists have made few contributions to cross-cultural studies of patience despite its importance. Drawing on five-quarter panel data from 154 Amerindians (10-80 years of age) from the Tsimane' foraging-horticultural society in the Bolivian Amazon, we use hyperbolic and exponential discounting to estimate patience and the correlation between patience and (a) modern human capital, (b) personal affluence, and (c) age. Levels of impatience in

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Tsimane' society are higher than in Western societies. We find a strong negative correlation between schooling and impatience and a weaker, but still negative, correlation between impatience and modern human-capital skills. We find mixed support for (b), probably because of sharing and reciprocity. We also find mixed support for (c), probably because of a truncated sample and measurement error of the age variable. We discuss areas for future research to encourage anthropologists to contribute to the cross-cultural understanding of patience.

PATIENCE, OR THE ABILITY to delay gratification, matters in the behavioral and medical sciences and in public policy because it correlates with a wide range of desirable outcomes. For instance, patience correlates positively with wealth (Laibson, Repetto, and Tobacman 1998; Laibson 1997), income (Green et al. 1996; Hausman 1979; Lawrance 1991), conservation of natural resources (Holden, Berkele, and Wilk 1998; Wilson, Daly, and Gordon 1998), savings (Laibson, Repetto, and Tobacman 1998), and health (Chapman and Coups 1996; Yan et al. 2003). Children with greater ability to delay gratification at four years of age had higher SAT scores as young adults (Shoda, Mischel, and Peake 1990). Patience correlates negatively with drug addiction (Gruber and Koszegi 2000; Kirby, Petry, and Bickel 1999) and with crime (Wilson and Daly 1997). The general level of patience in a society has implication for public policy. If people devalue the future, save or conserve too little, and underinvest in long-run sources of well-being, then public policies might be needed to redress the bias (Cropper and Laibson 1999; Laibson 1997). Because patience touches on so many areas, it affects how an entire economy operates (Frederick, Loewenstein, and O'Donoghue 2002).

Despite the importance of patience and despite growing research on the topic by economists and psychologists, anthropologists have made few contributions to the field. A decade ago, Rogers (1994) drew on evolutionary biology to propose an age dependency and a unique level of patience for humans. Among cultural anthropologists, Appadurai (2004) noted that culture shapes our ideas about the future and our capacity to aspire. Though he does not focus on patience, he says that anthropologists have rarely studied concepts of the future:

> On the anthropological side, in spite of many important technical moves in the understanding of culture, the future remains a stranger to most anthropological models of culture. By default, and also for independent reasons, economics has become the science of the future. . . . In a word, the cultural actor is a person of and from the past, and the economic actor a person of the future. (Appadurai 2004:2)

Appadurai goes on to hypothesize that wealthier and richer individuals should see the future with more clarity, should "have a more fully developed capacity to aspire," and, by implication, should have more patience. Rogers and Appadurai aside, we do not know of other anthropologists who have studied patience or people's cultural construction of the future. The gap is lamentable because anthropology with its unique four-field perspective could bring fresh ideas to the topic, for several reasons.

First, nearly all studies of patience among humans come from mainstream populations of industrial societies, such as undergraduate students (Kirby and Marakovic 1996; Loewenstein 1992; Pender 1996; Thaler and Loewenstein 1989). Anthropologists, who often work with rural peoples in developing nations or with ethnic minorities and disadvantaged groups in developed nations, are well placed to test whether findings from mainstream populations of developed nations also apply in different cultural settings.

Second, there are reasons to think that patience should vary across and within cultures. Anthropologists are well placed to document such variation. For instance, as we shall see shortly, economic theory suggests that credit constraints, low life expectancy, and lack of material resources to spend in future-oriented capital should work together to make poor people in developing nations more impatient than their more affluent counterparts in Western societies. Further, if people in small-scale rural societies engage in sharing and reciprocity, as many case studies suggest (Godoy 2001), then measures of patience in these populations should display lower variance than measures of patience in industrial societies. If material constraints shape patience, then lower indices of material inequalities should correlate with lower variance in patience.

Third, anthropological studies of patience could contribute to the nascent field of experimental anthropology. Economic and evolutionary anthropologists have recently started to use field experiments to test a wide range of hypotheses about pro-social behaviors in small-scale societies and have found that results often do not mesh with findings from industrial nations (Henrich 2000; Henrich et al. 2002). Long-term research in the same site would allow anthropologists the opportunity to develop, pilot-test, and validate reliable instruments for measuring patience and, thus, add to the methodological tool kit of other disciplines.

Finally, the propensity of anthropologists to do long-term research with the same subjects (G. Foster et al. 1979; Kemper and Royce 2002) allows anthropologists the opportunity to assess how patience varies over the life cycle and across generations. Except for the study we are about to present, we know of only one other study of patience with repeated observations of the same subjects (Pender 1996), and even the information presented in our article was collected over a short time—only five consecutive quarters. Studying patience over a long stretch of time with the same subjects and across generations would allow anthropologists the opportunity to use subjects as their own controls and to analyze the role of hereditary and environmental factors in shaping patience. Present studies do not allow one to disentangle hereditary and environmental factors.

We use the terms patience, private rate of time preference, delay-discount rate, and private discount rate as synonyms. As Frederick, Loewenstein, and O'Donoghue (2002) point out, these terms encompass different dimensions, such as impulsiveness, inhibition, and compulsiveness. We do not attempt to unpack the concept of patience but are mindful of the need to do so in future empirical research. In the rest of this article, we use the terms patience or private rate of time preference to capture the preference for immediate utility over future or delayed utility. The rate of private time preference determines the slope of the curve (the discount curve) relating present value to delay. A rate of private time preference of zero indicates that delay has no effect on the present value of a reward; it indicates that a person is indifferent to waiting for a reward or having a reward now. A high rate of private time preference implies more impatience, impulsiveness, myopia, and inability to delay gratification. By convention, the rate of time preference is defined as the natural logarithm of the marginal rate of substitution between future and present consumption.

