
Showing Off

Tests of an Hypothesis About Men's Foraging Goals

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It is widely assumed that among hunter-gatherers, men work to provision their families. However, men may have more to gain by giving food to a wide range of companions who treat them favorably in return. If so, and if some resources better serve this end, men's foraging behavior should vary accordingly. Aspects of this hypothesis are tested on observations of food acquisition and sharing among Ache foragers of Eastern Paraguay. Previous analysis showed that different Ache food types were differently shared. Resources shared most widely were game animals. Further analysis and additional data presented here suggest a causal association between the wide sharing of game and the fact that men hunt and women do not. Data show that men preferentially target resources in both hunting and gathering which are more widely shared, resources more likely to be consumed outside their own nuclear families. These results have implications for 1) the identification of male reproductive trade-offs in human societies, 2) the view that families are units of common interest integrated by the sexual division of labor, 3) current reconstructions of the evolution of foraging and food sharing among early hominids, and 4) assessments of the role of risk and reciprocity in hunter-gatherer foraging strategies.

KEY WORDS: Sharing; Hunting; Foraging strategies; Sex roles; Risk; Ache.

The role of men in provisioning their wives and children is frequently nominated as a distinctive human pattern, perhaps a fundamental hominid characteristic on which other features of human social behavior depend. According to a common view, male provisioning makes nuclear families the basic units of human societies, both evolutionarily (White 1959; Isaac 1978; Lovejoy 1981; Lancaster and Lancaster 1983) and structurally (Murdock 1949; Levi-Strauss 1956; Sahlin 1972). Among hunter-gatherers, the goal of family provisioning is assumed to determine both the suite of resources men exploit and the way these resources are distributed for consumption. Yet, three observations are inconsistent with this view. First, there is wide variability in the amount of time that men in

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different hunting and gathering communities spend acquiring food and this difference is not simply correlated with variation in return rates (Hill et al. 1984; Hawkes 1987). This implies that men are sometimes settling for smaller foraging incomes than time would allow. Second, hunters sometimes preferentially target resources with expected energetic return rates which are lower than available alternatives (Lee 1968; Hill et al. 1987); they could supply more calories to their families for the same time spent if they chose otherwise. Third, although sharing is widely reported to favor closer kin (Sahlins 1965, 1972), meat is often more widely shared than other resources (Marshall 1961). In some cases, game is regularly distributed in ways that give no advantageous share to the hunter or his spouse and children (Gould 1982; Lee 1979; Kaplan et al. 1984). These practices suggest that family provisioning might not always be the only, or even the principal goal of foraging men.

THE PROBLEM

If men forage primarily to provision their families, we might expect them to allocate their time to foraging and to choose their foraging strategies so as to provide the highest income. They would also direct the resources they acquire to their wives and children. Apparent departures from these expectations may not be as inconsistent with the assumption of family provisioning as I have suggested. The availability of non-foraging opportunities which contribute to family welfare might lead men to allocate more time away from foraging. Common currencies for foraging return rates may inaccurately measure resource value. Widespread sharing might promote returned shares and so increase family income over time. Pursuit of two of these possibilities has produced refinements of the provisioning hypothesis. The first applies especially to meat as a preferentially targeted resource. While the caloric rate of return for game may be lower than available alternatives, its overall nutritional return rate may be higher (Hill et al. 1984; Hill 1988; Kaplan et al. 1990). The second pertains to extensive sharing. For resources which are taken unpredictably but in large packages, reciprocal sharing among families would result over time in lower daily variation and higher daily average amounts of food for a sharer's spouse and children (Sahlins 1972; Kaplan 1983; Kaplan and Hill 1985b; Winterhalder 1986). Both of these refinements indicate productive directions for continuing research. However, because the most widely shared resources are typically taken by men, other factors might profitably be examined as well. This is especially so since the widespread sharing labeled "reciprocity" by ethnologists includes "sustained one way flows" (Sahlins 1965, 1972). Such patterns are unlikely to be instances of "reciprocal altruism" (Trivers 1971) to reduce the variance in daily income. That kind of reciprocity can persist only when benefits re-

turned to the giver offset the immediate costs of the gift (Axelrod and Hamilton 1981).

The two ethnographic generalizations, that men hunt, and that meat is widely shared, indicate a sex bias in resource choice and a difference in the spread of resources acquired by men and women. Men exploit resources which are more widely distributed. This association could result from correlations between two causally unrelated things and the same independent variable. The sex of the acquirer of a resource and the extent to which the resource is shared, like the age of George Williams and the size of the earth's human population, could be correlated with each other only because of their common association with something else. If, however, the distribution patterns are causally linked to resource characteristics, expected distribution should affect the value which a forager assigns to a target resource. If different distribution patterns are valued differently by different foragers, resource choices might differ accordingly.

Differences between the sexes invite examination in this light. There are differences in the character of reproductive costs and benefits for males and females which could lead to differences in the value to men and women of various patterns of resource distribution. Relevant general theory and observations began with Darwin's concept of sexual selection (1859, 1871). More recently (see discussion in Bradbury and Andersson 1987), following Bateman (1948), Williams (1966), and Orians (1969), Trivers (1972) linked sexual selection to parental investment and so broadened the array of differences in sexual strategies which can be associated with choosing and competing for mates. Just as for other species, human females do not multiply the number of offspring they can have by multiplying their mates. Human males, on the other hand, can more nearly produce as many offspring as they have wives and lovers. Under many circumstances, women gain relatively greater fitness benefits than men by focusing on the care and provisioning of offspring, while men gain relatively greater fitness benefits than women from additional mates.

Men chosen as mates by more women can have more children, so characteristics which lead women to choose them as mates provide fitness advantages to men. Women enhance their own fitness by choosing mates with characteristics that contribute to the survival and success of offspring. Conflicts of interest both between and within the sexes emerge. Females can collect some advantages for their offspring from multiple sources. If women can collect benefits for a child from more than one man, then women may earn net benefits by giving chances of paternity to more than one man rather than certainty of paternity to only one. Women may even collect "good genes" by providing paternity chances differentially, more chances to some men and little or none to others. A chance of paternity would not be as valuable as certainty to a man, but it might cost him less as well. If more paternity certainty cost men too much in chances of paternity foregone, then men might benefit by giving up certainty in one case, or a few, for chances

in several. If men who accumulate more chances of paternity benefit more than those who do not, female choice would make the behavior of men which elicited more of those chances the optimal strategy for males.

Relationships among men could also shape male mating strategies. If alliances played a role in male competition for mates, so that males who lacked allies suffered significantly reduced mating chances, then behavior which attracted favorable attention from other males could net corresponding fitness rewards. Thus, reproductive gains to men could come from activities which promoted either sexual favors from many women or support in disputes from many men (and women). These arguments suggest that men may have more to gain by attracting the favor of a wide pool of community members, both male and female. Acquiring resources for general consumption may give men more fitness benefits (Siskind 1973; Hill and Kaplan 1988a,b; Hawkes 1990) than it would give women. According to this hypothesis, under some circumstances men may have more to gain if they pursue goals which could be in conflict with family provisioning.

THE SHOWOFF HYPOTHESIS

Imagine two alternative investment strategies for foragers who acquire more food than they consume themselves. One strategy is to invest the extra in present and future offspring, that is, to provision spouse and children. The other is to make the extra food widely available and so attract the favorable attention of potential future mates and potential allies for future contests over mating access. Some patterns of resource acquisition may be better for one than the other. For example, imagine two foraging strategies. One earns a steady mean income, with little variance. Daily totals are never very high and never low. The other strategy earns amounts which vary widely from day to day. The periodic bonanzas of the second strategy are visible to all. These bonanzas are large enough to more than fill immediate family demands. That is, consumers could satisfy their hunger, and value additional portions less, before they'd eaten the whole thing. If such bonanzas were unsynchronized among coresidents, widespread sharing could result by means of what Blurton Jones (1984, 1987) called "tolerated theft." As he pointed out, individuals would give up extra amounts of food to others who had less because the extra would be worth less to those who had already eaten. The cost of not sharing the extra, of defending it, would be set by its value to those who had little or none, a cost higher than its benefit to one no longer hungry.

Foragers who adopted the steady, low variance, strategy would thereby acquire amounts no greater than their families' needs. The absence of occasional jackpots would mean that immediate associates, family members, would not get more than they could economically defend (Brown 1964). A forager who earned a higher average, steady income which was more than

family members could afford to defend, should soon acquire more dependents, i.e., a larger family, reliant on the regular provisions. On the other hand, foragers who adopted the high variance strategy would not be good family providers. Between their irregular jackpots they would come home empty-handed. When they were successful, their bonanzas would be too large for anyone, including family members, to economically defend. Tolerated theft would spread the benefit to others as much as to their own families. The low variance strategy would earn benefit in the form of well-fed families, and so, if fitness turned largely on well-fed families, then individuals would benefit most by adopting this strategy. Usually, women would be likely to do better with this strategy.

