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Subsistence Productivity and Hunting Effort in Native South America

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The question of why people work more or less at various activities is an old one in anthropology and recently has surfaced in studies of native South American societies. Growing out of debates about protein scarcity, arguments have arisen over the reasons why people spend time on hunting and fishing. Some authors suggest that labor allocation and other societal features can be explained with reference to absolute minimum requirements for specific nutrients (e.g., protein). This study presents data from four native Central Brazilian societies on the time spent at various subsistence tasks and the productivity of those tasks. The evidence suggests that decisions to allocate labor to hunting and fishing are influenced more by the overall possibilities for production in an area than by the availability of animal proteins alone. Satisfaction of calorie requirements appears to take precedence over satisfaction of protein requirements. In those societies in which gardening is highly productive, people can spend more time on hunting and fishing and improve the overall quality of their diet.

KEY WORDS: hunting; protein; South American natives; subsistence productivity; cultural ecology.

INTRODUCTION

The "lazy natives" are the subjects of a perennial debate in anthropology. Foreigners in general, and perhaps Westerners in particular, frequently have observed that the natives of particular areas work very little or dislike work. Anthropological responses to such observations tend to be exculpatory in nature. One school argues that the basic cognitive orientations or status systems of a people do not incline them to hard work or achievement. Another school

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approaches this issue differently, seeing prospensity to work as a result of social, economic, or political factors.

This debate about work has also surfaced in recent studies of native South American societies. Growing out of a prior debate on protein scarcity,[3] arguments have arisen over why people devote their time to hunting and other subsistence tasks. In one study Lizot (1977) found that members of one Yanomamo village with apparently less abundant game in their area hunted more than members of another village where game was more plentiful.[4] The protein scarcity argument would predict that people in areas with low game resources would hunt more in order to meet minimum nutritional requirements. But in Lizot's study, those who had less available game actually consumed more meat than those in the better supplied village. By putting in more hours, they were able to capture more game than those in the more protein-rich environment. Lizot claimed that people in the game-rich area were simply "lazier" than those of the other.

In another study Allen Johnson (1977) reported that the Machiguenga of Eastern Peru moved away from hunting and fishing toward increased use of protein-rich garden foods and domestic animals to meet their protein requirements. He suggested that this was not a simple response to game depletion, but rather to the relative productivity of gardening vs. hunting. Since technological changes (steel axes, hoes, etc.) made gardening easier, since the Peruvian government provided incentives to sedentarize, and since game became increasingly scarce, the Machiguenga changed their subsistence strategies. Johnson's study illustrates the importance of relative production rates on people's decisions about how to make a living. But it leaves open the issue raised by Lizot: How do we account for the extra work some people invest to get protein they could pre-

[3] In this debate anthropologists explored the influence of animal protein availability on social customs in native lowland South America. Siskind (1973) offered an explanation, based on game scarcity, of sexual practices among the Sharanahua and other societies. Harris (1974) used protein scarcity to explain the intense warfare and infanticide that occur in other lowland societies. Gross (1975), following a number of earlier writers, suggested that animal protein limits the size and permanence of lowland South American settlements. Ross (1978) explained food taboos as serving to maintain game at optimal levels.

While all these writers emphasized the presumed scarcity of protein in Amazonia, others challenged this assumption. Vickers (1975), Lizot (1977), and Chagnon and Hames (1979) all presented data showing that protein rations appear to be adequate in some native South American societies. They presented evidence that such practices as warfare and payment for meat in exchange for sexual favors do not correlate with even relative shortages of protein in the diet.

In this paper we are not concerned with the question of whether there are or are not absolute shortages of protein. Instead, our main focus is on the question of why groups differ in the amount of time they devote to procuring animal proteins.

[4] Lizot's data on abundance of game come from surveys in which he recorded the time intervals between sightings of game as he walked along forest trails. He does not provide information on the number of surveys or on the sizes and weights of the animals sighted.

sumably do without? Conversely, how can we account for the failure of other groups to work for protein when they seem to need it more?

This paper also addresses the question of why people devote themselves more or less vigorously to hunting or other subsistence tasks. But rather than examine subsistence effort as a response to a single absolute need (e.g., protein), we propose to look at a range of activities on which people spend time, and at the various needs these activities satisfy. This approach views the overall economic possibilities for a group as influencing the choice of a given subsistence strategy. Like other maximization models, it lays special stress on the rates of return of various activities and asks whether people allocate their energies on the basis of what they can gain in return.