DETERMINANTS OF PATIENCE: REVIEW OF THEORIES

Several authors have reviewed the psychological and the economic literature on the correlates of patience (Ainslie 1992; Frederick, Loewenstein, and O'Donoghue 2002; Kirby 1997; Laibson 1997; Rachlin 2000). We build on those reviews and on the original sources to divide the literature into five major theoretical perspectives. Although some of the perspectives overlap, we split them into distinct groups to highlight core ideas. To paraphrase Rogers (1997:248), some perspectives succeed where others fail, but none explains all the facts.

Human-Capital Perspective

Researchers such as Becker and Mulligan suggest that people train themselves and learn to become patient and to select the amount of patience they wish to have (Becker and Mulligan 1994, 1997; see also Rachlin 1995). We call this a human-capital perspective because people invest in enhancing their ability to see the future more clearly.

Becker and Mulligan acknowledge that people initially do not display much variance in patience, and what variance they display reflects innate endowments. They note that people spend resources to see the future more clearly and to become more patient. Becker and Mulligan say that patience reflects the time and effort spent appreciating future pleasures and the investments people make on goods and activities that direct their attention away from present to future pleasures. These investments allow people to see the future with more feeling, realism, and clarity, which, in turn, make them more patient.

One of the merits of the Becker-Mulligan model is that it produces testable hypotheses about the determinants of patience. For instance, they predict that schooling correlates positively with patience because schooling focuses attention on the future and helps children to learn the art of scenario simulation and to plan for the future. They predict that good health should correlate with more patience because increasing life expectancy increases the returns on investments in human capital; people who invest in seeing the future more clearly should get higher return on those investments if they live longer from better health. They also make predictions about the link between age and patience. They predict that age should bear a U-shaped relation with impatience. During childhood, children learn and are taught to imagine and to plan for the future, thereby decreasing impatience. Since the probability of death increases as people age, the value of future consumption decreases as people get older. Impatience reaches a low point during middle age and increases gradually among older people. Last, Becker and Mulligan predict that patience should correlate positively with income and wealth because people with fewer material constraints will find it easier to invest in activities to see the future more clearly.

Researchers have yet to assess whether people consciously invest to increase patience, as Becker and Mulligan suggest. The core idea of the Becker-Mulligan model goes against recent thinking and empirical findings from behavioral economics. Some of that literature suggests that people have a hard time becoming more patient, are inconsistent about choices over time, and must use precommitment strategies to force themselves to save or to make long-term investments. For instance, people save by buying a home or by enrolling in pension plans and, thus, forfeit control over part of the income they might otherwise have spent (Laibson, Repetto, and Tobacman 1998).

Genetics and Physiology Perspective

A second perspective views differences in patience as reflecting neurological and physiological differences across people, which, in turn, might have a genetic or hereditary component (Apter et al. 1990). Depending on the strength of the association between neurological-physiological differences and genetic differences, patience could be a stable (Shoda, Mischel, and Peake 1990) or a variable personality trait (Meade 1981; Wingrove and Bond 1997), or both (McCrae and Costa 1994). A shortcoming of this approach is the inability to explain the systematic correlation found in developed nations between patience and many socioeconomic variables discussed above.

Life-Cycle, Evolutionary Perspective

Proponents of this perspective hold that evolutionary forces have made humans and animals put greater value on the present than the future in order to maximize survival choices (Rogers 1994, 1997; Dasgupta and Maskin 2002). Rogers is the most articulate proponent of this perspective. He conjectures that the evolutionary explanation for placing a greater weight on the present relates to: "(a) an expectation of rising consumption, (b) declining reproductive value, and (c) the possibility that delayed benefits may accrue to children or other descendants rather than to the investor" (Rogers 1994:477). He uses fertility and paternity data from nineteenth-century Utah and twentieth-century Libya and Taiwan to infer discount rates over the life cycle and finds that the long-term biological real discount rate is 2% per year, close to the 3% long-term (1727–1900) real interest rate of the economy. Rogers also finds that the link between impatience and age resembles an inverted U. Impatience rises during young adulthood and declines afterwards. He notes that high discount rates across cultures occur in young adulthood (especially among men) and that this might explain higher crime rates and driving accidents for this age cohort. A shortcoming of Rogers's hypothesis, as he admits, is the lack of evidence for how natural selection worked in prehistoric times to shape patience.

Support for Rogers's life-cycle hypothesis has been mixed. Contrary to

Rogers's prediction, some studies find that children become more patient with age (Metcalfe and Mischel 1999; Mischel, Shoda, and Rodriguez 1989). Laibson (1997) shows that patience increases over the entire life cycle. But other studies find that patience declines and stabilizes after about 30 years of age (Harrison, Lau, and Williams 2002), as predicted by Rogers (Kirby et al. 2002).

Contextual Cues Perspective

Other researchers have proposed that patience reflects environmental or contextual factors (Barratt 1991; Laibson 1996; Loewenstein 1996; Meade 1981; Wingrove and Bond 1997). This line of thinking suggests that contextual cues induce physiological changes, such as craving or hunger, which, in turn, increase impatience. Studies of animal foraging behavior indicate that animals will wait for a larger reward when they are not hungry but will want the immediate reward if they are hungry (Caraco 1980, 1981; Green and Myerson 1996; Kacelnik 1997). Though patience might reflect contextual variables, it likely also reflects deeper determinants. The contextual perspective cannot explain the age dependence of patience and why patience correlates systematically with many outcomes noted above.

Material-Constraint Perspective

Explicit in some of the theoretical and empirical work of economists is the idea that low levels of income and wealth and credit constraints correlate with lower patience. This idea is explicit in the theory of Becker and Mulligan and in the hyperbolic discount model of Laibson (1997). Income, wealth, and access to credit should enhance people's ability to borrow and make long-term investments to see the future with greater clarity. Empirical studies and simulations in industrial nations (Green et al. 1996; Hausman 1979; Laibson 1997; Laibson, Repetto, and Tobacman 1998; Lawrance 1991) and at least one study in rural India (Pender 1996) support the idea that lack of affluence and credit constraints correlate with greater impatience.

