Decision-making, Cultural Transmission and Adaptation in Economic Anthropology[1]

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It's our custom —Bartolo Gallardo (1998), a Mapuche farmer in Chile who was replying to my question about why his neighbors only plant winter wheat (1998).

Custom, then, is the great guide of human life—David Hume (1748).

With the exception of the instinct of self-preservation, the propensity for emulation is probably the strongest and most alert and persistent of the economic motives proper.–Thorstein Veblen (1899: 85)

Abstract

This paper argues that economic anthropologists need to reduce their reliance on cost-benefit decision-making, and incorporate a cognitively informed understanding of social learning, cultural transmission and information processing. Human behavioral patterns are unlikely to be primarily a product of cost-benefit decision-making because: 1) Laboratory data show that human information processing is so fraught with errors, biases and mis-calibrations that, if this is our primary mode of adaptation or of achieving individual goals, we should observe systematic patterns of maladaptation or of goal-averting behavior; and 2) Ethnographic data show that individuals often lack the kinds of information required by typical cost-benefit models. As a theoretical alternative, I argue that humans rely heavily on biased cultural transmission. By *selectively* copying certain individuals or ideas, biased cultural transmission can (over time) generate the well-integrated, adaptive, behavioral patterns that we observe ethnographically.

Keywords: Economic Anthropology, Cultural Transmission, Adaptation, Decision-making

Most research in economic anthropology relies heavy on the assumption that economic behavior and behavioral change can be understood as the product of individuals making decisions based on the costs and benefits of alternative options. From this perspective, the key to explaining widespread behavioral patterns, or the direction of change, resides in understanding how individuals evaluate information about specific problems (their perceptions) and integrate this with their preferences, beliefs and expectations. Depending on the researcher, 'culture' may be invoked to account for all, some, or none of these perceptions, preferences, beliefs and expectations. In this paper I argue that researchers should reduce their reliance on these cost-benefit decision models and incorporate cognitively-based models of social learning and cultural transmission processes. By understanding more of how individuals acquire cultural information from the minds of other individuals (in the form of ideas, behaviors, beliefs, values and worldviews), we can provide both alternative and complimentary explanations for behavioral patterns, adaptation (and maladaptation), change, tradition, and cultural evolution.

The issue debated here is not whether individuals or groups are well-adapted to their environmental, socioeconomic and/or political circumstances. Rather, the question is one of *process*: how or why do individuals or groups alter their behaviors or behavioral strategies to adapt, and sometimes mal-adapt, to their circumstances. Numerous anthropological studies from many different societies have convincingly shown that individuals and groups possess behavioral practices that are well suited to their environments or quite 'sensible' given the socioeconomic situation and cultural world. However, from a cognitive perspective, it remains unclear whether humans can perform the information processing necessary to generate the kinds of adaptation (and maladaption) that we observe. In many cases, human behavior and culture—with its intricately-integrated, well-adapted, and often subtle rules, decision-heuristics and scripts—seems too well adapted, given what we know about our decision-making abilities. In others cases, static cultures or traditions seem incredibly resistant to new information that, at least to outsiders, seems indicate a need for behavioral adjustments.

It's easy to misunderstand my characterization of *cost-benefit decision-making* as a simple a re-labeling of the infamous rational actor model that continues to pervade much of economics and political science. However, criticizing mainstream economic anthropology for adhering to rational models would be a big mistake, as most anthropologists have long abandoned the simplistic maximization models typically associated with the rational actor approach. Indeed, the classic rational actor represents a sub-category of cost-benefit decision-makers, but the overall cost-benefit category is much more general. Looking at the core assumptions, what both economics and economic anthropology have inherited, perhaps from Renaissance philosophy, is the intuitively-pleasing notion that people are best understood as goal-driven strategists who deploy their reasoning abilities (however meager) in pursuit of their goals. This is what I mean by *cost-benefit decision-making*. Decision-makers may have limited information, limited ability to process that information, multiple goals and a constraining social structure, but if they are evaluating information about alternative behaviors, then they're still doing cost-benefit decision-making. The cost-benefit category says nothing about where individuals' goals come from, only that individual have goals, and that they evaluate information relevant to achieving those goals—and make behavioral choices based on those evaluations. I am not arguing that people never do cost-benefit decision-making, but that this approach leaves out non-strategic cognition mechanisms, such as cultural learning that may substantially affect the evolution of behavioral patterns.

Most forms of cultural transmission create cultural evolution—i.e. a change in the frequency or distribution of behaviors, ideas, beliefs and values— under a wide range of conditions *without any cost-benefit decisions* being made by anyone. To demonstrate this, imagine human cognition has the learning rule 'preferentially imitate the person with the most children.' With such a rule, individuals of all ages will count the offspring of each person in the group and attempt to copy the behaviors, ideas, beliefs and practices of the most fecund person(s). In a foraging society, this will cause things such as tracking techniques, food preferences, child-rearing practices, private rituals, prey choice and arrow manufacturing procedures of the most fecund individual to spread through the group. And, to whatever degree this individual's behaviors and ideas initially differed from other members of the group, we will observe a shift in the distribution of ideas and behaviors in the group (i.e. cultural evolution). This occurs without anyone considering the costs and benefits of different foods, types of arrows or prey choice. If in a few years, as different person emerges as the most fecund, the current cultural configuration will shift to incorporate whatever idiosyncratic ideas and behaviors this individual possesses. If we call a culture 'well-adapted' when its configuration of ideas and behaviors promotes the efficient production and maintenance of offspring, then the process described above will produce a 'well-adapted' culture over several generations, without any cost-benefit decisions.[2]

My point is that cultural learning rules (or transmission mechanisms) do not necessarily pass beliefs and behaviors from one generation to the next in stable traditions. Under some conditions, cultural transmission mechanisms can create stable traditions that endure for long periods. If, in the above example, the idiosyncratic differences possessed by the most fecund individuals are never systemically (causally) related to the individual's fecundity, then the distributions of behaviors in the group will fluctuate through time without showing any directional evolutionary change, or stable adaptive pattern. Or, if people don't vary in the number of offspring they produce, then such a learning rule will not drive any cultural change. Under other conditions, however, cultural transmission mechanisms will produce rapid cultural change and drastic behavioral shifts. Note that the above example is only meant to illustrate a theoretical point, and is not intended to be a claim about human psychology.

The word 'culture' always creates some confusion. By 'culture' I refer to those ideas, beliefs, behaviors and values that *can* be transmitted from one individual to another via some form of direct social learning. From this perspective, animals are 'cultural' if they possess the cognitive ability to acquire information (i.e. behaviors, ideas, etc.) by observing or interacting with others. Humans, sea otters, songbirds and perhaps chimpanzees demonstrate at least some cultural abilities. This approach to culture allows us to make a clear distinction between 'social' and 'cultural' things. Humans, baboons and wolves (for example) are all social animals, meaning they frequently interact with one other and prefer to live in groups. However, of these three, only humans are cultural, because only humans possess the cognitive capacities for observation learning, imitation and other forms of direct social learning. In contrast, both songbirds and humans have cultural abilities, but songbirds are not very social. Consequently, we may talk of baboons' behavior being influenced by social factors (e.g. social structure, coalitions, or dominance hierarchies), but baboons cannot be influenced by the culture of their group—as best we know, baboons have no ability to acquire behaviors by direct social learning. For my goals in this paper, it's important to distinguish social from cultural forces—and I will focus on cultural forces.

Economic anthropologists invoke 'culture' in a variety of ways. Some staunchly void it, maintaining that 'culture' is not an explanation, but the thing to be explained. Others explain everything as cultural, and see that as sufficient. Most economic anthropologists, however, fall somewhere between these two extremes. In these instances, 'culture' may provide individuals with certain preferences, perspectives or context-specific heuristic rules. Unfortunately, labeling a belief, preference, or heuristic as 'cultural' halts further inquiry into why people possess that particular belief, preference or heuristic. For example, explaining the Mapuche's practice of planting only one major cereal crop (wheat) as a consequence of their belief that their god will bless only one crop requires explaining why they have that belief, and how its maintained in the face of alternative beliefs (why not believe that god will bless three crops?). In what's to come, I show how understanding the cognition of cultural transmission allows us to crash through the imaginary bulwark erected by the label 'cultural' to explain how certain things come to be widely shared, and why they change through time.

COST-BENEFIT DECISION-MAKING & 'CULTURE' IN ECONOMIC ANTHROPOLOGY

In this section I provide examples from recent work in economic anthropology to demonstrate two things. First, I show that economic anthropologists model individuals as cost-benefit decision-makers. Where appropriate, I detail the types of information and calculations necessary for the required cost-benefit decisions in order to emphasize the difficulty of such cognitive feats, given what we know about human cognitive abilities (which is subsequently discussed). Second, I illustrate how economic anthropologists invoke 'culture' and how this invocation halts further analysis.

Wilk's (1996) excellent introductory text on economic anthropology illustrates how tightly cost-benefit decision-making is interwoven into the fabric of economic anthropology—as well as into social and economic theory more generally. Wilk astutely divides the wide variety of approaches that have influenced economic anthropology into three categories according to their underlying assumptions about human nature. These three categories alternatively assume humans are rational, social and moral/cultural. Wilk's description of these three approaches can be simplified as follows: 1) *Rational* models assume humans are motivated by narrow self-interest; 2) *Social* models assume that humans give important weight to the well-being of others, their social group, or society; and 3) *Moral* models assume humans decisions are guided by a set of culturally learned principles that distinguish right from wrong.

