question, our choices of models to employ will be constrained. Among the Ache, for example, it appears that high variance in large game returns coupled with the adaptive value of low variance in food consumption sets the stage for exchange. Game in the optimal diet breadth has many high-yield but high-variance targets so that one may go several days without capturing sufficient game to meet the dietary needs of a hunter's family. As Kaplan and Hill (1984; Kaplan et al. 1985) show, sharing among hunters provides a solution to the problem by reducing the variance across hunters through pooling risk. The Ache perhaps could solve the problem of high variance by targeting smaller game whose return is less variable. However, the cost of doing so would lead to a nonoptimal diet breadth for a simple reason: hunters would not pursue risky game with higher long-term rates of return, thereby reducing their overall rate of return while hunting.

Given that sharing provides a means to reduce variance in intake, then the next problem to solve is how many and what kinds of individuals you need in a sharing coalition to reduce variance to an acceptable level (a problem mathematically modeled by Winterhalder 1986). The smaller the number of sharers, the better – for one thereby reduces the problem of free riders. As it turns out for the Ache, the number shared with is the same as the number of hunters and their families in a band. It may be the case that band size is adjusted to reflect this number. I would argue that RA is the only reasonable model to apply to this situation. So long as all hunters are making earnest efforts, one could not divert larger than equal portions to kin because one needs to depend on a greater number of hunters than found among close kin. Furthermore, favoring kin would cause the system to disintegrate because the pool necessary to reduce variance would be too small. Such a system does not rule out the possibility of especially proficient hunters from expending additional efforts as in the costly signaling (CS) model outlined by Gurven. However, it appears that CS or good hunters gaining extra-pair copulations (Kaplan & Hill 1984) seems decidedly secondary in such a situation.

There are undoubtedly any number of adaptive reasons for sharing, aside from variance reduction. As Gurven points out, in numerous cases cooperative acquisition leads to RA, and biasing kin would wreck a system of efficient group acquisition. In other instances, secondary food transfer to needy kin (e.g., young families with high consumer-to-producer ratios) in the context of RA variance reduction systems may be adaptive as long as the costs to one's fitness are less than the benefit to kin.

KS models will prove difficult to test, and Gurven does not provide us with insights on how we may evaluate such models. The classic KS model is dyadic in form, but humans live in families, and much more often than not food is given to other families and not individuals. This leads to a problem of how one calculates relatedness, and to what I have referred to previously as the targeting problem (Hames 1987). If a woman decides to give food to another family, does one measure the relatedness between the woman and her sister to whom she gives the food, or the woman's total or mean relatedness to other members of her sister's family? This issue is complicated by the fact that although one may give food to a family, one has no way of determining who in that family will ultimately consume the food.

In section 4.2 Gurven deals with the issue of whether food flows according to need. That is, do people who have an easy time making ends meet, provide food to families that are unable to feed themselves adequately. His review of the literature leads him to conclude that there seems to be considerable pressure on successful producers to share their largesse with those less fortunate and they "may receive prestige, support, or social insurance" in doing so. I agree. However, he fails to recognize that I tested (Hames 2000, Table 3) a need-based egalitarian model of food exchange whereby food should flow from households with low consumer-to-producer ratios to those with high consumer-to-producer ratios. It did not. Instead, what I did find, as Gurven notes (Table 2 of the target article), is moderately strong support for RA among the Yanomamö.

Furthermore, in the same section (sect. 4.3) and later in Gurven's analysis of Hiwi food flows, family need is measured by the number of consumers. I would think that a consumer-to-producer ratio is a much better measure of need. Imagine two families of five with two reproductive adults in each, but one has three children older than 16 years whereas the other has three under the age of 10. As Kaplan (1994) and Kramer (2002) demonstrate for horticultural groups, young children consume more than they produce and that production does not equal consumption until after the age of 16. Consumer-to-producer ratios are a much more sensitive measure of need or productive capacity than family size.

Despite these critiques, Gurven has produced the best overview of patterns of food transfers in traditional societies and a reasoned assessment of the models that attempt to account for them. As Gurven shows, it is apparent that not all food is the same and that even within a particular group multiple models may be supported. He importantly recognizes that we need to get a better idea of the moral systems that regulate food transfers, an important dimension of transfer theory that has long been neglected and has the potential to unite the behavioral economic literature (Henrich et al. 2001a) on cooperation with behavioral ecology.