PRODUCTION RATES AND WORK ACTIVITIES

Here we examine the production rates and work activities of four Indian villages of Central Brazil: the Mekranoti-Kayapó, the Xavante at the Pimentel Barbosa reservation, the Bororo at Posto Gomes Carneiro, and the Ramkokamekra-Kanela. The Mekranoti live in the tropical forest in the State of Pará, while the other groups live in the *cerrado* regions of Mato Grosso and Maranhão States (Fig. 1). Three of the groups speak languages of the Gê family, but the Bororo speak a language that may be only distantly related to Gê. The Mekranoti and the Xavante entered into permanent contact with Brazilian society only recently, while the Bororo and Kanela have been in contact for several generations. All four groups derive most of their subsistence from slash-and-burn gardening, growing manioc, maize, sweet potatoes, rice, bananas, and other crops. All of them hunt and fish in the general vicinity of their villages, but the Mekranoti have far more unoccupied hunting territory.[5] All the groups participate in cash exchange on regional markets, selling forest products, artisanry, labor, or other goods, but the Kanela and Bororo participate appreciably more than the other two groups. In general, the Kanela and Bororo habitats are considerably more degraded by human exploitation than the habitats of the Xavante and the Mekranoti. Forest biomass and soil nutrient levels are considerably lower in the Bororo and Kanela areas. Crop yields are also lower in these areas.[6]

How does the rate of return of subsistence activities affect the way in which these villagers allocate their labor? Tables I–III summarize data on the produc-

[5] Three of the groups live on government reservations. The Bororo community of 104 occupies a reservation of 19,000 hectares. One hundred ninety-eight Xavante live on 205,000 hectares. The Kanela, numbering 538, have a reservation of 225,000 hectares. The 285 Mekranoti reside in an unoccupied region; while they have no reservation they have much more land available to them than the other groups.

[6] The similarities and differences of their habitats are explored in considerably more detail in Gross *et al.* (1979).

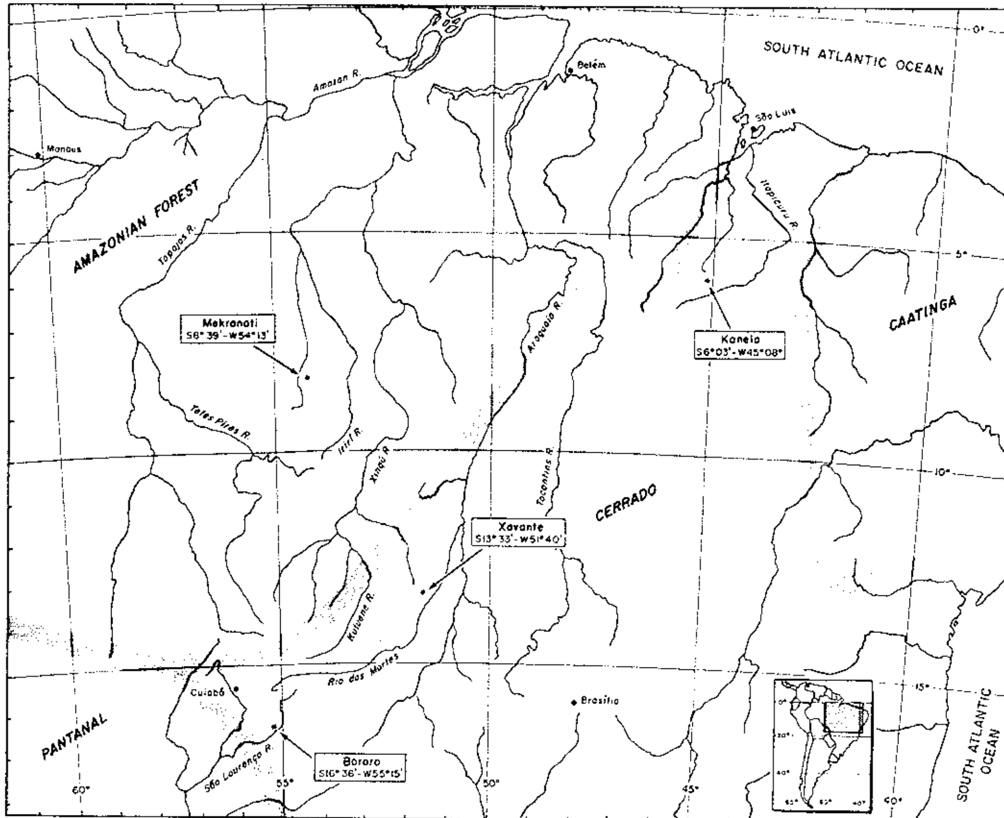

Fig. 1. Map of Central Brazil, showing study sites and major ecological zones.