On the other hand, it would be in the interest of any individual in groups composed of several families to have members of the *neighboring families* choose the high variance strategy. While neighbors who were provisioners worked only for their spouses and children, neighbors who took the gamble for occasional bonanzas would be working for everyone in the community and not especially for their own households. Even though a woman might prefer to be a provisioner and to have a provisioning husband, she would prefer the others in the community to bring in jackpots, that is, to behave as showoffs. Their frequent days of failure would impose no direct cost on non-family members, but their periodic bonanzas would provide direct benefit to all. Other things equal, showoffs would be preferred over provisioners as neighbors by both women and men. If the benefits of the bonanzas due to showoffs were high enough to community members, it would be in their interest to turn this preference into favorable treatment for those adopting the risky strategy. This could mean siding with them when groups fragment, not siding against them in disputes, or it could mean more active favors to encourage them to remain neighbors and to continue showing off. Men would be more likely than women to gain from this favorable treatment due to seeking bonanzas under a wider array of circumstances.

By this argument the bonanzas of showoffs are rather like public goods, all neighbors benefiting because the cost of excluding some consumers is not worth paying. The bonanzas would benefit all whether or not they treated showoffs favorably. We must consider the extent to which this would create a collective action problem (Olson 1965), such that "free-riders" who shared in the bonanzas without favoring the showoffs could net higher benefits than those who supported the showoff's behavior by their favors. To the extent that the favors imposed a cost on favor-givers, favor-givers would have to earn an off-setting benefit or free-riding would emerge as the optimal strategy, and benefits for showing off would disappear.

Consider first the benefits to women for giving sexual favors to showoff men. Offspring benefits for having showoff fathers might be expected to support female choice for showoffs as suggested by Fisher (1930; review of current models in Maynard Smith 1987). In a more formal treatment of a version of this showoff hypothesis (Hawkes 1990), favored treatment for the

children of showoffs by neighbors who gain from their father's bonanzas is part of the fitness benefit women get for choosing showoffs (although a collective action problem may be detected there as well). If groups are very flexible in composition, a tendency for showoffs to prefer the company of favor-givers (as all prefer the company of showoffs) could lead favor-givers to find themselves with showoff neighbors more often than would non-favor-givers. This could apply to male as well as female favor-givers. If disputes and group fissioning made choosing neighbors a frequent enough feature of social life then favor-givers might find themselves more often in the company of showoffs with consequently greater access to bonanzas.

Favorable treatment for showoffs could be a very low cost to give, e.g., following the showoff rather than another man, but quite beneficial to receive. For example, showoffs would be likely to be in larger groups and so less vulnerable to predators and enemies. Different assumptions about payoffs can lead to an overwhelming free-rider problem among males with none giving favors and showing off rewarded only through female choice, or to games of "chicken" (see e.g., Taylor 1987, Hawkes in preparation), in which, at least some men regularly do give favors to bias their chances of having showoff neighbors. Showoffs may have especially strong reasons for favoring other showoffs as neighbors, since supplements to their own varying income might be particularly welcome. An array of models which attend to various of the likely costs and benefits would clarify the necessary trade-offs. Here I assume only that there can be circumstances where benefits for showing off give a man higher fitness than he would earn from providing regular dependable provisions to his family, and under such circumstances men are likely to be showoffs.

This hypothesis entails two components. One of them is that "sharing" need not involve directing particular goods to particular recipients. In fact, such directed distributions could involve both the cost of showing favorites and, as Blurton Jones' model of "tolerated theft" points out, the cost of not sharing with other parties. The latter cost, that of excluding other claimants, could be imposed on both the giver, who must exclude others to deliver the goods, and the recipient, who must also exclude others to keep a special share. Such costs would not be worth paying if they were higher than the benefits earned. According to this argument, whether or not goods are widely distributed depends largely on features of the goods themselves which determine the cost of not sharing them.

The second component of the showoff hypothesis is that variation in the extent to which resources are distributed gives those resources different values for men and women. Men would be more likely than women to earn higher fitness from targeting widely shared resources. Men would pay less fitness cost than women in failing to provide for their families, and gain more fitness benefit from favorable treatment by a large number of neighbors. Package size and the synchrony of acquisitions exemplify features likely to make a difference in the costs of keeping resources and so in the extent to

which resources are suitable for showing off. However, any other features which make the same goods or services valuable to many at once could result in preferential treatment for those who provide them. A game theoretic model shows that under a wide array of likely parameter values, some preferential treatment by neighbors gives men who show off higher fitness than men who provision their families (Hawkes 1990).

THE ACHE: DATA AND TESTS

Data on foraging and sharing among the Ache suggested this hypothesis. The Northern Ache of Eastern Paraguay were full-time foragers before the 1970s when they began to live in mission sponsored agricultural communities established within their traditional forest range (Hill 1983; Hill et al. 1984; Hawkes et al. 1982). Settlement residents continued to forage both in daily excursions from the settlements and in extended trips, sometimes staying in the forest for several weeks. During these trips they depended on forest resources. Game animals were almost always acquired by men, as was the honey of *Apis mellifera*. Other resources were acquired by both men and women. A record of resource acquisition and consumption was kept on nine foraging trips in 1981–82. Initial analysis of the distribution patterns showed the Ache to be prodigious sharers. About three-quarters of anyone's consumption was supplied by someone outside the consumer's nuclear family. Foods of different types were differentially shared. While most collected items were more likely to be eaten by a member of the acquirer's nuclear family than by someone outside it, honey and game animals were so widely shared that members of the acquirer's nuclear family got no more than other members of the foraging party. In fact, the hunter himself got significantly less of his game than others did (Kaplan et al. 1984).

A review will highlight the problems that have emerged from further investigation of the sharing patterns (Kaplan 1983; Kaplan and Hill 1985b). Exploration began with the common assumption that family provisioning was the main goal of foragers. If so, the risk of failing to find and capture resources could present a problem foragers must solve. Kaplan and Hill hypothesized that reciprocal altruism (Trivers 1971) could provide the solution to this problem. If resources are found unpredictably, in packages larger than families could readily consume, foragers might reduce the variance and raise the nutritional value available to their families over time by reciprocal sharing (Kaplan and Hill 1985a; Winterhalder 1986).

Kaplan and Hill modeled the nutritional consequences of sharing versus not sharing various categories of resources, using the Ache data on daily acquisition and assuming a ceiling on daily consumption. This exercise showed that the benefits for sharing some categories of resources were greater than benefits for sharing others. Those in larger and more unpredictably acquired packages gave the greatest increase in daily consumable

Table 1. Correlations of All Acquisitions of Fifteen Resources

	% Taken by Men	Log Package Size	Log Unpredictability
% Eaten Outside Family	0.8252	0.7008	0.4764
	p = 0.001	p = 0.004	p = 0.073
% Taken by Men		0.6475	0.5460
		p = 0.009	p = 0.035
Log Package Size			0.8921
			p = 0.001

This matrix displays the Pearson's correlations among four attributes of the fifteen resource types most frequently acquired by Ache foragers over nine foraging trips in 1981–82. The values for three attributes: the percent shared outside the family, the average package size, and the unpredictability score are from Kaplan and Hill (1985b: 229–232, Tables 2, 5, and 7). Logarithmic transformations were used for package size and unpredictability values to straighten their skewed distributions (following Kaplan and Hill 1985b). Kaplan and Hill included two miscellaneous categories so these values are slightly different from those they calculated.

calories when shared. Moreover, almost all individuals and families, including those who produced significantly more than others, consumed more with sharing than they would have done without sharing.

Having demonstrated that the benefit of receiving shares of large unpredictable resources was greater than the cost of giving them up, Kaplan and Hill argued that it would be consistent with a pattern of reciprocal altruism if it were the larger, more unpredictably acquired resources which were more widely shared. They defined package size as the caloric value of the average amount of a resource taken in a continuous period of acquisition (e.g., a load of oranges) and unpredictability as the mean (overall days) of the standard deviation among families in the total amount of a resource type acquired each day.¹

Table 1 lists the fifteen most important resources acquired during the 1981–82 observation period, the set discussed by Kaplan and Hill (1985b). Values for four main attributes are reported for each with a set of two values given for three of the four. The main attributes are 1) the percentage of the observed consumptions in which the consumer was not the acquirer, the acquirer's spouse, or child; 2) the percentage of observed acquisitions in which the acquirer was male; 3) average package size in calories; and 4) the unpredictability score (Kaplan and Hill 1985b: 232, Table 7). For the first three attributes two scores are reported, one for all acquisitions of the resource (when the particular acquirer was known), and one which includes

¹ Mean standard deviation in daily rates of return, rather than daily totals, provide a better measure of unpredictable variation because it would distinguish differences due to effort from those due to differences in skill and luck. Measuring unpredictable variation across individuals rather than families would then be sensible. Most of these resources are taken whenever they are encountered, so such a measure would adjust the daily totals on which these means were calculated by the length of time spent in search each day. Palm starch is the salient exception. The ubiquity of suitable palms (Hill et al. 1987) makes search costs trivial, so, variation in return rates depends almost entirely on tool type, chopping pace, and palm quality. Note that the measure of unpredictable variation should be sensitive, as is standard deviation, to the mean size of a resource. The presence or absence of small items contributes less nutritional fluctuation to daily menus than the presence or absence of large ones.

ATTENTION READERS:

Please place this page of corrections in Hawkes: "Showing Off: Tests of an Hypothesis About Men's Foraging Goals," which appeared in the last issue [12:29-54 (1991)].