All three of these categories are actually sub-categories of the cost-benefit approach. *Rational* actors make choices and plan strategies based on their own self-interest—the goal being to maximize self-interest. *Social* actors make choices and plan strategies aimed at benefiting others, or their social group—so their goal, or at least one of them, is to help others or their social group. Moral actors make choices and plan strategies according to their principles—with the goal of living up to, or at least not violating, these principles. Underlying all of these models is the assumption that individuals are goal-driven, strategists who weight choices according to their own ends (i.e. they are cost-benefit decision-makers). Wilk's final chapter presents an interesting effort to construct a framework for incorporating all three models on varying temporal and social scales. His synthetic framework encompasses a vast range of cost-benefit models, but does seriously consider that cultural evolution might (sometimes) be driven by non-strategic cognitive processes, such as selective imitation (also see Rocha 1996).

Many economic anthropologists believe that cultural evolution, behavioral change and adaptation result from individuals making cost-benefit decisions *and* transmitting these decisions, or their behavioral outputs, via social learning to their progeny. So, although most see 'culture' or 'tradition' as part of the process, the actual cultural transmission among individuals (or generations) plays no dynamic role. In this view, cultural transmission simply replicates the existing distribution of behaviors, beliefs, etc. without substantially altering their distribution or form. I term this particular type of cultural learning 'static transmission'. From this perspective, the driver of changes lies in the decision-making process, not in the transmission process. Gladwin & Bulter (1984: 210), following Chibnik (1981), articulates this approach in three steps: 1) individuals evaluate alternatives using low-cost experiments to gather information; 2) these decisions become codified in cultural rules; and 3) these rules are *statically* transmitted to the next generation. For Gladwin, Bulter and Chibnik, the driver of change lies in the cost-benefit evaluation of alternatives based on low-cost experimentation, not in the intergenerational transmission of this information. Similarly, while Harris maintains that, "As a species we have been selected for our ability to acquire elaborate repertories of socially learned responses…"(1979: 62), he believes that sociocultural evolution is driven by individuals opportunistically selecting among cultural/behavioral variants according to their benefit/cost ratios. Throughout the rest of my discussion I term this combination of static transmission plus cost-benefit decision-making the *standard model*. In the standard model, cost-benefit decision-making can only be the primary driver of change if the inter-personal or intergenerational transmission does not substantially alter the distribution ideas, rules and behaviors through time. To the contrary, I will show that there's good reason to believe cultural transmission is heavily biased in ways that have substantial, and often adaptive, consequences.

In a more concrete example, Stonich (1993: 109) uses a cost-benefit approach to explain why farmers in the town of Oroquina (Honduras) rely on a system of intercropping of corn and sorghum:

> This farming system is a compromise between the clear cultural preference for corn, the staple of the peasant diet, and the need for the less desirable but climatically better adapted and more reliably yielding sorghum…The function of the more drought tolerant sorghum as a risk reduction crop is illustrated…

Stonich has modeled these farmers as maximizing a benefit/cost function containing both a "cultural" preference for corn and a preference for "better adapted and more reliably yielding" crops (sorghum in this case). To accomplish this farmers must calculate the proper amount of sorghum to cultivate, given the strength of their cultural preference, their desired degree of risk reduction, the average yields of corn and sorghum, and the variance in those yields (the variance is required to assess the risk involved). All this requires an accurate recall of crop production from previous years, the ability to calculate expected yields and variances, and some capacity to integrate and process all this information. As we'll see in the next section, this is no easy task for our meager primate brains.

Another question arises from considering the information required for this cost-benefit analysis:

How do Oroquinan farmers know *not* to plant crops that they don't routinely plant (and thus have no information on)? That is, why don't these farmers plant rice, millet or manioc? Do they somehow know the expected yields and yield variances for each of these, and can thus eliminate them? One might argue that such crops are not well-suited to the local environment, but how do farmers *know* this?[3]

Regarding culture, corn is invoked as a "cultural preference" when it doesn't seem to make good adaptive sense. The implication is that farmers should plant all sorghum, but don't because a cultural preference gets in the way. If this is true, why is such a preference maintained in the face of cost-benefit decision-making that favors sorghum? Why don't people have a sorghum preference? How do we explain the stability of the corn preference? If a corn preference is essential to explaining the behavior of these farmers, then the real key is to understand the process that spread and now maintains this corn preference.

Stonich also mentions risk reduction as a factor in farmers' computations. How do farmers compute or acquire their risk preferences? We know individuals and groups vary in their risk preferences (Henrich & McElreath 2000). Thus, a more complete explanation should explain where this risk preference comes from—that is, why do they want to reduce risk by this amount. Presumably, if they desired even *less* risk, they would plant even more sorghum. Why aren't they more risk averse? Is their risk aversion a cultural preference? How do well-suited risk preferences arise?

In another example, Eduardo Garland tries to explain why Andean colonists migrating into the Upper Huallaga region of the Peruvian Amazon employ extensive agricultural practices instead of more intensive agricultural methods:

> Their subsistence strategies are structured around very restrictive patterns of maximization (1995: 231). Colonists combine a strategy of reducing the requirements for labor [by cutting new land to avoid weeding] with that of minimizing risk [intensive agriculture is more productive, but requires risky expenditures]. Such an approach leads to a pattern of extensive land management and continuing deforestation… (1995: 224; brackets are my additions).

In this approach, individuals seem to be maximizing a utility function containing a preference for little work, a preference for low risk, and a desire for greater production/profit (implicit). To arrive at this behavior, individual farmers must be able to calculate the difference in the average amount of labor required to cut a new garden vs. that necessary to continue weeding an older field, and the difference between the expected crop yields from each garden. This requires sufficient experience in both continuing to weed older gardens and in cutting new gardens, as well as an accurate memory of the labor requirements and yields of each. Farmers must also be able to integrate the probability of catastrophic failure (the yield falling below a subsistence minimum) with the probability of generating greater income with higher crop yields, given environmental and market fluctuations. Such calculations require the accurate assessment of expected yields, yield variances, environmental conditions and market prices, as well as the ability to weight and process this information. Given that these are new *immigrants,* who have little or no experience with local markets, regional price fluctuations or the effectiveness of modern inputs under local conditions, it is difficult to see how farmers could acquire the necessary information, let alone process it.

Interestingly, Garland goes on to use this cost-benefit approach to analyze the differing rates of deforestation among five swidden agricultural groups in Peru: the Amarakaeris of the Madre de Dios, the Machiguenga of the Urubamba, the Ashaninka of Satipo, colonists of Satipo and colonists of the Upper Huallga (See Table 1). In standard fashion, Garland attempts to explain these differences by first examining how factors such as land pressure, wage labor and resource availability affect individual economic decisions. However, these situational differences seem small relative to the large differences in deforestation rates between indigenous peoples and colonists (note, for example, the difference between the colonists of Satipo and the Ashaninka of Satipo). In response, his analysis moves to focus on group-level differences in such things as resource management strategies, resource diversification, and conservation ethics—things that vary, not as a consequence of individual cost-benefit decisions, but as a consequence of individuals having been reared in certain social groups. ‘Culture’ is used to label beliefs and practices that vary among groups. Unfortunately, due to the lack of any *theory of culture*, the analysis stops once something is designated as ‘cultural’. The next question should be: why do beliefs and management practices differ between these groups, and how can such beliefs be maintained through time under changing economic and environmental circumstances, and in the face of opposing individual-level cost-benefit analysis? Static transmission processes will *not* maintain such a pattern in the face of even small amounts of migration or interaction. Garland’s analysis suggests that the key to understanding the differences in deforestation rates lies not in cost-benefit decision-making, but in the cultural processes that create and maintain differences in resource management strategies and conservation ethics among groups.

HUMANS ARE NOT VERY GOOD COST-BENEFIT DECISION-MAKERS

In this section I review evidence from cognitive psychology, experimental economics and ethnographic research to show two things. First, laboratory evidence indicates that humans lack the computational abilities to behave according to typical cost-benefit models (as illustrated in the above examples from Garland and Stonich). Of course, the fact that people are systematically inaccurate at analyzing information does not, in and of itself, mean that we don't rely on cost-benefit decision-making. It does means that people should *systematically* select alternatives that *do not best facilitate* their goals—that is, even if people are trying to make strategic decisions according to some set of goals, their cognition will cause them to systematically (and obstinately) make 'wrong' or goal-averting choices. Thus, any effort to explain human behavioral pattern as a consequence of informational analysis should account for these, and thus expect to observe systematic 'errors' or maladaptation. However, only rarely are these cognitive findings mentioned (e.g. Quinn 1978), let alone incorporated into explanations for persistent behavioral patterns. Second, field evidence further suggests that humans, whether peasants or MBAs, do not rely on cost-benefit models because people lack much of the information required by such models.

Because this experimental literature on decision-making has grown rapidly in both psychology and economics, many of these results are aimed at disputing or confirming specific theories within their respective disciplines. In this section however, I've tried to distill all this into a brief summary of the robust findings, and unfortunately have space only to detail a few studies as illustrative examples. Interested readers should begin with some of the excellent review papers: see Camerer (1995), Rabin (1998), Abelson & Levi (1985), and Thaler (1987).

Memory Bias

Experimental work suggests that human memories are biased by what psychologists call *availability* (Tversky & Kahneman 1973). In assessing the probability of events or frequency of items, people search or sample from their memory. Events involving recent examples and personal experiences are more available and overweighed (judged more likely). For example, a comparison of married couples indicates that individuals overweight their responsibility and contribution toward household activities, including their contributions to negative items like starting arguments and making messes (Ross & Sicoly 1979). Similarly, in judging the likelihood of the next earthquake, individuals who have recently experienced an earthquake greatly overestimate the short-term chances of another (Camerer 1995).[4]

In memory, some items are more "retrievable" or salient than others. For example, given a list of names of men and women, in which there are more men but more famous women, subjects remember the list as containing more women's names. Similarly, if asked which is more common, words that start with an “r” or words that have “r” as the third letter, most people reply that it’s words that start with an “r”, despite the great predominance of words with “r” as the third letter (Tversky & Kahneman 1973).

