

**Monitoring, reputation, and "greenbeard" reciprocity in a real-life public good game
among the Shuar of Ecuador**

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Summary

A collective action (CA), i.e., a group of individuals jointly producing a resource to be shared equally among themselves (as in a public good game), is a common interaction in organizational contexts. Ancestral humans who were genetically predisposed to cooperate in CAs would have risked being disadvantaged compared to freeriders, but could have overcome this disadvantage through “greenbeard” reciprocity, i.e., by assessing the extent to which their co-interactants were also predisposed towards cooperation, and then cooperating to the extent that they expected their average co-interactant to reciprocate. Assessment of others’ cooperativeness could have been based on the direct monitoring of others’ cooperativeness, and on reputational information about others’ cooperativeness. This theory predicts that (1) CA participants should monitor accurately, and (2) perceived higher-cooperators should have better reputations. These predictions were supported in a study of real-life CAs carried out by a group of Shuar hunter-horticulturalists: (1) members accurately distinguished “intentional” non-cooperators (who could have cooperated but chose not to) from “accidental” non-cooperators (who were unable to cooperate), and their perceptions of co-member cooperativeness accurately reflected more objective measures of this cooperativeness; and (2) perceived intentional cooperators had better reputations than perceived intentional non-cooperators. These results have direct applications in organizational contexts, e.g. for improving the cooperativeness of self-directed work teams.

Keywords: Collective action; cooperation; reciprocity; reciprocal altruism; greenbeard; monitoring; reputation

1. Introduction: Collective actions and organizational behavior

The evolution of cooperation/altruism (the two terms are often considered essentially synonymous in biology) is a central problem in behavioral biology. Many researchers agree that humans engage in cooperation to a degree that is beyond the explanatory reach of widely-accepted evolutionary theories of cooperation such as kin altruism (Williams & Williams, 1957; Hamilton, 1964) and dyadic reciprocal altruism (Trivers, 1971). Recent attention has focused on the origins of collective action (CA), defined here as multiple (not necessarily genetically related) individuals cooperating to produce some resource to be shared equally among themselves. The organizational behavior literature has focused on several forms of CA, most commonly on work teams, e.g. a team of auto engineers designing a new car that, when completed, will lead to rewards for all group members.¹ Improved understanding of cooperation in CAs, then, could have broad applications within the field of organizational behavior (Olson, 1965; Albanese & Van Fleet, 1985; Goren, Kurzban & Rapoport, 2003), and an evolutionary analysis could contribute to such an understanding by illuminating the ways in which psychological adaptations influence behavior in CAs (Price, Cosmides & Tooby, 2002).

This paper will present an evolutionary theory of cooperation in CAs, and also a field

¹ Recent examples include, e.g., Alper, Tjosvold & Law, 1998; Sheremata, 2000; Beersma et al., 2003; Chen & Bachrach, 2003; Tjosvold, Hui, Ding, & Hu, 2003; Piccoli & Ives, 2003. The organizational behavior literature also examines CA in the context of common pool resource dilemmas (Wade-Benzoni, Tenbrunsel & Bazerman, 1996; Rapoport & Au, 2001), inter-organizational cooperation (Ingram & Inman, 1996; Monge et al., 1998), and labor relations (Traxler, 1999; Ospina & Yaroni, 2003).

study, carried out among hunter-horticulturalists in the Ecuadorian Amazon, that tested some predictions of this theory. The CAs of hunter-horticulturalists may at first seem far removed from those conducted in organizations in industrialized societies, but behavior in both contexts should be similar, to the extent that it is produced by psychological adaptations for cooperation that characterize humans as a species. Knowledge about species-typical aspects of CA participation, then, could be useful to organizers of CA in very different cultural contexts.

1.1 *The freerider problem and the evolution of collective action*

In a CA involving the joint production of an equally-shared resource, a participant can cooperate in two basic ways: by *contributing* directly towards the production of the resource, or by *punishing* co-participants for their low contributions towards this production. Such punishment would be cooperative if it produced resources for all CA participants by motivating low contributors to increase their contributions to resource production (Gintis, 2000). Because both types of cooperative behavior produce resources for other people, both are puzzling from the perspective of individual fitness promotion (Olson, 1965; Price et al., 2002). The puzzle exists because if each participant receives an equal share of the resource produced by his or her cooperativeness, then each participant's net benefit depends solely on his or her cost of cooperativeness (contribution and/or punishment effort), and lower-spending freeriders should do better than higher-spenders.² These higher net benefits should translate into fitness advantages for freeriders, and so, all else equal, selection should favor those individuals who contribute the least in CAs.

If freeriders had fitness advantages in the ancestral past, however, it is unclear how a behavioral tendency to cooperate in CAs could have evolved. From the perspective of selfish replicating genes (Hamilton, 1964; Dawkins, 1976), a psychological predisposition to cooperate would seem to be at a selective disadvantage compared to a predisposition to freeride: any gene or group of genes that encoded a cooperative predisposition would likely be out-competed by genes for freeriding. But despite this freerider problem, cooperativeness in CAs apparently did evolve: costly contribution and punishment of freeriders are typical behaviors in CAs cross-culturally (e.g. Yamagishi, 1986; Ostrom, 1990; Fehr & Gächter, 2002; Price, in press). Thus, there is an apparent inconsistency between the behavior that standard genic-level selection theory would seem to predict, and the behavior in which humans actually engage.