Table I. Gardening Productivity and Gardening Time

	Mekranoti	Xavante	Bororo	Kanela
Total yield for all village gardens for one year (10^6 kcal)	1078.6	549.5	53.0	1318.4
Total number of person-hours spent gardening in 1 year	61,410	77,426	34,203	256,676
Avg. yield per hour of work (10^3 kcal)	17.6	7.1	1.5	5.1
Number of hours spent gardening per day per adult	1.21	2.09	1.44	2.50

Table II. Hunting Productivity and Hunting Time

	Mekranoti	Xavante	Bororo	Kanela
Avg. yield per hunt (dressed weight in kg)	3.78	2.78	1.18	0.51
Avg. number of hours per hunt	5.5	7	6	4.8
Avg. yield per hour in kg dressed meat	0.69	0.40	0.20	0.11
Number of hours spent hunting per day per adult	0.87	0.47	0.09	0.55

tivity and labor allocation for hunting, fishing, and gardening among the four groups. Table I shows that gardening yield per unit labor is highest among the Mekranoti and lowest among the Bororo.[7] The differences in yield probably can be attributed to the availability of undegraded garden land, which is low for the Kanela and Bororo, higher for the Xavante, and very high for the Mekranoti (see Gross *et al.*, 1979). Differences in crop mix alone could not account for the productivity differences. The hunting yields (Table II) follow much the same

[7] To assess garden productivity, the fieldworker in each society took samples of each food crop from gardens of various ages. In most cases, an area of given size was marked off and all the food from that area was weighed or counted. If counted, the food (such as unripe ears of corn) was converted to weights using a subsample of mature, edible produce as a standard. When necessary, conversions to dry weights were made using actual comparison samples. For some crops, e.g., bananas, the fieldworker found it more convenient to estimate yields by counting the number of plants in an entire garden, weighing the food produced by a few sample plants, By measuring and mapping gardens, fieldworkers calculated the average area devoted to each crop, with appropriate adjustment for intercropping. Community yields were calculated by multiplying average garden yields by the total number of gardens under production in each village.

Calculations of person-hours spent gardening were based on time allocation studies (see footnote11).

Table III. Fishing Productivity and Fishing Time

	Mekranoti	Xavante	Bororo	Kanela
Avg. yield per fishing trip (dressed weight in kg)	1.10	2.00	3.05	0.39
Avg. number of hours per fishing trip	5.5	5	4.5	6.7
Avg. yield per hour in kg of dressed fish	0.20	0.40	0.68	0.05
Number of hours spent fishing per day per adult	0.21	0.44	0.50	0.13

sequence.[8] Productivity per unit labor is highest among the Mekranoti and Xavante and lowest among the Bororo and Kanela. In the Kanela area some large species, such as peccaries and tapirs, have been hunted out. Fishing yields do not follow the same sequence as the hunting and gardening yields. For fishing, it appears that location on or near a large river is the determining factor in productivity. The Bororo village is adjacent to the São Lourenço River, and the Xavante village is close to the Rio das Mortes. Both groups show higher fishing yields than the Mekranoti and Kanela who live near very small streams.

What is the relationship between the yield of a given activity and the time devoted to it? Table III shows that for fishing the relationship is fairly straightforward: the higher the productivity, the more time villagers spend fishing.[8] For gardening and hunting, however, the relationships are more complex. The Mekranoti get the highest yields from their gardens and devote the least amount of time to gardening. But the Bororo, whose garden yields are lowest, also devote little time to gardening (Table I). The Mekranoti get the highest hunting yields, yet they spend *more* time at this task than the other groups. But the Kanela, who rate second highest on time spent hunting, get the least return from this activity (Table II).