When assessing the probability of a rare event or the risks involved in a novel task, people reveal an *imaginability bias*. When events or tasks have no precedents stored in memory, individuals judge the likelihood of risks associated with them according to the ease with which they can be imagined. In assessing the risks of a new practice or a dangerous journey, people disproportionately rely on imagining vivid potential contingencies without incorporating the probabilities of more difficult to imagine scenarios. Our capacity to evaluate such things depends on our ability to imagine different scenarios, but our ability to imagine different things does not seem to covary strongly with the occurrence of actual events (Tversky & Kahneman 1990).

If people cannot accurately store and retrieve the relevant information (see Kahneman et. al. 1982 for more biases), how can we expect them to properly compare crop yields from previous years, notice recurrent patterns in the environment, or accurately assess what past events tell them about the present? Now, from a cognitive/evolutionary perspective, memory should not be thought of as a monolithic information storage device, but rather a space differentially allocated and organized to meet the fitness challenges of life in our ancestral environment. Humans should be best at acquiring, storing and accurately recalling information that would best assist them in survival and reproduction.[5] For our purposes however, it does not matter if humans excel at remembering fitness enhancing items and forgetting other information. What matters is whether people possess sufficient memories of events and items, which were *never* encountered or selected for in the ancestral environment, in order to perform the computations required by most benefit/cost approaches. Can people, for example, remember a sufficient number of crops yields, rainfalls, labor allocations and market prices to make economic decisions in the way many economic anthropologists think that they do? This evidence suggests that they cannot.

Data processing biases

In addition to biases in their recall of information, people also have difficulty processing information. They often make systematic errors in processing information and making judgments. In this section, I review a small fraction of this data from six areas: sample sizes & the gambler's fallacy, regression to the mean, covariation detection and forecasting.

Sample Size and the Gambler's Fallacy

Humans often underweight or sometimes even ignore the effect of sample size when using data, depending on the type of problem. People reason as if they assume that samples of any size will be representative of the distribution or underlying process from which they arise (the '*representativeness heuristic'*). Small samples are often weighted as heavily as large samples. This means that individuals gather too little data and over generalize from these small samples to distributions, processes and decisions (Tversky & Kahneman 1971, 1993; Kahneman et. al. 1982).

For example, Kahneman and Tversky (from Nisbett & Ross 1980: 78) posed the following question to students at the University of Michigan:

> The average heights of adult males and females in the U.S. are, respectively, 5 ft. 10 in. and 5 ft. 4 in. Both distributions are approximately normal with a standard deviation of about 2.5 in. An investigator has selected one population by chance and has drawn from it a random sample. What do you think are the odds that he has selected the male population if:
>
> (i) The sample consists of a single person whose height is 5 ft. 10 in.?
> (ii) The sample consists of 6 persons whose average height is 5 ft. 8 in.?

As you might guess, a substantial majority of subjects estimated odds that favored the sample of one (choice i) over the sample of 6 (choice ii). The median odds estimated by the subjects favoring the male population for the 1-person sample were 8:1, while their odds favoring the male population for the 6-person sample were 2.5:1. The actual odds of 16:1 and 29:1, respectively, demonstrate that subjects misperceive the effect of sample size *in the opposite direction*—they favor the information provided by the small sample over a sample six times the size.

More recently, scholars have begun to refine the conditions under which humans (i.e. university students) properly weight, underweight and ignore sample size information. In a meta-analysis of this body of work, Sedlmeier & Gigerenzer (1997) have shown that people almost entirely ignore sample size when they are analyzing one kind of sample size problem (which they term "sample distributions" –a distribution of sample means), but that many people (70%) will use sample size information, in some fashion, to guide their judgments when analyzing problems involving standard frequency distributions—however, it remains unclear how well they use the information.

Although this distinction is an important refinement of the existing literature, and potentially related to the evolutionary origins of human brains, it does *not* help the cost-benefit decision-makers that inhabit the minds and models of economic anthropologists. Lots of real economic problems, to which anthropological peoples have well-adapted solutions, would require cost-benefit analysts to compare sample distributions. Many people need to "choose" among different gathering patches, fishing spots, crops, cropping techniques, domesticated animals, and hunting techniques. For example, if farmers relied on their individual informational processing abilities, they would incorrectly switch to new crops and practices based on small-scale experiments, limited information and one-time trials because they (being only human) would overweight small samples—notably, this is not what we generally observe among farmers. This research also indicates that if people relied primarily on cognitive data-processing algorithms that evaluate pay-off relevant information (crop yields, hunting yields, etc.), then people would not possess very stable, nor very adaptive, behavioral patterns.

This insensitivity to sample size may cause a phenomena termed the "gambler's fallacy" in which individuals perceive events in the world as occurring in swings or streaks. Basketball players and fans, for example, possess an unshakeable belief that certain players get "the hothand"—meaning they're on a scoring streak (i.e. field goals are positively autocorrelated).[6] In reality, however, actual hits and misses by players are remarkably close to independent (Gilovich et. al. 1985). When presented with this information, basketball coaches refuse to accept it and don't alter their strategy. Instead, they continue trying to get the ball to the player with "the hothand." Similarly, a mistaken belief in winning streaks creates systematic errors in betting odds on professional basketball games (Camerer 1989). People also consistently see streaks and patterns in random data (Bar-Hillel & Wagenaar 1993)—such data does not 'look' random. Consequently, farmers, herders and foragers should falsely perceive relationships between random events in the world, and as cost-benefit decision makers, they should unintentionally make goal-averting decisions based on these believed-patterns—just like basketball coaches do because of their belief in the 'hot-hand.'

Regression to the Mean

This insensitivity to sample size, or perhaps a tendency to assume any sample is representative of its underlying distribution or generative process, causes people to misperceive a statistical phenomena termed *regression to the mean.* I'll explain regression to the mean with an example. Pilot instructors, among many others, have 'learned' from experience that negative reinforcement (scolding and criticism of trainees) after a poor landing performance works better than positive reinforcement after a better-than-average landing. Unfortunately for trainees, pilot instructors are mistaken. If student pilots have an average quality of landing, then some landings will be better than average and some landings will be worse than average. A particularly poor landing is likely to be followed by a better-than-average landing, and quite likely to be followed by at least some improvement. Good landings are likely (as a statistical fact) to be followed by worse landings, and often worse-than-average landings. Pilot instructors recognize this, but rather than seeing it as a statistical phenomena, they falsely assume their negative reinforcement on bad landings had a positive effect on their students and their positive reinforcement after good landings had a negative effect. Psychologists exploring the influence of both positive and negative reinforcement on performance have accounted for this statistical tendency, and actually found that positive reinforcement improves average future performances, while negative reinforcement retards improvement! So, in many situations, human teachers do exactly the wrong thing.

Covariation Detection and Illusory Correlation

In general, evidence from psychology shows that people are poor detectors of covariation and correlation, except under very specific conditions. For example, after reviewing the data, Nisbett and Ross (1980: 111) conclude the following:

> The evidence shows that people are poor at detecting many sorts of covariation...Perception of covariation in the social domain is largely a function of preexisting theories and only very secondarily a function of true covariation. In the absence of theories, people's covariation detection capacities are extremely limited...Though the conditioning literature shows that both animals and humans are extremely accurate covariation detectors under some circumstances, these circumstances are very limited and constrained.

People often miss subjectively important strong covariations when the interval between the stimuli and the reinforcement, or the interval between successive sets of stimuli and reinforcements, is too long. For example, few insomniacs understand how temperature, the presence of an odd smell, exercise before bed or mental concentration prior to retiring influence their ability to get to sleep. Freedman & Papsdorf (1976) demonstrated that insomniacs, whose sleep onset was delayed by a pre-bedtime exercise program, nevertheless reported that the program *reduced* their insomnia.

Besides missing strong covariations, people also frequently see correlations where none exist—a phenomenon termed *illusory correlation*. Chapman & Chapman (1967, 1969, and 1971) found that scientifically-sophisticated clinicians insist that projective tests like the 'draw-a-person' and Rorschach tests are important diagnostic tools, despite the *fact* that empirical validation tests consistently show that most of these associations have little or no real correlation. The Chapmans argue that clinicians have some pre-existing notions that connect specific test results to certain diagnoses, and that these notions cause them to perceive correlations where none exist.

If people solve complex solutions in the manner suggested by many cost-benefit approaches, then individuals need the ability to detect a wide variety of correlations in environmental and economic information. For example, calculating when to stop investing labor in some activity by analyzing the diminishing marginal rate of return to labor input (the point of 'diminishing returns') in a stochastic environment (every real environment) requires the cost-benefit analyst to observe correlations between labor input and productive returns. Unfortunately, humans are terrible at observing such correlations, at least in laboratory settings, so it seems unlikely that individual-level computation is responsible for the subtle and intricate ways that humans have adapted to various environments. [7]

Forecasting

In studies intended to explore our ability to incorporate multiple predictor variables in a forecast of another dependent variable, psychologists have shown that learning is very difficult in simple deterministic situations and extremely difficult in stochastic situations (Castellan 1977; Brehmer 1980). Even experts perform worse than simple linearly-weighted combinations of observable variables. In over 100 careful studies of repeated judgements about stochastic outcomes in natural settings by medical doctors, psychiatrists and other experts, researchers have consistently shown that a weighted linear combination of observable variables outperforms these "experts" under most circumstances (Dawes, Faust & Meehl 1989). For example, Dawes (1971, 1982) discovered that the success of doctoral students could be better predicted by an equally-weighted linear sum of three measures—GRE scores, undergraduate school ratings and undergraduate grades—than by the rating of the faculty admissions committee.

