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Economic Experiments to Examine Fairness and Cooperation Among the Ache Indians of Paraguay

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INTRODUCTION

Economic experiments in modern societies suggest that people often cooperate in anonymous one-shot games where non-cooperation would lead to highest payoff for any individual player, but cooperation leads to the highest mean payoff for all players (Camerer and Fehr, Chapter 3, this volume). Such results are referred to in economics as 'anomalies' (Thaler 1992) because they are not consistent with rational self-interested decision-making that is the basis of most modern economic theory. In such experiments cooperation is especially high whenever interactants know each other, or when strangers are allowed to become somewhat familiar prior to interacting (Bohnet and Frey 1999), when responses of fellow interactants are known (Gächter and Fehr 1999), when interactants belong to the same artificially created group (Dawes, van de Kragt, and Orbell 1988), if they are allowed to communicate with fellow interactants before or during the experiment (Dawes and Thaler 1988; Orbell, Dawes, and van de Kragt 1988), or if interactants can punish non-cooperative interactants (Fehr, Fischbacher, and Gächter 2002). In almost all cases listed above strong incentives for cooperation come from group approval or disapproval. Consistent with this are the results of recent theoretical modeling (Boyd and Richerson 1992) showing that punishment alone is sufficient to obtain evolutionary stability for almost any costly social norm.

These results may imply an evolved tendency to cooperate that is unique to our species. If so, cooperative outcomes may be even more ubiquitous traditional hunter–gatherer societies, which are characterized by economic systems that more closely resemble those in which most human psychological mechanisms behind

economic choice, fairness, and cooperation probably evolved. On the other hand, it is possible that the observed cooperative outcomes reflect primarily the conditions of large modern societies where unfamiliar actors learn to interact cooperatively because of rigidly enforced cooperative regulations backed up by state level power structures.

To examine these issues two widely studied experimental economic games were carried out with the Ache, a tribal group of recently contacted hunter gathers living in South America. The games were the Ultimatum Game and the Public Goods Game. In the Ultimatum Game an individual (the 'proposer') is given a stake and then must offer some amount of that stake to the 'responder' who can chose to accept the offer or reject it. If the responder accepts the offer, he/she keeps the amount offered and the proposer keeps the remainder of the initial stake. If the responder rejects the offer neither individual gets anything. In the Public Goods Game, a group of n individuals are told they are playing together and each is given a stake. Each individual is given the opportunity to put some amount from their stake into a common pot. After all individuals have contributed their chosen amount to the pot, the amount in the pot is multiplied by a factor k ($n > k > 1$) and then divided out equally to the n members of the group.

In this chapter we examine how individual choices in the two games are affected by methodological permutations of the game and how the choices on one game are associated to choices in the other. We also consider how choices in the games are associated with other relevant characteristics of the individuals who played the games. The results of these games are especially interesting because the Ache are well known in the anthropological literature for their extensive food sharing (Kaplan *et al.* 1984; Kaplan and Hill 1985) and high levels of cooperative food acquisition (Hill 2001).

THE ACHE

History

The Ache are an isolated population of about 900 people living in the forested areas of Eastern Paraguay. Until the 1970s they were nomadic hunter–gatherers who had lived for centuries in the

headwaters and foothills regions between the Parana and Paraguay Rivers. In the pre-European period, they shared their geographical range with Guarani village horticulturists who favored larger rivers and semi-open cerrado grassland areas for their settlements. The earliest reports about the Ache come from Jesuit chronicles of the seventeenth century, where they are described as 'living like animals' roaming naked in the forest with no agriculture or domestic animals and very few material possessions. They had no peaceful interactions with the Guarani at the time of Spanish conquest. In the twentieth century, the Ache finally made first peaceful contact with outsiders, and at that time they were divided into four linguistic groups that were geographically separated by regions of colonization. This study took place with the Northern group of Ache, which is the largest, the last to be contacted, and the best studied of the groups.

The Northern Ache consisted of about 550 people who roamed an area of about 15,000 km^2 just prior to peaceful outside contact in the 1970s. They have been the subject of extensive ecological studies focusing on foraging decisions, time allocation to activities, the sexual division of labor, food sharing, mating patterns, demography and life history parameters (see Hill and Hurtado 1996 for review). Prior to contact these people resided in about 10–15 different bands, whose membership was highly fluid. All adults knew and occasionally interacted with all other adults in the population. All people outside this population were considered enemies. Typically bands were made up of between 15–60 individuals who moved camp every day at times, but more frequently remained in a single spot for a few days or even a week. Band members often split up for a day or two to forage for specific resources in known locations, and then reunited to share the proceeds of their forays.

Traditional economy

The Ache forest economy is based on hunting wild game, and extracting palm starch, growing shoots and larva from palms that are purposely cut to provide a substrate for the larva. During the wet season honey extraction is also important and gathering activities are focused on fruit collection for a few weeks each on four or five species each year. During the peak dry season palm fruit and

wild volunteer oranges (originally brought by the Jesuits) are collected.

Energetically the most important component of the Ache diet is wild game, which made up about 78 percent of the daily caloric intake in the forest during the 1980s and 1990s (Kaplan *et al.* 2000). During this sample period the most important game animals by biomass were nine-banded armadillos (35 percent), cebus monkeys (13 percent), paca (16 percent), white lipped peccaries (8 percent), coatis (6 percent), and tapir (10 percent). Typically men acquire about 4 kg of meat (live weight) per day. However, the probability of a single hunter not killing any game on a particular day is about 40 percent (Hill and Hawkes 1983); thus, families are interdependent on each other for food on a daily basis. We have only seen a few days with no game killed by any of the hunters in a residential band during a sample of over 300 days of forest foraging.

Cooperation during hunting is common and critical to success for some species. Men usually coordinate their prey search patterns to stay within earshot of each other. They call other men to help them when they find paca, monkeys, white-lipped peccaries, coati, and sometimes armadillo, or when there is a complicated pursuit of any species. They also call for help in tracking wounded large game. It is not yet known whether the help provided increases the expected hunting return rate of the individual calling, the individual who responds, or if such cooperation only increases the total food available to the band. Preliminary analyses suggests that men spend about 17 percent of their foraging time engaged in activities that appear to be designed to increase the foraging gain rate of another adult, at a cost to themselves (i.e. altruistic cooperation). About 80 percent of that time is dedicated to cooperation during hunting. Women also spend about 11 percent of their foraging time helping other individuals during food acquisition and 80 percent of that time is spent in hunting activities (usually helping their husbands hunt) (all results from Hill 2002). These cooperative food acquisition patterns are probably critical for understanding subsequent food sharing.