Can the process of change described by Johnson for the Machiguenga account for the differences in time devoted to hunting and fishing among our four cases? Although there may be some tendency for groups like the Xavante to

[8] To get a representative sample of hunting and fishing yields we used our random spot-check observations designed for measuring time allocation (see footnote 11) to code for productivity. Whenever an individual was reported out hunting or fishing during a spot-check, we returned later in the day to see what was killed or brought back. The first row in Table II shows the average hunting yield per trip. The first row in Table III shows the average fishing yield per trip. To obtain yield per hour we needed to know the average duration of a hunting or fishing trip. In the Kanela case systematic data were available to code this variable, but in the other three cases we had to rely more on anecdotal data from field notes. Row 2 of Tables II and III shows the estimated average duration of hunting and fishing trips among the four groups. Row 3 was calculated by dividing the figures in the first row by those in the second, giving average yields per hour.

Table IV. Calories and Proteins

	Mekranoti	Xavante	Bororo	Kanela
Garden produce (kcal) per person per day (from yield data)	10,392	7,568	1,350	6,681
Vegetable protein (gm) per person per day (from yield data)	89	138	24	53
Animal protein (gm) per person per day (from yield data)	63	37	44	7
Animal protein (gm) per person per day (from diet studies)	72	28	81	18[a]

[a] Includes 6 gm from purchased food and domesticated animals.

depend more on vegetable proteins, it may not always be possible for a group to compensate for lowered animal protein yields by intensifying gardening. The Kanela, with a high population density and a relatively poor environment, are less able to grow high-protein crops. Instead, they rely on protein-poor manioc (Table IV).

Apparently, the time devoted to a particular activity is not directly related to an absolute minimum need. Table IV shows that there are large differences in calorie and animal protein capture among the four groups.[9] Mekranoti gardens produce far more calories than the Mekranoti could possibly eat. Most of the excess simply remains stored as "insurance" against bad years, as a source of food for visitors from outside, and as a food cache in infrequently visited locations. The Bororo, on the other hand, do not produce enough calories to meet their minimum requirements (Table IV). Instead, they must purchase part of their food with cash. The data on protein intake show that the Mekranoti consume many times more portein than the Kanela. If the Kanela can live on less protein, then why not also the Mekranoti? Why do the Mekranoti work so much to get protein they could survive without?

We suggest that the issue is not one of simple survival. The Mekranoti could live with less protein, but they would not live as well. Meat not only tastes

[9] Figures in the first three rows of Table IV are based on the yield data for gardening, hunting, and fishing. Figures in the fourth row come from dietary studies repeated several times during the year in each of the four groups. In each study the food intake of members of selected families was monitored over a period of 3 to 5 days. Since part of the Kanela protein supply comes from purchased food and domesticated animals rather than from local game, these protein sources were distinguished in the dietary studies. Protein and calorie values were calculated using standard tables appropriate to the region. The differences between the yield values and the intake values for animal protein probably are due to sampling error.

good to them, but is also known to be beneficial from a nutritional point of view. Most nutritionists agree that abundant protein in the diet is helpful in conferring greater resistance to infectious disease, allowing optimal use of other nutrients for growth and reproduction, and in protecting against manioc poisoning (Lowenstein, 1973; Osuntukun *et al.*, 1969; Spath, 1971; Axelrod, 1964; Moore 1959).[10] The Mekranoti hunt more because hunting is a worthwhile pursuit in their environment, and they have the time to do it.

Table V brings this point home more clearly.[11] It compares the four groups on the amount of time they devote to a wide range of activities. The Mekranoti, the Xavante, and the Kanela all spend about the same amount of time each day on nonwork activities – eating, bathing, sports, chatting, or just staring into space (the Bororo are slightly different). The major difference among the three groups lies in the way they have allocated time to their work activities. Gardening appears to take precedence over other subsistence activities, probably because it provides the basic source of calories in the diet of all groups. The Kanela spend more time at gardening and market activities than the other three groups. The

[10] While manioc poisoning is relatively rare among native South American populations, cases of manioc poisoning have occurred, as among the Xavante, who were encouraged to adopt this crop by the Brazilian government in the 1950s.

[11] Time allocation studies employed the technique devised by A. Johnson (1975). Each field worker made 12 visits each week to as many households chosen at random, at randomly selected times between 0600 and 2000 hours. Upon entering the household the investigator took note of the activity in which each household member (or visitor) was engaged. The whereabouts and activities of absent household members were ascertained by asking one of the members present (spot checks showed that these reports were generally accurate). The activity was briefly described and coded. Provision was made for simultaneous activities (e.g., food preparation plus conversation) by noting each and providing for alternative analyses. For each of the communities studied, a corpus of 5,000-8,000 observations of individuals was built up over the period of 1 year.