Effect of training, practice and expertise

Some might think that many of the biases and decision-making patterns I have discussed result from a lack of training, practice or familiarity with these abstract tests. This is not the case. For example, the objection does not apply to evidence such as the basketball coaches' belief in the "hothand," or the systematic mistakes by odds makers, not to mention the repeated market games used by experimental economists. Outside the laboratory, actuaries and stockbrokers consistently reveal many of the same mistakes that freshmen do in the laboratory. Under some conditions, with well-structured feedback in repeated tasks, subjects can learn to avoid some of these mistakes, or at least diminish the strength of their biases, but extensive investigations demonstrate that these acquired abilities do not transfer well from task to task, across time or even when the parameters of the same task are altered (Camerer 1995). In short, there's no reason to believe that experience in the stochastic, poorly organized world of real life eliminates or even significantly reduces these errors and biases.[8]

Throughout the literature on judgment and data processing, humans place much greater weight on pre-existing theories, expectations and suspicions, than they do on data.[9] Most covariation remains quite invisible to human cognition without a pre-existing theory or expectation. The unfortunate consequence of this is that we often see correlations where none exist, just as we see patterns where only randomness exists. Perhaps researchers need to begin asking: From where do people get their pre-existing theories, expectations and suspicions? In the next section, I argue that individuals acquire such things from other people via biased cultural transmission.

Ethnographic Data

During my fieldwork among Mapuche farmers in south-central Chile, I explicitly addressed the question of whether economic behavioral patterns can be explained by cost-benefit decision-making. This research, based on extensive observational, experimental and interview data from 63 farmers, shows that many of the broad patterns of Mapuche economic behavior, although often quite "sensible" given their socioeconomic situation, do not result from typical cost-benefit decision-making models because people lack the required informational input to such models.

Before digging into the details of particular economic behavior patterns, I will briefly sketch the ethnographic context. The description derives from my work in the rural communities of Carrarreñi, Cautinche and Huentelar around the town of Chol-Chol.[10] In this cool, wet Mediterranean climate (similar to San Francisco), the Mapuche live in widely scattered farming households that range in size from two to 38 hectares, with an average size of approximately 10 hectares. All practice a form of 3-field cereal agriculture using steel plows and 2-oxen teams. Most households subsist primarily on wheat (consumed in the form of bread), but many also produce oats—which are used only as animal feed. Households supplement their diets with vegetables, legumes and livestock, as well as some store-bought foods. Cash income to buy these foods and other goods such as cooking oil, chemical fertilizers and school supplies derives from a number of other sources, including (listed in decreasing degree of importance): livestock, lumber (fast-growing pines and eucalyptus trees), wage labor, the sale of vegetables and cottage crafts.

My analysis examines the broad patterns of economic behavior among three Mapuche communities. The goal is to find theories (cost-benefit or otherwise) that explain the general patterns found in these data. Often the particularistic or idiosyncratic explanations of informants may seem to explain the behavior of one or two farmers, but the essential question is: can these explanations elucidate the overall pattern? Often candidate models can be eliminated from competition if it's clear that individual farmers do not possess the requisite information or knowledge to make the required calculation. For example, if price is considered a key decision-making factor used by farmers, yet nobody has even a vague idea of a product's market price, then models that incorporate price as a decision variable can be eliminated.

Here I analyze one of the most important decisions of farmers anywhere: which crop to plant. Among the 63 farmers, 100% always plant wheat, while 95% have never planted barley. Why not plant at least some barley? How can we explain this strong pattern of 'barley aversion'? This aversion seems particularly strange considering that, from everything I have found *including* the testimony of some Mapuche farmers, barley seems to be a fine crop for the local conditions, perhaps better than wheat. Local agronomists, working in the region's agricultural extensions, believe barley is an excellent crop for the climate and soil, and claim that regional breweries will subsidize the purchase of seeds and fertilizers. They frequently recommend barley to Mapuche farmers, and are willing to supply 'start-up' seeds. Similarly, crop ecologists have shown that barley sustains its yields in the face of drought much better than wheat (Loomis & Connor 1992: 374). Interestingly, the #1 farming concern of many Mapuche farmers is insufficient rainfall, and they often cite persistent droughts as the cause of their low wheat yields, yet most never plant barley.

As an economic anthropologist, my initial instincts were that the Mapuche's long experience with their land, climate, social structure, economic position and lifestyle must have revealed something to them that the agricultural extension agents and I were missing. This certainly would not have been an unusual occurrence in an anthropological inquiry. To address this, I asked 63 farmers why they (and their neighbors) do not plant barley. See Table 2 for a summary of their responses.

Methodologically, all interviews were done with farmers I knew well and had interacted with over several months. In this simple table, I have greatly reduced and summarized the data. It was extracted from long and repeated discussions about crops, farming practices and economic decisions. My method involves cross-checking responses from repeated discussions about the same topics with the same informants (separated by at least one month), and from data gathered from those same informants by local Mapuche assistants (who independently asked the same questions, but in my absence). On average, every informant was asked the same question twice. If answers from the same informant did not substantively match, I returned to the informant for further clarification. Often non-matching responses provided additional information rather than revealing contradictions or misunderstandings. Table II includes all 82 different responses given by 63 different informants/farmers—several guys gave more than one (non-contradictory) response to our probes. Whenever possible, interview data was checked against actual behavioral data. In this case, it's difficult to conceal what one sows in his field, especially around harvest time.

To understand this data, first compare the behavioral pattern (95% of farmers have never planted barley) to the informants' 18 different reasons for their behavior. Notably, of the 5% (3 out of 63) who have planted barley, two have just recently experimented with it, and the other one remembers planting it over 30 years ago. Here we have a strong behavioral pattern (avoiding barley), yet farmers fail to articulate any consistent reasons that could explain the prevalence of this *pattern*. The most common response (1 in 5 informants) was, "nobody here plants that," as if the low frequency of this behavior justified avoiding any further consideration of the idea (which suggests conformist transmission—see my later discussion).

I wanted to know if this pattern of cropping behavior could result from some kind of cost-benefit cognitive processing. Almost any economically-oriented, cost-benefit model of barley analysis would have to involve one or more of the following factors: barley yields (per unit of land), market price, labor requirements and processing difficulties/costs. I asked around, and none of my anthropological or economics colleagues could suggest a sensible model that did not incorporate at least two of these factors. Admittedly, the pattern could be a product of cost-benefit decisions not involving these factors.

Factor 1: Can knowledge or beliefs about barley yields (as compared to wheat) account for the observed pattern? The second and third most popular responses to my inquiry about barley begin to illuminate this question. These two answers mostly arose from my secondary probes. After initially asking, "why don't you plant barley?" I would wait patiently and record any responses. After the informant had said all they wanted, I would probe a bit further by suggesting, "perhaps barley gives a poor yield." This leading question produced an interesting result: 10 farmers *disagreed* with my suggestion and claimed that barley probably produces just fine, while 9 agreed that perhaps its yields are a bit low (compared to wheat). This disagreement among farmers about the productivity of barley suggests that the *strong* pattern of barley aversion does *not* result from a pervasive belief about the productive potential of barley (accurate or otherwise). Farmers who think barley grows just fine (producing as much as wheat or more) don't generally plant barley. Similarly, those who think its yields might be low also don't generally plant barley. Further, ethnographic experience tells me that, if anything, the answers to my leading question may have biased the answers toward a "low yield" response, as some might have though it more diplomatic to simply agree with me, especially if they were uncertain about the real yields of barley. This suggests that, perhaps, more than 10 of 19 believe barley yields are equal to or better than wheat—which means beliefs about barley yields are even less likely to account for barley aversion.

Further, almost no one has any experience with barley (60 out of 63 have never planted it), or even knows anybody who does have experience with cropping barley (57 out of 63). When I asked people, "what's the yield of barley?" they would typically answer "*no tengo idea*" ("I have no idea"). In contrast, *everyone* knows the yield of wheat. Of the 10 who claim that barley has a good yield, eight have never planted it and don't plan to in the near future; one has recently experimented with it and plans to plant more; and one has not planted it, but plans to next year. Of the nine who think its yields are low, one has just recently experimented with it *and* plans to try it again, while eight have never planted it and don't plan to in the near future.

This indicates that cost-benefit models, which require knowledge about the yield of barley relative to alternative crops, cannot explain the pattern of cropping among the Mapuche. There's no reason to believe that individual farmers possess experimental information or any accurate knowledge of barley's performance against other cereal crops. Further, there's no correlation between beliefs about barley yields (good or bad) and actual planting behavior. Most people admit they have no idea about barley yields, and those that do indicate a belief seem evenly divided on the issue. Meanwhile, the empirical pattern remains: almost no one plants barley or plans to plant it.

Factor 2: any cost-benefit model that includes the price of barley cannot explain the pattern of Mapuche behavior. I asked 61 farmers about the market price of barley and 57 of 61 had no knowledge of price—yet everyone knew the market price of wheat. Of those four who ventured a guess on the price, three were in the ballpark, and one was way off (3 times the actual price). All four of these farmers believed the price of barley was equal to, or higher than, wheat. In case people were not able to give the price numerically, I also asked if they thought the price was higher, about equal, or lower than the price of wheat. Only one additional person felt they had some sense of this, and guessed correctly that barley had a somewhat high price per sack than wheat. So, not only do most people not know the price of barley, but those few who do, believe its price is higher than wheat. Consequently, cost-benefit models that include price as an important variable cannot explain the observed pattern of barley aversion.

Factor 3: it's possible that some aspect of the planting, harvesting or processing of barley makes it less desirable by increasing labor or processing costs relative to alternatives. To address this, I asked a sub-sample of 20 farmers about these aspects directly. I found that no one thought barley producing and processing would be any more difficult than wheat. They also felt it would not be any trouble to make into bread. Of course, only three of these 20 had ever grown barley before, and only two of that 20 had ever milled it—the other farmer sold his barley after threshing. Therefore, even if it is true that barley is more difficult to process than wheat, nobody knows that, so that cannot be the reason for the strong pattern.