Palm starch is extracted by women from trees which are felled by men. When a good patch is found, about 15–20 trees must be felled in order to discover one with trunk fiber high in starch content. The trees are usually cut by one man who is accompanied by all the women in the band who wish to extract palm starch. The man who

cuts the trees extracts the growing shoot of each, while women accompanying the man test each tree for starch. Starch content cannot be determined without felling a prospective tree and cutting open a section about $\frac{3}{4}$ of the way up the trunk, pounding the trunk fiber with the back of an axe to soften it, and then tasting the pounded fiber. When a tree high in starch content is discovered the trunk is split open and one or two women extract all the fiber along about a 5–7 meter section of the trunk. The extracted fiber is then taken back to camp, usually in loads of about 20 kg per woman, and then mixed with water and hand-squeezed to extract the starch into the water. This starch water is boiled, and mixed with meat, honey, or insect larva. When the mix is allowed to cool it results in a pudding-like consistency of mildly sweet, but greasy '*bre'e*', which is the main carbohydrate staple of the Ache.

Hunters usually call other men to help them when they find honey while searching for game. Honey is extracted using fire to avoid getting stung. In pre-contact times, men often climbed trees to extract honey high in the branches using scaffolding or vines to tie themselves in place while chopping. Now more commonly men take turns chopping down the tree, chopping open an access window, and pulling out the honey comb. The whole process usually takes 1–3 hours for two or more men and nets up to 20 liters of honey in the peak season.

Fruits are gathered opportunistically by women and children during the wet season, and occasionally by men while hunting. All individuals who find a good fruit tree call to others nearby to collect with them. Usually a teenage boy or older man will accompany the women and children's foraging group to climb fruit trees and shake down fruits that are collected by all on the ground below. Men and children usually collect only enough for consumption on the spot, whereas women will often collect for longer periods and stash some fruit in a container which is later shared with their children or their husband when he returns from hunting. When the collectors consist of only a subset of the band's women and children they are more likely to collect in large quantities which are brought back to be shared with band members who have remained behind.

Larva are generally extracted from trees that have been previously cut (often for the specific purpose of providing a larval substrate). These trees are considered to be 'owned' by the person

who cut them, and taking larva without permission can cause social conflict. Men return to a stand of palms previously cut for palm starch when they think that larva will be plentiful (usually after a few months). Sometimes men and women work together to extract larva by splitting open the palm trunks and searching through the rotting fiber. When working as a couple the man does the chopping and the women search for the grubs. If women and children extract larva without the help of a man, a strong woman will do the chopping while other (younger and weaker) women and children search for the grubs. Whenever larva is found in large quantities much of it is tied up in leaves and taken back to the main camp to be shared out to members who were not present at the extraction site.

The food sharing patterns of forest living Ache have been described in previous publications (Kaplan *et al.* 1984; Kaplan and Hill 1985). Ache hunters typically abandon killed game at the edge of camp, and enter silently without comment on their hunting success. Hunters do not converse with anyone for about 5 minutes (a cooling down period of hunter modesty about the kill), but children and women noticing blood on the hunter or his arrows may quickly search in the direction from which he entered camp to discover the game he has deposited in the forest outside camp. Animals are cooked by a man's wife or other women (especially pregnant women who name their unborn child for the animal species that they cook). When the meat is cooked an older male (not the hunter) usually divides it up into pieces, or piles of pieces, and hands them out, often with the help of other adults who call out the names of each family that should receive a share. Other band members are quick to remind the distributors who has yet to receive a share (they never mention themselves, only others that they know have not eaten yet).

All meat is pooled and shared equally among adult band members. However, the hunter of the game is not supposed to eat from his own kill. Wives and children of hunters receive no greater portion of meat than any other individual in the band. Single men and women are given smaller portions and families are given larger portions depending on how many children they have. Children between the ages of about 7–20 with no resident parents may be slighted and receive no share or a very small share, especially if their biological father is dead. Teenage boys who do not hunt are not

guaranteed a share, but those that hunt seriously (i.e. all day long) receive an adult share.

Palm starch pudding is also shared in the same pattern as meat except that the husband of the woman who cooked the pudding usually distributes the portions. All other resources are shared differently with no taboo against eating one's own production, a tendency for the producer to keep more for his/her family than is given to other band members, a strong trend for sharing to increase with package size, and a statistically significant relationship between the amount shared to specific nuclear families and the amount received from them (Gurven, Hill, and Kaplan 2002). There are no sex differences in the sharing patterns once these factors are controlled.

Recent economy

Although the Ache still spend about 20 percent of all days living in the forest from wild resources, they now spend most of their time at permanent reservation settlements. At those settlements they live in small wooden board houses (about 4×4 meters) spread out about 5–15 meters from their nearest neighbor. Most activities are carried out in front of the house, and usually in full view of at least three or more neighboring families. Reservation Ache farm small plots of land where they plant manioc, corn, beans, peanuts, bananas, and a few other minor crops. They also raise chickens, pigs, a few cows and horses, and a large variety of wild 'pets' which are later eaten. Wage Labor is practiced mainly by young single males, but occasionally by all men in the population when seasonally available and high paying. Money is spent mainly to buy clothes, batteries, sugar, yerba mate tea, hard bread rolls, rice, and noodles. A few Ache men who have long-term employment purchase radios and bicycles. But, mean nuclear family net worth in 1992 was only $12 per family summing the value of all possessions, housing, and livestock. Firearms are still rare with most hunting carried out using bow and arrow, or by hand. Fishing is now a popular activity during the warm, dry months of the year.

Cooperation in the reservation economy is also common. This includes working together to clear forest for gardens, helping to transport heavy items, caring for each other's livestock, helping each other on house construction, sharing tools, and inviting other individuals along when good Wage Labor opportunities are discovered.

The reservation food sharing pattern is quite different from that on forest treks. About 50 percent of cultivated and store-bought foods are shared out to other nuclear families when acquired, whereas 75 percent of foods brought in from the forest and meat from domestic animals are shared to other families. But, typically, the number of recipient families was only 2–4 despite the fact that the study settlement had twenty-three families during the study period. Small groups of families mainly exchange foods with each other. This sharing shows a strong bias favoring close kin, those who live nearby, and favoring those families who share back in turn. Only when a very large animal is killed do all community members obtain a share (Gurven *et al*. 2001).

EXPERIMENTAL METHODS

Economic experiments were carried out at two Ache settlements in 1999. The large Chupa Pou settlement contained nearly 500 individuals living spread out over a 5-km linear strip. The smaller Arroyo Bandera settlement contained about 110 individuals living in a circular pattern within about 100 m of each other. Individuals in both settlements are closely related (to each other and to those in the other settlement) and have a long history of social interaction. Most adults have known all other adults their entire lives. The study population also contained a few individuals who had married into the community and had only a short time span of acquaintance with other adults. These individuals included several Ache from distant reservations as well as one Paraguayan woman who had married into the community, and a Guarani Indian schoolteacher.