Tables 1 and 6 were omitted from the original publication. They appear below. Renumber the four tables which were printed as 1-4 with the numbers 2-5, which match the numbering used in the discussions of the tables in the text.

This entails the following corrections. *First*, change the label of Table 1 on p. 36 to Table 2. *Second*, change the label of Table 2 on p. 40 to Table 3. *Third*, change the label of Table 3 on p. 42 to Table 4. *Fourth*, change the label of Table 4 on p. 43 to Table 5.

Table 1. Sharing and Acquisition By Sex

Resource ¹	% Beyond family ²		% By men ³		Package size ⁴		Unpredictability ⁵
	All ⁶	Family ⁷	All ⁶	Family ⁷	All ⁶	Family ⁷	All
Virella (a small fruit) ⁸	8	10	33	31	312	576	1308
Kurilla (a small fruit) ⁸	23	26	19	17	1355	1397	2158
Larvae	58	53	50	43	454	721	619
Oranges	68	64	62	64	8304	1207	1364
Palm starch	69	69	12	05	2906	2885	2001
Palm heart	72	70	70	65	419	437	327
Misc. honey (not <i>Apis</i>)	81	79	85	75	4013	4313	1996
<i>Apis</i> honey	85	87	97	97	16161	16161	8469
Collared peccary	89	89	100	100	23814	23814	11521
White-lipped peccary	89	86	100	100	42832	42832	19362
Monkey	90	88	100	100	3077	3077	2606
Armadillo	91	90	100	100	4765	4765	2782
Coati	91	92	100	100	6401	6401	3260
Deer	94	95	100	100	30555	30555	10663
Paca	95	92	100	100	10486	10486	3919

This table lists the fifteen most important resources acquired during the 1981-82 observation period as discussed by Kaplan and Hill (1985b). Values are listed for the extent of sharing, the sex bias in acquisition, and the package size and unpredictability of each. For the first three of these variables two values are listed: the first for the data set as a whole, the second for a subset of all acquisitions which excludes most notably those by single men.

¹ See Hill and Hawkes (1983) for description of game and Hill et al. (1984) for description of other resources.

² The percentage of consumption observations in which the acquirer and consumer did not belong to the same nuclear family. The values are from Kaplan and Hill (1985b).

³ The percentage of acquisition observations in which the acquirer was a man. See text.

⁴ Package size is the mean caloric value of the amount of the resource taken in a single acquisition event, e.g. a "load" of fruit, a bundle of palm starch.

⁵ Unpredictability is the mean standard deviation across families in total calories acquired each day (Kaplan and Hill 1985b:232 table 7). See footnote 3.

⁶ The values are for all acquisitions, from Kaplan and Hill (1985b:229-231 tables 1, 2, and 7).

⁷ The values are for acquisitions by men and women with families.

⁸ Species identification pending.

Table 6. Sharing of Non-game Foods by Sex

Resource	Consumptions acquired by a man with a family		Consumptions acquired by a woman with a family	
	N	% Out of Family	N	% Out of Family
Virella	23	13	132	9
Kurilla	15	0	54	33
Larvae	123	56	165	50
Oranges	128	70	67	52
Palm starch	88	60	541	70
Palm heart	295	68	132	76
Misc. honey (not <i>Apis</i>)	38	81	219	71
<i>Apis</i> honey	574	86	16	94
Total	1438	74	1145	58

This table lists the eight non-game resources. Only those acquired by adults with families are included. Consumptions have been separated by the sex of the acquirer to compare how much a resource type is shared by men with how much is shared by women.

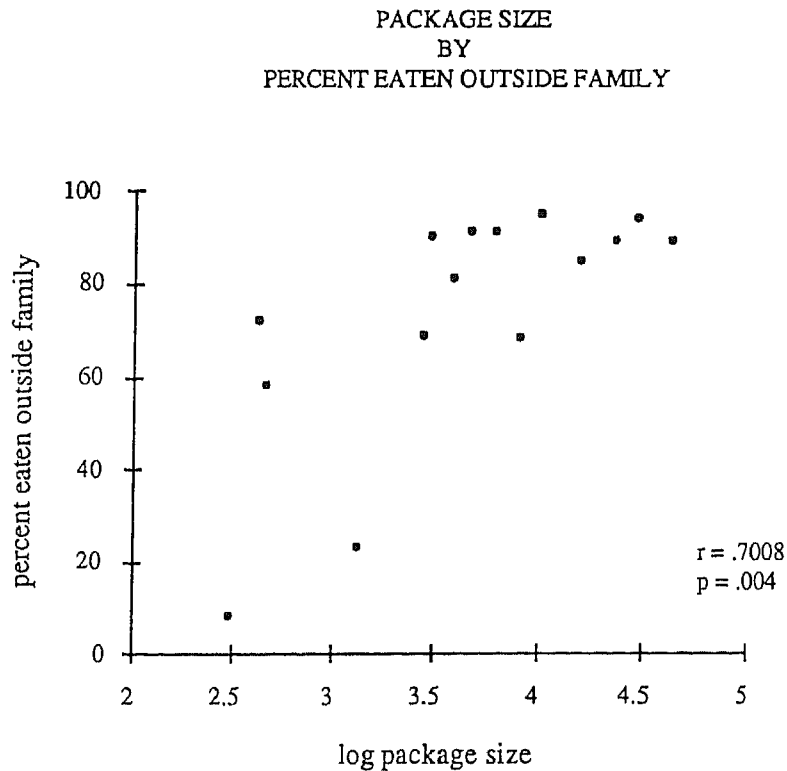


FIGURE 1. The log of mean package size of a resource type is correlated with the fraction eaten outside the nuclear family of the acquirer. Each point is a resource type.

only resources acquired by adults with families. The percentage of consumptions outside the nuclear family, the mean package size for the data set as a whole, and the unpredictability score come from Kaplan and Hill (1985b: 229–232, Tables 2, 5, and 7 respectively).

Kaplan and Hill showed that, indeed, there were positive correlations across resources between both package size (Fig. 1, using the logarithm to straighten the skew) and unpredictability (Fig. 2, again using the log) and the fraction of the observed consumptions in which the food was eaten by someone outside the nuclear family of the acquirer.²

They also performed the analysis which shows that the differential sharing of these resources is inconsistent with the general predictions of reciprocal altruism. It is not enough that the cost to givers is less than the benefit to recipients for reciprocity to persist. It must also be true that shares are given differentially to those more likely to return the favor in the future. If there is no bias toward reciprocators, if all receive equally, whether or not

² Kaplan and Hill (1985b) included two miscellaneous categories of resources which have been excluded here. These correlations are thus slightly different than the ones they report.

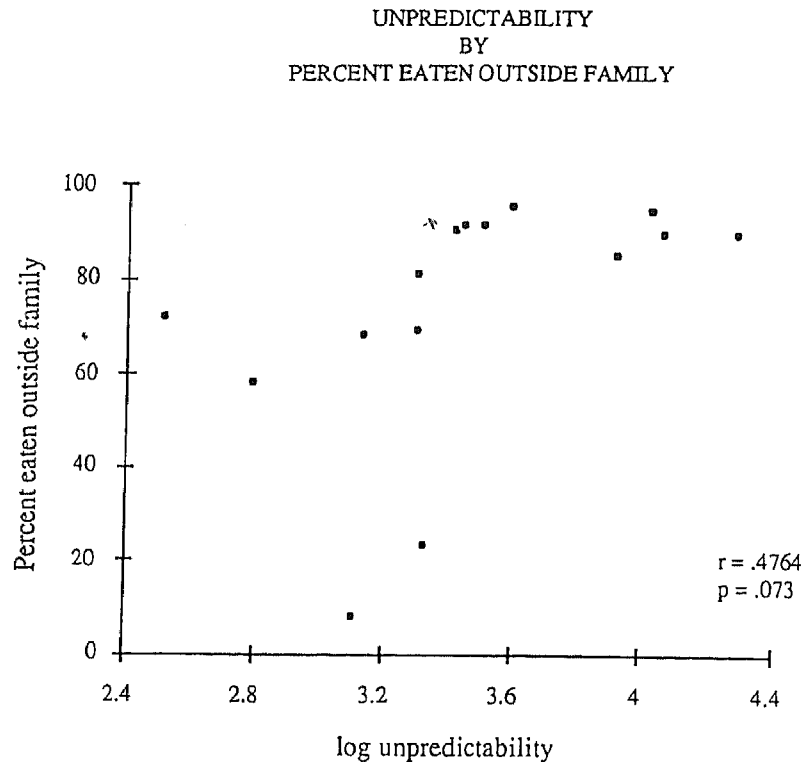


FIGURE 2. The log of unpredictable variation of a resource type (see footnote 1) is correlated with the fraction eaten outside the nuclear family of the acquirer. Each point is a resource type.

they have brought in resources themselves, then receiving future shares is independent of current giving. One of the most striking features of Ache food sharing is the lack of bias in consumption for the resources most widely shared. While there are very large and consistent differences in the amounts contributed by individual foragers, there is no tendency for those who produce more to receive more (Kaplan and Hill 1985b: 233). This means that reciprocal altruism to reduce consumption variance does not explain the wider sharing of unpredictable, large package resources.

