Competitive Altruism Explains Labor Exchange Variation in a Dominican Community

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Smallholder farmers rely on labor exchange to generate agricultural work when cash is rare and credit unavailable. Reciprocal altruism, biased by genetic kinship, has been implicated as the mechanism responsible for labor exchange; however, few empirical tests confirm this proposition. Competitive altruism could be operating if people differ in ability and use this information as a criterion for partnership selection. Labor exchange data are presented from a Dominican smallholder village over a 10-month period within the village's primary cash economic opportunity, bay oil production. Results indicate that competitive altruism better explains variation in labor exchange relationships and group size than reciprocal altruism and kinship, suggesting the presence of a biologic market for male exchange relationships. Bay oil laborers vary in altruistic behaviors, causing reputations for altruism to emerge. Men with reputations as high-quality altruists generate larger labor groups in bay oil production than do poor-quality ones. Larger groups induce bargaining wars, causing men to compete through altruistic acts, which allows high-quality individuals to discriminate potential partners for labor exchange relationships. Men with better reputations achieve more same-sex reciprocal partnerships but not a greater incidence of conjugal partnership, suggesting that male altruism is intra- but not intersexually selected.

The world's population is mostly rural, poor, and agrarian (International Fund for Agricultural Development 2010). These smallholders rely on labor exchange as a strategy to generate income and assistance in times of need (Erasmus 1955, 1956; Geschiere 1995; Guillet 1980; Moore 1975). People engage in labor exchange when land rights are vested in a single individual; however, labor inputs surpass what one person can perform working individually (Moore 1975), and the rarity of cash or credit markets makes wage labor difficult (Gilligan 2004). Ethnographers have noted the existence of labor exchange in small-scale societies since the 1930s (e.g., Provinse 1937); however, it was Erasmus (1955, 1956) and Moore (1975) who placed it in a cross-cultural perspective. They characterized labor exchange as an arrangement of rural community members who organize into small groups, usually of males, where laborers are all farmers with similar land holdings, live in close proximity, and are relatively poor.

Labor exchange groups are led by a single individual, known as a "chief-for-a-day" (hereafter CFAD; Horowitz 1967). The CFAD decides how work is completed, directs those assisting, and provides food and alcohol to incentivize labor. This leadership role does not extend to other aspects of village life. CFADs own all goods produced from their labor event. For this reason, labor exchange does not represent a true collective-action problem or common-pool resource. Rather, it is collective action resulting in private goods (goods that are *excludable*—individuals can be excluded from consuming the good—and *rivalrous*—consumption by one party prevents simultaneous consumption by others; Apesteguia and Maier-Rigaud 2006).

Ethnographic accounts suggest that reciprocal altruism is responsible for labor exchange (Erasmus 1956; Moore 1975), with the possibility of a selection bias whereby kin members prefer one another as exchange partners (Berte 1988; Hames 1987). However, the extent to which labor exchange represents a form of reciprocal altruism biased by kinship is unclear, as quantitative (Hawkes 1983) and qualitative (Erasmus 1956; Moore 1975; Trawick 2003) analyses also suggest that kinship is not a necessary criterion for partnership selection in some communities and can be tabooed among kin members in others (Erasmus 1955). Furthermore, recent advances in theoretical biology, social psychology, and economics suggest that mechanisms other than reciprocal altruism and kin selection may structure cooperation (e.g., "biologic market theory" [Noë and Hammerstein 1994, 1995] and "competitive altruism" [Barclay and Willer 2007; Hardy and Van Vugt 2006; McNamara et al. 2008; Roberts 1998]). Thus, it is debatable whether reciprocal altruism and kinship are responsible for labor exchange at all.

Our research seeks to explain variation in labor exchange relationships and group composition by comparing predictions derived from the candidate mechanisms of competitive altruism and reciprocal altruism biased by kinship against 10 months of labor exchange data from a Dominican community. Results suggest that competitive altruism explains labor exchange variation better than do reciprocal altruism and kinship, suggesting that a biologic market for male exchange relationships exists in this village.

Reciprocal Altruism, Competitive Altruism, and Biologic Markets

Reciprocal altruism (Axelrod and Hamilton 1981; Trivers 1971) is proposed as the mechanism responsible for labor exchange.