All individuals, except the newcomers, had known the interviewer (K. H.) for at least 20 years (or their entire life for those under age 20) and were well acquainted with scientific studies and occasional experiments. The study population had participated in a variety of foraging experiments (e.g. trying to hunt monkeys alone, different ages of girls trying to extract palm fiber) and also hypothetical scenario building (e.g. asking who is more attractive of a set of photos, who would make a better spouse for one's offspring, which foraging band would the interviewee chose to join under various conditions). In the past it had been explained that these 'experiments' were games that Americans set up in order to learn

something about other people. The Ache were comfortable with this explanation and had always been paid for participation and debriefed after experimentation. The relationship between the interviewer and the study subjects was relaxed with frequent joking throughout the experimental session.

Several days prior to the day of the experiment it was announced that all adults who wished to participate in a game where they could win money should arrive at the school building at the indicated time. We were careful to specify that no children would be allowed to attend (because of noise and distraction) and that women should arrange for childcare if they wished to participate. We also suggested that the instructions of the game were somewhat complicated and that the old people and those of limited intellect (there are some mildly retarded people in the study population) would probably not understand the game. Four rounds of games were run in each of the two study communities. They were carried out in the following order: (1) anonymous Ultimatum Game; (2) anonymous Public Goods Game; (3) public Ultimatum Game; and (4) public Public Goods Game. The first two games were played about a week apart and the third and fourth rounds were done on a single day about a week later.

Both types of games were explained to all prospective players congregated in a one-room school building, using the blackboard to illustrate specific examples. The details of how each game was explained are given below. During and after the explanations of the games participants were encouraged to ask questions, and K. H. occasionally asked them questions in order to determine if they understood the game. After the explanation period was over we announced that all individuals who had attended would be given $\frac{1}{2}$ the stake (worth about 50 percent of a days wage) whether they played or not, but that all individuals who felt they didn't understand the game should take the participation fee and leave.

The Ultimatum Game

(A1) First round, anonymous version—the rules of the game were read in Spanish (translation provided by J. Henrich), and then read translated into the Ache language (previously translated by K. H. and written down). Following the reading of the rules K. H. slowly explained the rules again in the Ache language in a manner that he

believed was likely to be fully understood. The game in the Ache language was called 'pire bowo' which has a double meaning of 'dividing up the money' or 'dividing the skin'. This latter phrase in Ache is used to refer to the division of animal skin with subcutaneous fat which is cut into strips and shared after successful hunting. The player who divides the initial stake was called the 'divider' and the respondent was called 'the one to whom it will be given'. We are not certain whether the Ache terms for the game and the two roles have implications for how the game should be played.

After the explanation, we gave some examples of hypothetical offers and responses to those offers and asked participants in the room to tell us the earnings of each player. After about five examples, it appeared that all participants could correctly assess the payoffs to each player in a hypothetical situation. The hypothetical examples included high and low offers and acceptance or rejection of the offer. Because some participants seemed puzzled about why one might reject an offer, we specifically stated that if the respondent believed that the division of the stake was unfair (e.g. if he were angry, disappointed, upset), he might reject the offer in order to punish a player who had made an unfair (stingy) division. The term 'unfair' does not exist in the Ache language, but the word 'stingy' does. When this was mentioned as a hypothetical reason why one might reject an offer, most participants nodded in apparent understanding.

After an hour and a half explanation session all players were asked to draw a number from a hat which determined which role they played in the game (proposer or responder) and in what order they would be called to make a decision. All participants were asked to leave the building and then were called in one by one, told what role they had been assigned, and asked to make a proposal or respond to one. The initial stake was 10,000 Guaranies (about US$ 3.70, one day's wage). Any amount could be offered in 1,000 Gs increments. Proposers were called in first and then responders were randomly assigned to an offer, although players were not aware of this fact and did not know who was assigned what role. Responders had no way of knowing who had made the offer that they were presented. After all choices had been recorded individuals were called in again in random order and paid in cash.

(B1) Second round, public version—participants arrived at the schoolhouse and it was announced that the 'pire bowo' game would

be played again. A much shorter explanation session was provided since most had played the game a week earlier and all had heard about the game in the intervening week. It was then stated that all offers and responses would be announced publicly in the school in front of all other players, but proposers would not know who would receive their offer until after the offer was made. This led to nervous laughs by many players. Again each participant drew a number from a hat which determined their role in the game and the order in which they would be called on to play. All proposers were required to state their offer in turn, and this was done in a loud voice and repeated in front of all players in that round. After all proposals had been made, those individuals who were responders were matched up at random with an offer and asked to announce to all whether they would accept or reject the offer.

The Public Goods Game

(A1) First round, anonymous—the rules of the game were read in Spanish and then in a previously prepared written translation in the Ache language. After the reading, we spent about a half hour explaining the game slowly in the Ache language and giving examples. The game was called 'contribution' in Spanish, a word which most Ache understand because communal 'contributions' are sometimes requested by tribal leaders to pay for public goods (a feast, school repairs, etc.). The initial stake was 10,000 Gs which was presented as play money in 1,000 Gs notes inside an envelope. It was explained that the contribution to the 'pot' would be done anonymously by leaving any amount of money that one wished in the envelope (including zero) and then depositing the envelope in a slotted box. Players were grouped in sets of five with each envelope marked (e.g. Group one player A, B, C, etc.) which allowed us to assign each contribution to an individual (thus, the contributions were not anonymous to the experimenter). It was explained that the contribution pot would be doubled and then re-divided amongst all five members in each group.

Because the Ache have no formal mathematical training, only some could calculate the double of a specified amount and none could divide the final pot by five to calculate their exact share of the public good. But extensive practice with examples gave them a

good sense of the form of the payoffs. Specifically we showed them that: (1) if all players contributed everything they each earned twice as much as if all contributed nothing; (2) if only one player failed to contribute and all others contributed everything, the non-contributor gained more than any other player and more than the players in scenario (1) above; and (3) if only one player contributed all and the other four contributed nothing, that contributor would gain less than any of the players in his round or any other players in any of the above scenarios. It was then restated to the participants that (i) if all contribute they earn more than if all fail to contribute; (ii) if most contribute but a few do not, those non-contributors gain more than anybody; and (iii) if most fail to contribute but a few do, those few contributors get the lowest payoffs possible. We believe that most participants at this point grasped the essence of the game in a qualitative fashion even though they could not calculate the exact payoff to players in any given scenario. We then pointed out to them that this problem was analogous to many common public goods problems at their settlement and we named a few examples (the Ache engage in many communal projects for the common good). At that point all players seemed to have a good understanding of the game.

Each participant then drew a random number from a hat which determined the group to which they were assigned. They were called into a room one by one and given an envelope containing money that they took to a corner. They secretly extracted whatever amount they wished not to contribute, and then deposited the remainder in a slotted box. None of the players knew the identity of other players in their group.