Convergences in Perspectives

So far, we have reviewed different theoretical perspectives in the study of patience. Despite differences, researchers have shown convergence in two broad areas. Growing evidence from laboratory and observational studies among humans and animals indicates that hyperbolic discounting explains observed data better than exponential discounting (Ainslie 1992; Dasgupta and Maskin 2002; Frederick, Loewenstein, and O'Donoghue 2002; Kirby 1997; Laibson 1997, 2003; Mazur 1987; O'Donoghue and Rabin 2001). With exponential discounting, the present value (V) of an amount A at time d can be expressed as $A / (1 + k)^d$, where k is the discount rate. Exponential discounting has been the norm in most practical applications, such as project appraisal. There are several formulas for hyperbolic discounting (Frederick, Loewenstein, and O'Donoghue 2002). A widely used formula, and the one used here, is associated with the work of Mazur (1987), Herrnstein (1981), and Kirby (Kirby and Marakovic 1996; Kirby, Petry, and Bickel 1999), where the present value of an amount A at time d is given by the expression, A / (1 + kd).

With either type of discounting, the future loses value as time into the future (d) increases—either because of the higher risks of not being able to obtain rewards or because people cannot evaluate future pleasures or costs with accuracy. A higher discount rate, k, means the discount factor, $1 / (1 + k)^d$ or 1 / (1 + kd), decreases, thereby lowering the present value of A. As Laibson (1997) notes, with hyperbolic discount functions, events in the immediate future are discounted more heavily than with exponential discounting, but events in the distant future are discounted less heavily than with exponential discounting. With hyperbolic discounting, the rate of private time preference declines as the event or reward moves farther into the future. With exponential discounting, the implicit rate of time preference remains constant with the time to payoffs. Besides fitting the data better, hyperbolic discounting has the added advantage of being able to explain preference reversals. People and animals confronted with two delayed rewards often switch in favor of the immediate reward "as the time to both rewards diminishes" (Frederick, Loewenstein, and O'Donoghue 2002).

The second area where researchers show agreement concerns the methods used to elicit data on time preference. There is growing agreement that measures of private time preference vary by the size and type of reward and by framing effects. For example, people discount gains and small amounts more heavily than losses or than large amounts (Frederick, Loewenstein, and O'Donoghue 2002).

METHODS

Drawing on several years of observational and experimental studies among the Tsimane', a foraging-horticultural people in the Bolivian Amazon (Godoy 2001; Godoy and Jacobson 1999; Godoy, Kirby, and Wilkie 2001; Kirby et al. 2002), we make an empirical and methodological contribution to the cross-cultural study of patience. First, we test, compare, and assess the human-capital, material-constraint, and life-cycle perspectives. We did not collect information to test other perspectives. For instance, we did not collect data on hunger or on physiological states associated with hunger. Testing several competing perspectives rather than testing only one perspective has merit because the usefulness of a perspective depends on how well it does relative to competing perspectives.

Second, we assess whether findings from developed nations also apply in this unique setting. We would expect Tsimane' to be more impatient than subjects in Western societies because Tsimane' are highly self-sufficient, poor, and credit constrained. Goods bought in the market accounted for only 2.7% of the total value of household consumption. Mean annual personal income from earnings and from the imputed value of farm and forest consumption was US$332, a third of the average for Bolivia (US$980/person) or for all low- and medium-income nations (US$1,140/person) (Godoy et al. 2002). In a later study (2001–2002), we found that only 13.73% of the sample reported having access to credit if faced with a medical emergency. Since sharing and reciprocity are widespread—only 4.45% of 559 households in 2001–2002 reported not having made a gift or offering help to other villagers the week before the day of the interview—we would expect Tsimane' to have lower variance in patience than people in developed nations.

Last, we exploit the panel dimensions of the study to make a methodological contribution. By drawing on repeated observations of the same subjects during five consecutive quarters, we control for potential biases from endogeneity (or reverse causality) and from fixed effects. We can control for potential endogeneity, in part, by lagging explanatory variables in regressions. Fixed effects refers to attributes that do not change during the study but that affect patience and its covariates. Personal fixed effects refers to unobserved heterogeneity in endowments and preferences of the subjects (e.g., risk-taking propensity, genetic factors; Riddley 2000) that likely affect patience and its covariates. Household fixed effects refers to household attributes (e.g., role models, household wealth) that remain unseen or unmeasured, that do not change over the course of the study, but that nonetheless might affect parameter estimates. Although the literature contains many suggestions on the determinants of patience and on how to obtain valid estimates of patience, it has paid less attention to how to correct for endogeneity and for fixed effects in the empirical analysis.

Using quarterly panels allows us to control for these confounding effects, but it also has other advantages. By reinterviewing subjects, we enhanced subjects' understanding of the experimental tasks used to elicit data on patience and reduced random measurement errors. This technique is known as time-in-sample, panel conditioning, or the reinterviewer effect and refers to changes in a subject's response from exposure to repeated surveys (Bailar 1994). We show that panel conditioning worked in our favor to improve the reliability of responses. Further, repeated exposure to the same researchers probably lowered subjects' perceived risk of not receiving the delayed rewards.

Sample

The study took place among the Tsimane' in the tropical rain forest of the Department of Beni, Bolivia. Several authors have provided historical and ethnographic background on the Tsimane' (Chicchón 1992; Daillant 1994; Ellis 1996; Z. Foster et al. 2003; Huanca 2000; Reyes-García 2001; Reyes-García et al. 2003a; Vadez et al. 2003).

The study included 154 subjects (10 to 80 years of age) from 49 households in two villages along the Maniqui River (Figure 1). One village, Yaranda, is more traditional, has lower cash income, and is relatively inaccessible. Yaranda is 47.7 km upriver from the market town of San Borja (population 16,000) and can be reached mainly by river transport. The other village, San Antonio, is more integrated to the market, has higher cash income, is only 10 km downriver from San Borja, and is accessible all year by road. Only two households in the remote village ($n = 27$) and three households in the more accessible village ($n = 22$) refused to take part in the study for reasons that remain unclear.