Researchers have suggested several solutions to this paradox. Some have suggested that even if cooperativeness were damaging to individual fitness, genes for cooperativeness could still replicate successfully if there were biological group selection for groups that contained more cooperators (Sober & Wilson, 1998; Gintis, 2000). Explanations that require biological group selection to overcome individual fitness deficits, however, are usually less plausible than those invoking individual fitness advantages (Williams, 1966; Tooby & Cosmides, 1996). As an alternative to such theories, cultural evolutionary and gene-culture co-evolutionary theories of CA have been proposed (reviews in Boyd, Gintis, Bowles & Richerson, 2003; Henrich, 2004). While such theories merit close consideration, this paper will focus on a theory for how cooperative behavior in CAs could have evolved by standard genic-level selection. This theory

² More formally: in a CA involving n participants, one's cost c of cooperating is multiplied by m and redistributed equally among all. When $1 < m < n$, one can produce resources for the group by cooperating, but can profit more individually by freeriding. For example, if $c = 1$, $m = 2$, and $n = 3$, and two participants cooperate while one freerides, each cooperator earns a net benefit 0.33, while the freerider, who retains c , earns 1.33.

requires no cultural or group selection effects, and suggests that cooperativeness could be enabled by ordinary individual-level adaptations.

1.2 *Standard evolutionary theories of cooperation*

The most widely-accepted evolutionary theory of altruism is Hamilton's (1964) kin selection, which proposes that a mutation for altruism could benefit itself, and thus promote its own replication, by promoting altruism towards close genetic kin (see below). But because CAs in human ancestral environments could have involved participants who were not close kin, some other theory must be invoked to explain the evolution of CA. The most widely-accepted evolutionary theory for cooperation among non-kin is reciprocal altruism (Trivers, 1971). As originally conceived and as usually portrayed, "classical" reciprocal altruism involves two individuals involved in a mutually beneficial exchange of resources (e.g. Axelrod & Hamilton, 1981; Henrich, 2004). For example, if Individual A incurs a cost of size 1 to provide Individual B with a benefit of size 2, and B reciprocates by incurring a cost of size 1 to provide A with a benefit of size 2, then A and B will each have exchanged a cost of size 1 for a benefit of size 2.

Classical reciprocal altruism is usually explained in terms of dyadic cooperation. However, if reciprocal altruism is understood from a reductionist, genic-level perspective, then it may also be capable of explaining cooperation in more complex interactions. The theory of greenbeard reciprocity presented below takes such a perspective on reciprocal altruism, in order to explain cooperation in CAs.

2. **Greenbeard reciprocity theory**

2.1 *The evolution of altruism via genic self-favoritism*

To understand how reciprocal altruism could explain cooperation in a CA, it helps to understand the basic theory of how altruism could evolve via genic self-favoritism. Hamilton (1964) contributed crucially to the development of this theory when he suggested that a mutation for altruism could promote its own replication if it directed altruism preferentially towards individuals who were likely to carry the same mutation. In order to engage in such preferential altruism, the carrier of the altruistic mutation must have some way of recognizing other carriers. One likely method of achieving such recognition would be via some cue associated with genetic relatedness: closer genetic kin are more likely to contain the same mutation, so if the carrier of a mutation for altruism could recognize its kin, it could direct altruism preferentially towards them, and thus enable the mutation's replication. This theory of kin selection, mentioned above, predicts that altruism will be relatively likely to evolve among close kin.

In the theory of kin selection, overall genetic relatedness indicates the probability of an altruistic mutation being present in another individual. However, in theory, an altruistic mutation's presence could also be indicated by some cue unrelated to overall genetic relatedness. To use Dawkins' (1976) well-known "greenbeard" example, imagine a gene that gives carriers a conspicuous phenotypic label like a green beard, and also motivates them to bestow altruism preferentially on other individuals who display this label (i.e., other greenbeards). A greenbeard gene which thus motivated carriers to direct altruism preferentially at other carriers could harvest the benefits of altruism primarily for itself, and thus avoid being out-replicated by freeriding, non-altruistic genes (see also Haig, 1996; Queller, Ponte, Bozzaro & Strassmann, 2003).

If genetic altruists may be capable of bestowing altruism preferentially on other genetic altruists via greenbeard recognition, then what phenotypic label of genetic altruism (greenbeard) might they use in order to identify each other? The greenbeard example imagines genetic altruism being indicated by an arbitrary label (a literal green beard) that is not intrinsically related to altruistic behavior itself. However, selection should in fact favor greenbeards that are maximally non-arbitrary indicators of genetic altruism. This is true because when greenbeards are arbitrary, selection should favor mutations for deceptive greenbeards, i.e., greenbeards *without* the altruistic tendency. Because they could obtain the benefits of altruism without sharing in the costs, these deceivers would exploit real greenbeards to extinction. Real greenbeards would lose out because of their failure to accurately recognize other real greenbeards; however, if they utilized a more reliable and difficult-to-fake label of genetic altruism, then they would be less vulnerable to exploitation. An obvious candidate for such a label would be actual engagement in altruistic behavior (Dawkins 1976). Therefore, conspicuous altruistic action would be a relatively likely greenbeard of an altruistic gene.

2.2 *Could reciprocal altruism have evolved via genic self-favoritism?*

The preceding discussion suggests that kin- and greenbeard selection are two ways in which altruism could in theory evolve via genic self-favoritism. How does the above-mentioned theory of reciprocal altruism (hereafter “reciprocity”) fit into this discussion? Will reciprocity be likely to involve genic self-favoritism? Yes, assuming that the reciprocity occurs between members of the same species. As conceived by Trivers (1971), reciprocity can occur both between members of the same species and between members of different species (e.g. a cleaner fish and its host). While between-species reciprocity is unlikely to involve genic self-favoritism, within-species reciprocity is likely to involve it. This is true because in the latter case only, reciprocal partners share a species-typical genome. Reciprocity is impossible unless both individuals in an interaction are capable of reciprocity, and if two members of a species are both genetically capable of reciprocity, then their reciprocity-enabling genes are likely to have the same loci in both individuals (Rothstein, 1980). If these individuals produce a mutual benefit for themselves via reciprocity, then the genes for reciprocity in each individual will have benefited the same genes for reciprocity in the other.