Questions are therefore posed by the sharing patterns. First, why should a man forage if it makes no difference to the shares he and his families will receive from others? Second, why should men target resources likely to be consumed as much by neighbors as by their wives and children? Or, why should they allow the resources they acquire to be so widely shared? The showoff hypothesis is directed toward these questions. If Ache men were practicing a showoff strategy they would forage to attract favors by making food widely available. If different resources are shared differently by all, showoffs would target the more widely shared resources.

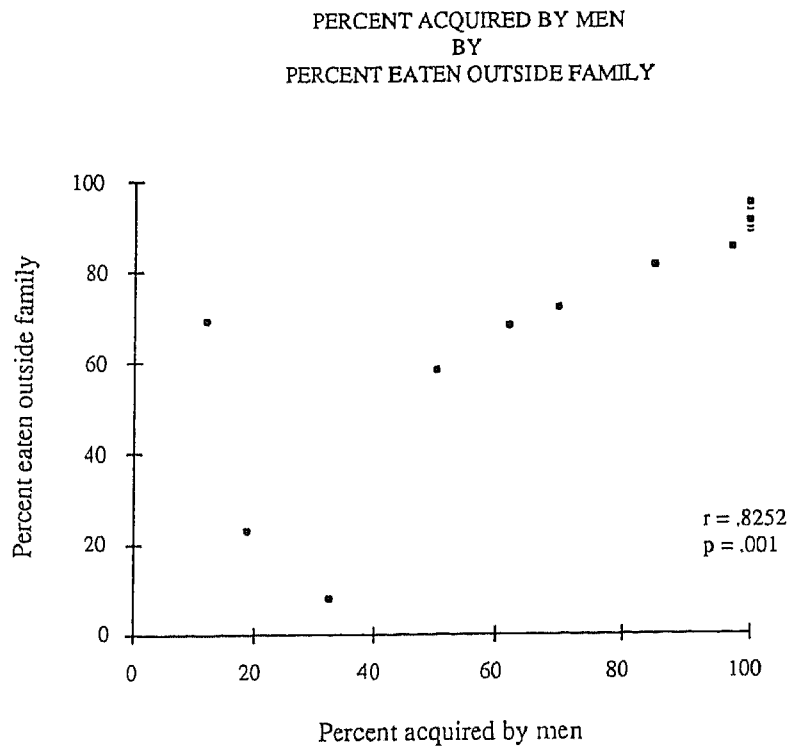


FIGURE 3. The fraction of a resource type acquired by men is correlated with the fraction eaten outside the nuclear family of the acquirer. Each point is a resource type. (The outlier, upper left, is palm starch. See subsequent discussion in the text).

If Ache men are showing off (and women are not), the sex of the acquirer of a food should predict how widely it is shared. Figure 3 shows the relationship between the fraction of a resource acquired by men and the fraction eaten by someone other than the acquirer, or the acquirer's spouse or children. The correlation is strong and positive: $r = 0.8237$ ($p = 0.001$). Fully two-thirds of the variation in sharing is accounted for by the probable sex of the acquirer.

According to the tolerated theft argument, resources which are large and unpredictable are more likely to be widely shared. As noted above, (Figs. 1 and 2) Kaplan and Hill showed there are positive correlations between the fraction of a resource eaten outside the nuclear family and the package size of the resource, and between the fraction of a resource eaten outside the family and the unpredictability of the resource. These correlations appear in Table 2. The table also shows that there is a correlation between these characteristics and the fraction of the resource acquired by men. The relationships are plotted in Figures 4 and 5.

If men's primary foraging goal is showing off, and features other than mean package size and predictability make a difference in how resources

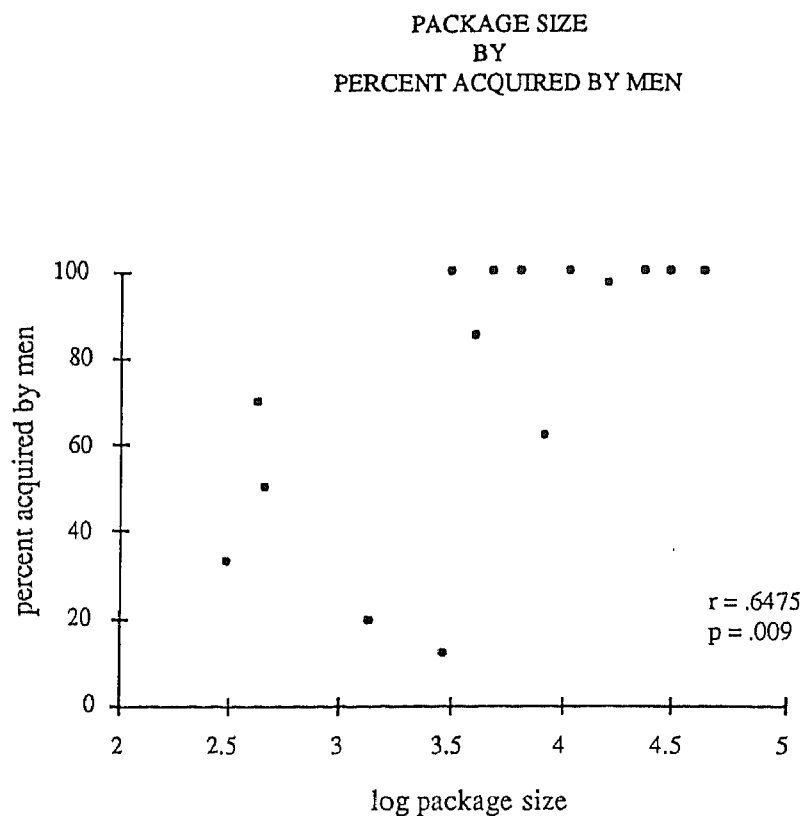


FIGURE 4. The log of mean package size of a resource type is correlated with the fraction acquired by men. Each point is a resource type.

Table 2. Partial Correlations of All Acquisitions of Fifteen Resources

	% Taken by Men	Log Package Size	Log Unpredictability
% Eaten Outside Family	held constant	0.3868	0.0545
		$p = 0.172$	$p = 0.853$
% Eaten Outside Family	0.6832	held constant	-0.4618
	$p = 0.007$		$p = 0.096$
% Eaten Outside Family	0.7671	0.6944	held constant
	$p = 0.001$	$p = 0.006$	
% Eaten Outside Family	0.7256	held constant	held constant
	$p = 0.005$		

This matrix displays the partial correlations calculated from the values in Table 1. Each row presents the results of an analysis in which the indicated variables are held constant.

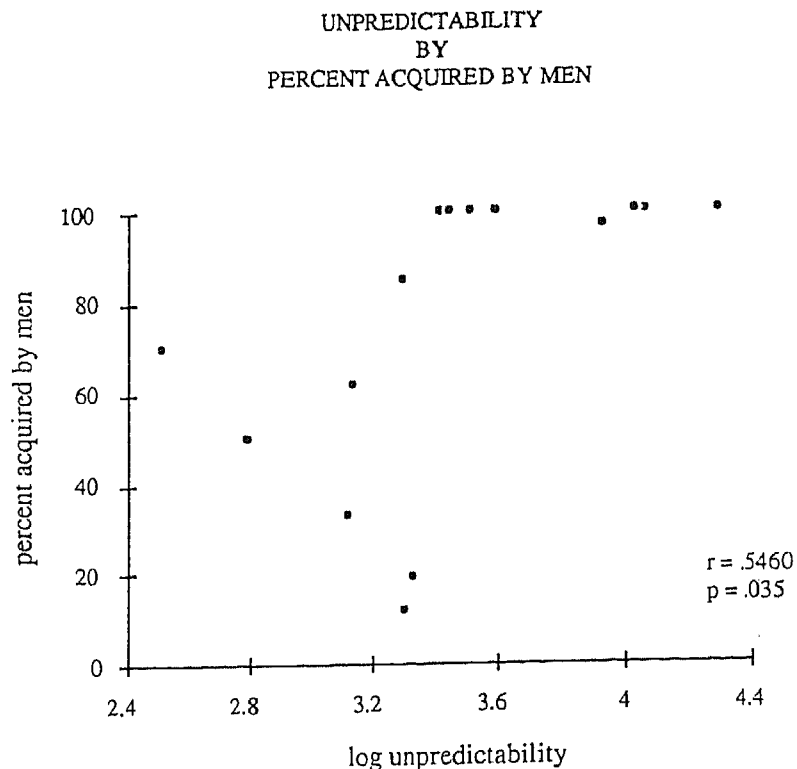


FIGURE 5. The log of unpredictable variation of a resource type (see footnote 1) is correlated with the fraction acquired by men. Each point is a resource type.

are shared, sex of the acquirer should be a good predictor of sharing even when package size and predictability are held constant. If, on the other hand, men forage for reasons which are independent of sharing patterns, sex of the acquirer could be a poorer predictor of sharing than are the other variables. Holding these variables constant in turn and calculating partial correlations can further test whether men's resource choice is consistent with the hypothesis that a primary goal of Ache men's foraging is to make food widely available beyond their nuclear families.