On sharing a pie: Modeling costly prosocial behavior

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Abstract: In this comment, I describe how the processes of free giving can be simulated with the help of the Reflexive Intentional Model of the Subject (RIMS). This simulation demonstrates that there are two essential factors affecting the size of a share given to others: limits accepted by the society as "normal," and the individual's subjective estimation of a mean share donated by other members of the society.

In his article, Gurven mentions that costly prosocial behavior is viewed by many researchers as "anomalous" because it violates the "axiom of rationality." This axiom underlies the majority of formal models of economic behavior, resulting in difficulties of using them for representing the situations in which "individuals give valuable resources away to others." Within the last decade, a new model has been developed, the Reflexive Intentional Model of the Subject (RIMS), which allows us to include into consideration, in addition to economic factors, the subject's prestige and his ability to make bipolar moral evaluations (Adams-Webber 1997; Krylov 1994; Lefebvre 1992; 2001; Miller & Sulcoski 1999). Among other uses, RIMS is employed for modeling terrorist activity (Kaiser & Schmidt 2003). I will show below how RIMS can be used for modeling the processes of products' distribution.

Let a subject have the task of cutting a pie in two parts: one for himself and the other to give away. Let the subject's social status depend on the pie share he takes: the smaller the share, the higher the status. (I have to note that this assumption is not universal. For example, in contemporary Russian and German cultures, one's offering too big a "pie share" to another person may be considered a sign of mockery or challenge. I will return to this later.) Let two types of subjects exist. For the first type, social status is the most important value; for the second type, the pie itself is the dominant value. The latter would increase his share even at the cost of losing his social status. Note that the situation described is not an ultimate game (see, e.g., Fehr & Gachter 2000), because the subject is not punished economically if others reject his giving.

I will now describe a simple procedure of pie sharing based on RIMS. This model can be used in such situations as when the subject distributes a product between two "agencies" under the condition that giving the product to one agency is considered by the subject as a positive action, and giving it to the other agency as a

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negative action. In the simplest case, the share related to the positive action is represented with the following equation:

$$X_1 = x_1 + (1 - x_1)(1 - x_2)x_3, \quad (1)$$

where x_1,x_2,x_3 belong to interval [0,1] (Lefebvre 1992). The value of X_1 is the share which the subject is *ready* to give to the positive agency; x_3 is the share which the subject has *intention* to give, that is, the share he would give to the positive agency if no external factors influence him; x_1 is the pressure of the close environment inclining the subject to give the entire pie to the positive agency, and x_2 is the subject's evaluation of the normative pressure.

The model represented by equation (1) allows formal definition of the subject's state in which he is capable of making an *intentional choice.* This state corresponds to an additional limitation $X_1 = x_3$. In this case the subject's readiness coincides with his intention, and variable X_1 can be eliminated:

$$x_3 = x_1/(x_1 + x_2 - x_1x_2), \quad (2)$$

where $x_1 + x_2 > 0$.

One of the agencies to which the subject distributes the pie shares can be the subject himself, and the other one, other people. For the subject of the first type, the one who cares about his social status, the positive action is *to give,* and the negative action is *to not give.* For the subject of the second type, who prefers the pie to the status, the positive action is *to not give,* and the negative action is *to give.* I begin with modeling the first type of subject. The value of x_3 in equation (2) is the share of pie which this subject intends to give to the others. I assume that the larger the share the subject intends to give to others, the less the pressure from the environment on him: $x_1 = 1 - x_3$. Besides the closest surroundings, information about the "larger" society also influences the subject. He has some view of what share other people usually give away; I designate it x*. Then, the individual's subjective estimation of the normative pressure is $x_2 = 1 - x^*$. After substitution of these values for x_1 and x_2 and transformation, I obtain the following equation:

$$x_3 = 1/(1 + \mathrm{SQRT}[1 - x^*]) \quad (3)$$

It follows from equation (3) that the share which the subject will give away depends only on x*, that is, on the share given by other members of the society, from the subject's point of view. For example, if $x^* = 1$, that is, from the subject's point of view, other people offer up the entire "pie," the subject will also donate the entire "pie" ($x_3 = 1$). If, from his point of view, the others do not give at all, $x^* = 0$, the subject will donate half of the pie ($x_3 = 1/2$).