From this perspective, within-species reciprocity can be seen a particular kind of greenbeard altruism (Humphrey, 1997). To illustrate this concept, imagine that in a population of non-reciprocators, a mutation appears which enables Carrier X to engage in reciprocity when X can benefit from doing so. Like all beneficial mutations, this mutation would be rare and fortuitous. In order for this mutation to benefit X, somebody besides X in the population would also need to be carrier, or else X would have nobody to reciprocate with. Because the chances of two such mutations occurring at different loci in the same population at about the same time would be relatively slim, the more plausible scenario is that X would end up cooperating with another carrier of the same mutation.³ X could recognize other carriers by their tendency to

³ Because close genetic kin are relatively likely to carry the same mutation, other carriers would likely be close relatives of X, so the mutation would probably initially promote reciprocity among kin. However, if the mutation promoted reciprocity *per se* – i.e., if it encoded a psychological system that behaved altruistically in response to information that this altruism was being reciprocated by the beneficiary, without concern for information about whether the beneficiary was a genetic relative – then nothing would restrict the mutation from ultimately promoting reciprocity among non-kin, once it spread beyond the family in which it appeared initially.

reciprocate, and this tendency would constitute a phenotypic label, i.e. greenbeard, of the mutation. Thus, X's preferential cooperation with other reciprocators would promote the evolution of the reciprocity mutation via greenbeard effects.

2.3 Greenbeard reciprocity in collective actions

It was suggested above that greenbeard reciprocity may explain cooperation in CAs involving more than two individuals. To understand how, consider again that greenbeard altruism may evolve if genetic altruists can recognize and cooperate preferentially with each other, so that there is a better-than-average chance that their altruism will benefit another genetic altruist, rather than a freerider (Hamilton 1964; Dawkins 1976; Henrich 2004). The greenbeard reciprocity theory allows for such recognition and preferential cooperation among altruists, because it regards an individual's predisposition towards reciprocity as a genetic attribute that should persist through time: if Individual X carries a mutation that predisposes it towards reciprocity, then X's likelihood of reciprocating should be predictable to some degree. This view does not assume that X's predisposition should be the only factor determining X's likelihood of reciprocating in any one interaction,⁴ only that ancestral individuals who were genetically predisposed towards reciprocity would have been more likely, on average, to actually engage in reciprocity. And to the extent that others' likelihood of reciprocity is predictable, it should be possible for reciprocators to cooperate preferentially with other reciprocators, and therefore for reciprocity to evolve via greenbeard selection. Such preferential cooperation could occur in interactions involving either two, or more than two, individuals: With two individuals, a mutation for reciprocity should promote cooperation to the extent that it is likely present in the other interactant (i.e., to the extent that the other interactant is reciprocating); With more than two individuals, it should promote cooperation to the average extent that it is likely present in other interactants (i.e., to the average extent that others are reciprocating).

2.4 Summary and predictions of greenbeard reciprocity theory

In summary, the theory of greenbeard reciprocity states that genes for within-species reciprocity, in both dyadic and n -player cooperative interactions, should produce benefits preferentially for their carriers (and therefore for themselves), and should thus out-replicate genes for freeriding. While explaining the theory of greenbeard reciprocity may seem complicated, especially to those who are unfamiliar with evolutionary approaches to cooperation, the theory makes straightforward predictions that are directly relevant to understanding how people cooperate in organizational contexts. The core prediction is that individuals will be adapted to cooperate in CAs to the extent that they expect their average co-participant to reciprocate. A key secondary prediction is that individuals will be adapted to acquire

⁴ In any one interaction, factors other than one's genetic predisposition towards reciprocity should also determine one's likelihood of reciprocation. For example, this likelihood could depend on one being sufficiently healthy, skilled, spatially proximate, and/or desirous of the resource that would be jointly produced. Thus, reciprocity mutation carriers should direct altruism not just towards other carriers, but towards other carriers whose probability of reciprocation is not diminished by extraneous factors. By thus promoting two-way altruism (reciprocity), such a mutation would benefit the carrier's whole genome, and avoid problems related to intragenomic conflict that some greenbeard genes might cause (Ridley & Grafen, 1981; Haig, 1996), and that it might cause if it promoted one-way altruism, i.e., altruism towards individuals who were genetically predisposed towards reciprocity, but who were unable to reciprocate due to extraneous factors.

information about others' current and prior behavior in cooperative interactions, in order to formulate accurate expectations about others' likelihood of reciprocation. A growing body of evidence in support of this theory suggests the following:

- (1) Subjects in experimental economic games do cooperate preferentially with perceived reciprocators, i.e., they (a) tend to cooperate when they expect their partners to cooperate too, and (b) prefer to interact with expected cooperators, when allowed to choose their interaction partners;
- (2) People often base their expectations about partner cooperativeness on (a) information about the partner's reputation for cooperativeness, and (b) information acquired via direct observation of the partner's cooperative behavior (monitoring).

A brief review of this evidence follows.

3. Evidence of greenbeard reciprocity in humans

Conditional cooperation and trust. A standard finding of experimental CAs (public good games), including one conducted in a small scale society (Henrich & Smith, 2004), is that subjects are "conditional" or reciprocal cooperators, i.e., they cooperate more when they believe that co-players are reciprocating (Orbell & Dawes, 1991; Ledyard, 1995; Lubell & Scholz, 2001), and less when they believe that co-players are freeriding (e.g. Kurzban, McCabe, Smith & Wilson, 2001; Fehr & Gächter 2002). One particularly comprehensive study of reciprocity in public good games (Croson, 2001) found players' contributions to be positively correlated not just with the mean expected co-player contribution, but with the actual mean co-player contribution; in other words, players' expectations tended to be accurate. An fMRI study suggests that such reciprocity may be promoted by an emotional system causing people to enjoy cooperating when they perceive partners to be cooperating at similar levels (Rilling et al., 2002).