We collected data during six consecutive quarters (May 1999–November 2000) but do not use data from the first quarter because we used it to train researchers, enhance interobserver reliability, anchor questions, and train subjects

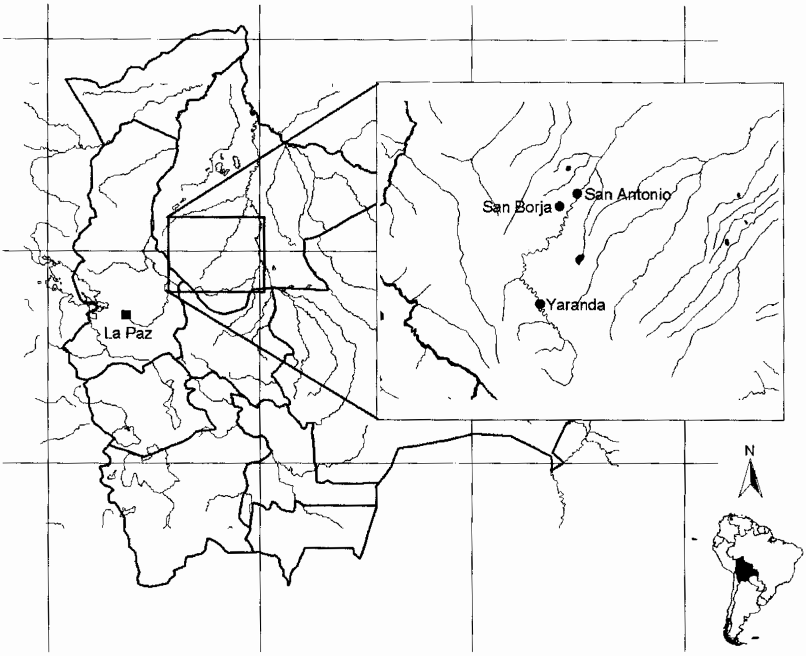

Figure 1. Map of Bolivia showing Tsimane' territory and field sites

in the tasks of the survey. The composition of the sample remained stable over time. Permanent attrition was not a problem. In fact, the number of households and adults in the sample grew because people married and formed new households and because outsiders married into the villages during the study. People who moved into the village were added to the panel.

We did not track temporary attrition or try to correct for missing information among subjects who responded. Temporary attrition arose if people left the sample during a quarter but returned during a later quarter. Question or item nonresponse arose if people were present but could not answer the questions posed or could not do the tasks we asked them to do. Item and unit nonresponse and the inclusion of permanent in-migrants explain why we do not have a balanced panel.

Dependent Variables

The method used to elicit data on patience is the same as the method we have used in previous studies with the Tsimane' and other Amerindian populations (Godoy, Kirby, and Wilkie 2001; Kirby et al. 2002), so here we provide a summary of the method.

We asked subjects to make real (rather than hypothetical) choices between having a smaller reward now or having a larger reward 7–157 days in the future. We used money and candy as rewards. Subjects were asked to make eight choices using money as a reward and seven choices using candy as a reward. We presented subjects with the choices in the order shown in Table 1 but did not test whether changing the order of questions affected results. Since we had to use whole numbers of candies, we generated seven questions with discount rates as similar as possible to those used for money.

To make choices real and to lower the perceived risks of the experiment, we followed several steps. First, we told subjects that at the end of the interview, we would select at random one of the monetary choices and one of the candy choices they had made and would give them those rewards (either immediately or later, depending on the choice). To reduce concerns of subjects about whether researchers would deliver delayed rewards, data collection during the fourth quarter was done early enough so that we could deliver delayed rewards before fieldwork ended. Despite the timing of the payment schedule, our permanent presence in the field, and our assurances that we would pay in the future, subjects may have opted for immediate rewards because of the perceived uncertainty of future payments (Spence and Zeckhauser 1972).

Future money rewards were in nominal rather than in inflation-adjusted *bolivianos* (US$1.00 ≈ $b 6 [*bolivianos*]), so there is an upward bias in our estimates of discount rates for monetary rewards; but it should not affect the estimated parameters of the regressions since inflation affected all subjects in the same way. The values of the monetary rewards were not trivial; the average reward amounted to 25% of a daily wage.

TABLE 1
Choice values and associated discount rates for questions used to elicit private time preference for money and candy

	Reward values		Delay	Rate at indifference	
Question no.	Today	Later	(days)	k	r
Money					
5	$b 8.0	$b 8.5	157	0.00040	0.00039
3	$b 6.7	$b 7.5	119	0.0010	0.00095
4	$b 6.9	$b 8.5	91	0.0025	0.0023
1	$b 5.5	$b 7.5	61	0.0060	0.0051
8	$b 5.4	$b 8.0	30	0.016	0.013
7	$b 4.1	$b 7.5	20	0.041	0.030
6	$b 3.3	$b 8.0	14	0.10	0.063
2	$b 3.1	$b 8.5	7	0.25	0.14
Candy					
4	16	17	157	0.00040	0.00039
3	13	15	153	0.00101	0.00094
1	11	15	61	0.0060	0.0051
7	11	16	28	0.016	0.013
6	8	15	21	0.042	0.030
5	7	17	14	0.102	0.063
2	6	17	7	0.26	0.15

Note: "Rate at indifference" indicates the values of the hyperbolic (k) and continuously compounded exponential (r) discount rates at which the immediate and the delayed rewards are of equal value. US$1.00 ≈ $b 6.00 ($b = *bolivianos*).

We estimated a person's discount rate from the choices they made using a hyperbolic and an exponential discount function. For each question, we solved for the value of k (hyperbolic) or r (exponential) that made a person indifferent between each of the immediate and the delayed rewards of Table 1. Columns 5 and 6 of Table 1 contain the estimated values for k and r. Taken together, the questions define nine ranges of discount rates for money and eight ranges of discount rates for candy.

Using monetary rewards as an example, we see that seven of the ranges are bounded above and below. To illustrate, in question 2 we offered participants a choice between $b 3.1 today or $b 8.5 in seven days. A participant with a discount rate of 0.25 would be indifferent between the two rewards. Suppose that a participant chose the immediate reward on question 6 (implying $k > 0.10$) but chose the delayed reward on question 2 (implying $k < 0.25$). Taking the two trials together, one could infer that this person has a discount rate between 0.10 and 0.25, and the midpoint of the interval would provide the best estimate of the person's discount rate. We used the geometric mean of the range to avoid assigning less weight to the smaller of the two rate parameters. In this example, the method produces an estimated discount rate of 0.16. Choices of all eight immediate rewards or of all eight delayed rewards represent the endpoints of our measure, and for such choices, we cannot place bounds on the estimate of k. Participants who chose in this way were assigned the value of k corresponding to those endpoints.