The analysis of this data is based on the assumption that the proportion of observations of a given activity was the same as the proportion of time actually spent on that activity during the 14 hour day used. This procedure provides a more representative and reliable picture of time allocation than do studies of a few people over short periods.

A number of corrections had to be introduced into the data to correct for biases inherent in the data-collection system or peculiarities of the communities themselves. To correct for variations in the number of observations made over different periods due to absences of the fieldworker from the study community, absolute values for each month were converted into percentages, then averaged to obtain year-round statistics. Whenever the total of observations for a given month fell to a very low level, that month's data were discarded and replaced by values interpolated from the two adjacent months. In the Kanela and Mekranoti villages, villagers spent long periods of time away hunting or gardening. To fill in these gaps, additional time allocation studies were made on treks and at garden sites and corrections were introduced into the village-based data.

The aim of time-allocation studies was not so much phenomenological accuracy as comparability among the four cases. Our definitions of what constituted various activities were designed to yield consistent codings across all four groups. For other purposes researchers may prefer using different definitions from ours. For example, we coded childcare only if an individual was physically interacting with a child – e.g., talking, reprimanding, holding, nursing. Other researchers might include other behavior under the childcare rubric, such as "being responsible for nearby children."

Table V. Average Use of Time by Adults[a]

	Mekranoti	Xavante	Bororo	Kanela
Hunting	0.87	0.47	0.09	0.55
Fishing	0.21	0.44	0.50[e]	0.13
Total animal protein capture (hunting plus fishing)	1.08	0.91	0.59	0.68
Gathering	0.17	0.32	0.31	0.07
Gardening	1.21	2.09[d]	1.44	2.50
Domestic animal care	0.03	0.08	0.12	0.08
Market activities	0.43	0.57[d]	1.09[e]	1.48
Nonsubsistence work[b]	4.34	3.29	2.80	2.51
Nonwork[c]	6.72	6.73	7.69	6.80

[a] Number of hours per 14 hour day, from 6:00 A.M. to 8:00 P.M.
[b] Includes child care, food preparation, housekeeping, manufacture of tools, gathering firewood, business transactions within the community.
[c] Includes eating, ceremonial activities (singing), hygiene, conversation, recreation (e.g., soccer game), and sitting idly.
[d] Part of the Xavante harvest is sold on the market. Prorating for the proportion of food sold, one could take 0.17 hours out of the gardening time and place it in the market activities category, giving figures of 1.93 hours a day for gardening and 0.74 hours a day for market activities.
[e] Part of the Bororo fish catch is sold on the market. Prorating for the proportion of food sold, one could take 0.07 hours out of the fishing time and place it in the market activities category, giving figures of 0.43 hours a day for fishing and 1.16 hours a day for market activities.

increased workload in both of these activities may be a response to the poverty of the Kanela habitat. This forces them to spend more time in their gardens (e.g., weeding and building fences). Low garden productivity also encourages the Kanela to manufacture handicrafts for sale and to work for wages in order to buy some of their food and other necessities (Gross *et al.*, 1979). The Mekranoti, in contrast, produce plenty of food with much less garden work. They can devote their time to tasks that provide a higher quality diet and other comforts. For example, while nights are colder in the Kanela area, the Kanela often go to bed without the warmth of the many fires the Mekranoti enjoy. The Mekranoti have more time to collect extra firewood; the Kanela restrict the use of firewood primarily to cooking. Neither group has blankets in any quantity. The Mekranoti work more at hunting and fishing than the Kanela because these activities yield valued products for a moderate input of labor and no other activity competes heavily for Mekranoti time. The greater amount of time the Kanela spend gardening leaves less time for other pursuits.

How consistent are the Xavante and Bororo data with this explanatory scheme? The Xavante fit the scheme well. When we consider animal protein capture as a whole (fishing plus hunting), they fall between the Mekranoti and Kanela cases on both the productivity and time allocation scales (Tables I, II III, and V). Although Xavante fishing productivity is higher than that of the

Mekranoti, this is balanced by lower Xavante hunting productivity. Xavante garden production is also intermediate between the Mekranoti and the Kanela. On all the major work activities (animal protein capture, gardening, market activities, and nonsubsistence work) the Xavante again stand between the Mekranoti and the Kanela.