Cooperation with other cooperators has also been elicited experimentally in the form of "indirect reciprocity" (Alexander, 1987): experimental subjects will cooperate more with people whom they have observed cooperating with others (Wedekind & Milinski, 2000; Milinski, Semmann & Krambeck, 2002; Barclay, 2004), and who they therefore presumably expect would cooperate with them. Further, the finding that cooperation flourishes in environments characterized by high levels of trust, i.e., when people expect others to cooperate, has been reported consistently in the literature of organizational behavior and other fields (Jones & George, 1998; Kramer, 1999; Dirks & Ferrin, 2001; Ostrom, 2003).

Partner choice. The above examples of reciprocity suggest that people cooperate more when they perceive co-interactants to be cooperating, and less when they perceive co-interactants to be freeriding. Another way in which cooperators could avoid cooperating with freeriders would be if they could somehow avoid interacting with them the first place. Experimental evidence does suggest that when players are allowed partner choice, cooperators attempt to interact with reciprocators and to avoid freeriders. In a study in which subjects were allowed to join the public good game group of their choice, there was "a continual flight of the more cooperative subjects away from the less cooperative ones" (Ehrhart & Keser, 1999). Similar results were found in 2-player public good games in which subjects could bid for the option of choosing a new partner (Coricelli, Fehr & Fellner, 2004). In another public good game study, subjects were informed of the contribution histories of other players, and allowed to form groups based on mutual partner preference. The highest contributors chose to cooperate with each other,

and proceeded to behave even more cooperatively, in the confidence that their new, mutually chosen partners would reciprocate (Page, Putterman & Unel, in press).

It is reasonable to expect that in human ancestral environments, people would have had some ability to choose their interaction partners, and that they could have exercised a preference for reciprocators, just as they do in modern environments. Such preferential cooperation may be enabled by psychological system specialized for tracking individual histories of cooperative behavior: compared to neutral faces, faces of people who have cooperated or defected in a prisoner's dilemma game are remembered better, and elicit more activity within a neural system associated with social cognition (Singer, Kiebel, Winston, Dolan & Frith, 2004).

Reputation. Reputation systems are a universal feature of human societies (Trivers, 1971; Panchanathan & Boyd, 2003), and several studies suggest a correlation between cooperativeness and goodness of reputation, both in small-scale societies and in a western business context (Flynn, 2003), with reputations being based on how much people contribute public goods such as meat (e.g. Hawkes, 1993; Gurven, Allen-Arave, Hill & Hurtado, 2000), military service (e.g. Meggitt, 1977; Chagnon, 1988), and labor in group work projects (Price, 2003). People seem particularly skilled at remembering the faces of people with reputations for *not* cooperating (Mealey, Daood, & Krage, 1996; Oda, 1997).

Monitoring. People also seem well-equipped to assess cooperativeness directly, in the absence of reputational information. Extensive cross-cultural fieldwork has documented that wherever there are CAs, there is mutual monitoring (Erasmus 1977; Ostrom 1990): "In all known self-organized resource governance regimes that have survived for multiple generations, participants invest resources in monitoring and sanctioning the actions of each other so as to reduce the probability of free riding" (Ostrom, 2000:138). Villagers in a small-scale society accurately monitor the extent to which co-villagers engage in pro-community altruism (Price, 2003), and subjects in both industrialized and small-scale societies can solve logic problems better when these problems entail detecting a cheater in a social exchange (Cosmides & Tooby, 1992; Sugiyama, Tooby & Cosmides, 2002). A brain-injured patient showed selective impairment in this cheater-detection ability (Stone, Cosmides, Tooby, Kroll & Knight, 2002), suggesting that the ability is enabled by a specialized cognitive mechanism.

Possible indicators of cooperative intentions other than cooperative behavior. Reciprocity might also be facilitated if others' cooperative intentions could be assessed with information gathered via communication and face-to-face interaction. Experimental subjects cooperate more successfully when they have opportunities for such interaction (review in Ostrom, 2003), perhaps because they can discuss their intended behavior (Ostrom, Walker & Gardner, 1992), and make inferences based on co-player dispositions (Frank, Gilovich & Regan, 1993), facial expressions and features (Brown & Moore, 2002; Brown, Palameta & Moore, 2003; Eckel & Wilson, 2003; Yamagishi, Tanida, Mashima, Shimoma & Kanazawa, 2003), and other verbal and nonverbal indicators of cooperative intent (Brown et al., 2003; Bochet, Page & Putterman, in press).

In summary, evidence suggests that humans may be adapted for greenbeard reciprocity: people appear to skillfully assess the cooperativeness of others, and to cooperate preferentially with perceived cooperators. (For a more formal presentation of this greenbeard theory, and a more complete review of the evidence supporting it, see Price, under review). However, additional predictions of the greenbeard theory remain to be tested, and that is the goal of the research described below.