The results that we present below do not depend on using a hyperbolic rather than an exponential function. The values of k and r with exponential or hyperbolic discounting are nearly identical over most of the observed range, as shown in columns 5 and 6 of Table 1. Because we measured delays in days, the hyperbolic discount rate parameters that we report, multiplied by 100, are approximately interpretable as expressing percentage decreases per day. This is only an approximate interpretation because for hyperbolic functions, the percentage decrease gets smaller as delays increase. For reasons discussed earlier, we use the hyperbolic discount rate k in the regression analysis.

Because a person's choices were not always consistent with a single value of k, the parameter estimates could not be made simply by identifying the switch from the immediate to the delayed rewards moving down Table 1. Instead, we assigned each participant a k value that yielded the highest proportion of consistent choices. That is, for each participant we computed the proportion of that person's choices that were consistent with assignment to each of the nine values of k defined by the questionnaire (bounded or unbounded). Participants were assigned the value that yielded the highest consistency among her or his choices of any of the nine possible values with money or of the eight possible values with candy. Consistency here is a relative rather than an absolute measure, with the discount rate that yields the highest relative consistency across trials providing the best estimate of the participant's k value. When two or more values yielded equal consistency, the participant was assigned a value corresponding to the geometric mean of those values. In the regression analysis we only use data from participants for whom we were able to assign values that were consistent with at least six of the eight monetary choices and with at least five of the seven candy choices.

The mean consistency score for patience using money (0.946) was nearly identical to the mean consistency score for patience using candy (0.947). Almost three-quarters of subjects (70.35% for money and 72.67% for candy) had fully consistent measures (i.e., consistency = 1). Some inconsistency (i.e., consistency < 1) using money as a reward was exhibited by 29.65% of subjects, and 18.99% of subjects had some inconsistency using candy as a reward. Only 14 subjects (2.71%) had consistency scores with money below 0.75, and only eight subjects (1.55%) had consistency scores with candy below 0.71; we excluded these subjects from the analysis. We found a moderate positive correlation between consistency with candy and consistency with money. We regressed the score of consistency with money against consistency with candy and found a positive and statistically significant coefficient (coefficient = 0.41; t = 10.50).

Repeated surveys with the same subjects improved the reliability of answers as the study unfolded, probably because subjects understood the task better and trusted researchers more. For instance, mean consistency scores using money or candy improved from 0.91 during the first quarter to 0.96 during the last quarter. Within-subject correlation in scores of patience also improved over time. Within-subject correlation coefficients of patience between the first and the second quarter were 0.004 for money and 0.12 for candy, and in neither case were results statistically significant. Within-subject correlation coefficients for patience between the third and the fourth quarters (the last two quarters of data collection) were 0.32 for money and 0.46 for candy, and in both cases results were statistically significant at the 99% confidence level or higher.

Mean measures of patience using money ($k = 0.143$) were 20.10% lower than mean measures of patience using candy ($k = 0.172$), probably because of a built-in bias to select the delayed reward with money and a built-in bias to select the immediate reward with candy. People in remote areas such as the Bolivian Amazon have few opportunities for spending money immediately, so using money as a reward may have induced subjects to select the delayed reward. Subjects who may have selected the larger delayed reward for money may have opted for the smaller immediate candy reward owing to the absence of storage technology to preserve more food received in the future. Measures of patience with the two currencies were strongly correlated across subjects for the entire panel. Using hyperbolic measures of patience, we regressed scores of patience measured with money against scores of patience measured with candy for subjects with consistency scores above 0.75 for money and with consistency scores above 0.71 for candy and found a positive and statistically significant coefficient (coefficient = 0.639; $t = 12.71$; $R^2 = 26$).

Explanatory Variables

Through structured interviews and direct measures, we collected quarterly information on the following explanatory variables: age, wealth, cash earnings, and anthropometric indices of short- and long-run nutritional status. We collected information on age during the first quarter and made adjustments for elapsed time during each subsequent survey.

Only during the first quarter did we collect information on schooling and the following modern human–capital skills: math and competence reading, writing, and speaking Spanish and Tsimane'. Although we gave objective tests to measure skills, the variables for skills may contain measurement error because we did not use culturally appropriate methods to test for both practical and academic skills. For instance, Tsimane' may have known math but may have displayed competence only when asked to solve practical problems with meaning in their daily lives (Grigorenko and Sternberg 2001; Sternberg et al. 2001, 2002), not when asked to solve academic problems, such as the ones we gave them.

Modern human-capital skills were highly collinear, with pair-wise partial correlation coefficients of generally over 0.70. Because of measurement error and high collinearity between skill variables, we tested whether measures of skills reflected an underlying dimension and found a Chronbach alpha of 0.86. We used principal component factor analysis to combine skills into one variable. We used varimax rotation and found that skills loaded into one factor, with an eigenvalue of 2.81; all other factors had eigenvalues below one. We use the index of human-capital skills in the regressions.

Control variables in all regressions included the sex of subject, a village dummy, rainfall and temperature on the day of the test, time of the week, and a full set of dummy variables for surveyors and quarters. Table 2 contains definition and summary statistics of the variables used in the regressions. Recent publications contain further explanations of how we measured variables (Godoy et al. 2002; Godoy, Kirby, and Wilkie 2001; Kirby et al. 2002; Reyes-García et al. 2003a, 2003b).