(B1) Second round, public—A much shorter explanation session was required since most participants had played in a previous round or had heard about the game prior to this last session. After the explanation it was stated that the contributions would be announced in public. Each individual drew a number and was assigned to a group. Players were not informed who was in their group. Then individuals were asked to announce one by one how much they would contribute to a common pot. They did not know which other individuals were assigned to their group, but as the offers were announced they were able to assess the general level of cooperation exhibited by other players on the same day. Those who

played first had no information about the level of contribution of others, whereas those who played last had a general sense of whether prior players had contributed a lot or a little.

Anonymity

Players of both games were given a hypothetical stake (on the books or in paper play money) and made decisions about how they wished to play each game. The decisions were recorded by us and after calculations about the payoffs, each individual was called into a room and paid in paper play money. After the payoff to all participants a bank was set up to convert play money into real money. This payout was done in a semi-private setting. The use of play money was necessary because it was impossible to obtain enough currency in small denominations to play all games with all participants using real money. Because winners often were required to pool their play money at the bank (e.g. a winner of 20,000, 17,000, and 13,000 Gs together might be paid in a 50,000 G note which could then be taken to a store and cashed for each to receive his share), some individuals were able to determine how much some other individuals won. This, in combination with some information about the game and what role was played by each individual, could allow some individuals to calculate how other individuals might have played the game. While we have no evidence that anybody actually carried out such calculations, the experimenter (K. H.) was able to do them quickly. Thus, even the anonymous rounds of the games were not perfectly anonymous in the end.

However, greater erosion of Anonymity was due to the fact that many people talked about the games afterwards in small groups and divulged how they had played, and the fact that K. H. had recorded all choices by all participants and that they knew that he was doing so. Because K. H. has a long history in the community and participates in social activities and political decision-making, and because he is known to have allies and enemies in the community and is often involved in distributions of other goods and services, it would be naïve to assume that players were indifferent to the fact that K. H. knew how they played. It is not clear how this effect could be eliminated since K. H. is the only outsider who can speak the language well enough to conduct the games, and since participants cannot read and write, meaning that they must verbally report their choices to someone who then records them.

RESULTS

The Ultimatum Game

About 195 individuals heard all the instructions for both rounds of the game. Four of these chose not to play because they did not understand the game. Of the 95 who had the role of proposer, four were eliminated from analysis because they looked and acted confused and/or their offer seemed to indicate that they did not understand the game (they offered 100 percent of the stake to the responder). However, we are still not completely certain that the two individuals who offered the entire stake to the responder did not understand the game. They looked embarrassed when they made the offer and in debriefing sessions were embarrassed to talk about their offer. This could either mean that they were embarrassed to admit they didn't understand the game, or embarrassed that their offer might seem silly to us. Scaled to 10, the mean offer in the anonymous version of this game for first time players was 4.65 ($n = 47$, SE = 0.15). The mean offer for first time players in the public version of the game was 4.45 ($n = 29$, SE = 0.30). The frequency distributions of offers for first time players in the anonymous and public versions of the game are presented in Figure 13.1.

While the mean offers in both versions of the game are similar, the spread of offers is greater in the public version of the game. In the anonymous version, 81 percent of all offers are four or five whereas in the public version only 55 percent of the offers are four or five. The most notable thing about the distribution of offers is that 14.3 percent of all offers were greater than five, and only 6.6 percent were less than three. Surprisingly, two offers of nine were made by individuals who, when debriefed, clearly understood the game. And interestingly, all five offers of seven or above were made by women (as were the two offers of ten that were eliminated).

Five variables could potentially associate with the amount offered by the proposer in our data set. They are age (range 14–57), sex (male = 1), settlement size (Settlement Size) (large = 1), number of times played (one, two), and type of game (anonymous = 0, public = 1). In a multivariate regression none of these variables was significantly associated with the size of the offer (Table 13.1), and in univariate analyses none of these variables were significant except

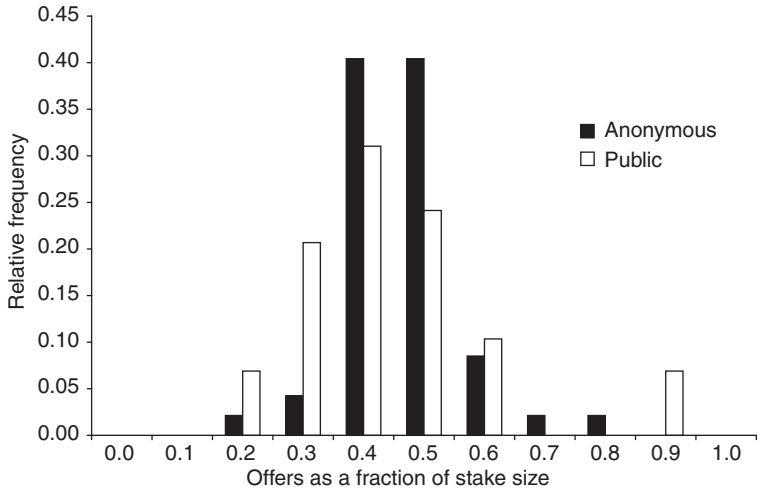

FIG. 13.1. Frequency distribution of offers by first-time players in the Ultimatum Game played anonymously ($n = 47$) and in public ($n = 29$)

number of times played.[1] The mean offer in the public version of the game, when only first time players are examined, was almost identical to the mean offer in the anonymous version of the game (see above). Thus, playing the game in public did not seem to affect the mean size of the offer. For the fifteen individuals who were proposers in both rounds of the game the average first offer was 4.27 (SE = 0.27) and the average second offer was 3.73 (SE = 0.42). The reduction in offer size for individuals who played a second time was not statistically significant,[2] but the sample size is very small here and the effect (a 15 percent reduction in offer) seems economically important.

Ninety-six individuals were responders in these two rounds of the Ultimatum Game. Eight of those individuals were eliminated

[1] Least squares multiple regression, for Ultimatum Game offer, independent variables are yearborn, sex (1 = male), large settlement (1 = large), game type (1 = public), times played (1,2) showed the following coefficients and p values: yearborn -0.0159, $p = 0.25$; sex -0.145, $p = 0.65$; large settlement 0.417, $p = 0.17$; public play -0.271, $p = 0.41$; times played -0.587, $p = 0.18$. In univariate regressions the only variable with a p value less than 0.10 is times played, coefficient -0.839, $p = 0.031$.

[2] Paired t-test, one-tailed $p = 0.15$.