This analysis indicates that any cost-benefit model of crop selection, which includes prices, yields or labor/processing costs cannot account for the pattern of Mapuche behavior. Other researchers have made similar observations. For example, Ortiz (1980) has argued that Colombian farmers lack sufficient knowledge of weather and price dynamics to make decisions based on this information (also see Quinn 1978).

Evidence from interviews with older farmers combined with past ethnographic work (Latcham 1909; Stuchlik 1976; Titiev 1951) among the Mapuche, sometimes in the same communities, suggests that somewhere between 30 and 50 years ago these Mapuche farmers abandoned planting barley. Ten out of 63 interviewees mentioned that they (only one case), their fathers or their grandfathers cultivated barley. Four of these accounts noted that there was a problem with *polvillo* (a symptom of a crop disease where the seeds crumble). This indicates that in the past Mapuche farmers did include barley in their planting strategy, but dropped the practice a generation or two ago as a crop disease spread. Nowadays, such crop diseases are not a serious problem as most farmers (over 90%) routinely disinfect their wheat seeds with commercially available chemicals (the same technique could be applied to barley). Thus, memories of a crop disease in barley are not the reason why so few people plant barley now. Plus, no one suggested that a fear of *polvillo* was the reason why they were not presently cultivating barley.

Finally, some preliminary evidence suggests that the practice of planting barley may be gradually re-entering the farmers' repertoire. The pattern of re-adoption suggests, not individual-level cost-benefit decision-making, but biased cultural transmission. Two farmers have recently experimented with barley and another plans to plant it in the coming year. Of the two, Martín claims he got the idea while working in a local *fundo* (a large-scale, managed farm). The other guy, Domingo, says he got the idea from a local agricultural extension agent who is also a friend. The farmer who intends to plant it, José, got the idea and all his information from his neighbor, Domingo. So, the practice was transmitted from one individual to another, and perhaps from higher status individuals, or at least through social networks.[11]

Machiguenga slash and burn agriculture

It's my view that cultures are often too well adapted, given what we know about human information processing abilities and about what people actually know. The Machiguenga's approach to tropical forest agriculture provides an example. Many anthropologists and agronomists agree that swidden agriculture is adaptive in the infertile tropical soils of the Amazon (Moran 1993; Johnson 1983). Cutting and burning trees, bushes and other plants release a range of important nutrients into the soil and slows the invasion of weeds (although it also sublimates valuable nitrogen). This nutrient boost helps for a couple of years, but soil quality soon declines. When this occurs, swidden agriculturalists like the Machiguenga typically cut new gardens—sometimes every year or every other year (Johnson 1983; Baksh 1984; Henrich

1997). This practice creates an agro-ecological cycle in which farmers can always plant in richer soil, while avoiding the labor of weeding older gardens. Further, the small size of these gardens and their rapid turnover rate allows forest re-growth to fill in fairly rapidly. Meanwhile, these plots continue to supply supplemental foods to families.

The Machiguenga of Camisea live at the confluence of the Urubamba and Camisea rivers and farm on soils much more fertile than typical Amazonian soils. In fact, many of the soils around Camisea are even more fertile than interfuvial parts of the same region (ERM 1996). As a result, government agents have attempted to convince the Machiguenga to switch to an alternative method of *slash and mulch* agriculture, but farmers have been entirely uninterested in this suggestion and continue to use fairly traditional swidden techniques. This led me to ask: Do swidden agriculturalists like the Machiguenga practice slash and burn agriculture because they understand the soil-enhancing and agro-ecological benefits of slash and burn agriculture, or is it part of a culturally-transmitted agricultural script (see Alcorn 1989)? As part of my investigation, I asked Machiguenga farmers three questions: 1) Why do you burn after you cut a new garden? 2) Does burning or the ash affect the soil? and 3) If you had a machine to clear your garden, would you continue to burn? Table 3 summarizes their responses.

This research indicates that the Machiguenga do not understand the adaptive connection between the burning of forest biomass in swidden agriculture and the temporary infusion of nutrients and organic matter into the soil. The Machiguenga clearly believe that, given their present agricultural system, not burning would make planting and moving about the garden too difficult (Table 3A). However, they recognize no general connection between burning and improving soil quality (Table 3B). And, if given the ability to clear the garden without burning, they would discontinue burning entirely (Table 3C). [12] Because no Machiguenga farmers in the region practice methods of slash & mulch agriculture, the Machiguenga of Camisea haven't had any exposure to alternative agricultural systems that deal with the difficulties of infertile Amazonian soils. Consequently, they have no way to comparatively *evaluate* the relative costs of systems that involve burning with those that do not—and no one has experimented with not burning. In this particular section of Machiguenga territory, slash & mulch *may* be superior (in terms of long-term yields per unit land), but the Machiguenga maintain an agro-ecological system adapted to more typical regional environments and lower population densities—only recently (in the last 30 years) did Machiguenga begin living in communities along major rivers near more fertile soil. Thus, the generally-adaptive pattern of tropical forest agriculture (averaged across environments and time) used by the Machiguenga cannot be a product of cost-benefit decisions related to ecological or productive advantages because they lack the necessary comparative information, as well as the impetus to obtain the information via experimentation. Instead, it appears consistent with the patterns created by cultural transmission mechanisms adapting agricultural practices to more traditional Machiguenga environments—which were not along the fertile ground of the Lower Urubamba. This finding is similar to that of Alcorn (1989) for Bora and Huastec farmers, and of Wilken (1987) for Mexican farmers. If individuals' adaptation results from an adherence to such agricultural scripts, and not cost-benefit decision-making, then explaining adaptation relies on understanding the cultural transmission processes that assemble adaptive scripts, or spread particularly useful rules of thumbs. It's also worth emphasizing that static transmission will not maintain practices in the face of opposing cost-benefit decision-making. Only biased transmission can subvert the directional force of cost-benefit decision, which can be quite helpful since our decisions are so wrought with mistakes.

Perhaps peasants acquire their behavioral strategies like MBA students (no offense to peasants). In a multi-round investment experiment, MBA students had to divide their allotted money among three different investment options (A, B & C). Each of these investment options had different mean returns and different amounts of variation on those returns. The returns between investments were sometimes correlated (e.g. a high yield in A probabilistically predicts a high yield in C), but these correlations changed as the game proceeded. Students were informed of all this and could also borrow money to invest (at interest). Students were highly motivated because their overall performance strongly affected their grade in the class. After each round, the experimenters posted a ranking of each student's performance (including both their allocations). As part of their analysis, these economists regressed the decisions made in each round by each individual against those of the top-performer in the previous round and found strong evidence that students were "mimicking" the behavior of top-performers (Kroll & Levy 1992).

Further, when Kroll & Levy compared the overall results of this experiment against a previous experiment in which results and rankings were not posted between rounds, they found that copying high performers allowed the whole group to move *much* closer to the optimal allocation behavior (as predicted by *Portfolio Theory*) compared to the no-copying control—which was very far from optimal, even after students had 18 rounds of experience. Perhaps peasants, foragers and horticulturalists possess well-adapted behavioral repertoires, not because they are each effective cost-benefit calculators, but because simple rules like 'copy the most successful individual' generate well-adapted behavior in cultural evolutionary time.

PEOPLE RELY ON BIASED CULTURAL TRANSMISSION

In an earlier version of this paper I devoted considerable space to persuading readers that humans rely heavily on cultural transmission and imitation to acquire most of their behavior, beliefs, ideas and values. After receiving feedback on this, I realized that what many anthropologists were missing was not that people rely heavily on cultural transmission, but that the nature of cultural learning processes can create behavioral and ideological change (cultural evolution), in the absence of cost-benefit decision-making, by favoring the acquisition of ideas and behavior from certain people or by favoring particular kinds of ideas/behaviors. The next three sections address this as follows: 1) I briefly sketch the evidence for a substantial reliance on cultural transmission; 2) I show that this transmission is heavily biased in ways that can assemble and maintain adaptive behavioral repertoires—as well as create or maintain maladaptive practices under certain circumstances; and 3) I point out that when circumstances require flexible behavioral responses, biased cultural transmission can generate adaptive 'rules of thumb' or context-specific heuristics over several generations.

People rely heavily on cultural transmission

Social Learning Theory

In his book, *Social Learning Theory*, Bandura (1977) argues that psychologists must abandon approaches that emphasize reinforcement or internal drives and replace them with a cognitively detailed understanding of social learning—an understanding of how people acquire their behaviors, ideas, beliefs and values from other people.[13] After more than two decades of research, Bandura concludes:

> The capacity to learn by observation [learn socially] enables people to acquire large, integrated patterns of behavior without having to acquire them gradually by tedious trial and error…it is difficult to imagine a social transmission process in which the language, lifestyles, and institutional practices of a culture are taught to each new member by selective reinforcement of fortuitous behaviors, without the benefits of models who exemplify the cultural patterns (brackets are mine; 1977: 12).

Social learning research within psychology further shows that humans have the ability to infer abstract behavioral rules directly from observed behavior. Experiments demonstrated that:

> Modeling has been shown to be a highly effective means of establishing abstract or rule-governed behavior. On the basis of observationally derived rules, people learn, among other things, judgmental orientations, linguistic styles, conceptual schemes, information-processing strategies, cognitive operations, and standards of conduct (Bandura 1971; Rosenthal & Zimmerman 1977). Evidence that generalizable rules of thought and conduct can be induced through abstract modeling reveals the broad scope of observational learning (1977: 42).

Bandura's work, and those of his fellow social learning theorists, show that human cognition is strongly biased towards social learning. Humans will acquire behaviors and beliefs via social learning unconsciously, *without* positive reinforcement, and when they are unaware that a "correct" answer is sought or available. In experiments, individual display the same propensity for social learning regardless of incentives or whether they are informed that correct imitation will be rewarded (Bandura et. al. 1966; Rosenthal & Zimmerman 1977). Bandura (1977: 38) writes, "one cannot keep people from learning what they have seen."