RESULTS

Human-Capital Perspective

The results shown in Table 3 suggest that schooling correlates with lower discount rates. Regressions 3 and 4 suggest that an additional year of schooling correlates with an 11.2–11.6% lower discount rate if we control for household fixed effects and with a 14.6–16.6% lower discount rate if we do not control for household fixed effects (regressions 1 and 2). In all cases, results were statistically significant at the 95% confidence level or higher. In regressions 5–8 we estimate the correlation between patience and the index of modern human capital. A one-unit increase in skills correlates with a 16.6% lower private discount rate if we control for household fixed effects (regression 8) and with a 21.1–25.5% lower discount rate if we do not control for household fixed effects (regressions 5–6). Results were statistically significant at the 95% confidence level or higher. Regressions 9–12 include both schooling and skills. Schooling continues to be strongly correlated with a lower discount rate, but skills does not. An additional year of schooling correlates with a 9.8% lower discount rate after controlling for household fixed effects (regression 12) and with a 14.5–15.7% lower discount rate without such controls (regressions 9–10). In the more complete econometric specification (regressions 9–12), the coefficient of the variable for skills retains the right (negative) sign but is statistically insignificant. Although skill by itself is

TABLE 2
Definition and summary statistics of variables

Name	Definition	*n*	Mean	Std. dev.	Min.	Max.
Dependent variables (discount rates)						
Money	Time preference using money with consistency > 0.75; see Table 1 and text	464	.143	.098	.0003	.248
Food	Time preference using candy with consistency > 0.71; see Table 1 and text	508	.172	.096	.0003	.261
Explanatory variables						
Wealth	Quarterly wealth owned by person in $b 1000s	491	6.17	1.27	0.69	9.13
Earnings	Quarterly earnings by subject in $b 1000s	491	.078	.172	0	1.713
Height	Z scores of height for age standardized relative to U.S. norms (Frisancho 1990)	455	-.954	.540	-2.661	.974
BMI	Body-mass index; kg/mt^2	465	22.52	2.623	14.90	31.92
Age	Exact age of subject on day of measurement; regression includes square term for age	455	32.93	15.50	10.73	80
Skills	Principal-component factor from score in math and reading test in Spanish, reading test in Tsimane', and speaking ability in Spanish	516	-.0003	1	-1.07	1.58
Schooling	Maximum years of school completed	516	1.84	2.15	0	10
Male	Sex of person (1 = male; 0 = female)	516	0.52	0.49	0	1

Note: US$1.00 ≈ $b 6.00.

insignificant, the tests of joint significance for skill and for schooling in regressions 9–12 are generally significant at the 95% confidence level or higher, suggesting that both forms of human capital matter.

We reestimated regressions 5–8 without the skill index and, instead, entered the different human-capital skills separately to identify which skill mattered most. We found that no skill was statistically significant, suggesting that the significance of skills stems from their joint effect rather than from the effect of any one skill working in isolation. We also reestimated the parameters of the regressions adding a measure of folk ethnobotanical knowledge (Reyes-García et al. 2003a, 2003b) to assess whether traditional human capital also correlated with lower patience. We found that the coefficient for ethnobotanical knowledge was positive but statistically insignificant. We could not use a person fixed-effect model because we measured schooling and skills only once during the study, so the variables would have lacked within-subject variance.

TABLE 3
Regression results: Human-capital perspective

Covariates	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
	Dependent variable: Patience measured with money ($n = 411$)											
Schooling	-.166***	-.146***	-.116**	-.112***					-.157**	-.145***	-.097	-.098*
	(.049)	(.035)	(.058)	(.038)					(.068)	(.048)	(.075)	(.051)
Skills					-.255**	-.211***	-.183	-.166**	-.028	-.003	-.058	-.044
					(.107)	(.081)	(.119)	(.082)	(.144)	(.109)	(.153)	(.109)
Age	-.009	-.005	.009	.012	.009	.012	.022	.026	-.008	-.005	.011	.013
	(.026)	(.017)	(.026)	(.018)	(.026)	(.081)	(.026)	(.017)	(.027)	(.017)	(.027)	(.019)
Age^2	.0001	.0001	.00002	-.00002	-.00008	-.00004	-.00009	-.0001	.0001	.0001	.00005	-.00004
	(.0003)	(.0002)	(.0003)	(.0002)	(.0003)	(.0002)	(.0003)	(.0002)	(.0003)	(.0002)	(.0003)	(.0002)
Test: age and age^2	.66	.62	2.76	2.09	2.09	1.81	5.52	4.50	0.60	0.59	2.71	2.06
	(.717)	(.538)	(.251)	(.125)	(.351)	(.164)	(.063)	(.011)	(.741)	(.55)	(.258)	(.128)
Test: skills and school									11.07	8.65	4.02	4.33
									(.003)	(.0002)	(.133)	(.013)
Regression	RE	OLS	RE	OLS	RE	OLS	RE	OLS	RE	OLS	RE	OLS
Fixed effects	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
BP	11.47		2.65		12.43		3.03		11.48		2.67	
	(.0007)		(.103)		(.0004)		(.081)		(.0007)		(.102)	
Hausman	17.53		15.18		20.06		19.38		17.72		10.91	
	(.063)		(.125)		(.028)		(.035)		(.059)		(.365)	

Table 3 continued

Covariates	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
	Dependent variable: Patience measured with candy (n = 448)											
Schooling	-.152***	-.149***	-.140***	-.143***					-.131**	-.126**	-.112**	-.115*
	(.037)	(.040)	(.042)	(.045)					(.051)	(.052)	(.055)	(.059)
Skills					-.251***	-.246***	-.228***	-.228***	-.063	-.065	-.087	-.084
					(.078)	(.073)	(.086)	(.070)	(.106)	(.091)	(.110)	(.093)
Age	-.009	.010	.003	.002	.026	.028*	.019	.019	.011	.012	.006	.005
	(.019)	(.017)	(.019)	(.017)	(.019)	(.015)	(.018)	(.016)	(.019)	(.017)	(.019)	(.018)
Age^2	-.00009	-.0001	-.000004	.00006	-.0002	-.0002	-.0001	-.0001	-.0001	-.0001	-.00003	-.00002
	(.0002)	(.0001)	(.0002)	(.0001)	(.0002)	(.0001)	(.0002)	(.0001)	(.0002)	(.0001)	(.0002)	(.0002)
Test: age and age^2	.33	.18	.60	.29	3.18	1.78	3.36	1.59	0.39	0.27	.61	.24
	(.847)	(.835)	(.740)	(.747)	(.203)	(.169)	(.185)	(.206)	(.822)	(.764)	(.737)	(.785)
Test: skills and school	17.09	7.12	11.29	6.32								
	(.0002)	(.0009)	(.003)	(.002)								
Regression	RE	OLS	RE	OLS	RE	OLS	RE	OLS	RE	OLS	RE	OLS
Fixed effects	No	No	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	Yes
BP	8.08		.01		9.04		.05		7.92		.01	
	(.004)		(.935)		(.002)		(.818)		(.004)		(.919)	
Hausman	24.02		17.47		6.63		1.53		19.62		1.24	
	(.007)		(.064)		(.759)		(.998)		(.033)		(.999)	