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Reciprocal altruism requires that individuals encounter each other repeatedly, that both are able to provide assistance, and that the cost of providing assistance by the donor is less than the benefit derived by the recipient (Nowak 2006; Trivers 1971). Mathematical (Boyd 1990; Winterhalder 1996) and empirical (Gurven 2006) treatments indicate that reciprocal altruism can evolve via unequal exchange as long as individuals act in a contingent manner. Furthermore, formal models and ethnographic data demonstrate that naturally occurring assortment mechanisms such as genetic kinship (Berte 1988; Boyd and Richerson 1988; Hames 1987; Morgan 1979) and spatial proximity (Allen-Arave and Gurven 2008; Hames and McCabe 2007; Kaplan and Gurven 2005; Nowak 2006; Ohtsuki et al. 2006) reduce the costs associated with cooperation through positive assortment, thus permitting contingent reciprocity. The benefits derived from reciprocal altruism decrease as group size increases because the likelihood that a nonreciprocator exists in the group becomes high (Boyd and Richerson 1988). However, ethnographic data suggest that when genetic kinship fails, norms governing social kinship (i.e., lineage membership) reduce the cost of cooperation in groups, facilitating altruism (Alvard 2003; Morgan 1979).

If reciprocal altruism predicts labor exchange, then any labor given to another should result in some nonzero, positive amount of labor to be contingently reciprocated in the future. In addition, if naturally occurring assortment mechanisms facilitate contingent reciprocity, then labor received from others should be positively associated with living proximity, genetic kinship, or lineage membership.

Competitive altruism (Roberts 1998) and biologic-market theory (Noë and Hammerstein 1994, 1995) consider how variation in ability and partner choice affects cooperation. When individuals differ in their ability to cooperate, behavior functions as a signal of quality (Fishman, Lotem, and Stone 2001; Leimar 1997; Leimar and Hammerstein 2001; Lotem, Fishman, and Stone 2003; Roberts 1998; Sherratt and Roberts 2001) and altruistic reputations become salient (Alexander 1987; Nowak and Sigmund 1998; Zahavi 1995). When altruistic behavior (McNamara et al. 2008) or reputations (Fu et al. 2008) are used as a choice criterion for interactions, cooperation is favored, because altruists can discriminate high-quality partners from low-quality ones (Barclay and Willer 2007; McNamara et al. 2008; Nesse 2007; Roberts 1998). Because high-quality altruists tend to be rare in a population and provide direct and indirect benefits to those who partner with them (Panchanathan and Boyd 2004), competition for access to altruists can be intense (Nesse 2007; Noë and Hammerstein 1994, 1995), resulting in larger audiences seeking their services (Gintis, Smith, and Bowles 2001; Roberts 1998) and/or bidding wars to curry their favor (Noë and Hammerstein 1994, 1995). Because of the demand for high-quality individuals, altruists can choose with whom to form reciprocal partnerships, resulting in high-quality individuals that cooperate with some people but not others. Thus, competitive altruism assumes a biologic marketplace for exchange relationships, whereby commodities such as labor and reputations are asymmetrically distributed in the population, individuals exchange these commodities, and market forces of supply and demand determine their value (Noë and Hammerstein 1994, 1995).

Competitive altruism predicts (1) that the amount of labor given to others will be positively associated with one's reputation for altruism, (2) that group size will vary as a function of reputation, (3) that as group size increases, people will send stronger signals of commitment to a CFAD by offering more days of service, (4) that reciprocal dyads will be more likely to form as the number of days of labor given to a CFAD increases or if a laborer has a reputation for altruism, and (5) that males with good reputations should form more partnerships.

Study Site and Organizational Context

The village of Bwa Mawego (pseudonym) is located on the southeast coast of the Commonwealth of Dominica, an independent Caribbean nation. The village has a population of approximately 500–600 residents living in 180 households (Decker and Flinn 2011). Women are more than twice as likely to emigrate from the village than men (Quinlan 2005), resulting in a population that is numerically male biased. Nearly all residents are related to one another through either consanguineal or affinal ties. Although land inheritance is largely patrilineal, village life has a matrifocal orientation (Quinlan 2006), similar to that in other Afro-Caribbean populations (Smith 1996). Females, across the life course, experience parental resource favoritism (Quinlan 2006; Quinlan, Quinlan, and Flinn 2005). Because of the scarcity of resources and the matrifocal orientation of village life, men experience local resource competition within households (Quinlan and Flinn 2005). The combination of local resource competition and female-biased parental investment, compounded by the limited number of females in the community, leads to (1) male difficulties in achieving reproductive success (Quinlan and Flinn 2005), (2) greater alcoholism and poverty rates in men (Quinlan 2006), and (3) cultural models of fairness, such that men in households with relatively many males become more generous while females in such households become less so (Macfarlan and Quinlan 2008).

Village economy is a mix of slash-and-burn horticulture and small-scale commercial activities. The primary crops cultivated include tubers and plantains for personal consumption and the West Indian bay tree (*Pimenta racemosa* [Miller] J.W. Moore). The primary cash opportunity is bay leaf farming and distillation of bay oil (Macfarlan 2010).