The pertinent partial correlations are shown in Table 3. The values indicate that when the effects of package size and unpredictability are held constant, the likelihood that a resource was acquired by a man remains a strong predictor of whether it will be shared outside the nuclear family. The probable sex of the acquirer, independent of its effect through the other variables, accounts for more than half of the variation in sharing. Conversely, with sex of the acquirer held constant, package size has a much reduced effect, accounting for only 15% of the variation in sharing, predictability having no effect. These patterns are consistent with the hypothesis that men forage in order to share.

Table 3. Correlations of Acquisitions by Adults with Families

	% Taken by Men	Log Package Size	Log Unpredictability
% Eaten Outside Family	0.8135 p = 0.001	0.7152 p = 0.003	0.5156 p = 0.049
% Taken by Men		0.6825 p = 0.005	0.5712 p = 0.026
Log Package Size			0.9553 p = 0.001

This matrix displays the Pearson's correlations among the values for the same variables manipulated in Table 1, except the sample includes only acquisitions by men and women with families. Logarithmic transformations were used for package size and unpredictability values to straighten their skewed distributions (following Kaplan and Hill 1985b).

These analyses of sharing patterns used consumption observations aggregated by resource as they appeared in Kaplan and Hill (1985b). The next step is to break down the consumption observations of each resource by sex of the acquirer and compare the extent to which resources acquired by men and women are distributed outside their nuclear families.

Review of the individual consumption events reveals the important constraints on the sharing patterns imposed by the composition of foraging parties. As Kaplan and Hill (1985b) reported, there were 45% more adult men (mean = 9.6) than adult women (mean = 6.6) in the foraging parties observed in 1981–82. Provisioning wives and children was not an option for these extra single men. If nearly one-third of the hunters had no families to feed, wider sharing of resources acquired by men could be the pattern even if men with families were favoring their wives and children. Almost all women (all but one woman on one of nine trips) were accompanied by spouses and children, so this difference between the sexes in the opportunity to provision might, by itself, make resources acquired by men more likely to be consumed by individuals outside the nuclear family of the acquirer.

To discover whether the sharing bias is a demographic artifact, let us restrict attention to only the acquisition and distribution by adults with families, that is, only those individuals who could provision spouses and children. Table 4 reports the correlations between the attributes listed in Table 1 where the sample excludes the acquisitions of all single individuals and includes only food taken by men and women who actually have families they could provision. As the table shows, the correlation between the fraction of a resource taken by men and the fraction eaten outside the family remains high ($r = 0.8135$, $p = 0.001$). Figure 6 plots this correlation. Its similarity to Figure 3, which included the single men, is striking. Table 5 repeats the calculation of partial correlations on the values in Table 4, those for acquisitions by adults with families only. The similarity between the values in Tables 2 and 4 and Tables 3 and 5 confirms what simple inspection of the pairs of values in Table 1 suggests: acquisition and sharing patterns for all acquirers, including single men, differ little from acquisition and sharing patterns when single men are excluded. Men with and without families

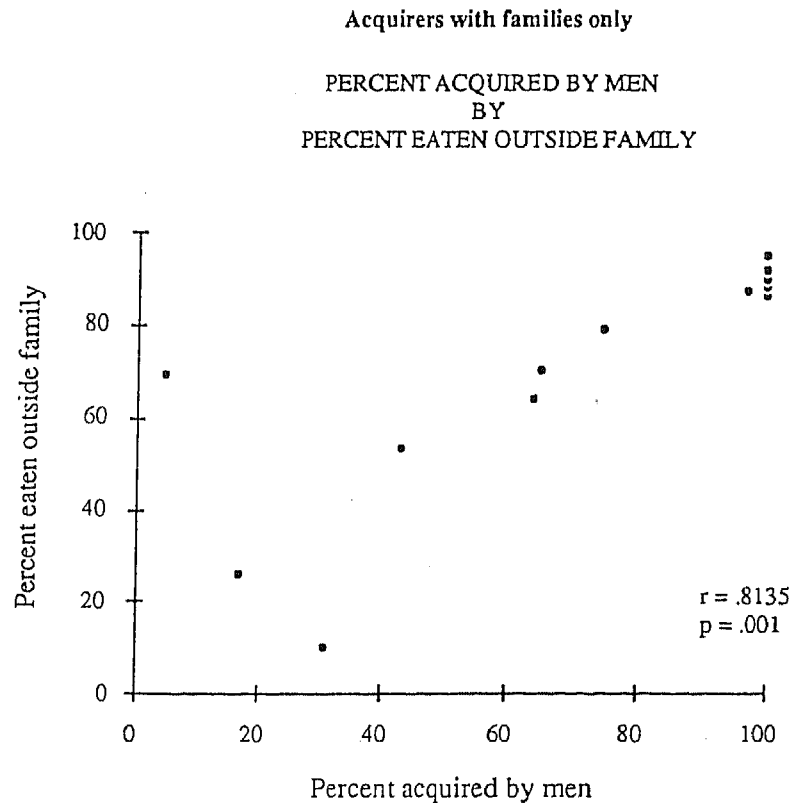


FIGURE 6. Restricting the sample to resources acquired by adults with families present, the fraction of a resource type acquired by men is correlated with the fraction eaten outside the nuclear family of the acquirer. Each point is a resource type. (The outlier, upper left, is palm starch. See subsequent discussion in the text).

Table 4. Partial Correlations of Acquisitions by Adults with Families

	% Taken by Men	Log Package Size	Log Unpredictability
% Eaten Outside Family	held constant	0.3764 $p = 0.185$	0.1067 $p = 0.717$
% Eaten Outside Family	0.6869 $p = 0.014$	held constant	-0.8112 $p = 0.001$
% Eaten Outside Family	0.7379 $p = 0.003$	0.8789 $p = 0.001$	held constant
% Eaten Outside Family	0.6152 $p = 0.025$	held constant	held constant

This matrix displays the partial correlations calculated from the values in Table 3. Each row presents the results of an analysis in which the indicated variables are held constant.

choose resources and distribute them in similar ways. The partial correlations of Table 5 demonstrate that resources acquired by men with families are much more likely to be shared outside the family than resources acquired by women, even when package size and predictability are held constant. Conversely, as with the larger sample, when the sex of the acquirer is held constant, package size and unpredictability have no significant effect on sharing.

These results do not show whether the difference in the sharing patterns of food acquired by men and by women is due to differences in the way the same resource is shared by the sexes or to differences in the relative number of times women and men take particular resources which have their own distinctive sharing patterns. The latter pattern is consistent with the showoff hypothesis as developed here: predictable sharing patterns for different resources lead men and women to have different foraging preferences. To test these alternatives, consumption observations in and out of the family must be tabulated by the sex of the acquirer.

Of the 4012 observed consumptions of these fifteen resources acquired by a man with a family, 3374 (84%) were by consumers other than himself, his wife, or his children. Of the 1153 observed consumptions of these resources acquired by a woman, 672 (58%) were by consumers other than herself, her husband, or her children (chi-square = 503.3; 3 df; $p = 0.0001$). If we exclude all game animals and consider only the remaining eight resources in this list of fifteen, the difference between men and women still persists. For the eight non-game resources combined, when the food was taken by a man with a family, 1066 of 1438 observed consumptions (74%) were not by family members. When the food was taken by a woman with a family, 668 of 1145 observed consumptions (58%) were not by her family members (chi-square = 90.8; 3 df; $p = 0.0001$). The change in the size of the difference between the amount of sharing by the sexes when game, acquired only by men, is excluded is consistent with an expectation that features of the resource itself affect the extent to which it is shared. If, in addition to game, we exclude the honey of *Apis* which is mostly taken by men, 593 (67%) of 891 observed consumptions were outside the family of the (family) man who acquired it; while 653 (58%) of 1129 observed consumptions were outside the family of the woman who acquired it (chi-square = 25.5; 3 df; $p = 0.0001$). Excluding the other honeys as well, 416 (62%) of the 672 consumptions were outside the family of the (family) man who acquired the resource, 626 (57%) of the 1091 consumptions were outside the family of the woman who acquired the resource (chi-square = 10.1; 3 df; $p = 0.0178$). The "sharing patterns" of men and women converge as we restrict attention to resources often acquired by both. This is consistent with the hypothesis that features of the resource itself affect how much it is shared.

The large size and unsynchronized captures of game animals make the costs of not sharing high and so make them particularly suitable targets for

showing off. But, what of the resources Ache men gather? If showing off were a goal of men's gathering, this might affect not only the resources they chose but other aspects of their acquisition strategy as well. Some resources are encountered as isolated individuals or small discrete patches so that package size is not affected by the forager's behavior. Others, however, occur in sizeable clumps and foragers can take varying amounts. Women foraging for their own family's consumption might reach diminishing returns for extra units of a food more quickly than would men who were foraging to share with the whole party. If men could gain benefits from wider distribution of the food they acquire, they might take larger packages when they have the chance.

For the eight non-game resources, the mean package size was calculated separately by sex of the acquirer for acquisitions by adults with families. Three show no significant difference between the size of packages taken by men and women. For four of the other five, however, men take significantly larger packages than women do. Men's mean package size for larvae was 1005 Cals, s.d. = 1752 ($n = 66$ acquisitions), women's mean package size was 506, s.d. = 651 ($n = 88$) (difference of means: $p = 0.0076$, one-tailed). For palm hearts, men's mean package size was 493 Cals, s.d. = 807 ($n = 137$), women's was 335 Cals, s.d. = 250 ($n = 74$) (difference of means: $p = 0.0514$, one-tailed). For virella men's was 1313, s.d. = 1181 ($n = 17$), women's 285, s.d. = 299 ($n = 38$) (difference of means: $p = 0.0001$, one-tailed). The honey of *Apis mellifera* was taken so rarely by women that no statistic could be calculated, but men averaged 16305 Cals ($n = 59$ acquisitions), women only 5344 ($n = 2$ acquisitions).