TABLE 13.1. Multiple regression models for offers in the Ultimatum Game and contributions in the Public Goods Game

Ultimatum Game	Model 1: (adjusted R square = 0.0418, $F = 1.785$, $p = 0.124$, obs. = 91)	
Variable	*Coefficient*	*p value*
Intercept	36.279	0.1843
Yearborn	−0.016	0.2522
Male	−0.145	0.6470
Large settlement	0.417	0.1735
Public	−0.271	0.4064
Times played	−0.587	0.1835
Public Goods Game	Model 2: (adjusted R square = 0.175, $F = 6.91$, $p < 0.001$, obs. = 140)	
Variable	*Coefficient*	*p value*
Intercept	48.688	0.1679
Yearborn	−0.022	0.2236
Male	0.671	0.0788
Large settlement	0.228	0.5305
Public	2.385	0.0000
Times played	−1.942	0.0002

from analyses because they acted very confused, rejected, or accepted the offer before the amount was stated, changed their response several times looking to K. H. for guidance, or tried to make an offer as the proposer rather than playing the responder. Eighty-six of the remaining eighty-eight were matched with offers chosen randomly from those made by Ache proposers. None of the offers were rejected. In the remaining two cases we fabricated a sham low offer (one, or two) in order to see if we could elicit a rejection. Both of these low proposals were accepted. Thus, *all* proposals were accepted by the responders, including one proposal of one, seven proposals of two, and fourteen proposals of three.

The Public Goods Game

There were 140 individuals who played the Public Goods Game in twenty-eight groups of five. A handful of individuals who heard the instructions chose not to play. Again, the initial stake was 10,000 Gs. Scaled to 10, the mean contribution for first time players in the anonymous version of the game was 4.48 (SE = 0.22). The mean contribution for first time players in the public version was 6.47 (SE = 0.35). The frequency distributions of contributions for first

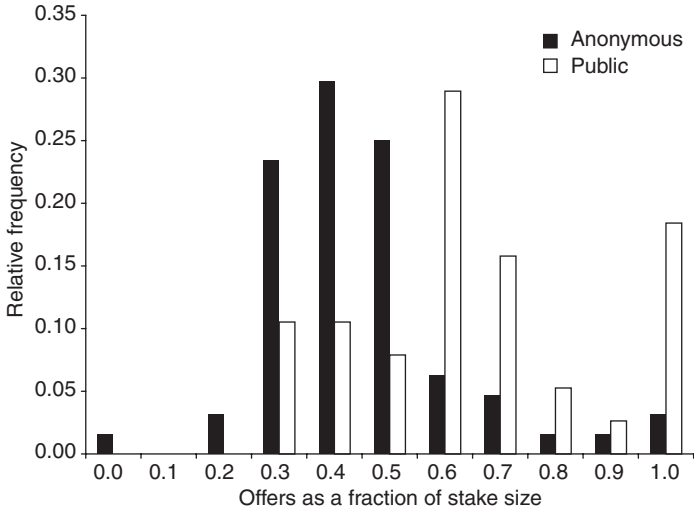

FIG. 13.2. Frequency distribution of contributions to the Public Goods Game played anonymously ($n = 64$) and in public ($n = 38$)

time players in the anonymous and public versions of the game are presented in Figure 13.2.

Again, the most notable thing about the frequency distribution of the contributions is the high proportion of contributions greater than five (17 percent in the anonymous version, 71 percent in the public version) and the low proportion of contributions less than three (4.6 and 0 percent, respectively). Again, many of the highest contributions were from women (7/10) of the individuals who contributed their entire stake to the pot.

The same five independent variables listed above were regressed with the size of contribution. Because, Settlement Size, sex, time played, and public versus anonymous were all strongly colinear (one round of the game was played in public with only women at the large village), univariate analyses are multiply confounded and not instructive. However, the multivariate model with all five independent variables entered together showed strong significant associations between contribution and sex, number of times played, and anonymous versus public (Table 13.1). Men contributed a mean of 0.7 units more to the public pot. Playing a second time reduced the mean contribution by about 1.9 units, but playing in public increased the contribution by about 2.4 units (with all other variables controlled).

Associations with other measures of cooperative tendency

We also looked at the relationship between the choices on each game and several other individual characteristics potentially relevant to cooperation. The first analysis was simply a correlation between how individuals played the two games. Specifically, we examined whether those that made high offers in the Ultimatum Game were more likely to contribute more in the Public Goods Game. Because no methodological variables were significantly associated with offer in the Ultimatum Game, we pooled all Ultimatum Game offers together. The results of the analyses are mixed. There is no relationship between offer in the Ultimatum Game and contribution in the anonymous version of the Public Goods Game, but there is an almost statistically significant positive relationship between offers in the Ultimatum Game and contribution in the public round of the Public Goods Game[3] (Figure 13.3).

Second, we examined the relationship between the offers or contributions in the two games and the measured time discounting rate for money for a handful of individual players. The preferred discount rate was determined by examining the response to differing amounts of money offered at different points in time. Respondents were asked to choose between 3 days' salary now and increasing multiples of that amount after a 15-day delay. The options varied from a 1.5 percent increase to a 150 percent increase on top of the initial offer if the respondent was willing to delay the payoff date. The interest rate at which respondents switch from a preference for immediate payoff to preference for the delayed higher payoff is used to estimate the preferred discount rate. It has been previously suggested that a lower time discount rate is more likely to be associated with a willingness to engage in cooperative economic strategies since some forms of cooperation are simply preferences for a higher payoff after a time delay rather than immediate payoff (Clements and Stephens 1995). Because we observed cross-overs in time discounting preference during our field trial, we assigned all respondents to three rankings: low time discounting (always preferred the higher

[3] Analyses of Ultimatum Game offers and contribution in the anonymous version of the Public Goods Game: least squares regression $n = 45$, coeff. $= 0.042$, $p = 0.75$. Analyses of Ultimatum Game offers and contribution in the public version of the Public Goods Game: least squares regression $n = 66$, coeff. $= 0.143$, $p = 0.073$.

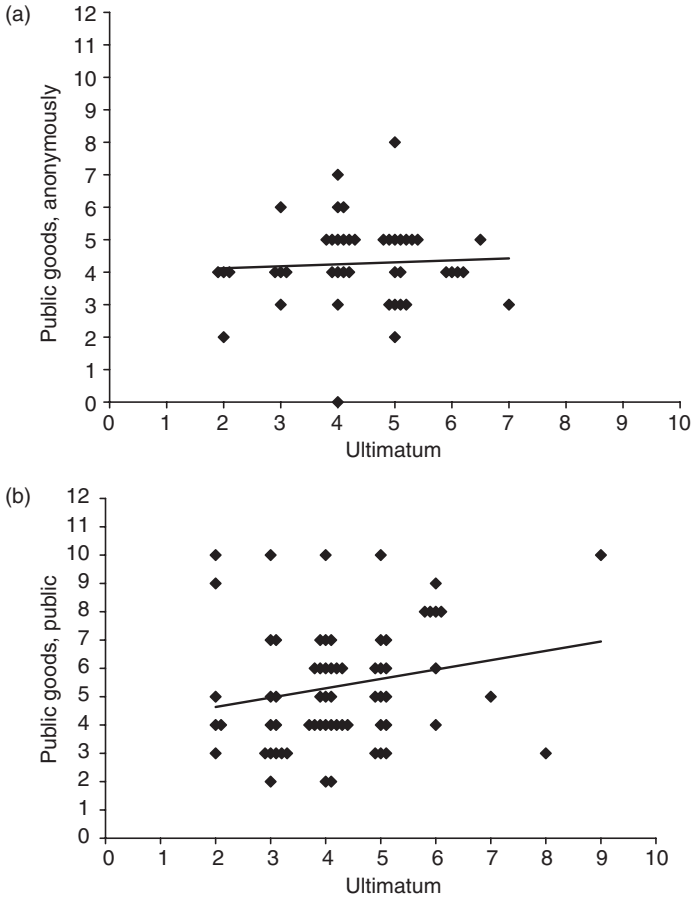

FIG. 13.3. The relationship between offers made by single individuals in the Ultimatum Game and their contributions in the Public Goods Game played (a) anonymously, or in (b) public