Consider now the subject of the second type. The value of x_3 in equation (2) corresponds to the share that the subject intends to take. Considerations similar to the one given above leads us back to equation (3), where x* is the share that, from the subject's point of view, other people take themselves. If $x^* = 1$, that is, the others take the entire pie, then $x_3 = 1$, the subject also takes the entire pie; if $x^* = 0$, that is, the others, from the subject's point of view, offer up the entire pie, the subject will offer up one half of the pie ($x_3 = 1/2$).

If the subject does not know the pressure applied to other people, the normative pressure is equal to the pressure he experiences, and we have to assume $x_1 = x_2 = 1 - x_3$. After substituting these values in equation (1) and applying condition $X_1 = x_3$, I obtain the following cubic equation:

$$x_3^3 - 2x_3 + 1 = 0. \quad (4)$$

Two roots out of the three belong to interval [0,1]: $x_3^{(1)} = 1$ and $x_3^{(2)} = (\mathrm{SQRT}\ (5) - 1)/2 = 0.618\ldots$. The second root is the golden section value. Thus, the model predicts that in this case, the subject gives either the entire pie to the positive agency or the part of it equal to the golden section value.

In conclusion, I will consider a problem of pie sharing from the more general point of view. We know that in the large modern societies, there are limits within which product distribution is considered "normal." For example, if after winning $20,000 in a lottery, a person gives away everything to the first comer or escapes without paying taxes, his behavior is considered insane or criminal. To reflect these limits in a formal model, I introduce values P_{max} and P_{min}. Then the size of the pie analyzed earlier is:

$$S = P_{max} - P_{min}. \quad (5)$$

Under certain circumstances, equation $P_{max} = P_{min}$ may hold; this means that the society completely determines how to share the product. For example, $P_{max} = P_{min} = 1/2$ means that the society dictates that its member should share the product in two equal parts.

The history of human food transfers: Tinbergen's other question

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Abstract: Emphasis on cross-cultural testing, multiple currencies, multivariate analyses, and levels of explanation makes this an important paper. However, it does not distinguish current function from evolutionary origin; it lacks history. Rather than distinct alternatives, tolerated scrounging (TS), costly signaling (CS), and reciprocal altruism (RA) are likely to be sequentially evolved components of a single integrated system (and kin selection (KS) important only among very close relatives).

Tinbergen (1963) famously described four ways to ask "why" with respect to any biological trait. What is its survival/reproductive value (function); what proximate factors make it happen (causation); how, in the course of an individual's life, does it come to be (development); and finally, how, in the course of phylogenetic history, did the three preceding factors come together to produce the trait we see (evolutionary history)?

Gurven has made a valuable contribution to the first of these questions and has touched on excellent evolutionary psychological approaches to at least some elements of the second (e.g., Henrich et al. 2001b). The third is largely ignored (though implicit in cross-cultural work), but the real danger is that readers will take from his analysis of contemporary function the idea that evolutionary history has been addressed. Gurven concludes (sect. 9, "Conclusion," para. 2) that "[s]ome of the difficulties in understanding sharing behavior stem from a confounding of the levels of analysis: proximate motivations, cultural prosocial norms that partially correlate with actual behavior, and outcomes in terms of genetic fitness." He is absolutely correct, and this is an important point, but he addresses only the first three of Tinbergen's questions. The general problem of confusing function and history is not new; the spandrels of San Marcos are well known to behavioral ecologists.

The problem is that efforts to model the evolution of reciprocal altruism (RA) always have difficulty with getting it started. Once RA is established in a population sub-unit, it is not hard to see that noble band of non-brothers winning out; within that first group, though, one must appeal to failed kin recognition or some similar *deus ex machina* to overcome the initial disadvantage of being a lone altruist. One approach has been to argue that altruism is not altruistic; in the case of food sharing, it is not difficult to (conceptually) evolve tolerated scrounging (TS) and/or costly signaling (CS) via individual selection (and kin selection [KS] is not a theoretical problem, though it may be an empirical one [Moore 1992]). The problem is that humans are clearly capable of real, genuine altruism that just does not fit KS, TS, or CS predictions. As Gurven points out, at present none of the models can be eliminated, and this leaves us with three logical alternatives. Further evidence will exclude one or more; two or more evolved independently, are not proximately connected, and only seem similar; or finally, two

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