For palm starch, the pattern is reversed: women's mean package size was 2997, s.d. = 2737 ($n = 165$), men's only 819 Cals, s.d. = 1137 ($n = 9$), (difference of means: $p = 0.0094$). Palm starch is also exceptional in other ways. It is more widely shared than any other resource that women collect more often than men, raising an interesting question for future research. It is also a resource which men usually fail to take when they encounter it. The high unpredictability score for this resource (Table 1) results from the fact that the measure of unpredictability cited here is insensitive to whether income differences are due to differences in acquisition effort or encounter luck. Palm starch is almost ubiquitously available (Hill et al. 1987). If men took it whenever they could, they would spend so little foraging time searching for resources that they would rarely have a chance to encounter anything else. I comment further on these trade-offs below.

Average package size alone is not a good predictor of how much different gathered resources are shared ($r = 0.557$; $p = 0.1518$). (Neither is it a good predictor of the fraction of gathered resources taken by men [$r = 0.612$; $p = 0.1066$].) The features which account for the variation in how much gathered foods are shared cannot yet be specified. However, the convergence of the sharing patterns of men and women for the pool of resources often taken by both is consistent with the hypothesis that there are such

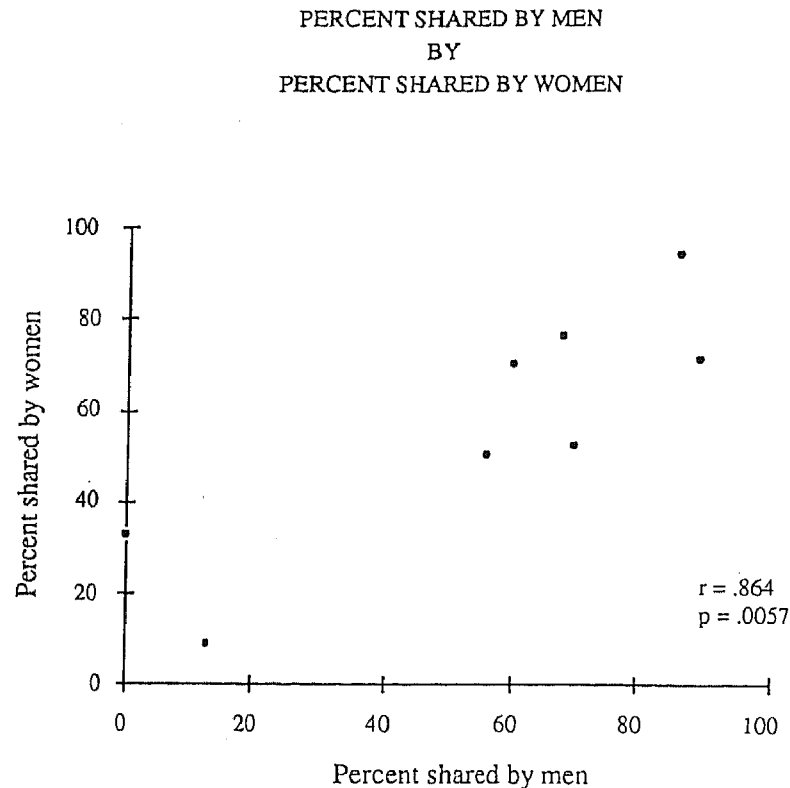


FIGURE 7. The fraction of consumptions of a resource acquired by men with families which are not by the acquirer himself, his wife, or their children is correlated with the fraction of consumptions of the resource acquired by women with a family which are not by the acquirer herself, her husband, or their children. Each point is a collected resource type.

features, i.e., that some resources are more "sharable" than others. If so, the sharing patterns of the sexes ought to be correlated across these resources. For the eight gathered resources analyzed here, the correlation between the fractions of observed consumptions of each resource which were outside the nuclear family of woman and (family) man acquirers (Table 6) is strong and positive, $r = 0.864$ ($p = 0.0057$). Figure 7 plots this relationship. Resources more widely shared by men are more widely shared by women also. This pattern is consistent with the expectation that something about the food itself determines the extent to which it is shared.

If some of these gathered foods are more "sharable," the showoff hypothesis predicts, for that reason, that men would prefer to acquire them more than women would. Considering only the gathered resources taken by adults with families, the correlation between the fraction of a food acquired by men and the fraction of consumptions of that food outside the family of the man who acquired it (values from Tables 1 and 4) is 0.723 ($p = 0.0428$).

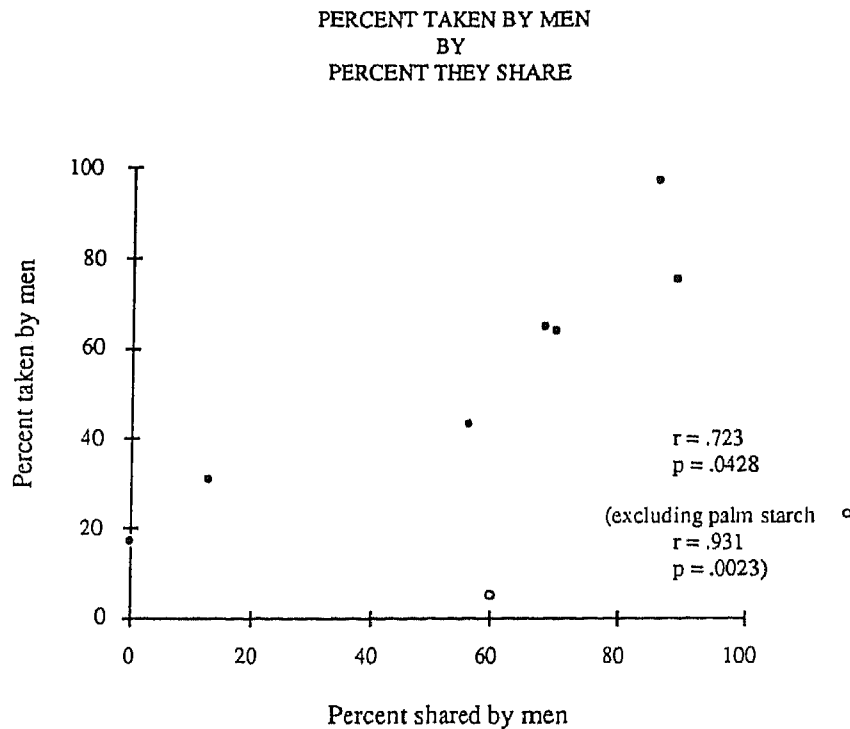


FIGURE 8. The fraction of consumptions of a resource acquired by men with families which are not by the acquirer himself, his wife, or their children is correlated with the fraction of the resources acquired by adults with families which are acquired by men. Each point is a collected resource type. (The low outlier, open circle, is palm starch. See text).

Figure 8 plots the scatter. Palm starch is an outlier here as in all other correlations involving sharing patterns and acquirer's sex. Some of its special features were noted above and they are discussed again below. Excluding palm starch, the correlation between the fraction of a resource men acquire and the fraction which men share outside their families for the seven other non-game resources is 0.931 ($p = 0.0023$). Men's preference for sharable resources is apparent even when we ignore hunting. As is consistent with the showoff hypothesis, men even prefer gathered resources which are more likely to be eaten outside their nuclear families.

This pattern within the collected foods is particularly notable because the comparison of men's and women's food acquisition patterns is generally complicated by the difference in nutrient composition of game versus plant foods, the general difference in the procurement strategies used for game versus seeds, fruits, and vegetables, and the relative unpredictability and mobility of animals compared to sessile plants. When only the suite of gathered resources is considered, these other variables are less confounding. The difference in preferences of the sexes for gathered resources can be

explained by the same difference in goals which would lead men, and not women, to hunt. This is consistent with the hypothesis that Ache men hunt because they are foraging to show off.

SUMMARY

Appraisal of the data on resource acquisition and consumption among the Ache in light of the showoff hypothesis reveals the following patterns. 1) Food taken by men is more widely shared than food taken by women (Figure 3). 2) Resources which come unsynchronized in large packages are more widely shared (Figures 1 and 2) and men take more of them (Figures 4 and 5). 3) The probable sex of the acquirer of a resource remains a strong predictor of sharing, even when average package size and mean unpredictable variation are held constant (Table 3). On the other hand, when the probable sex of the acquirer is held constant, neither package size nor unpredictable variation are significantly correlated with sharing (Table 3). 4) Analysis restricted to only those who could provision families affirms that the probable sex of the acquirer of a food is the best predictor of how much of it is distributed outside the family (Figure 6 and Table 4). 5) The difference between men and women in the fraction of their acquisitions shared outside the nuclear family is greatest when all foods are considered, but it remains significant even when game and honey are excluded (see text). 6) Men take larger packages of many of the same collected foods that women take. The reverse is true for only one resource: palm starch (see text). 7) Package size predicts sharing across the whole suite of fifteen resources (Figure 1 and Table 2), but not across the collected resources alone; yet some feature or set of features of the foods themselves makes them more or less likely to be widely distributed. This is indicated by the fact that while there is wide variation in the extent to which different gathered foods are shared, there is a strong correlation between the fraction of a particular food which is shared by women and the fraction of that food shared by men (Figure 7). 8) Men with families take more of the collected resources which are more widely shared. They take less of those which are more likely to be consumed by their own nuclear family members (Figure 8). The preference men show for collected foods which are more widely shared suggests that the same preference may lie behind the fact that hunting is so frequently a speciality of men.