Bay Oil Production

Bay is an essential oil produced from the indigenous Caribbean tree of the same name (Honychurch 1986). It is used in the cosmetic industry as an ingredient in perfumes; locally, however, people use it to treat rheumatism (Quinlan 2004). Bay oil production is a largely male task and a major component of daily social life, as the physical demands of labor

Table 1. Descriptive statistics for bay oil distillation

	N	Mean (SD)	Median	Minimum	Maximum	Total
Male days worked	94	7.3 (8)	4	1	38	690
Female days worked	20	3.5 (2.7)	2.5	1	9	68
Male days as CFAD	59	4.3 (3.7)	3	1	20	255
Female days as CFAD	5	3 (2)	3	1	5	15
Male days assisting	82	5.4 (5.8)	3	1	31	435
Female days assisting	17	3.2 (2.9)	2	1	9	53
Group size	244	3.1 (1.2)	3	1	11	
Altruism reputation	53	.6 (.3)	.8	0	1	

Note. CFAD = chief-for-a-day.

require collective action. Oral histories suggest that residents have operated bay farms for at least 100 years.

Production has two phases. The first consists of a 1-month period when bay leaves are harvested and bundled from individually managed plots of land and then carried on foot to one of eight village distilleries. Logwood fuel is required to heat the stills. This is obtained from primary- and secondary-growth tropical forests located on the periphery of the village. The second phase is a 1–6-day distillation period, when the leaves are steamed and the essential oil produced.

Both phases of production are energetically taxing. To distill a single batch of oil, 1,000 kg of bay leaves and 700 kg of logwood fuel must be carried on foot to a distillery (a distance that can exceed 3 km). In addition, one must be present in a factory for 16 hours to maintain temperatures and sufficient water in the still for proper distillation. Without monitoring, the oil can be ruined, or worse, the still could explode, causing injury or death.

When an individual desires to distill bay oil, he/she may publicly state that they will work in the near future. A villagewide norm suggests that people who owe labor should assist; however, people other than those owing labor may work. The CFAD directs all operations and provides cigarettes, rum, and food to keep the group content. The group that is formed is ephemeral, lasting only as long as the distillation event, is not named, and does not compete with other groups. All oil (and subsequently, money) that is produced from the distillation event is owned by the CFAD, except for one 0.75-L bottle of oil, which must be paid to the factory owner per distillation event.

Methods

Labor Exchange

Following the protocol of Hames (1987), one village resident and one author (S.J.M.) performed daily instantaneous scan samples of the village's eight distilleries over a 10-month period (July 1, 2007–April 30, 2008). During distillery scans, we recorded the number of people present, the CFAD, and all individuals providing assistance. In addition, we collected the name of the hamlet where each individual resided (there are 12 hamlets within the village) and whether they were in a conjugal relationship with a member of the opposite sex. Genetic kinship and patrilineal membership data were obtained through a series of genealogic interviews between 1987 and 2004 (see Quinlan and Flinn 2005; Quinlan and Hagen 2008).

Two hundred and forty-four distillation events were recorded over the 10-month period, representing 114 people (table 1). Forty-nine people acted as a CFAD and assisted at least one other CFAD, 15 people acted as a CFAD but did not assist anyone, and 50 people assisted at least one CFAD but did not act as a CFAD. Average group size was three individuals. Of the 94 men represented, 44 had a conjugal partner. Because of the small sample of women represented as CFADs, the remaining analyses were run on males only.

There were 288 dyads (144 unique pairs), representing 59 men. Of those, 82 dyads (41 unique pairs) showed evidence of contingently reciprocal labor exchange: 33 unique dyads showed a single instance of contingency (e.g., "A" gave to "B," followed by "B" giving back to "A"), and eight had prolonged contingency (e.g., "A" gave to "B," "B" gave back to "A," followed by "A" giving to "B," etc.). Average contingency time was 35 days (median = 8.5 days); however, the data are Poisson distributed, indicating that most people reciprocated labor within a short time interval (minimum = 1 day, maximum = 148 days). Of the 288 dyads, 126 (44%) resided in the same hamlet and 44 (15%) were members of the same patrilineage. Sufficient information existed to re-

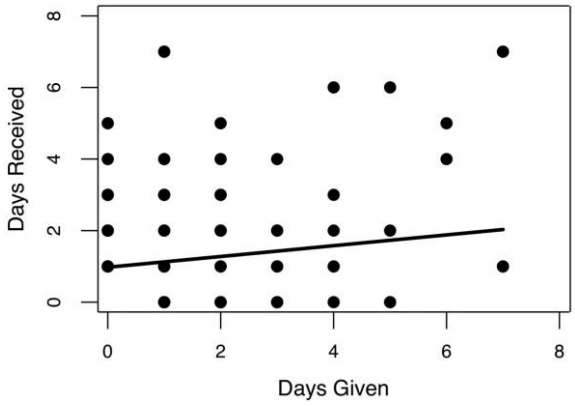

Figure 1. Relationship between days of labor given and received.