Anthropology and Child Development

In a recent paper that summarizes a great deal of research from cross-cultural studies of child development, Fiske (1998) argues that children learn most of what they need to know by observation and unconscious imitation, not from active instruction. Fiske finds the same patterns of imitation plus individual experimentation across time, space and anthropological subfields. Children first imitate older siblings, peers or adults, and then rehearse these imitations through play and practice. Children receive only the most general kind of negative feedback (in most places, adequate performances are expected). As with many things, western society seems to be a strange aberration, where children may receive positive feedback and lots of active instruction (LeVine & LeVine 1977).

Children learn almost all of the their adult behavior, including their economic practices and practical knowledge, by imitation and practice. In reference to rice agriculture in Okinawa, Maretzki & Maretzki (1966: 144) write, "Children learn by observing and experimenting. Whatever adults are doing, children are present to watch their activities and overhear their conversations" (see Titiev 1951: 91 for a similar observation among the Mapuche). Block (1994:278, from Fiske 1998) gleans findings from a number of sources to make a similar point:

> In non-industrialized societies most of what takes people's time and energy—including such practices as how to wash both the body and clothes, how to cook, how to cultivate, etc.—are learned very gradually through imitation and tentative participation…Knowledge transmission tends to occur in the context of everyday activities through observation and "hands-on" practices…

At first glance, 'imitation plus experimentation' may sound like the standard model. But, as I show in the next section, there's good reason to believe the imitation process is biased. If children, for example, selectively copy *certain* peers, sibling or adults, then the imitation process may generate cultural change prior to the experimentation component of the process—experimentation may then produce further change.

The Diffusion of Innovations

This interdisciplinary body of literature focuses on understanding why certain ideas, technologies and practices spread, why some spread rapidly and others more slowly, and why some never spread. Rogers (1995, p.18) summarizes some of the lessons from 50 years of research as follows:

> Diffusion investigations show that most individuals do not evaluate an innovation on the basis of scientific studies of its consequences, although such objective evaluations are not entirely irrelevant…Instead, most people depend mainly upon a subjective evaluation of an innovation that is conveyed to them from other individuals like themselves who have previously adopted the innovation. This dependence on the experience of near peers suggests that the heart of the diffusion process consists of the modeling and imitation by potential adopters of their network partners...

According to Rogers, thousands of studies indicate that the costs and benefits of alternative practices, no matter how clearly observed, cannot explain the behavioral change process recorded in many places. In contrast, what does consistently emerge as essential to the diffusion process are the patterns of social interaction, modeling and imitation.

Substantial reliance on social learning is consistent with evolutionary models

Evolutionary anthropologists might wonder how imitative capacities could arise in a species if imitation sometimes causes individuals to do maladaptive things. In addressing this question, a number of theoretical evolutionary models have convincingly shown that natural selection favors the evolution of imitative capacities under a wide range of conditions (Boyd & Richerson 1985, 1989). Imitation acts like a short-cut to a good answer (but maybe not the best answer), and evolves because it saves the cost of individual experimentation and information gathering. Cultural transmission will evolve as long as the savings created by the short-cut exceeds the costs of occasionally acquiring maladaptive or less-adaptive traits. Henrich & Boyd (1998) constructed an evolutionary simulation model that allowed the degree of reliance on cultural transmission vs. individual learning (experimentation etc.) to evolve in multiple subpopulations with migration and temporally changing environments. The model robustly shows that a strong reliance on cultural transmission will emerge from a population that begins with almost complete reliance on individual learning, under a wide range of conditions. Only when environments change very rapidly, or problems are very easy, does individual learning (cost-benefit analysis) predominate.

Parent-child transmission is not the dominate mode of cultural learning

The standard model of cost-benefit decisions plus static transmission typically assumes (usually implicitly) that children acquire their cultural beliefs and practices of their parents. Although there are other transmission models that will produce static replication (e.g. if individuals copy people at random), most other transmission processes generate cultural evolution. However, there's solid reasons to think that parent-children cultural transmission is relatively unimportant compared to other forms of transmission. In a recent book, Harris (1998) summarizes an enormous array of findings from across psychology, anthropology and behavioral genetics to argue that children do not acquire their culture from their parents. Numerous behavioral-genetic studies comparing the behavior of parents and offspring, show that parent-child transmission (or 'common family environment' more generally) accounts for little of the behavioral variation, once genetic similarities between parents are offspring are accounted for. Averaging over many behavioral/belief domains common-family environment (which contains parent-child transmission) accounts for only 5% of the variation, the extra-family social world accounts for 45% (or 90% of the non-genetic influence), and genes account for 50% of the variation. Children do resemble their parents (behaviorally), but this similarity mostly arises from having the same genes. Anecdotal data focusing on the culture acquired by children raised by their immigrant families, but with a different cultural world outside the home, suggests that such children acquire their culture from their peers, not from their parents. A great deal of work in psychology is consistent with this finding. Anthropology's long time assumption (Mead 1959: vii) that children acquire their cultural from their parents is probably wrong.

Human cognition biases cultural transmission

There's an enormous number of ways that cultural transmission is, or could be, biased. Here, I focus on only two: *prestige-biased transmission* and *conformist transmission*. I selected these two transmission mechanisms for two reasons. First, both are content general—that is, as far as we know, they influence the transmission of ideas and behaviors across many domains. Domain-specific biases affect only beliefs about certain cultural domains, like 'food', 'animals' or 'ghosts' (see Boyer 1994, Sperber 1996). And, second, both tend to favor adaptive behavior on-average, but may favor maladaptive behavior under certain predictable conditions. Other examples of transmission biases that depend on the characteristics of the model (as opposed the characteristics of the transmitted belief) cue off of such things as gender, age and healthful appearance.

Prestige-biased transmission

Humans possess a strong propensity to preferentially copy the ideas, behaviors, values and opinions of particularly prestigious or successful individuals in their social group—I term this cognitive mechanism *prestige-biased transmission*.[14] When sufficient information is available about who is the best hunter, forager, warrior, musician, or farmer (for example), people preferentially acquire his or her traits, beliefs and practices. And, probably because the world is a noisy and uncertain place in which it's often difficult to tell why someone is so successful, people copy whole bundles of ideas, behaviors, linguistic patterns and practices from successful individuals, even when the belief or practice's connection to the individual's success is unclear In copying the best hunter, for example, it's difficult to tell whether his success results from his tracking techniques, his prayer rituals, his diet of carrots, or his habit of getting up early. Prestige-biased transmission, as a component of human cognition, biases cultural evolution in favor of those beliefs and practices possessed by successful individuals. On-average, over many generations, it leads to the spread of those combinations of beliefs/practices that create successful individuals (i.e. good hunters, farmers, warriors, etc.). However, it can also drags along lots of maladaptive or neutral traits that happen to covary with those beliefs/practices that promote success (Boyd & Richerson, chapter 8).

Prestige is important when individuals lack sufficient information about who are the most successful individuals in their group. Under these conditions, naïve individuals (children, young people and immigrants) observe the deferential behavioral displays of others (noting to whom these displays are aimed) and use this as cues for whom to begin copying. These status-cues provide a short-cut means of exploiting the knowledge of others and figuring out whom to begin copying (see Gil-White & Henrich 2000 for details and an explanation of why).

A wide range of psychological, economic and ethnographic literature confirms that people preferentially imitate prestigious individuals and overweight their opinions in making judgments. In laboratory studies examining the social influence of prestigious individuals, Ryckman et. al. (1972) and Ritchie & Phares (1969) found that individuals significantly shifted their opinion on 'student activism' and 'national budget priorities' (respectively) to match those of the prestigious individuals, even when the prestigious individual would not know the subjects' opinion, and when the discussion topic was well outside of the prestigious individuals' domain of expertise. Similarly, in solving a maze game, Bauer et. al. (1983) found that subjects copied the slow and "deliberate style" of a prestigious model, and thus performed worse than subjects exposed to no model or a low-prestige model.

Using real world data from the vast literature on the diffusion of innovations, Rogers (1995) argues that the diffusion of new ideas, technologies and practices is strongly influenced by "local opinion leaders." Compiling findings from many diffusion studies, Rogers describes these individuals as: 1) locally high in prestige (e.g. high prestige within the village), 2) well respected, 3) widely connected and 4) effective social models for others (items 1,2 and 4 are all parts of prestige-biased transmission). Consequently, the spread of novel technology depends on the prestige of whoever initially adopts it. Interestingly, Van den Ban (1963, from Rogers 1995) effectively demonstrates the pitfalls of prestige-biased transmission in his study of farmers in the Netherlands. He shows that small-scale farmers copied the mechanized farming practices of prestigious, large-scale farmers *even* when such practices were clearly inappropriate for their small-scale situations.

In the multi-round investment game I mentioned earlier, Kroll and Levy (1992) found that MBA students tended to mimic the decisions of successful players even though rewards were distributed on a competitive basis (Kroll & Levy 1992). However, what I did not mention was that this imitation pattern caused several individuals to go 'bust' as they repeatedly copied the margin-buying strategies of short-term winners. This experiment shows how prestige-biased imitation operates to adapt the overall behavior of the group, while simultaneously creating errors for those who too readily copy the short-run successes of lucky individuals. I discuss this pattern further in my discussion of the Kantu of Borneo.

As I discussed earlier, children acquire much of their culture via observation and imitation (Fiske 1998), probably by copying their peers (Harris 1998). However, psychological research on imitation (Brody and Stoneman 1981, 1985) indicates that children selectively copy their peers using both age and success (as demonstrated in 'competence' for a specific task) as positive cues. Brody & Stoneman (1985) show that second graders preferentially copy (in order of decreasing preference): same-age-high-competence, younger-high-competence, same-age-low-competence, younger-low-competence. This is true even when competence information comes from an *unrelated* task.