DISCUSSION

The showoff hypothesis accounts for aspects of variation in resource choice between the sexes which had been interpreted as evidence of provisioning. It also points to patterns which had not been previously appreciated. More-

over, other features of Ache behavior which had seemed quite puzzling are consistent with the showoff hypothesis. These include the pattern of hunters calling others to join a game pursuit although callers lower their personal mean return rate by doing so (Hill and Hawkes 1983), and hunters eating significantly less of their own kills than others do (Kaplan et al. 1984). The relative value of the favors earned by sharers is suggested by the fact that better hunters spend more time hunting (Hill and Hawkes 1983), increasing their disproportionate contribution to others' consumption. The privileged sexual access and increased offspring survivorship which better hunters enjoy (Kaplan and Hill 1985b; Hill and Kaplan 1988a,b) suggest that their sharing does earn them very material favors.

The results have four general implications. First, they provide a basis for reexamining assumptions about the choice of resources men exploit. Analyzing foraging activities as though there is an average forager who represents either sex (e.g., Hawkes et al. 1982) may obscure important aspects of foraging strategies (Jochim 1988). When women's activities are under scrutiny, reproductive issues receive attention (Brown 1970; Murdock and Provost 1973). Foraging Ache women give up some resource acquisition efficiency to increase their direct attention to children (Hurtado 1985; Hurtado et al. 1985). The same reproductive trade-offs do not apply to men, but other tradeoffs do (Hill and Kaplan 1988a,b). Many aspects of the social organization and behavior of nonhuman primates, as well as other nonhuman organisms have been clarified by research which does not assume that environmental constraints affect a population uniformly, but instead, views differences in ecological pressures on the sexes as fundamental (e.g., Wrangham 1979; Wrangham and Rubenstein 1986). I have treated the showing off and family provisioning hypotheses as competing alternatives. It seems likely that while the goals of these two strategies are often in conflict, circumstances in which men could gain from serving each to some degree might be common. If so, modeling the patterns to be expected under varying allocations of effort to the two goals could guide the construction of more realistic predictions to test.

Second, while many aspects of recently favored scenarios of hominid evolution have been under sharp attack, the assumption that males provision mates and offspring has received less criticism (Isaac 1984; Toth and Schick 1986). Among modern humans, men may acquire food for reasons quite different from family provisioning. Such patterns invite consideration of the role such reasons may have played among other hominids. This is so especially for scenarios of initial changes toward increased procurement of food in amounts larger than the forager consumes himself (Hill 1982). From the perspective of the showoff hypothesis, men's hunting may have more in common with the food calls of male chimpanzees (Wrangham 1977), than has otherwise been evident.

Third, the family is viewed as a unit of common interest not only among early hominids, but among modern human societies. This assumed identity

of purpose among those who share a household has been important in analyses of hunter-gatherer groups (Steward 1936; Service 1962; Lee and Devore 1968; Lee 1979), peasant communities (Wolf 1966, Chayanov 1966), and nonindustrial economies generally (Fried 1967; Service 1962; Sahlins 1972; Johnson and Earle 1987). Conflicts of interest between the sexes are noted by ethnographers, but widely assumed to be overshadowed by the interdependence of men and women imposed by the sexual division of labor. Even the standard description of the differences between men's and women's work as a "division of labor" implies this interdependence and mutual interest of the sexes. It also implies that the joint requirements of a man and a woman and the requirements of a family, determine the goals of work (Sahlins 1972). The showoff hypothesis suggests that differences in men's and women's activities, including many differences in resource procurement patterns, may result from the pursuit of quite different goals.

Fourth, the analysis has implications for treatments of reciprocity and risk. Recently, increasing attention has been focused on risk management as a central problem in many human populations, especially those which rely on hunting and gathering (Cashdan 1985; Gould 1982; Harpending 1981; Hayden 1981; Jochim 1983; Kaplan and Hill 1985b; Kaplan et al. 1990; Lee 1968; Smith 1988; Winterhalder 1987). An array of strategies, most especially reciprocal sharing of food and information, are seen as common solutions. However ethnologists have characterized many resource transfers as "generalized reciprocity," a label coined by Sahlins (1965) for transfers which are not characterized by "quid pro quo." To the extent that these arrangements persist in the absence of returned differential repayment of the goods or services to those who supply them, they are unlikely to be reciprocal altruism (Trivers 1971; Axelrod and Hamilton 1981). This removes the basis for arguments that such arrangements serve to "minimize risk." Moreover, reducing risks of failure may sometimes involve preferring alternatives which offer high variance in returns. The possible high jackpots may be worth the gamble. According to the show-off hypothesis, men may choose certain foraging strategies partly because they are risky.

From this perspective, palm starch would be an inferior resource choice for Ache men, although they would earn a high mean rate of gain from exploiting it. Measured in calories, it is about double the mean rate they get from exploiting other resources (Hill et al. 1987). A more accurate measure of relative nutritional value for comparing these alternatives would probably reduce the palm starch average relative to the exploited array (Hill et al. 1987; Hill 1989; Kaplan et al. 1990). Even if the mean nutrient rate of gain for palm starch were greater than the mean rate for exploiting alternative resources, the great difference in variance of the two rates could be just as important as the means in determining men's resource choice. Ache men who specialized in palm starch would reduce the day to day variation in their income by almost an order of magnitude. In pursuing game animals, honey, and other resources instead of palm starch, men are choosing a strat-

egy which gives them a chance for intermittent bonanzas, bonanzas impossible if they chose the low variance option (Hawkes 1990). Any corrected index of nutrient value which raised relative mean rates for the resources men usually take above the mean for palm starch would commensurately raise both the relative variance and the nutritional value of the probable jackpots men would forego if they regularly exploited palm starch.

Among the Hadza of Northern Tanzania mean return rates for hunters, calculated over hundreds of hunter-days, are higher than those Ache hunters earn (unpublished data). But averages over a few days or weeks for individual Hadza men, who hunt animals much larger than those available to the Ache, are often zero. Yet they continue to hunt large animals, tolerating long stretches of failure in circumstances where the variance, the chance for very large bonanzas, is especially high. Recent modeling and empirical research on the foraging of other animals shows that minimizing variance is not always the best way to reduce the risk of failure (Caraco 1980; Stephens and Krebs 1986). The success of lotteries, casinos, and the penchant for gambling are all around us. Data and analysis presented here support the hypothesis that under some circumstances, men may choose risky endeavors, not in spite of, but partly because the gamble gives them the chance to claim the favors they can win by showing off.

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REFERENCES

- Axelrod R. and Hamilton, W.D., The Evolution of Cooperation. *Science* 211: 1390-1396, 1981.
- Bateman, A.J. Intra-sexual Selection in *Drosophila*. *Heredity* 2: 349-368, 1948.
- Blurton, Jones, N.G. A Selfish Origin for Human Food Sharing: Tolerated Theft. *Ethology and Sociobiology* 4: 145-147, 1984
- . Tolerated Theft, Suggestions About the Ecology and Evolution of Sharing, Hoarding and Scrounging. *Social Science Information* 26(1): 31-54, 1987.
- Bradbury, J.W. and Andersson, M.B. (Eds.). Sexual Selection: Testing the Alternatives. Chichester: John Wiley and Sons, 1987.
- Brown, J. A Note on the Sexual Division of Labor. *American Anthropologist* 72: 1073-1078, 1970.
- Brown, J. L. The Evolution of Diversity in Avian Territorial Systems. *Wilson bulletin* 76: 160-169, 1964.
- Caraco, T. On Foraging Time Allocation in a Stochastic Environment. *Ecology* 61: 119-128, 1980.
- Cashdan, E. Coping with Risk: Reciprocity among the Baswara of Northern Botswana. *Man* 20: 454-474, 1985.
- Chayanov, A.V. The Theory of Peasant Economy. Homewood Ill: Richard D. Irwin for the American Economic Association, 1966.
- Darwin, C. On the Origin of Species by Means of Natural Selection. London: John Murray, 1859.