Table 2. Multilevel Poisson regression model predicting days of labor received

Variable	*B* (SE)	*z*	*P*
Constant	−.4 (.2)	−2.4	.02
Living proximity	.4 (.2)	2.9	.004
Days given	.08 (.05)	1.7	.09
Genetic kinship	−.4 (.8)	−.5	.6
Lineage membership	−.3 (.3)	−1.1	.3

construct the genetic relatedness between 244 dyads. Average relatedness was 0.06 ± 0.13 (median = 0.04).

Reputations

Altruistic reputations were assessed by one author (M.R.), who asked five villagers to rate 53 men on their altruistic tendencies through a dichotomous scale (1 = would be altruistic; 0 = would not be altruistic), using the French patois prompt "Koudmen" (the term is a shortened version of the French phrase *coup de main*). Koudmen refers to one who gives labor freely to others with no expectation of receiving work in the future. It is a tradition widely acknowledged by Dominicans (Ehret 1995).

Interrater reliability on men's reputations was evaluated through Cronbach's α (Vogt 2005). Although conventions vary in the social sciences, most authors agree that reliability coefficients greater than 0.7 indicate that raters agree on the construct of interest. A high reliability coefficient was achieved for male altruism reputations (Cronbach's $\alpha = 0.79$; $N = 53$). Reputation scores were then averaged across the five raters (mean = 0.6 ± 0.3; median = 0.8).

Results

Reciprocity hypothesis 1: a positive relationship exists between labor given and labor received. Contingent reciprocity predicts that labor given should result in some positive, nonzero amount of labor to be received in the future. All reciprocity data violate the assumption of independence of errors, because data units are structurally autocorrelated. Therefore, a multilevel model is required for statistical hypothesis testing (Rabe-Hesketh and Skrondal 2008). For the bay oil labor exchange data, labor received took the form of a Poisson distribution, necessitating the use of a multilevel Poisson modeling procedure (implemented with Stata, ver. 10). When the effects of the individual who provided labor (i.e., autocorrelated data, hereafter the "laborer") and the dyad (i.e., autocorrelated data, hereafter the "dyad") are modeled, labor given has a positive, significant relationship with labor received (Wald $\chi^2 = 6.0$; $P = .01$; $N = 288$; log likelihood = −413.6; labor given: $B = 0.1 \pm 0.05$; $P = .01$; constant: $B = -0.3 \pm 0.1$; $P = .03$; fig. 1). Although days of labor given predicts days of labor received, only 28% of all dyads reciprocated labor contingently, suggesting that contingent reciprocity cannot be the sole mechanism. Perhaps assortment mechanisms affect contingent reciprocity.

Reciprocity hypothesis 2: naturally occurring assortment mechanisms facilitate contingent reciprocity. Contingent reciprocity predicts that assortment mechanisms, such as spatial proximity, genetic kinship, or lineage membership, should facilitate labor exchange. Spatial structure and patrilineal membership were operationalized as dummy-coded presence/absence variables (living proximity: 1 = dyad live in the same hamlet, 0 = dyad do not live in same hamlet; lineage membership: 1 = dyad are members of the same patrilineage, 0 = dyad not members of the same patrilineage). When the effects of laborer and dyad are modeled, the model as a whole is significant (Wald $\chi^2 = 20.3$; $P = .0004$; $N = 244$; log likelihood = −346); living proximity predicts days of labor received, while labor given, genetic kinship, and patrilineal membership do not (table 2). Under the "larger-is-better" information criterion, it appears that the second model has greater parsimony, suggesting that the mechanism of contingent reciprocity, biased by kinship, is not operating.

Competitive-altruism hypothesis 1: labor given predicts altruistic reputation. Competitive altruism suggests that when individuals differ in ability, reputations can emerge. Thus, the more people a man assists, the better his reputation. The number of CFADs a man assisted predicted his altruistic reputation ($r^2 = 0.31$; $\beta = 0.5$; $N = 53$; $P < .0001$; fig. 2).

Competitive-altruism hypothesis 2: altruistic reputations predict group size. Competitive altruism predicts that when people differ in altruistic ability and actors can use other's level of altruism as a choice criterion, people will prefer high-quality altruists for interactions. To operationalize this, the group size formed around a CFAD to distill bay oil must be examined. However, when a CFAD distills more than a single batch of bay oil, group sizes vary around that individual. To account for data autocorrelation related to a CFAD, a multilevel linear model using CFAD as the random component was implemented. Altruistic reputations predicted group size (Wald $\chi^2 = 14.8$; $P < .001$; $N = 195$; log likelihood = −305; table 3; fig. 3).