Note: Dependent variable is logarithm of private time preference using money or candy to elicit information. Standard errors in parentheses. *, **, and *** significant at the 90%, 95%, and 99% confidence level. Controls variables in all regressions not shown include: (1) sex, (2) daily rainfall, (3) mean daily temperature, and (4) dummy variables for villages, day of the week, quarters, and coders. BP = Breusch-Pagan and refers to Lagrangian multiplier test for random effects. Hausman is specification test that there is no correlation between random effects and explanatory variables. Under regression type, RE = random effect, FE (fixed effect) = OLS (ordinary least squares) with village and household fixed effect and robust standard errors. Regression with money is for subjects with consistency above 0.75, and for candy it is for subjects with consistency above 0.71. For definition of consistency, see text. Under joint test for age and age^2 or for schooling and skills, we report Chi square values and probability of exceeding values (in parenthesis).

Material-Constraint Perspective

To estimate the correlation between material constraints and patience we used a two-pronged strategy. First, we used individual-level measures of wealth and earnings as explanatory variables. Second, because these variables could contain measurement errors, we used two standard proxies for economic well-being: body-mass index (BMI) and age and sex-standardized z scores of height for age. BMI proxies for short-run nutritional status, height proxies for long-run nutritional status, and both tend to correlate with affluence (Steckel 1995). Of course, anthropometric indices could stand on their own as proxy variables for nutritional status or general health. Recall that Becker and Mulligan hypothesized that good health should increase patience, so whether we view anthropometric indices as proxy variables for affluence or as proxy variables for health-nutrition, they should still correlate negatively with private rates of time preference.

As expected, earnings correlated with lower rates of time preference, but only when using candy to measure patience (Table 4). An increase of 1000 *bolivianos* in personal earnings correlated with 76.5–96.4% lower rates of private time preference (regressions 7–9). Results were robust to the type of regression used (OLS or random-effect) and to controls for household fixed effects. Earnings bore no statistically significant correlation with patience measured with money (regressions 1–3), and wealth bore no statistically significant correlation with patience, whether measured with money or with candy (regressions 1–3, 7–9).

BMI, the proxy variable for earnings, bore the expected negative correlation with private rates of time preference when using money to measure patience. An increase of BMI of one unit correlated with a 8.0–8.2% lower rate of private time preference (regressions 4–6), and in all cases results were statistically significant at the 95% confidence level or higher. BMI bore no correlation with rates of time preference measured with candy (regressions 10–12), and height bore no correlation with scores of time preference measured with money or with candy (regressions 4–6, 10–12). We reestimated the regressions of Table 4 lagging BMI and height by one quarter and found that BMI still correlated negatively and in a statistically significant way with patience measured with money, but not with patience measured with candy.

Life-Cycle Perspective

We find mixed support for the life-cycle perspective. In almost none of the regressions of Table 3 are the terms for age and age squared individually or jointly statistically significant. But in the regressions of Table 4, the rate of private time preference bears the hypothesized inverted U-shaped relation with age, and in all regressions of Table 4, the tests of joint significance for age and age squared are statistically significant at the 97.5% confidence level or higher.

We carried out two further tests to ensure robustness. First, we reestimated the regressions of Table 4 with personal fixed effects and found that none of the results discussed earlier held up. Second, we lagged right-hand side variables for anthropometric indices, income, and wealth, and in almost no case did we find a significant correlation except, as mentioned, with lagged values of BMI; these

TABLE 4
Regression Results: Material-constraint perspective

Covariates	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
	Dependent variable: Patience measured with money						Dependent variable: Patience measured with candy					
	n = 392			n = 411			n = 429			n = 448		
Earnings	-.214	-.413	-.306				-.899**	-.964*	-.765**			
	(.512)	(.553)	(.523)				(.384)	(.558)	(.387)			
Wealth	-.284	-.423	-.284				.216	.077	.413			
	(.283)	(.301)	(.328)				(.230)	(.198)	(.266)			
BMI				-.080**	-.080***	-.082**				-.016	-.020	-.008
				(.036)	(.027)	(.038)				(.028)	(.023)	(.029)
Height				-.013	-.044	.021				.116	.111	.089
				(.109)	(.079)	(.113)				(.082)	(.089)	(.086)
Age	.025	.026	.030	.039	.038**	.051*	.039*	.041***	.023	.040*	.042***	.028
	(.027)	(.018)	(.026)	(.029)	(.019)	(.028)	(.020)	(.015)	(.020)	(.021)	(.015)	(.021)
Age^2	-.0001	-.0001	-.0001	-.0002	-.0003	-.0004	-.0003	-.0003**	-.0001	-.0003	-.0003**	-.0002
	(.0003)	(.0002)	(.0003)	(.0003)	(.0002)	(.0003)	(.0002)	(.0001)	(.0002)	(.0002)	(.0001)	(.0002)
Joint test of:												
1. Age and age^2	7.23	4.80	9.10	9.16	6.78	12.63	11.43	7.07	7.31	10.85	7.36	8.02
	(.026)	(.008)	(.010)	(.010)	(.001)	(.001)	(.003)	(.001)	(.025)	(.004)	(.0007)	(.018)
2. Earnings and wealth	1.16	1.29	1.05				6.56	1.52	6.90			
	(.559)	(.275)	(.591)				(.037)	(.220)	(.031)			
3. Anthropometric				4.92	4.34	5.30				2.73	1.93	1.38
				(.085)	(.013)	(.070)				(.0254)	(.146)	(.502)
Regression	RE	OLS	RE	RE	OLS	RE	RE	OLS	RE	RE	OLS	RE
Fixed effects	NO	NO	YES	NO	NO	YES	NO	NO	YES	NO	NO	YES
BP	12.67		2.64	10.68		2.64	11.11		0.16	11.32		0.31
	(.0004)		(.104)	(.001)		(.104)	(.0009)		(.690)	(.0008)		(.579)
Hausman	20.80		38.76	18.39		20.52	9.50		3.72	5.99		3.05
	(.053)		(.0001)	(.104)		(.057)	(.659)		(.987)	(.916)		(.995)

Note: Explanation of abbreviations same as for Table 3.

continued to correlate negatively with private rates of time preference measured with money.