- . The Descent of Man and Selection in Relation to Sex. London: John Murray, 1871.
- Fried, M. The Evolution of Political Society: an Essay in Political Anthropology. Random House: New York, 1967.
- Gould, R.A. To Have and Have Not: The Ecology of Sharing among Hunter-Gatherers. In *Resource Managers: North American and Australian Hunter-Gatherers*. Nancy M. Williams and E.S. Hunn (Eds.). Westview Press: Boulder, 1982.
- Harpending, H. Perspectives on the Theory of Social Evolution. In *Current Developments in Anthropological Genetics, Theory and Methods. Vol. 1*, J. Mielke and M. Crawford (eds). New York: Plenum Press, 1981, pp. 45-64.
- Hawkes, K. How Much Food Do Foragers Need? In *Food and Evolution: Toward a Theory of Human Food Habits*. M. Harris and E. B. Ross (Eds.). Temple University Press: Philadelphia, 1987, pp. 341-355.
- . Why do Men Hunt? Some Benefits for Risky Strategies. In *Risk and Uncertainty in Tribal and Peasant Economies*. E. Cashdan (Ed.). Boulder: Westview Press, 1990, pp. 145-166.
- . in preparation. Sharing and Collective Action. In *Ecology, Evolution and Behavior*. E.A. Smith and B. Winterhalder (Eds.). Chicago: Aldine de Gruyter.
- Hawkes, K., Hill, K., and O'Connell, J.F. Why Hunters Gather: Optimal Foraging and the Ache of Eastern Paraguay. *American Ethnologist* 9: 379-398, 1982.
- Hayden, B. Subsistence and Ecological Adaptations of modern Hunter-Gatherers. In *Omnivorous Primates*, R. Harding and G. Teleki (Eds.). New York: Columbia University Press, 1981, pp. 344-421.
- Hill, K. Hunting and Human Evolution. *Journal of Human Evolution* 11: 521-544, 1982.
- . Adult Male Subsistence Strategies among Ache Hunter-Gatherers of Eastern Paraguay. Ph.D. Dissertation. Department of Anthropology. University of Utah, 1983.
- . Macronutrient Modifications of Optimal Foraging Theory: An Approach Using Indifference Curves Applied to Some Modern Foragers. *Human Ecology* 16: 157-197, 1988.
- Hill, K., Hawkes, K., Kaplan, H., and Hurtado, A. Seasonal Variance in the Diet of Ache Hunter-Gatherers in Eastern Paraguay. *Human Ecology* 12: 145-180, 1984.
- Hill, K. and Kaplan, H. Tradeoffs in male and female reproductive strategies among the Ache: Part 1. In *Human Reproductive Effort*, L. Betzig, P. Turke, and M. Borgerhoff-Mulder (Eds.). Cambridge: Cambridge University Press, 1988a, pp. 277-289.
- . Tradeoffs in male and female reproductive strategies among the Ache: Part 2. In *Human Reproductive Effort*, L. Betzig, P. Turke, and M. Borgerhoff-Mulder (Eds.). Cambridge University Press, 1988b, pp. 291-305.
- Hill, K., Kaplan, H., Hawkes, K., and Hurtado, A. Foraging Decisions Among Ache Hunter-Gatherers: New Data and Implications for Optimal Foraging Models. *Ethology and Sociobiology* 8: 1-36, 1987.
- Hurtado, A.M. Women's Subsistence Strategies among Ache Hunter-Gatherers of Eastern Paraguay. Ph.D. Dissertation. Department of Anthropology, University of Utah, 1985.
- Hurtado, A., Hawkes, K., Hill, K. and Kaplan, H. Female Subsistence Strategies Among Ache Hunter-Gatherers of Eastern Paraguay. *Human Ecology* 13:1-28, 1985.
- Isaac I. The Food Sharing Behavior of Early Hominids. *Scientific American* 238(4): 90-108, 1978.
- . The Archaeology of Human Origins: Studies of the Lower Pleistocene in East Africa 1971-1981. *Advances in World Archaeology* 3: 1-87, 1984.
- Jochim, M. Optimization models in context. In *Archaeological Hammers and Theories*, A. Keene and J. Moore (Eds.). New York: Academic Press, 1983, pp. 157-172.
- . Optimal Foraging and the Division of Labor. *American Anthropologist* 90(1): 130-136, 1988.
- Johnson, A. and Earle, T. The Evolution of Human Societies: from Foraging Group to Agrarian State. Stanford: Stanford University Press, 1987.
- Kaplan, H. The Evolution of Food Sharing among Adult Conspecifics: Research with Ache Hunter-Gatherers of Eastern Paraguay. Unpublished Ph.D. Dissertation. University of Utah, Salt Lake City, Utah, 1983.
- Kaplan, H., Hill, K., Hawkes, K., and Hurtado, A. Food Sharing among Ache Hunter-Gatherers of Eastern Paraguay. *Current Anthropology* 25(1): 113-115, 1984.
- Kaplan, H. and Hill, K. Hunting Ability and Reproductive Success Among Male Ache Foragers. *Current Anthropology* 26: 131-133, 1985a.

- . Food Sharing among Ache Foragers: Tests of Explanatory Hypotheses. *Current Anthropology* 26: 223–245, 1985b.
- Kaplan, H., Hill, K., and Hurtado, A. Risk, Foraging, and Food Sharing Among the Ache. In *Risk and Uncertainty in Tribal and Peasant Economies*. E. Cashdan (Ed.). Boulder: Westview Press, 1990, pp. 107–143.
- Lancaster, J.B. and Lancaster, C.S. Parental investment: the hominid adaptation. In *How Humans Adapt: A Biocultural Odyssey*. D. J. Ortner (Ed.) Washington, D.C., Smithsonian Inst. Press, 1983, pp. 33–66.
- Lee, R. What Hunters Do for a Living: or, How to Make out on Scarce Resources. In *Man the Hunter*, R. Lee and I. DeVore (Eds.). Chicago: Aldine, 1968.
- . The Kung San: Men, Women, and Work in a Foraging Society. Cambridge: Cambridge University Press, 1979.
- Lee, R. and DeVore, I., (Eds.). *Man the Hunter*. Chicago: Aldine, 1968.
- Levi-Strauss, C. The Family. In *Man Culture and Society*. Shapiro H.L. (ed.). New York: Oxford University Press, 1956.
- Lovejoy, O. The Origin of Man. *Science* 211: 341–350, 1981.
- Maynard Smith, J. Sexual Selection—A Classification of Models. In *Sexual Selection: Testing the Alternatives*. J.W. Bradbury and M.B. Andersson (Eds.). Chichester: John Wiley and Sons Limited, 1987, pp. 9–20.
- Murdock, G.P. Social Structure. New York: Free Press, 1949.
- Murdock, G.P. and Provost, C. Factors in the Division of Labor by Sex. *Ethnology* 12: 203–225, 1973.
- Olson, Mancur. The Logic of Collective Action: Public Goods and the Theory of Groups. Cambridge: Harvard University Press, 1965.
- Orians, G.H. On the Evolution of Mating Systems in Birds and Mammals. *American Naturalist* 103: 589–603, 1969.
- Sahlins, M. On the Sociology of Primitive Exchange. In *The Relevance of Models for Social Anthropology*, M. Banton (Ed.). ASA Monographs 11. London: Tavistock, 1965.
- . Stone Age Economics. Chicago: Aldine, 1972.
- Schick, K. and Toth, N. The First Million Years: the Archaeology of Protohuman Culture. *Advances in Archaeological Method and Theory* 9: 1–96, 1986.
- Service, E. Primitive Social Organization: An Evolutionary Perspective. New York: Random House, 1962.
- Siskind, J. Tropical forest hunters and the economy of sex. In *Peoples and Cultures of Native South America*, D. Gross (Ed.). Natural History Press, Garden City, New York, 1973, pp. 226–240.
- Smith, E. Risk and Uncertainty in the "Original Affluent Society": Evolutionary Ecology of Resource Sharing and Land Tenure. In *Hunters and Gatherers: History, Evolution and Social Change*, T. Ingold, D. Riches, and J. Woodburn (Eds.). Oxford: Berg, 1988, pp. 223–252.
- Stephens, D. and Krebs, J. Foraging Theory. Princeton: Princeton University Press, 1986.
- Steward, J. The Economic and Social Basis of Primitive Bands. In *Essays in Anthropology Presented to A. L. Kroeber*. R. Lowie (Ed.). Berkeley: University of California Press, 1936.
- Symons, D. The Evolution of Human Sexuality. New York: Columbia University Press, 1979.
- Taylor, Michael The Possibility of Cooperation. Cambridge: Harvard University Press, 1987.
- Trivers, R. The Evolution of Reciprocal Altruism. *Quarterly Review of Biology* 46: 35–57, 1971.
- . Parental Investment and Sexual Selection. In *Sexual Selection and the Descent of Man*, B. Campbell (Ed.). Chicago: Aldine, 1972, pp. 139–179.
- White, L. The Evolution of Culture, New York: McGraw Hill, 1959.
- Winterhalder, B. Diet Choice, Risk, and Food Sharing in a Stochastic Environment. *Journal of Anthropological Archaeology* 5: 369–392, 1986.
- Wrangham, R. Feeding Behavior of Chimpanzees in Gombe National Park, Tanzania. In *Primate Ecology*, T.H. Clutton-Brock (Ed.). pp 503–538. New York: Academic Press, 1977, pp. 508–538.
- . On the Evolution of Ape Social Systems. *Social Science Information* 18: 335–368, 1979.

- The Significance of African Apes for Reconstructing Human Social Evolution. In *The Evolution of Human Behavior: Primate Models*, W. Kinzey (Ed.). Albany: SUNY Press, 1987, pp. 51-71.
- R. Wrangham, and D. Rubenstein (Eds.). *Ecological Aspects of Social Evolution*. Princeton: Princeton University Press, 1986.