4. Study: Monitoring and reputation in a Shuar work team

Engagement in greenbeard reciprocity requires the ability to assess the cooperative dispositions of other people. As discussed above, this assessment could plausibly be based on (1) reputational information, or (2) information acquired through mutual monitoring. The greenbeard theory predicts that one's reputation should be impacted by one's perceived cooperativeness, and that people should be cognitively equipped for accurate monitoring. In this paper, these predictions will be tested among participants in the CAs of a Shuar work team. Somewhat similar predictions were tested in a previous study (Price, 2003), which recorded the opinions of Shuar villagers about the extent to which co-villagers acted "in general, to help the community." This measure of how much co-villagers were *perceived* to engage in *general* helpfulness correlated positively with measures of how much they *actually* engaged in *specific* helpful activities, a result which suggested that villagers were accurately monitoring altruism at the community level. Further, villagers who were perceived as more altruistic had better reputations. The present study focuses not on perceived general altruism for the benefit of the whole community, but on perceived engagement in particular kinds of altruistic activities in a single ongoing CA. Thus, compared to Price (2003), the present study investigates cooperation in a more explicitly CA-type context, and more precisely measures the extent to which people accurately monitor others' engagement in specific cooperative behaviors.

Study participants were from a hunter-horticultural Shuar village (pop. 300) in the Ecuadorian province of Morona Santiago. Their most important crops are plantains and sweet manioc, they have had contact with Protestant missionaries for several decades, they rely heavily on timber sales for cash, and most can speak Spanish. Some elements of traditional Shuar culture persist strongly, e.g. individuals within the village are highly related, the average coefficient of relatedness in the village being .045 (for reference, the coefficient of relatedness between second cousins is .031), they all speak Shuar with each other, and, like many Andean/Amazonian groups, they regularly practice traditional CAs known as *mingas*.

In a *minga*, a group labors towards some collective goal, e.g. clearing a field or building a house. This study focused on an association of sugarcane cultivators (*cañicultores*) who, once or twice a week, would hold a *minga* to clear their fields of weeds with machetes. The expected benefits of association membership were an equal share of the profits that would be made from sugarcane sales, while the costs were participating in *mingas* or being fined US\$2 for each unjustified absence (a significant amount, equivalent to what a Shuar could make in one day working as a farmhand for a non-Shuar). Attendance records were kept by the association secretary in order to record how much each member owed in fines for nonattendance. For each *minga*, members were recorded as "present" (*presente*), "unjustifiably absent" (*falta*) or "justifiably absent" (*justificado*). A *falta* occurs when the member is perceived to have been capable of attending, but to have chosen not to; a *justificado* is due to some incapacitating sickness or injury that the member did not voluntarily bring upon him- or herself, and, unlike a *falta*, is not fined. Thus, an absence's justifiability depends on whether it is perceived to have resulted from intentional non-cooperativeness on the part of the absentee member, or from accidental circumstances beyond that member's control, and as in western societies, accidental non-cooperativeness is not considered "cheating" (Rabin, 1993; Dufwenberg & Kirchsteiger, 1999; Bottom, Gibson, Daniels & Murnighan, 2002; Gintis, Bowles, Boyd & Fehr, 2003; Singer et al., 2004). The distinction between intentional and accidental absences is interesting from the perspective of greenbeard reciprocity theory, because this theory predicts that CA participants will assess the cooperative dispositions of co-participants. Because only intentional absences.

and not accidental absences, should be considered evidence of a non-cooperative disposition, the theory predicts that information about the two kinds of absences should be processed separately in the minds of CA participants, and that only intentional absences should damage a participant's reputation for cooperativeness.

4.1 Hypotheses

A member's cooperativeness in a *minga* can be assessed in at least two ways: how much physical work effort the member exerts in *mingas*, and the extent to which the member is intentionally absent from *mingas* (as noted above, accidental absences should not be considered freeriding). Accordingly, the study tested the following predictions of greenbeard reciprocity theory:

- (1) Members will accurately monitor co-member work effort, i.e., have perceptions of work effort that correlate positively with a more objective measure of work effort;
- (2) Members perceived as being harder workers will have better reputations;
- (3) Members will accurately monitor co-member intentional absences, i.e., (a) not mistake accidental absences for intentional ones, and (b) have perceptions of intentional absences that correlate positively with a more objective measure of such absences;
- (4) Members perceived as being intentionally absent less often will have better reputations; however, a member's accidental absences will not adversely affect his or her reputation.

4.2 Method

The study population was all 13 members of the *cañicultores* association. Membership was voluntary, but limited to official "citizens" (*socios*) of the community. Because people are usually not elected *socios* until their twenties, all members were adults. Machete work in *mingas* is traditionally considered men's work, and most members (12 of 13) were male.⁵ All members were native Shuar speakers, but also fluent in Spanish.

Variables included: how much work effort each member is perceived to exert in *mingas* (PERCEIVED EFFORT), which should accurately reflect a more objective measure of work effort (ACTUAL EFFORT); the number of days that each member is perceived to have been intentionally absent (*falta*) from *mingas* (PERCEIVED INTENTIONAL ABSENCES), which should accurately reflect the actual number of *faltas* (ACTUAL INTENTIONAL ABSENCES), and should not confuse these with *justificados*, i.e., accidental absences (ACTUAL ACCIDENTAL ABSENCES); and, each member's reputation (REPUTATION). Each member's age (AGE) was also recorded, so that it would be possible to control for age in analyzing relationships between the cooperativeness measures and REPUTATION (see below). All variables passed the Shapiro-Wilk normality test, except where indicated; those which failed were transformed.

To measure PERCEIVED EFFORT, *cañicultor* subjects ranked Polaroid photographs of all *cañicultores* (including themselves) in response to the question (asked in Spanish): "Which of these two people works harder and faster when working in an association *minga*?" (According to members, speed is the most important component of work effort in *mingas*). A complete ranking was achieved using a binary comparison pile sort technique (see Appendix). Each member's PERCEIVED EFFORT score was his or her average ranking, coded so that greater values

⁵ The female was the wife of the association president. She sometimes worked in the fields with the males, and also prepared and distributed *chicha* (a traditional alcoholic drink) during *minga* breaks.

indicate greater work effort. Ten of the 13 *cañicultores* were available to provide rankings, sufficient to achieve a highly reliable measure ($\alpha = .97$).