DISCUSSION AND CONCLUSIONS

The most significant finding to emerge is the strong, negative, and statistically significant correlation between years of schooling and impatience. Results held up after controlling for a wide range of covariates, including skills and village and household fixed effects. Results also held up under different model specifications. The absence of a strong correlation between skills and patience in the more complete models (e.g., regressions 9–12, Table 3) likely reflects attenuation bias from random measurement error of the skill variable. Results conform with the predictions of the Becker-Mulligan model and with several empirical studies from developed nations that show a positive correlation between patience, skills, and schooling (Harrison, Lau, and Williams 2002 ; Lawrance 1991; Warner and Pleeter 2001).

Since we controlled for skills, the coefficient for the schooling variable could pick up the ability of people to simulate future scenarios, as Becker and Mulligan hypothesize. But it could also pick up something else. In several publications, Bowles and Gintis (1975; Bowles, Gintis, and Osborne 2001) have argued that schooling instills respect for authority, obedience, and conformity. It is possible that the positive correlation between patience and schooling could also reflect unmeasured personality and behavioral traits learned in school. Last, patience and schooling could correlate positively because people who are more patient may have accumulated more schooling in the past (Warner and Pleeter 2001).

We found mixed support for the life-cycle or material-constraints perspectives. One reason why we found mixed support for the life-cycle perspective has to do with measurement error and with the range of ages in the sample. A test faithful to the life-cycle hypothesis requires measures of patience over the entire life cycle of subjects; we did not include children in our study, so we had a sample truncated at the lower end of the age distribution. More important, random measurement error of the age variable produced an attenuation bias. In a subsequent survey (2001) in thirty-seven Tsimane' villages with about 350 adults and 350 children, we asked adults for their age and asked parents for the ages of their children. We returned a year later at about the same time of the year and again asked adults for their age (and the ages of their children) even though we knew that their age had increased by roughly one year (± 1–2 months to account for delays in the reinterview date or for reinterviews that took place before the completion of a full year). Only 20% of subjects reported their age correctly. A quarter reported an age that represented an increase of more than one and a half years; for example, a subject who was 20 years old in June 2001 would report being over 21 years and 6 months old in June 2002. More than half of the sample (55%) reported an age that represented a decrease of more than a half a year. Random measurement error in the age variable weakens the validity of our tests of the life-cycle hypothesis.

We cannot explain why material constraints did not bear a more consistent correlation with patience. As mentioned, we would have expected material constraints to correlate with lower patience since so many studies from industrial nations show a negative correlation between impatience and affluence. One reason may have to do with widespread patterns of sharing and reciprocity. Social capital smooths differences in affluence and, in so doing, weakens the possible role that material determinants could have in shaping patience. Put differently, when social norms dilute personal wealth and personal income in the collectivity, the effect of income and wealth on patience may be diluted as well.

How do rates of time preference for the Tsimane' compare with rates of time preference from industrial societies? We cannot answer the question with confidence because researchers disagree on how to measure patience. Frederick, Loewenstein, and O'Donoghue (2002) recently summarized the results of forty-two empirical studies on patience and found "spectacular" differences in discount rates across studies. To compare patience across cultures, researchers must use the same good (e.g., money, food), the same time range, the same size of rewards, and the same method to elicit data (e.g., matching, price, choice).

Bearing those caveats in mind, we nonetheless compare our results with two studies from the United States because we all used nearly identical methods to elicit data and to compute hyperbolic discount rates. In one study with heroin addicts and a control group, Kirby, Petry, and Bickel (1999) found that addicts had mean discount rates (the k values discussed earlier) of 0.025 and controls had mean discount rates that were half as high, $k = 0.013$. The figures translate roughly into discount rates of 2.5%/day for addicts and 1.3%/day for subjects in the control sample. In another study with college undergraduates, Kirby and Marakovic (1966) found mean discount rates of 0.007 (0.7%/day). In contrast, the Tsimane' have much higher discount rates. As the summary statistics of Table 2 suggest, mean discount rates for Tsimane' were $k = 0.172$ using candy and $k = 0.143$ using money, which translate into daily discount rates of about 17.2% and 14.3% for candy and money, respectively. Median patience scores for Tsimane' were 16.0%/day for candy and 15.9%/day for money. Possible reasons for the higher rates of time preference of Tsimane' might relate to one or more of the following: poverty, lack of trust of researchers, low stocks of modern human capital, and possible shorter life expectancy. The studies by Kirby and colleagues do not report standard deviations, coefficients of variation, or ranges, so we cannot compare the range of variation in patience across the studies.

We conclude with some suggestions for future research. First, the study of patience could benefit from cross-cultural theorizing. We know of no study on the topic, but the added value of such studies would be large since so little has been done on the topic.

Second, before cross-cultural studies can yield useful results, researchers will need to agree on a more narrow range of method(s) for measuring patience. There are so many ways of measuring patience that case studies are unlikely to add much to the cross-cultural understanding of patience unless researchers reach closure on some of the most reliable and promising methods. If the field is too young to reach closure, then anthropologists could contribute to it by bringing new methods to the table or by assessing the reliability of methods across cultures. Frederick, Loewenstein, and O'Donoghue (2002) note that patience probably includes many different dimensions that have been treated as a unitary concept. If true, then anthropologists could help to unbundle the concept.

Third, since the comparative advantage of anthropologists often lies in the collection of primary data in the field, anthropologists should be mindful of attenuation biases produced by measurement errors of explanatory variables. Our use of the age and skill variables provides an apt example of what we mean.

Last, anthropologists studying patience should capitalize on their likely long-term presence in the field to obtain a more dynamic view of patience. Current empirical work on patience provides only static, synchronic snapshots. Anthropologist could add a much-need dynamic perspective.

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