The Bororo are exceptional. Garden productivity is very low, providing an inadequate calorie ration per person (Tables I, IV). Part of the Bororo fish production is exchanged on the market for high-calorie foods (e.g., bread, rice). The Bororo could probably catch more fish, since fishing yield per hour is relatively high – as high as Mekranoti hunting productivity. Why don't they invest more time in protein capture for their own consumption, like the Mekranoti, or catch more fish for sale? Commercial fishing may be limited by the fact that the principal market for fish is more than 100 km away and the sole fish buyer who visits this village pays very low prices. In trading animal protein for calories, the rate of exchange is weighted against the Bororo. Increased fishing for direct consumption would provide more calories in the diet. But possibly the Bororo fail to fish more because of the high rate of illness and invalidism in the village, which makes some people less able to work. The Bororo fish from canoes on the swift São Lourenço River. This activity requires a great deal of physical stamina. Finally, because of the relatively small number of dependent children in their village the Bororo lack this incentive to increase production. In terms of the ratio of dependent children (less than 15 years of age) to total population the Bororo rank lowest at .375, compared to the Mekranoti (.512), Xavante (.490), and Kanela (.476). This means that Bororo adults have fewer children to feed.

DISCUSSION

We have offered economic explanations for differences in effort devoted to hunting and other activities. Other authors have stressed personality and social structural factors to explain differences in work inputs. Lizot (1977) concluded that motivation, as an independent variable, accounted for differences in work input where environmental factors could not. Still other authors treat motivation as an intervening variable rather than as an independent variable. Mary Douglas (1962) offered an explanation for work inputs in two neighboring Central African societies. According to her, the greater work inputs of the Bushong as compared to the Lele can be traced to a greater sense of deferred gratification among the Bushong. As the argument goes, the lower productivity of the Lele environment provided no incentives to manufacture elaborate tools like those of the Bushong. Thus the Lele did not establish a pattern of investment for the future. Certain social customs followed: Prestige was not accorded to high Lele producers; people entered the work force fairly late in life and retired early; polygynous older men monopolized women, leaving wifeless young men to dissipate their energies in fighting rather than engage in productive activities. According to Douglas, many of these social factors came to play a more important role than the environment in maintaining low productivity. Going a step further, Douglas argued that the Lele resisted expansion of production even when it would have been advantageous. Douglas' data do not support her argument very well. Even after significant changes in social arrangements took place (e.g., the abandonment of polygyny), the Lele continued to produce at low levels. According to Douglas, work inputs increased only *after* trade goods became more generally available. It seems, then, that it was changes in the economic, rather than in the social, conditions that precipitated changes in the motivation to produce.

Just as Lizot and Douglas stressed the importance of personality variables like "laziness" or "deferred gratification," LeVine (1966) stressed "achievement motivation." He used psychological tests to show that the Igbo are more achievement motivated than the neighboring Hausa of Nigeria. He argued that the differences in personality arose because the possibility for social mobility among the Igbo encouraged people to "get up" while the lack of social mobility among the Hausa discouraged such ambitions.

A major question left open when explaining economic motives through the use of personality or social factors as intervening variables concerns the length of time it takes people to adjust once the original economic equations have changed. When social mobility becomes possible, for example, how long does it take before people become motivated to achieve? The same question arises when using social factors, such as those proposed by Mary Douglas, to explain economic motives. How long does it take members of a society to adjust? If there is no appreciable time lag, perhaps it is unnecessary to invoke intervening variables to account for cross-cultural variation.

We do not have the longitudinal data with which to evaluate questions of this type. Our data refer to a period of only 1 year in each society. Nevertheless, our ability to explain work inputs directly from environmental differences suggests that communities may be able to make fairly fine and rapid adjustments. The groups we studied, like most native societies in South America, are undergoing rapid change. If, under these conditions, they can adjust their work inputs to environmental factors, we may have some reason to believe that the intervening process (e.g., the formation of personality traits appropriate in dealing with a particular environmental challenge) do not require long periods of delay. In any case our data suggest that researchers elsewhere should carefully evaluate the alternative possibilities open to a group before they pass judgment on the rationality or irrationality of the economic choices made. This is not to say that "personality" and "social structure" cannot play important roles as intervening variables but it does suggest that a first look should go to the basic economic alternatives available.

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