To measure ACTUAL EFFORT, 6 *mingas* (34.9 *minga* hours) were observed, and data about work effort recorded. A scan sampling methodology was used: every few minutes during the *minga*, the author observed each member for a 7-second period, and scored his or her level of work effort on a scale of 0-4. A score of 0 indicated that the member was resting, i.e., not working at all. A score of 1 indicated light work: filing a machete, or standing (not bending) while making a minimal effort to strip dead leaves off a sugarcane stalk. A score of 2 indicated moderate work: 1-2 machete swings during the 7-second period, standing or bending while intently stripping dead leaves off a stalk, or replanting a stalk. A score of 3 indicated heavy work: at least 3-4 machete swings. A score of 4 indicated the fastest and most laborious work: 5 or more machete swings. At the end of the *minga*, all of a participant's scores were averaged for a single *minga* work effort score. Ultimately, all of a member's *minga* work effort scores were averaged to calculate ACTUAL EFFORT. The length of time between scans varied depending on the spatial distribution of workers (wide dispersion made rapid scans difficult), but the average over all 6 *mingas* was 1 scan every 5.0 minutes.

PERCEIVED INTENTIONAL ABSENCES was the average response that *cañicultor* subjects gave when they were shown a photo of each *cañicultor*, and asked (in Spanish): "How many intentional absences [*faltas*] do you think this person has had in association *mingas*?" Ten of the 13 *cañicultores* were available to provide rankings, enough to achieve a highly reliable measure ($\alpha = .92$). Three members were perceived as having been especially frequently-absent, so PERCEIVED INTENTIONAL ABSENCES required a normalizing square-root transformation.

ACTUAL INTENTIONAL ABSENCES was the number of days each member was listed as *falta* by the association secretary in all 30 *mingas* that had occurred by the time at which PERCEIVED INTENTIONAL ABSENCES was measured.

ACTUAL ACCIDENTAL ABSENCES was the number of days each member was listed as *justificado* in the same *minga* attendance records on which ACTUAL INTENTIONAL ABSENCES was based, and it required a normalizing square-root transformation.

REPUTATION was measured by the same method used for PERCEIVED EFFORT. Photos of all members were ranked according to the question (asked in Spanish): "Which of these two people is more respected by the other *cañicultores*?" REPUTATION values were each member's average ranking, coded so that greater values indicate greater respect. Ten of the 13 *cañicultores* were available to provide rankings, enough to achieve a highly reliable measure ($\alpha = .96$).

AGE was determined by referencing each member's state-issued ID card or birth certificate. If these sources were unavailable, members' self-reported ages were recorded, then cross-checked by comparing them to ages of other individuals (e.g., siblings) whose ages were known, and interpolating based on birth order.

4.3 Results

Table 1 shows means, standard deviations, and Pearson's r correlations for all variables. Results suggested accurate work effort monitoring: PERCEIVED EFFORT was highly correlated with ACTUAL EFFORT ($r = .79, p = .001$; all p values are 1-tailed).⁶ Results also suggested that

⁶ Two of the 6 observed *mingas* occurred after I had begun collecting data for PERCEIVED EFFORT, so I could have been non-consciously biasing my observations for ACTUAL EFFORT to be consistent with the opinions of the *cañicultores*. However, no bias was evident: a second version of ACTUAL EFFORT, consisting only of scores from the

members allocate more respect to perceived harder workers: PERCEIVED EFFORT was highly correlated with REPUTATION ($r = .62, p = .012$). This correlation increased ($r = .78, p = .001$) with the removal of an outlier (standardized residual = -2.34). The outlier, the president of the *cañicultores*, is the most respected member, but perceived as only the 7th-hardest worker; work effort is expected to be one predictor of REPUTATION, but not the only one.

Another potential predictor of REPUTATION might be AGE; the *cañicultores*' ages ranged widely (from 29.5 to 54.5 years old), and older members might be higher status. And since older members might also be less capable of hard physical labor, then a negative relationship between AGE and PERCEIVED EFFORT could weaken a positive correlation between PERCEIVED EFFORT and REPUTATION. Thus, to more directly investigate the impact of PERCEIVED EFFORT on REPUTATION, it could be important to control for AGE. In fact, AGE and REPUTATION were moderately but non-significantly positively correlated ($r = .33, p = .139$); however, the relationship between AGE and PERCEIVED EFFORT was weak, and, after controlling for the effects of AGE, the correlation between PERCEIVED EFFORT and REPUTATION remained strong (part [semi-partial] $r = .59, p = .016$).

| Variable | Mean | s.d. | 1 | 2 | 3 | 4 | 5 | 6 |
|-----------------------------------|---------------------------|-----------------------------|-------|-------|-----|-------|-------|-----|
| 1. ACTUAL EFFORT | 2.3 | 0.35 | - | - | - | - | - | - |
| 2. PERCEIVED EFFORT | 7.0 | 3.42 | .79** | - | - | - | - | - |
| 3. ACTUAL ACCIDENTAL ABSENCES | 1.2 [†] [2.5] | 1.00 [†] [2.60] | .19 | .11 | - | - | - | - |
| 4. ACTUAL INTENTIONAL ABSENCES | 6.3 | 2.49 | -.21 | -.62* | .30 | - | - | - |
| 5. PERCEIVED INTENTIONAL ABSENCES | 2.2 [†] [5.1] | 0.67 [†] [3.23] | .05 | -.38 | .38 | .72** | - | - |
| 6. REPUTATION | 7.0 | 3.33 | .25 | .62* | .15 | -.57* | -.49* | - |
| 7. AGE | 37.8 | 7.45 | -.08 | .11 | .04 | .07 | .07 | .33 |

* $p < .05$, ** $p < .01$; [†]Variable was transformed; pre-transformation mean and s.d. are in parentheses.