payoff after a delay), high discounting (never preferred the delayed payoff), and intermediate (preferred the delayed payoff depending on the increase associated with the delay). We found no association between the preferred discount rate of individuals and their offers or contributions in the Ultimatum Game and Public Goods Game[4] (Figure 13.4).

[4] Rank regressions of Ultimatum Game offers of Public Goods contributions by time discounting category $p > 0.5$ for both.

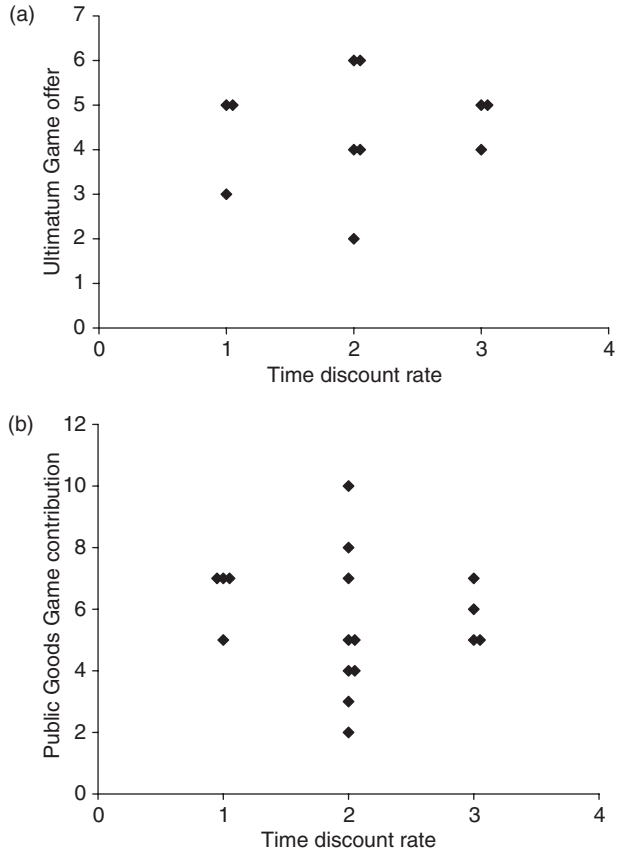

FIG. 13.4. The relationship between the measured discount rate for individuals and their offers in the (a) Ultimatum Game, or (b) their contribution to the Public Goods Game. Discount rates as defined in the text are low (1), medium (2), and high (3)

Finally, we examined the relationship between observed food production and sharing patterns and Ultimatum Game offers or Public Goods Game contributions by individuals in the Arroyo Bandera settlement. Food production and distribution were monitored in detail between January and May 1998 at the Arroyo Bandera settlement (Gurven *et al.* 2001). These data provide information of individual and family total food production (measured in kg produced during sample period) and the percentage of

TABLE 13.2. Regression of individual play in economic games by observed food production or food sharing patterns

	Individual		Household	
	% food kept by family	Total kg food produced	% food kept by family	Total kg food produced
Anonymous trials				
Offer in UG				
p value	0.85	0.64	0.49	0.24
Coefficient	−0.06	−0.13	−0.14	−0.09
n	16	16	16	16
Contribution in PGG				
p value	0.23	0.36	0.54	0.63
Coefficient	−0.41	0.11	0.13	−0.04
n	24	24	24	24
Public trials				
Offer in UG				
p value	0.53	0.65	0.27	0.58
Coefficient	−0.19	−0.06	0.17	−0.04
n	18	18	18	18
Contribution in PGG				
p-value	0.98	0.61	0.61	0.43
Coefficient	−0.01	−0.07	−0.11	−0.06
n	30	30	30	30

foods acquired that were shared to individuals outside the nuclear family of the acquirer. Offers in the Ultimatum Game appear to measure willingness to divide a valuable resource, and contributions in the Public Goods Game may indicate willingness to cooperate in an arrangement of reciprocal altruism. To test this hypothesis we regressed the observed offers and contributions against the level of food sharing exhibited by the same individuals approximately 1 year earlier. No significant relationships were found (Table 13.2). Likewise, although overall food production rates vary quite substantially among study subjects, and this may effect their willingness to offer resources in the Ultimatum Game, or to contribute in the Public Goods Game, our data show no relationship between food production patterns and choices in the two economic experiments (Table 13.2).

DISCUSSION

The results from these economic experiments provide some interesting insights into concepts of fairness in human societies and some of the social forces behind observed resource sharing patterns. We suspect that the Ache, like many other groups with little experience in such unique conditions for interpersonal interaction, are likely to play the games in ways that to some extent reflect real life patterns of interaction that are favored or at equilibrium in the Ache context. We do not mean to imply that economic behavioral patterns are inflexible to changed conditions, but only that the adoption of behaviors far outside the typical daily range and in contradiction to internally incorporated systems of ethical and moral behavior might require some time to emerge.

In the Ultimatum Game, a significant proportion of offers were greater than five and almost none less than three despite the fact that no offer was ever rejected. If we assume that proposers anticipated that responders were unlikely to reject low offers, then the experiment constitutes a Dictator Game (Dictator Game) (Forsythe *et al*. 1994) in some sense. The offers did not vary by age, sex, settlement, or whether the game was played in public. There may have been a slight decrease in offers by second time players. Although this provides only sketchy information with many possible interpretations, we will suggest a few qualitative insights. First, the Ache are not familiar with the possibility of anonymous behaviors without social consequences and we believe that a number of trials would be required before this possibility would be accepted and incorporated into behavioral decisions. Indeed there is a serious question as to whether true guaranteed Anonymity ever exists even in large scale modern societies. We do expect, however, that offers might erode over a period of time as the Ache began to appreciate the apparent lack of social consequences of making a high or low offer in the game (see Fehr, Fischbacher and Gachter 2002). In addition, it must be remembered that all players live together in a very close community. General lack of fairness in the game context could affect overall community relations in a negative way as players began to realize their neighbors were not cooperating in the game. This might motivate anonymous fair offers by those who are concerned with the 'social environment' of the community, which

favors frequent cooperation. Also, detailed discussion of the game after it ended might sometimes reveal those who made 'unfair' offers if it is difficult for the Ache to lie convincingly to close friends and relatives. Certainly, all Ache would be very uncomfortable at the thought of having to lie under these circumstances, and might therefore make fair offers because they knew they would be asked about their offer after the game ended.