Conformist transmission

Under conformist transmission, individuals possess a propensity to preferentially adopt the cultural traits (ideas, beliefs, values and behaviors) that are most frequent in the population. This psychological bias makes individuals more likely to adopt common traits than they would under static cultural transmission (the standard model). At the population-level, conformist transmission causes more common traits to increase in frequency. If cultural transmission is static, then, barring the action of other forces, transmission will leave the frequency of the traits unchanged from one generation to the next. For example, if 60% of a population is performing a certain behavior, barring other forces, 60% of the population in the next generation will also perform that behavior. In contrast, conformist transmission increases the frequency of the trait from 60% in one generation to, say, 65% in the next generation. All other factors being equal, the frequency of the most prevalent trait will continually increase from one generation to the next. If it were the only transmission bias, conformist transmission would rapidly cause the most frequent cultural traits in the population to become the only cultural traits. Operating among other learning mechanisms (mechanisms that select, prioritize and evaluate different kinds of social and environmental information) and under constraining external conditions, conformist transmission creates a directional force that tends to establish and maintain cultural norms. When combined with prestige-biased transmission, conformist transmission provides a 'brake' on an individual's tendency to copy 'lucky' short-run successes.

There are both theoretical and empirical reasons for believing that conformist transmission exists. Theoretically, evolutionary models of social learning and conformist transmission demonstrate that natural selection favors the evolution of both a heavy reliance on social learning and a potent conformist effect, except when environments changes very rapidly or the migration rate between groups is quite high (Henrich & Boyd 1998).

Empirically, numerous studies from psychology on social influence and conformity suggest that individuals rely on the judgements of others in making individual choices or decisions. Beginning with the famous Asch experiments in the 1950's, researchers from all over the world have demonstrated that people's perceptions and judgments are strongly influenced by others. Unfortunately, from my perspective, much of this work confounds by two different explanations. The more standard interpretation of these results, "normative conformity", proposes that people conform to the behavior of others because they want to appear similar to others, to be "a part of the group," and/or to curry favor with others or avoid punishment by agreeing. A less popular hypothesis consistent with conformist transmission suggests that people use the opinions, perceptions and judgements of others as a source of information relevant to the issue at hand—as a means of improving one's chances of being correct[15].

In a recent study sensitive to these two hypotheses, Baron et. al. (1996) demonstrated two phenomena consistent with Henrich & Boyd's (1998) model of social learning and conformist transmission. In the experiment, subjects had to pick previously observed suspects out of a 'criminal' line-up after hearing the selections of two others participants (confederates). Baron et. al. varied both the problem difficulty and the compensation subjects' received for correct answers. This study attempts to mitigate the influence of normative conformity by increasing compensation—presumably, the subjects' desire to appear like everyone else is balanced against their desire for cash. In the easy problem, which 97% of control subjects answered correctly without any social influence, conformity diminished when compensation increased—but some people still conformed to wrong answers. However, in a moderately difficult problem, which 76% of the control group got correct, subjects *increased* their conformity when compensation *increased*. This means that in problems with real monetary stakes, subjects rely *more* on social information as the problem difficulty *increases*. This finding concurs with our conformist model, which predicts that as a problem becomes more difficult, or environmental information becomes more ambiguous, subjects should shift their reliance from individual evaluations to biased transmission.

Insko et. al. (1985) demonstrated that increasing the group size (the number of models) increases people's degree of conformity, *even* when responses are clearly private. Using a color perception task, these researchers varied the group size by using between 1 or 4 confederates, and varied the form of the response between public and private. Subjects either stated their responses aloud or wrote down their responses in secret. These results are consistent with conformist transmission in two respects: 1) they show an effect of group size (bigger groups should be a more salient cue); and 2) people remain conformists even when their responses are clearly secret—mitigating the effects of normative conformity.

In a study of the effect of social influence on common-pool resource games, Smith and Bell (1994) argue that players sometimes copy other players when they're uncertain of what to do. Two forms of a multi-round common-goods game were used. In these games, one subject and two confederates make withdrawals of "points" from a common pool that initially contains 15 points. The number of points in the pool doubles every other round, but cannot exceed 15. The game lasts until the common pool goes to zero, or for a maximum of 15 rounds. In version 1 of the game, players receive "lottery tickets" (a chance of winning real money) according to their personal point totals at the end of the game; in version 2, players receive "lottery tickets" according to their group's point total at the end of the game. In both versions, subjects show a significant reliance on mimicking the behavior of confederates. When confederates underutiltize the resources, subjects tend to underutiltize resources, and when confederates overutiltize resources, subjects tend to overutilitze resources. Because subjects behave similarly when their self-interest equates with the group-interest, and when it's opposed to the group, the authors argue that subjects mimic as a means of using social information under uncertainty, and not to compete with the other players (confederates). These results and conclusions are consistent with the predictions conformist transmission and are important because they address economic decisions not related to perception. Wit (1999) produced similar findings using a voting game.

It's worth emphasizing that both conformist and prestige-biased transmission produce adaptive behavior under a wide range of conditions, and both are favored by natural selection over static transmission (Gil-White & Henrich 2000; Henrich & Boyd 1998; Boyd & Richerson 1985). Neither, however, involves the direct evaluation of information about the costs and benefits of alternative choices. Evolutionary models show that when environmental information is somewhat noisy or environments are variable, individuals who *selectively* acquire the behaviors, ideas, etc. from other members of their social group are better adapted than those who rely on experimentation and cost-benefit decision-making.

Using formal cultural evolutionary models (Henrich 2000), I recently compared the dynamics generated by biased transmission (prestige-biased plus conformist transmission) with the 'standard model' (experimentation plus static transmission). My analysis of the diffusion dynamics produced by these two approaches shows that the adoption of new ideas, practices and techniques results primarily from biased cultural transmission, and not from the standard model. The diffusion of innovations literature robustly shows that adoption curves (frequency of adopters vs. time) form an "S-shape." These curves rise slowly, accelerate to a maximum adoption rate near the middle, and then taper offer toward the end of the adoption cycle (forming an "S" like shape). Interestingly, formalizations of the standard model do not generally produce S-shaped adoption curves, while models of biased transmission always produce S-shapes. Combined models, which mix biased transmission with the standard model, do *not* produce the S-shapes, unless biased transmission is the dominant force. Consequently, this evidence (based on over 3,000 empirical studies) indicates that biased cultural transmission is likely to be important in any theory about the adoption of new techniques, technologies and practices.[16]

Biased Cultural Transmission and Experimentation

Even when behavioral patterns are affected by experimental processes, biased transmission acts to reduce the range of possible experiments, thereby directing experimental efforts towards favorable possibilities, as well as to selectively spread the behavioral output of successful experiments (and lucky guesses). For example, Johnson (1971) describes how a Brazilian sharecropper, after observing a new method of planting bananas at a "technically advanced plantation," then performed a controlled experiment in which he planted alternating rows of bananas with the new and traditional methods—the traditionally-planted rows acted as a control group for comparison with the new method. Here, the farmer first acquires an idea from a 'prestigious cultural model,' and then experiments with the idea, before incorporating it into his behavioral repertoire. He did not arrive at a new method *de novo*, through calculation. He copied a prestigious model, and then experimented.

In my work with Mapuche farmers I've found similar cases of prestige-biased transmission and experimentation. Although generally the Mapuche seem less inclined towards experimentation than Johnson's sharecroppers, the Mapuche sometimes acquire an idea from working at a local *fundo,* or from someone they trust, and then experiment with the idea. The re-adoption of barley that I described earlier fits this pattern, and I've seen similar examples with the sowing of spring wheat (vice winter wheat) and the application of lime in soil management.

PEOPLE RELY ON CULTURALLY-TRANSMITTED SCRIPTS & HEURISTICS.

Despite the continued emphasis on cost-benefit decision-making in economic anthropology, ethnographic data soundly demonstrates the people rely heavily on tightly-defined rules of thumb or context-specific heuristic when economic circumstances call for behavioral flexibility (e.g. Wilk 1996; Quinn 1978; Johnson 2000). Mapuche farmers, for example, decide when to sow winter wheat by watching for the initial emergence of weeds after the first rains of winter. This simple rule effectively accounts for both the variable timing of the winter rains and existing moisture in the soil. In 63 interviews, no farmer admits to having tried alternative rules—nobody, for example, has tried the rule ‘plant on June 3’, or the rule ‘plant 3 days after the first winter rains.’ The theoretical question should be: where do these rules and heuristics come from, or how did they evolve?

Do we think that the ancestors of each of these Mapuche farmers systematically experimented with a wide range of possible rules and all converged on this *one* rule, which was then passed down father to son? Or, if we think a few farmers occasionally experimented with modifications (which is currently what Mapuche do), then how do we account for the subsequent spread of this one rule through the population, especially since human cognition lacks both the data and the information processing ability to accurately select among rules that are approximately equal in effectiveness? If rule selection was a product of cost-benefit decisions, then we should expect extreme heterogeneity in the rules used (which is sometimes the case). Biased cultural transmission, however, can spread and maintain such adaptive rules, even if people don’t experiment, but only occasionally mis-acquire the rule. Biased transmission takes advantage of the individual variation in a population, and allows for different rules to be recombined to form novel rules. If people sometimes vary in what they copy and from whom, then the transmission process can create novel combination of cultural elements, which will probabilistically spread according to their influence on their possessor’s success or prestige (Boyd & Richerson 2000).

Bird Augury among the Kantu of Kalimantan

Dove's analysis (1993) of how the Kantu of Kalimantan use bird augury to select swidden garden locations provides an excellent example of both the systematic errors in human judgement and how cultural evolution can provide unconscious adaptation without individual cost-benefit decisions. Dove first points out how some Kantus reasoned that, because destructive floods had not occurred for several years, they should locate all their gardens on high ground (because a flood seemed "due"). In contrast to this classic exposition of the ‘gamblers fallacy,’ Dove writes:

> Cyclical resonance is a key heuristic device in many ecological models, in industrial societies as well as tribal societies (Henderson 1987: 253 cf. Dove 1985: 76). But there is no evidence of cyclical patterns in rainfall or flooding in Kalimantan. Consequently, the nonoccurrence of a rice-destroying flood during a three-year period does not affect the statistical likelihood of such a flood during the following year: it is no more or less likely than in any other year (1993:147).