Table 1: Means, standard deviations, and correlations

Results also suggested that the *cañicultores* accurately monitor intentional *minga* absences: PERCEIVED INTENTIONAL ABSENCES correlated highly with ACTUAL INTENTIONAL ABSENCES⁷ ($r = .72, p = .003$). And as hypothesized, PERCEIVED INTENTIONAL ABSENCES

4 *mingas* that occurred prior to PERCEIVED EFFORT data collection, was about as correlated with PERCEIVED EFFORT ($r = .81, p = .001$) as was the original ACTUAL EFFORT ($r = .79, p = .001$).

⁷ Did the *cañicultores* pay more attention to more recent intentional absences? At the time PERCEIVED INTENTIONAL ABSENCES was measured, they had completed 30 *mingas* in 7 months, but took a 2.5-month break from *mingas* near the middle of this period to allow for sugarcane growth. A variable was created by summing only intentional absences that occurred in the 11 post-break *mingas*; this variable explained significant variance in PERCEIVED INTENTIONAL ABSENCES, beyond what was already explained by ACTUAL INTENTIONAL ABSENCES (part $r = .42, p$

correlated negatively with REPUTATION ($r = -.49, p = .044$). To more directly analyze the impact of PERCEIVED INTENTIONAL ABSENCES on REPUTATION, it was again necessary to control for the effects of AGE on REPUTATION; after doing so, the former relationship remained strong (part $r = -.52, p = .033$).

Also as hypothesized, members did not seem to confuse intentional absences with accidental ones: ACTUAL ACCIDENTAL ABSENCES did not explain significant variance in PERCEIVED INTENTIONAL ABSENCES ($r = .38, p = .100$). This correlation was inflated because both variables were correlated with a 3rd variable, ACTUAL INTENTIONAL ABSENCES. After controlling for the variance in PERCEIVED INTENTIONAL ABSENCES explained by ACTUAL INTENTIONAL ABSENCES, ACTUAL ACCIDENTAL ABSENCES explained very little additional variance in PERCEIVED INTENTIONAL ABSENCES (part $r = .17, p = .221$).

Finally, as predicted, while intentional absences had a negative impact on a member's reputation, accidental absences did not: REPUTATION was significantly negatively correlated with both PERCEIVED INTENTIONAL ABSENCES (see above) and ACTUAL INTENTIONAL ABSENCES ($r = -.57, p = .021$), but not with ACTUAL ACCIDENTAL ABSENCES ($r = .15, p = .309$).

Table 2 presents the results of REPUTATION regressed on PERCEIVED EFFORT and PERCEIVED INTENTIONAL ABSENCES. The two predictors together explained 35% of the variance in REPUTATION ($R^2\text{-adj} = .35, p = .023$); however, they were negatively correlated with each other ($r = -.38, p = .098$), and while PERCEIVED EFFORT explained significant unique variance in REPUTATION (part $r = .47, p = .037$), PERCEIVED INTENTIONAL ABSENCES did not (part $r = .28, p = .132$).

| Step | Variable added | R | R ² | R ² -adj | ΔR ² | ΔF | p of ΔF |
|------|--------------------------------|-----|----------------|---------------------|-----------------|------|---------|
| 1 | PERCEIVED EFFORT | .62 | .38 | .33 | .38 | 6.81 | .012 |
| 2 | PERCEIVED INTENTIONAL ABSENCES | .68 | .46 | .35 | .08 | 1.40 | .132 |

R, R², and R²-adj are cumulative, and ΔR² denotes change with step addition.

Table 2: Stepwise linear regression of REPUTATION on perceived cooperativeness measures

5. Discussion

Results were largely consistent with hypotheses. The *cañicultores* appeared to monitor co-member cooperativeness accurately: harder workers were correctly perceived as being harder-working, and more-frequently intentionally absent members were correctly perceived as being more-frequently intentionally absent (as opposed to merely “absent;” i.e., their intentional absences were not significantly mistaken for their excused absences). Further, members perceived as working harder, and as being less-frequently intentionally absent, had better reputations. Accidental absences, however, were not reputation-damaging.

The accuracy of the *cañicultores*' monitoring was impressive, given their apparent lack of deliberate, formal monitoring effort. Although the association secretary kept an attendance record, it was not distributed among the *cañicultores*. And while the formal work effort measure used in this study required a complex evaluation system including written records, the *cañicultores* made similar assessments based on informal evaluation alone. The accuracy of their monitoring is predicted by the theory that selection equipped humans with the psychological machinery necessary for greenbeard reciprocity.

= .014). Thus, members apparently remember recent absences better, or otherwise weigh them more heavily, in assessing co-member absences.

5.1 Relevance to organizations in industrialized societies

Self-directed work teams. CA organizers in any sociocultural context might consider that monitoring and reputation effects not only may have been integral to adaptive CA participation in the ancestral past, but may also promote successful CA in the present. For example, the theory and results presented above have direct implications for how to promote cooperativeness in a self-directed work team (SDWT), an increasingly common type of organizational CA in industrialized societies (Alper et al., 1998; Douglas & Gardner, 2004), and one that closely resembles the Shuar *minga*. The greenbeard theory predicts that one's ability to confirm (through monitoring) co-member cooperativeness will significantly affect the extent to which one is him- or herself motivated to cooperate, and therefore that inadequate monitoring opportunities will inhibit the cooperativeness of SDWT members. The *cañicultores* appeared to monitor each other constantly, and their ability to do so was enhanced by the fact that they always worked together in the same place and at the same time. In some SDWTs, however, the frequency of monitoring opportunities may be reduced, and inversely related to the extent to which team members work independently or in isolation from one another (e.g. from home or over email). When members have few opportunities to verify that they are not being free-ridden, they may be less motivated to cooperate.