Competitive-altruism hypothesis 3: group size predicts the

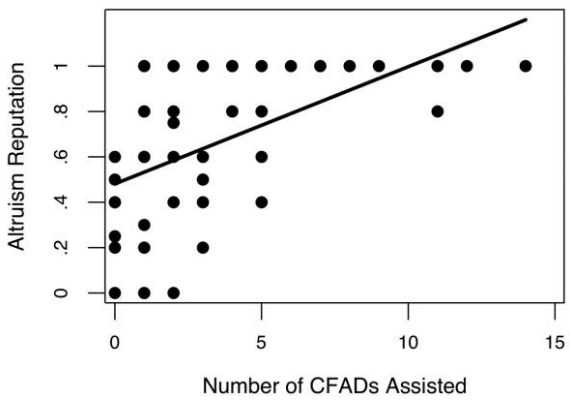

Figure 2. Relationship between number of chiefs-for-a-day (CFADs) a man assisted and his altruism reputation.

Table 3. Multilevel Poisson regression model predicting group size

	B (SE)	*z*	*P*
Constant	2.1 (.3)	7.3	<.001
Altruistic reputation	1.4 (.4)	3.9	<.001

number of days given to a CFAD. A necessary condition for competitive altruism is that individuals compete through generosity. To analyze this relationship, the maximum group size associated with each dyad was determined (group sizes vary around a CFAD if he distills multiple batches of bay oil; if the same helper assists the CFAD multiple times, then group sizes vary around each dyad). Larger group sizes should result in greater competition and induce a bargaining war. Thus, the larger the group, the more labor others should offer a CFAD. Controlling for the effects of laborer and dyad, a multilevel Poisson regression model shows that maximum group size predicts days of labor given to a CFAD (Wald $\chi^2 = 3.8$; $P = .05$; $N = 288$; log likelihood $= -403$; table 4).

Competitive-altruism hypothesis 4: a higher number of days of labor given to a CFAD or the laborer's altruism reputation increases the likelihood that a CFAD chooses that man as a reciprocal partner. Competitive altruism requires that high-quality altruists achieve a greater number of reciprocal partnerships; otherwise, altruism has no saliency and should disappear from the population. Reciprocal partnership was measured as a dummy-coded contingency variable (dyad reciprocated labor contingently $= 1$, dyad did not reciprocate labor contingently $= 0$). A multilevel logistic-regression model, with CFAD and dyad as the random components, shows that days of labor given (Wald $\chi^2 = 3.9$; log likelihood $= -140$; odds ratio $= 6.0 \pm 5.2$; $z = 2.0$; $P = .05$; $N = 288$), but not altruistic reputation (Wald $\chi^2 = 0.01$; log likelihood $= -139$; odds ratio $= 0.3 \pm 1.1$; $z = -0.3$; $P = .7$; $N = 228$), predicts who a CFAD chooses for reciprocal labor exchange.

Competitive-altruism hypothesis 5: men with better altruistic reputations will form more partnerships overall. Competitive altruism suggests that people desire high-quality altruists as partners and that therefore high-quality altruists have disproportionate opportunity to form relationships. A positive relationship existed between altruistic reputation and the number of same-sex reciprocal partnerships formed (Poisson regression: Wald $\chi^2 = 7.0$; $B = 1.3 \pm 0.5$ [robust standard errors]; $P = .008$; $N = 37$; fig. 4); however, reputation did not predict association with a conjugal partner (logistic regression: pseudo-$r^2 = 0.005$; $P = .6$; $N = 53$).

Discussion and Conclusion

This research sought to identify the mechanism responsible for labor exchange and to explain group size variation. On the basis of data from 10 months of bay oil distillation in a Dominican village, competitive altruism explains variation in labor exchange relationships and group size better than do contingent reciprocity and kinship. If contingent reciprocity explained labor exchange, then any labor given to another should result in some positive amount of labor to be received in the future; however, only 28% of all dyads reciprocated labor contingently. Labor exchange is reciprocal to the extent that a norm for reciprocity is present, men seek reciprocal partnerships, and some reciprocal partnerships occur. Biologic-market theory and competitive altruism explain why some form reciprocal partnerships but others do not.

Variation in cooperative abilities exists in Bwa Mawego. Some men offer large quantities of labor to others, while others offer little to none. This variability causes altruistic reputations to become salient, and individuals are recognized along this dimension. Individuals with better reputations are more desirable, and as such they form larger audiences when they distill bay oil. Once an audience is present, a CFAD must choose with whom to reciprocate labor. Biologic-market theory suggests that CFADs should choose individual(s) who offer better prices; however, the level of competition in the market determines price. Larger groups induce greater competition and therefore higher prices. CFADs forming larger groups receive greater amounts of labor per person, suggesting that males calibrate the amount of labor given to a CFAD on the basis of its signaling value. Competitive altruism requires that high-quality individuals be favored for reciprocal partnerships. In Bwa Mawego, CFADs prefer individuals who provide more days of labor for partnership formation but not individuals with the best reputations. Actions are more salient than reputations for the purposes of partner choice in this village. Furthermore, living proximity affects the amount of labor one receives, suggesting that individuals prefer to labor for others they are likely to interact with on a regular basis. The biologic market for altruists in Bwa Mawego, in conjunction with living proximity, acts as a filtering mechanism, allowing assortment of individuals and the emergence of contingent reciprocity, but only for a subset of all dyads. This is consistent with formal models demonstrating that spatial structure acts as an assortment mechanism (Nowak 2006;