This means that interpreting floods as part of a cyclical process makes cultivators more likely to make mistakes. Cultural evolution, however, seems to have solved this problem: Kantu farmers rely on a system of cultural rules that effectively randomizes their interpretation of bird omens with respect to environmental and climatic factors, and thereby allows them to select garden sites without the negative influence of the gambler's fallacy (see Moore 1957 for a similar system). Decisions depend not only on seeing a particular species of bird in a particular location, but also on what type of call the bird makes.

Dove also notes how augury rules inhibit the operation of another important learning bias—prestige-biased transmission—which could cause cultivators to copy the short-term successes of lucky neighbors (which also occur multi-round investment games). He writes, "The Kantu are keen observers of one another's harvest successes and failures, and when one household enjoys conspicuous success, other households are tempted to copy its strategies" (1993: 147). Short-term strategies used by successful households in one particular year could be disastrous the following year. Cultural proscriptions, however, make the results of each household's bird augury a big secret, and the rules indicate that failure to heed one's own omens or the use any others' omens will result in bad luck and a poor harvest. Copying short-term success would also tend to homogenize the group and deplete essential, risk-managing variation. So, these rules also promote inter-household diversification, which acts as insurance against local failures of certain land types.

Interestingly, no rules prevent households from copying the bird augury *beliefs* themselves from successful neighbors. This system of bird augury seems to have evolved and spread throughout this region since the 17th century when rice cultivation was introduced—which makes good adaptive sense since it's rice cultivation that is most positively influenced by randomizing garden locations. It's possible that, with the introduction of rice cultivation, a few farmers began to use bird sightings as an indication of favorable garden sites. On average, over a lifetime, these farmers would do better (be more successful) than farmers who relied on the gambler's fallacy. Using prestige-biased imitation, individuals would copy whole sets of traits from successful individuals, including their rules and beliefs about garden selection. Consequently, within 400 years, the bird augury system spread throughout the agricultural populations of the Borneo region, yet remains conspicuously missing or underdeveloped among local foraging groups and recent adopters of rice agriculture (illustrating a maladaptive temporal lag, as recent adopters of rice haven't yet acquired the bird augury beliefs), as well as among populations that rely on irrigation agriculture (e.g. the Rungus, who would experience no advantage from the omen beliefs). Here, cultural evolutionary processes seem to have retrofited some rare beliefs about bird omens to deal with the problem of garden site selection (and avoid the gambler's fallacy), and adorned this belief system with prohibitions that prevent the short-term cascade effect sometimes generated by biased imitation.

CONCLUSION

In this paper, I have argued that economic anthologists should incorporate an understanding of biased cultural transmission into their existing models of decision-making. Laboratory evidence demonstrates that people (i.e. university students) lack the cognitive abilities to perform the kinds of analyses required by most cost-benefit models—without creating goal-averting mistakes. Similarly, field evidence shows that many behavioral patterns, despite being quite adaptive, cannot be products of cost-benefit decision-making. Rather than relying on unrealistic cost-benefit models, we need to develop psychologically-informed approaches that include both the relevant aspects of cultural transmission, as well as cost-benefit decision-making. Most researchers would agree that people's behaviors, beliefs, values and ideas result from a combination of cultural transmission, experimentation and decision-making. Individuals, standing on a body of culturally inherited rules, beliefs and practices, use experimentation and their own decision-making abilities to adjust and adapt to their own circumstances. Most economic anthropologists, however, have focused on the 'experimentation and decision-making' part of the equation, which often accounts for much of the variation among individuals within social groups. I propose that we now consider how cultural learning processes have assembled the body of cultural stuff upon which individual decision-makers stand. Such processes seem likely to illuminate much of the variation between social groups—i.e. variation among cultures instead of variation among individual within cultures.

Endnotes

[1] The author would like to thank Allen Johnson, Natalie Smith, Robert Boyd, Jean Ensminger, Pete Richerson, Nick Blurton-Jones and three anonymous reviewers for their helpful comments and criticisms of earlier versions of this manuscript.
[2] This model requires a source of variation—that is, some mechanism to create idiosyncratic differences among individuals. Such variation can be incorporated by imagining that creative individuals occasionally do experiments and/or cost-benefit analyses, or by simply assuming that people make errors through their cultural learning process.
[3] Recent work in cognitive psychology shows that people may rely on domain-general heuristics that could help solve these kinds of information-poor dilemnas (Gigerenzer, Todd & the ABC research group 1999)
[4] The chances of another earthquake, given that one has recently occurred, are actually lower than the base rate of earthquakes because the stress has been temporally relieved.
[5] For example, a general bias toward *availability* might even be adaptive if most events in the real world were autocorrelated. And, under specific circumstances, shorter memories that preferentially retain the most recent information actually outperform longer memories in accurately recognizing correlated patterns in the environment (Kareev 1995).
[6] Positive autocorrelation means that the occurrence of an event increases the likelihood of that same event in the next trial or time period. For example, if coin flips were positively autocorrelated instead of independent, the appearance of "heads" on the first flip would increase the chance of heads on the next flip from 50% to, say, 60%.
[7] Humans are also poor at searching for information. Economists have shown that people search too little, accept too soon and respond too slowly to changes in the distribution of wage and price offers (Braunstein & Schotter 1982).
[8] Non-human animals reason like humans. For example, while studying the economic decision-making of bees, Real (1994) showed that, like humans, bees underweight low probabilities and overweight high probabilities in making risky decisions. Like humans, these animals also show an *availability bias*, in which they remember only the most recent or salient events (Bees: Real 1994; starlings: Cuthill et. al. 1990; Brunner et. al. 1992, 1996). When researchers compare the human and non-human animal literatures they conclude that animals exhibit the same errors and biases that humans do (Camerer 1995; Davis & Holt 1993; Kacelnik 1997).
[9] Psychologists have shown that somewhat ambiguous data will actually drive people's opinions farther apart as individuals interpret new data in favor of their existing view (Lord, Ross & Leper 1979).
[10] More generally, the Mapuche are a growing indigenous group of approximately 1 million people. In the last 50 years, this population has been expanding out of the rural regions of central Chile (Bengoa 1997: 11).
[11] This anecdotal finding is consistent with research from the 'diffusion of innovations' literature (Rogers 1995).
[12] If one wanted, one could use the machine to clear the garden (saving the cost of labor), and still leave some trees and branches behind to burn—thereby saving the labor and getting the nutrient fix. I suggested this during a few interviews, but the Machiguenga seemed to think it was a ridiculous suggestion. Why would one burn if one did not have to burn (i.e. it's both dangerous and extra work)? Of course we know that other groups use topical agricultural systems that do not involve burning (see Orejuela 1992).
[13] Note, Bandura is arguing with psychologists, so he frames his argument for cultural transmission in opposition to the predominant approaches of the time in psychology—i.e. reinforcement learning and internal drives.
[14] Many other researchers have noted this tendency, see Dove 1985; Hammel 1962; Rogers 1995; Moore 1957; Miller & Dollard 1943. This research is summarized in Gil-White & Henrich 2000.
[15] These are not mutually exclusive hypotheses. I think both types of conformity are part of our cognition.
[16] Admittedly, it's possible that my formalizations of the standard model missed some key element(s). Readers of Henrich (2000) are encouraged to send me modifications. So far, however, no one has produced those 'key elements.'

Table 1. Estimated Deforestation Rates for five Peruvian Groups

Group	Estimated Deforestation
Amarakaeris of the Madre de	0.31
Machiguenga of the Urubamba	0.68
Ashaninka of Satipo	0.76 or 0.81*
Colonist of the Upper Huallga	1.47
Colonists of Satipo	2.13

*Depends on the assumptions about cropping cycle

Table 2. Why don't you plant barley?

Why don't you plant barley?	***# of Responses***	***Percentage***
Nobody here plants that	16	19.5
Good yield/good rotation w/wheat	10	12.2
Poor yield	9	11.0
Don't know why	8	9.8
No seeds	8	9.8
Not enough land	6	7.3
Don't like it	6	7.3
Needs lots of care/fertilizer	5	6.1
Low market price	4	4.9
Tough to cut with sickle	2	2.4
It's not our custom	1	1.2
Birds eat it	1	1.2
No transport to market	1	1.2
No good land	1	1.2
Hills are good for barely	1	1.2
Good market price	1	1.2
Don't like to eat it	1	1.2
Type of seed is gone now	1	1.2
Total Number of Responses	82	100.0

Table 3. Machiguenga farmers in Camisea use of slash and burn agriculture

A. Why do you burn?

Responses	Number of responses	Percent of total
To clear thorns and stickers	19	90.5
No response§	3	---
Clear out snakes	1	4.76
Custom	1*	4.76
Total	24	100.00

B. Does burning or the ash affect the soil?

Responses	Number of responses	Percent of total
No	12	85.7
No response§	2	---
Yes (improves it)	1*	7.1
Affects a little (damages it)	1	7.1
Total	16	100.00

C. If you had a machine to clear your garden, would you continue to burn?

Responses	Number of responses	Percent of total
No	10	100
No response§	6	----
Total	16	100.00

§ By this I mean that the farmers either did not respond or avoided the question—even after further explanation and questioning. Machiguenga are quite independent, and if they don't like a question or are confused, they often simply don't respond, or ignore the question. In this case, I inferred from facial expressions and ethology that some were confused by the question.

This "1" in A and B represents the same individual. He has spent a substantial amount of time in the mestizo towns doing wage labor. This acculturative experience may explain his divergent responses.

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