Second, we believe that the high number of extra-fair offers (offer > 5) is related to the fact that in Ache society food producers often share out more than 50 percent of what they acquire in a particular patch (and Ache men generally don't eat from their own kill after a successful hunt). Indeed, giving more than half of what one acquires is so typical, that it may even be expected in some cases. One proposer who offered 6.5 in the anonymous Ultimatum Game session spent a long time thinking about his offer and then commented to us during his offer that he was concerned the responder might be angry *if he offered less*. The forces behind the Ache sharing pattern are complicated, but it is important to note that the Ache probably conceive of the Ultimatum Game as a 'sharing' context since there is a clear opportunity to divide that which has been acquired. Extra-fair offers are likely to be related to both the desire to display generosity, and the concern over social approval and disapproval. It must be remembered that K. H. was an observer to all distributions and the Ache were quite aware of that fact. Also, the offers were discussed publicly after the game ended (and lying may be difficult here, as mentioned above). An extra-fair distribution in real life is in fact the only distribution (offer) that would be universally approved. It was K. H.'s sense that those individuals who would score highest in the personality dimension of 'concern about social approval' were also those who made the highest offers in the Ultimatum Game.

Low rates of rejection in Ultimatum Games have been previously interpreted as illustrative of the gain maximizing strategy that should characterize responders. However, we suggest that this is not the correct interpretation of the Ache pattern. Ache proposers behaved in a manner very different from that predicted on the gain maximizing principle. Would these same people turn around and adopt strategies of pure gain maximization as responders? This seems unlikely and instead we suggest that the Ache failed to reject offers because to do so would be a form of serious interpersonal

confrontation. According to Ache custom it is bad manners to show anger or disappointment in public. It would be unacceptable in Ache society to refuse a piece of shared meat because the share appeared to be unfairly small. Although distributions are indeed sometimes perceived as unfair or 'stingy', the recipient never confronts the divider over such an issue. Instead the recipient grumbles to other members of the social group about the size of the share, thus damaging the reputation of the divider who ultimately hears about the recipient's displeasure. Such a process constitutes social punishment and may be sufficient to motivate most dividers to seek fair (and even extra-fair) solutions. Thus, the Ache may view rejection of an offer as extraordinarily confrontational. This interpretation is strengthened by the comment of one responder. He was asked to respond to an offer of four. He looked at K. H. and smiled and said, 'could you tell me one more time what will happen if I reject this offer'. K. H. was surprised by his question since he knew that the man had understood the game very well during the explanation phase. K. H. repeated the consequences of rejection by the responder and he said, 'so if I say no, the proposer will get nothing—in that case I had better accept, because (my rejection) would cause problems'. This comment was overheard by another observing anthropologist who had been working with the Ache for over 10 years. He interpreted the lack of rejection as due to a fear of social confrontation (just as we have).

The results from the Public Goods Game also reflect aspects of typical Ache behavior. Public goods dilemmas are common on current reservation settlements. Indeed, when the game was called 'contribution' the Ache immediately recognized its basic form. Chiefs often ask for contributions for public projects, to pay the electric bill for the water pump and school, to pay for medicines at the clinic, to work together fixing the community soccer field, to help care for communally owned domestic animals, to plant and harvest communal fields, etc. Many public goods projects partially succeed, but with a high rate of free riding unless individuals are singled out one at a time to elicit contribution. The rules for participation in generating public goods are much more flexible (less morally rigid) than food sharing rules in Ache society, and adults have a good deal of experience in assessing how much participation serves their interests. The Ache also have a long history of experience informing them that many individuals are 'free riders' in public

goods situations. Again, however, there is also a strong social display component to contribution. In real life contexts, individuals who fail to 'contribute' usually invoke important excuses, and when no easy excuse is at hand they usually contribute, sometimes excessively and with vigorous and overt attempts to draw attention to their cooperative behavior (e.g. singing very loud while working on a public goods project).

In the first round, when the Public Goods Game was played anonymously, almost everyone contributed something (because there was no 'excuse' not to and the game was probably not really anonymous in the Ache view). The 'chiefs' of both communities were high contributors (mean 6.2), just as they would be expected to be in a real life situation.

In the second round played in public, there was a lot of verbal encouragement to cooperate during the explanation period. Because all players could monitor the contributions of all others, not surprisingly the mean contribution increased significantly. Even in the first few public plays, before participants could assess how much others would cooperate, the offers increased by about 20 percent (mean 5.7 for first five plays at each settlement). There was no significant trend in contribution by order of play in the public version of the game ($p = 0.71$ for AB and $p = 0.22$ for CP). In the public version, nobody offered less than three and nearly 20 percent of the players contributed the entire stake. The highest *monetary* payoff went to those who contributed the least, but high contributors looked happiest after the game when we were distributing the winnings. In order to understand the high offers, one must realize that long discussions of the game took place in the days following it, and those who had contributed the full stake were mentioned over and over and became known by most of the community, including individuals who did not attend the session. Indeed, we got the impression that the big 'winners' from the game (in social utility rather than the monetary payoff of the game) were those who had contributed the full stake.

In a more general sense the most interesting thing about the results from both games is the suggestion that players seem conditioned to treat them as part of an iterated sequence of interpersonal interactions even when they are explained as one time anonymous choice experiments. The payoff matrix in our version of the Public Goods Game is a classic prisoners dilemma in which money

contributed can never be recovered fully from the pot, (since the payoff for a contributor is only $\frac{2}{5}x$ when x is the contribution). But money contributed does increase the payoff to fellow players. If the game is clearly understood as a one time prisoners dilemma (which it is) all players should contribute nothing. The fact that contributions are often quite high may suggest that individuals treat the experiment as if it were part of a much longer set of social interactions. We believe that this perception is correct for the Ache. All participants continued to interact intensively after the game was concluded. Defection during the game, while not detectable on an individual basis (in theory) is quite detectable on a community level. We suspect that all players were concerned that an erosion of the high levels of cooperation characteristic of the community due to defection during the game, would have negative consequences for the whole community long after the game had ended. In other words players acted as if future harmonious (cooperative) community interactions were at stake rather than just the prize money in the game.