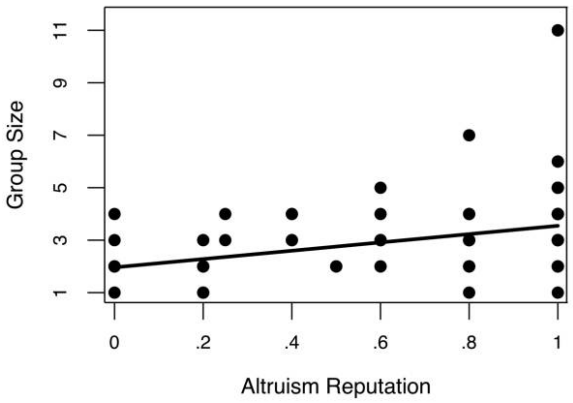

Figure 3. Relationship between altruistic reputation and group size.

Ohtsuki et al. 2006) and ethnographic descriptions that suggest that smallholders strategically pool risk across proximity-based labor networks (Horowitz 1967).

Neither genetic nor social kinship predicted labor exchange in Bwa Mawego. The lack of a relationship between genetic kinship, social kinship, and labor exchange is consistent with most ethnographic descriptions (Erasmus 1955) and makes sense in light of Afro-Caribbean male socioecology. Bwa Mawego is a matrifocal community where resource scarcity causes male-male competition within households (Quinlan 2006), leading males to seek relationships with men who reside outside the household (Macfarlan 2010) or patrilineage. However, different socioecologies may affect the costs and benefits associated with cooperation in unique ways, causing kinship to be an important determinant for labor exchange in some communities (e.g., Berte 1988; Hames 1987) but not others (e.g., Hawkes 1983).

Finally, competitive altruism predicts that high-quality individuals obtain more same- and/or between-sex partnerships. In Bwa Mawego, individuals with better altruistic reputations form more same-sex reciprocal partnerships but not more conjugal partnerships, suggesting that male altruism may be intra- (not inter-)sexually selected.

This study has several limitations. Any research relying on "snapshots" of daily life misses contingent relationships that straddle the tail ends of the data collection time frame; this study is no different. In addition, an underlying assumption of the data collection protocol is that contingent reciprocity in labor exchange occurs "in kind." It is the case that men in Bwa Mawego exchange labor for other services. Examples include using one's chain saw to cut wood in lieu of exchanging labor in a distillery and exchanging labor in bay farm fields for labor in distilleries. Although the inclusion of such data would increase the likelihood of detecting within-community contingent reciprocity, the weight of evidence supporting labor exchange as a form of competitive altruism is overwhelming, as individuals vary in ability and others use this information when choosing partners.

This research does not suggest that all labor exchange is based on a biologic market for altruists. However, anytime labor exchange involves individuals who differ in altruistic ability and others use this as a choice criterion for reciprocal partnership formation, then competitive altruism will likely operate.

Table 4. Multilevel linear regression model predicting days of labor given to chiefs-for-a-day

	B (SE)	*z*	*P*
Constant	−.3 (.2)	−1.9	.05
Maximum group size	.08 (.04)	2.0	.05

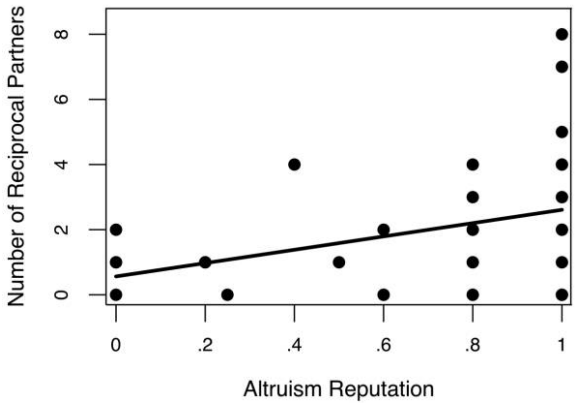

Figure 4. Relationship between altruistic reputation and the number of contingently reciprocal partnerships formed.

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References Cited

Alexander, Richard D. 1987. *The evolution of moral systems*. New York: Aldine de Gruyter.

Allen-Arave, Wesley, and Michael Gurven. 2008. Reciprocal altruism, rather than kin selection, maintains nepotistic food transfer on an Ache reservation. *Evolution and Human Behavior* 29(5):305–318.