Another factor preventing effective monitoring would be large team size: monitoring requires increased effort when teams are larger, and accurate monitoring may become impossible with too many co-members. Researchers commonly suggest an optimal team size of 10 members or fewer (e.g. Govindarajan & Gupta, 2001), and a reason why smaller teams are more effective may be because they better enable monitoring. Finally, monitoring opportunities may promote successful SDWTs not just by allowing members to verify the cooperativeness of co-members, but also by reducing the appeal of adopting a freeriding strategy. The temptation to freeride is reduced when one's freeriding is likely to be detected and punished, and formal and informal punishment systems can be important aspects of eliciting contributions from would-be freeriders and of promoting CA success (e.g. Yamagishi, 1986; Falk, Fehr & Fischbacher, 2001). Because freeriding cannot be detected except by monitoring, increased monitoring opportunities, combined with a formal or informal punishment system, should deter freeriding.

While monitoring and freerider punishment may promote successful cooperation in SDWTs, however, they may also involve substantial costs (Yamagishi, 1986; Ostrom, 1990). How could these costs be reduced without sacrificing team success? Monitoring costs may be cut with trust: team members monitor each other less when they trust each other more (Uzzi, 1997; Langfred, 2004). If members trust co-members to reciprocate, then they can cooperate without fear of being freeridden, and without engaging in constant costly monitoring. Punishment costs might be reduced by fostering a social environment in which participants have reason to care about their reputations. When participants are more concerned about avoiding reputation costs (e.g., when they regard co-participants as valued colleagues with whom they will be interacting repeatedly in the future), the prospect of such costs should more effectively motivate cooperation (Milinski et al., 2002; Barclay, 2004). By thus reducing the need for punishment, a system characterized by reputation effects could sidestep the costs associated with formal sanctions, and might be especially important in CAs characterized by the absence of a centralized, sanctioning authority such as a SDWT (see also Ostrom et al., 1992).

Transaction cost economics. The field of transaction cost economics (TCE) straddles organizational behavior and economics. Because TCE is concerned with solving problems

related to economic cooperation, many of the issues raised in the above study are also frequently discussed in TCE. For example, in the parlance of TCE, the integrity of cooperative economic transactions is often threatened by the self-interested opportunism or shirking of interactants, such as the freeriding behavior described above. Monitoring systems and reputation effects are widely recognized in TCE as an important force for keeping opportunism in check, and for allowing interactants to act cooperatively in the confidence that their partners will reciprocate (Demsetz, 1993; Williamson 1996). The above study suggests that the opportunism-related problems inherent to economic transactions, and also the ways in which these problems can be solved, may reflect how humans are psychologically adapted to behave in cooperative contexts. The desire to gain an advantage by engaging in undetected freeriding may be a basic temptation of human nature, and the desire to cooperate preferentially with other cooperators – and to confirm their cooperativeness with reputational or monitoring-related information – may be equally deeply-rooted in our evolved psychology.

5.2 Limitations

Two study limitations in particular bear mentioning. First, the demonstrated relationships between cooperativeness and reputation were only correlational, and possibly caused by 3rd variables. For example, work effort and reputation could both be positively influenced by good health; if so, vigorous work effort might be a “costly signal” of an attractive underlying quality (health), and harder workers might be more respected not because they are more cooperative *per se*, but because they are healthier and therefore more attractive (see Smith & Bliege Bird, 2000; Gintis, Smith & Bowles, 2001). Ruling out this possibility would require a study with an experimental manipulation to reveal the direct impact of perceived cooperativeness on reputation (as in Price, 2003). Second, the study’s sample size was small because there were only 13 members of the *cañicultores* association. Although data about all members were collected, and correlations were strong enough to achieve significance, a larger sample would have been better. A future study could attempt to replicate the above results with a larger sample.

6. Conclusion

The above results suggest that in the real-life CAs of Shuar hunter-horticulturalists, work team members are cognitively well-equipped to accurately monitor co-member cooperativeness, a task that would be integral to greenbeard reciprocity. Another prediction of greenbeard reciprocity theory, that members perceived as being more cooperative will have better reputations, was also supported. Cross-cultural replication of the above results would help in evaluating both the extent to which they reflect species-typical psychological adaptations for CA participation, and also the usefulness of the greenbeard theory for explaining how work team members solve freerider problems. To the extent that such studies improve our understanding of how people cooperate effectively, they will have important applications in organizational contexts.

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Appendix: Pile sort technique

First, I would randomly select two photographs, place them on a table, and ask the subject (in Spanish) the relevant question, e.g., to measure PERCEIVED EFFORT: "Which of these two people

works harder and faster when working in an association *minga*?” The perceived faster worker would be placed to the right of the perceived slower worker. Next, I would draw a new photograph and ask the subject to compare it with *one* of the two photographs already on the table (again, selected at random). If the new person was said to work faster than the faster already-sorted person, the new person would be placed to the right of both photos. If the new person was said to work slower than the slower already-sorted person, the new person would be placed to the left of both photos. If the new person was said to work faster than the slower already-sorted person, I would ask the subject to compare the new person with the faster already-sorted person, and then I would know whether to place the new person to the left or right of the faster already-sorted person. The sorting process continued in this fashion, with each newly-drawn person being compared to one already-sorted person at a time, until I was able to determine how each subject thought all of the *cañicultores* ought to be ranked. This method of binary comparison, while time-consuming, broke the ranking process down into relatively simple cognitive tasks of individual-against-individual comparisons.