The lack of relationship between offers in the Ultimatum Game and contributions in the Public Goods Game is somewhat puzzling. Equally puzzling is the lack of a relationship between choices in the experiments and real life economic parameters. Both experiments seem to measure some commitment to fairness and cooperation between players. It is possible that high offers in the Ultimatum Game are simply motivated by the fear of rejection (and therefore motivated by gain maximization), but this seems incongruous with the total lack of rejection of low offers by Ache participants. It seems difficult not to conclude that contribution to the Public Goods Game indicates a willingness to cooperate with others, but perhaps some Ache misunderstood the payoff matrix and interpreted the game as an opportunity to gamble. Those who contributed most may have hoped to double their money by gambling that other players would also contribute a lot. They may have mistakenly calculated that their contribution had the possibility of paying back more than they gave up, or perhaps believed that their contribution would influence the contribution of others. One of the most notorious gamblers in the community contributed 0.9 of his initial stake and was heard commenting after the game that he had really hoped to double his money. In this case, however, many of the Ache seem to have learned after the first round of the game that

other individuals were less cooperative than they hoped, since second round contributions declined significantly.

Most troublesome, however, is the issue of what individual variation in game play actually indicates about individual behavioral tendencies. Not only did responses in the two games show no correlation, but responses in the games shows no significant association with real life behaviors such as measured time preference, previously measured food-sharing generosity, or variation in food production. Some economists have treated individual responses as indicators of individual variation in fairness or a tendency to cooperate. Thus, not only mean responses are reported, but the frequency distribution of various response categories are often reported and compared. However, the Ache data suggest that variation in responses by single individuals the first time they are exposed to the game may indicate little about the variation in those same individual's generosity or tendency to cooperate with others in real life. Is this because responses at one point in time are too influenced by a variety of other factors (e.g. mood, current financial situation, rapid understanding of the game, etc.) that do not necessarily indicate long term characteristics of the individual? This should be examined in more detail, perhaps by regressing play in the first exposure to a game with subsequent play during longer periods of time. Does play in any round predict play in any other round. How strong is the correlation? Perhaps food-sharing patterns would correlate with the average offer in the Ultimatum Game over many trials but not with any one particular offer.

Despite our invocation of culturally specific explanations for some aspects of the Ache results, we are aware that most patterns observed amongst the Ache may be found in many other settings. The mean Ache offers and contributions are not particularly different than those found elsewhere. Extra-fair offers above five in the Ultimatum Game (and even the Dictator Game) are observed in societies that probably have very different food sharing patterns than those of the Ache. Complete lack of rejection of Ultimatum Game offers may be rare but have been found in other societies as well (see Henrich and Gurven, Chapter 5 this volume). The mean Ache contribution to the Public Goods Game is also not exceptional, nor are the findings that offers decrease in subsequent rounds of play, and increase in more public contexts (Dawes and Thaler 1988). Thus, our comments on the Ache may be relevant to

other societies as well. Perhaps most individuals have an initial expectation of human interaction based on real life and feel uncomfortable being unfair or stingy even when special contexts are set up that allow or favor such strategies. Optimal behavior in a one time interaction may take some time to fully incorporate, especially for those with no prior experience that such a thing is possible. Frank (1988) has hypothesized that sticking to a moral 'rule of thumb' such as 'always divide fairly' may be an adaptive response under some conditions. Perhaps the rule of thumb includes always behaving in a fair and cooperative manner initially until one can truly determine that behaving otherwise is appropriate (e.g. learning that other individuals will defect, or that one's own defection truly cannot be detected).

At this point we think more investigation into the effects of changed experimental conditions will teach us more about cross-cultural variability than we can learn by simply increasing the sample size of different cultures tested. Multiple trial experiments should be especially interesting as they can remove any doubts about the subjects understanding of the game, or familiarity with its novel conditions relative to their daily lives. If offers and contributions decline it is important to determine whether this is due to learning about the game (e.g. understanding that it really can be played anonymously or that no punishment is possible) or learning about the tendencies of other players (e.g. if the optimal play is to always defect just a tiny bit more than others, this will drive offers and contributions down through time when information is acquired).

In a review of results from the Public Goods Game, Dawes and Thaler (1988) give an example of farmers who leave fresh produce on a table with a box that is attached in which clients can insert (but not extract) payment. They conclude that the farmer's view of human nature is that most people will cooperate but that one must always protect oneself from the few who will exploit the situation. We believe the Ache enter the Ultimatum Game and Public Goods Game with the same general attitude but have higher expectations of fairness and cooperation than are found in some other societies. Perhaps Ache expectations lead them to play these games slightly differently than other human groups. However, the most striking thing about these games is the pan-human pattern of fairness and cooperation which seems so different from that of other primates. The question we are left with is how we got to be this way.

Regardless of the explanations and the amount of cultural variation, humans seem to have tendencies toward fairness and cooperation that are stronger than those of other animals. Reciprocal altruism is rarely observed in nonhumans. The conditions of the Dictator Game are replicated over and over among animals in captivity and in the wild, and 'dictators' rarely voluntarily hand over much of their original stake (acquired food) to neighbors (see DeWaal 1997; DeWaal and Berger 2000 for exceptions in experimental conditions allowing for reciprocity in primates).

Human cooperation is so ubiquitous that people appear to have a sense of 'fairness' that contradicts predictions from rational self-interest models in economics and is unparalleled in nonhuman organisms. This is illustrated by several outcomes in recent economic experiments, such as: (1) the willingness to divide resources with anonymous partners who cannot retaliate if no division takes place ('Dictator' Game, Forsythe *et al*. 1994), or who are known to be unlikely to retaliate (Ultimatum Game without rejections, this chapter; Henrich and Gurven, Chapter 5, this volume); (2) the willingness of a Respondent to reject resources from divisions in which the proposer keeps a large fraction of the total stake split between a proposer and a Respondent if rejection punishes the divider; and (3) the willingness to pay a cost to punish individuals who do not cooperate in the production of public goods, even if no further interaction with those individuals is possible (public goods games with punishment in the final round, Fehr, Fischbacher, and Gächter 2002). Particularly notable is the willingness to punish those who behave unfairly even at an extremely high cost to the punisher. For example, Cameron (1999) shows that a substantial number of players will reject offers in the Ultimatum Game that they consider unfair even when the initial stakes are 3 months' salary!

In addition to the above results, studies on the development of cooperative behavior in children suggests that children go from noncooperative to a hyper-cooperative phase prior to reaching an adult phase of contingent cooperative behavior (Murningham and Saxon 1994). Thus, the available data on human cooperation suggests the possibility that humans have an evolved predisposition to: (1) seek cooperative solutions which will benefit all interactants relative to the alternative payoffs from noncooperation; (2) share the resources cooperatively acquired by groups of

individuals who are defined as belonging to the same economic 'group', or to share resources individually acquired in which the identity of the initial acquirer of the resource is partially or wholly determined by luck; and (3) punish noncooperative exploitation and unwillingness to divide gains that are understood to belong to all, even when punishment is costly. These traits characterizing interactions between adult non-kin seem particularly well developed in humans relative to any other mammal and are probably ultimately based in evolved psychological mechanisms unique to our species.

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