Alvard, Michael. 2003. Kinship, lineage, and an evolutionary perspective on cooperative hunting groups in Indonesia. *Human Nature* 14(2):129–163.

Apesteguia, Jose, and Frank P. Maier-Rigaud. 2006. The role of rivalry: public goods versus common-pool resources. *Journal of Conflict Resolution* 50(5):646–663.

Axelrod, Robert, and W. D. Hamilton. 1981. The evolution of cooperation. *Science* 211(4489):1390–1396.

Barclay, Pat, and Robb Willer. 2007. Partner choice creates competitive altruism in humans. *Proceedings of the Royal Society B: Biological Sciences* 274(1610):749–753.

Berte, Nancy. 1988. K'ekchi' horticultural labor exchange: productive and reproductive implications. In *Human reproductive behavior: a Darwinian perspective*. Laura Betzig, Monique Borgerhoff Mulder, and Paul W. Turke, eds. Pp. 23–33. Avon: Cambridge University Press.

Boyd, Robert. 1990. The evolution of reciprocity when conditions vary. In *Coalitions and alliances in humans and other animals*. Alexander H. Harcourt and Frans B. M. de Waal, eds. Pp. 473–489. New York: Oxford University Press.

Boyd, Robert, and Peter J. Richerson. 1988. The evolution of reciprocity in sizable groups. *Journal of Theoretical Biology* 132(3): 337–356.

Decker, Seamus A., and Mark V. Flinn. 2011. Parenting styles and gender-linked drinking behaviors in Dominica. *Ethos* 39(2):189–210.

Ehret, Pierre. 1995. *Farm profiles in Dominica: a typology of operating systems*. Roseau, Dominica: Republique Française (Mission Fran-

çaise de Cooperation) and Commonwealth of Dominica (Ministry of Agriculture).

Erasmus, Charles J. 1955. *Reciprocal labor: a study of its occurrence and disappearance among farming peoples in Latin America.* PhD dissertation. University of California, Berkeley.

———. 1956. Culture structure and process: the occurrence and disappearance of reciprocal farm labor. *Southwestern Journal of Anthropology* 12(4):444–469.

Fishman, Michael A., Arnon Lotem, and Lewis Stone. 2001. Heterogeneity stabilizes reciprocal altruism interactions. *Journal of Theoretical Biology* 209(1):87–95.

Fu, Feng, Christoph Hauert, Martin A. Nowak, and Long Wang. 2008. Reputation-based partner choice promotes cooperation in social networks. *Physical Review E* 78(2):1–8.

Geschiere, Peter. 1995. Working groups or wage labour? cash-crops, reciprocity and money among the Maka of southeastern Cameroon. *Development and Change* 26(3):503–523.

Gilligan, Daniel O. 2004. *The economics of agricultural labor exchange with evidence from Indonesia.* PhD dissertation, University of Maryland, College Park.

Gintis, Herbert, Eric A. Smith, and Samuel Bowles. 2001. Costly signaling and cooperation. *Journal of Theoretical Biology* 213(1): 103–119.

Guillet, David. 1980. Reciprocal labor and peripheral capitalism in the central Andes. *Ethnology* 19(2):151–167.

Gurven, Michael. 2006. The evolution of contingent cooperation. *Current Anthropology* 47(1):185–192.

Hames, Raymond. 1987. Garden labor exchange among the Ye'kwana. *Ethology and Sociobiology* 8(4):259–284.

Hames, Raymond, and Carl McCabe. 2007. Meal sharing among the Ye'kwana. *Human Nature* 18(1):1–21.

Hardy, Charlie L., and Mark Van Vugt. 2006. Nice guys finish first: the competitive altruism hypothesis. *Personality and Social Psychology Bulletin* 32(10):1402–1413.

Hawkes, Kristen. 1983. Kin selection and culture. *American Ethnologist* 10(2):345–363.

Honychurch, Penelope N. 1986. *Caribbean wild plants and their uses.* Oxford: Macmillan-Caribbean.

Horowitz, Michael M. 1967. *Morne-Paysan: peasant village in Martinique.* New York: Holt, Reinhart, & Winston.

International Fund for Agricultural Development. 2010. *Rural poverty report: 2011.* http://www.ifad.org/rpr2011/ (accessed January 1, 2011).

Kaplan, Hilliard, and Michael Gurven. 2005. The natural history of human food sharing and cooperation: a review and a new multi-individual approach to the negotiation of norms. In *Foundations of social reciprocity.* Herbert Gintis, Samuel Bowles, Robert Boyd, and Ernst Fehr, eds. Pp 75–113. Cambridge, MA: MIT Press.

Leimar, Olof. 1997. Reciprocity and communication of partner quality. *Proceedings of the Royal Society B: Biological Sciences* 264(1385): 1209–1215.

Leimar, Olof, and Peter Hammerstein. 2001. Evolution of cooperation through indirect reciprocity. *Proceedings of the Royal Society B: Biological Sciences* 268(1468):745–753.

Lotem, Arnon, Michael A. Fishman, and Lewis Stone. 2003. From reciprocity to unconditional altruism through signaling benefits. *Proceedings of the Royal Society B: Biological Sciences* 279(1511): 199–205.

Macfarlan, Shane J. 2010. *The logic of labor exchange in a Dominican village: competitive altruism, biologic markets, and the nexus of male social relationships.* PhD dissertation, Washington State University, Pullman.

Macfarlan, Shane J., and Robert Q. Quinlan. 2008. Kinship, family, and gender effects in the ultimatum game. *Human Nature* 19(3): 294–309.

McNamara, John M., Zoltan Barta, Lutz Fromhage, and Alasdair L. Houston. 2008. The coevolution of choosiness and cooperation. *Nature* 451(7175):189–192.

Moore, M. P. 1975. Co-operative labour in peasant agriculture. *Journal of Peasant Studies* 2(3):270–291.

Morgan, Charles J. 1979. Eskimo hunting groups, social kinship, and the possibility of kin selection in humans. *Ethology and Sociobiology* 1(1):83–86.

Nesse, Randolph M. 2007. Runaway social selection for displays of partner value and altruism. *Biological Theory* 2(2):143–155.

Noë, Ronald, and Peter Hammerstein. 1994. Biological markets: supply and demand determine the effect of partner choice in cooperation, mutualism, and mating. *Behavioral Ecology and Sociobiology* 35(1):1–11.

———. 1995. Biological markets. *Trends in Ecology & Evolution* 10(8):336–339.

Nowak, Martin A. 2006. Five rules for the evolution of cooperation. *Science* 314(5805):1560–1563.

Nowak, Martin A., and Karl Sigmund. 1998. Evolution of indirect reciprocity by image scoring. *Nature* 393(6685):573–577.

Ohtsuki, Hisashi, Christoph Hauert, Erez Lieberman, and Martin A. Nowak. 2006. A simple rule for the evolution of cooperation on graphs and social networks. *Nature* 441(7092):502–505.

Panchanathan, Karthik, and Robert Boyd. 2004. Indirect reciprocity can stabilize cooperation without the second-order free rider problem. *Nature* 432(7016):499–502.

Provinse, John H. 1937. Cooperative ricefield cultivation among the Siang Dyaks of central Borneo. *American Anthropologist* 39(1):77–102.

Quinlan, Marsha B. 2004. *From the bush: the front line of health care in a Caribbean village.* Belmont, CA: Wadsworth.

Quinlan, Robert. 2005. Kinship, gender, and migration from a rural Caribbean community. *Migration Letters* 2(1):2–12.

———. 2006. Gender and risk in a matrifocal Caribbean community: a view from behavioral ecology. *American Anthropologist* 106(3): 464–479.

Quinlan, Robert, and Mark V. Flinn. 2005. Kinship, sex, and fitness in a Caribbean community. *Human Nature* 16(1):32–57.

Quinlan, Robert, and Edward H. Hagen. 2008. New genealogy: it's not just for kinship anymore. *Field Methods* 20(2):129–154.

Quinlan, Robert J., Marsha B. Quinlan, and Mark V. Flinn. 2005. Local resource enhancement and sex-biased breastfeeding in a Caribbean community. *Current Anthropology* 46(3):471–480.

Rabe-Hesketh, Sophia, and Anders Skrondal. 2008. *Multilevel and longitudinal modeling using Stata.* 2nd ed. College Station, TX: Stata.

Roberts, Gilbert. 1998. Competitive altruism: from reciprocity to the handicap principle. *Proceedings of the Royal Society B: Biological Sciences* 265(1394):427–431.

Sherratt, Thomas N., and Gilbert Roberts. 2001. The importance of phenotypic defectors in stabilizing reciprocal altruism. *Behavioral Ecology* 12(3):313–317.

Smith, Raymond T. 1996. The *matrifocal family: power, pluralism, and politics.* New York: Routledge.

Trawick, Paul B. 2003. *The struggle for water in Peru: comedy and tragedy in the Andean commons.* Stanford, CA: Stanford University Press.

Trivers, Robert L. 1971. The evolution of reciprocal altruism. *Quarterly Review of Biology* 46(1):35–57.

Vogt, W. Paul. 2005. *Dictionary of statistics and methodology: a nontechnical guide for the social sciences.* 3rd edition. Thousand Oaks, CA: Sage.

Winterhalder, Bruce. 1996. A marginal model of tolerated theft. *Ethology and Sociobiology* 17(1):37–53.

Zahavi, Amotz. 1995. Altruism as a handicap: the limitation of kin selection and reciprocity. *Journal of Avian Biology* 26(1):1–3.