Hunter-gatherers maintain assortativity in cooperation despite high-levels of residential change and mixing

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Abstract

Widespread cooperation is a defining feature of human societies from hunter-gatherer bands to nation states. But explaining its evolution remains a challenge. While positive assortment – of cooperators with cooperators – is recognized as a basic requirement for the evolution of cooperation,[1,2] the mechanisms governing assortment are debated. Moreover, the social structure of modern hunter-gatherers, characterized by high mobility, residential mixing and low genetic relatedness, undermine assortment and add to the puzzle of how cooperation evolved.[3] Here, we analyze four years of data (2010, 2013, 2014, 2016) tracking residence and levels of cooperation elicited from a public goods game (PG), in Hadza hunter-gatherers of Tanzania. Data were collected from 56 camps, comprising 383 unique individuals, 137 of whom we have data for two or more years. Despite significant residential mixing, we observe a robust pattern of assortment necessary for cooperation to evolve: In every year, Hadza camps exhibit high between-camp and low within-camp variation in cooperation. We further consider the role of homophily in generating this assortment. We find little evidence that cooperative behavior within individuals is stable over time or that similarity in cooperation between dyads predicts their future cohabitation. Both sets of findings are inconsistent with homophilic models that assume stable cooperative and selfish types (e.g. partner choice). Consistent with social norms, culture and reciprocity theories, the data suggest that the strongest predictor of an individual's level of cooperation in any given year is the mean cooperation of their campmates in that year. These findings underscore the adaptive nature of human cooperation – particularly its responsiveness to social contexts – as a feature important in generating the assortment necessary for cooperation to evolve.

Keywords: evolution of cooperation, homophily, partner choice, social influence, social norms, hunter-gatherers

The scope and scale by which we help one another, including cooperative acts with those who bear no genetic relation to us, is considered a hallmark of being human. And yet, this emblematic feature of our humanity has challenged scientific thinking.[4–6] How can natural selection favor costly cooperation in the face of possible exploitation by defectors? Biologists have proposed multiple theoretical models to explain cooperation, but there is little evidence on what theories actually explain human behavior in evolutionarily-relevant settings. To understand this, we analyze data on cooperation and migration patterns in a hunter-gatherer population over a six-year period. Crucially, the data contain detailed information about how individual cooperative behavior persists, and how cooperators sort across time and space – vital elements that tease apart the most prominent theoretical models. And the presence of positive assortment of cooperators in space is a fundamental requirement of these models.[1,2]

Current hunter-gatherers live in dynamic fission-fusion societies with substantial inter-group mixing and consequently, low within-group relatedness.[7] This mobility poses a challenge to assortment. Common descent, where individuals preferentially interact with kin,[8] and reciprocity, where individuals limit their cooperation to known reciprocators[9] can generate assortment, but social mobility undermines it by 1) decreasing relatedness among group members and 2) allowing cooperative groups to be invaded by free-riders or "rovers".[3,10] As such, these classic models fall short in explaining how cooperation evolved in early humans under these presumed social dynamics.

For this reason, three additional classes of theoretical models explaining cooperation and assortment have been emphasized. In models of biological markets involving partner choice, individuals compete for the most cooperative partners and the most cooperative choose each other.[11] In models involving conditional strategies that respond to group-level behaviors, such as generalized reciprocity[12] and/or the switching of groups,[13] cooperation can stabilize when the groups are small.[12] In models of gene-culture co-evolution, culturally evolving social norms, supported by an underlying norm-psychology, can generate within-group similarity and between-group differences in cooperation.[14]

While nearly all models involve some degree of behavioral flexibility such that an individual's level of cooperation is contingent on the social environment, partner choice models assume that individuals have stable traits, often genetically determined, on which the choice of partners is based.[13,15–17] In these models, individuals can leave current partners or reject prospective partners based on their observations and past interactions. The real-world applications of these models hinge on the existence of trait-like differences in cooperativeness. Yet, few studies have examined longitudinal stability in cooperativeness in humans,[18,19] and none have examined it in natural settings between members of existing social groups who know each other well.

To tease apart these existing theories, we study cooperation in an extant hunter-gatherer population – the Hadza of Tanzania – who provide an important test case for evolutionary models of cooperation. Their daily life is marked by widespread sharing of food, labor, and childcare and their lifeways more closely approximate pre-Neolithic populations compared to samples drawn from Western Educated Industrialized Rich and Democratic (WEIRD) societies.[20]

We collected data on cooperation and residence patterns over a six-year period (2010, 2013, 2014 and 2016). To capture the conflict between individual and group benefits we used a PG game. We chose to use an experimental game to maximize comparability across camps and years. The PG game was chosen because it is directly germane to hunter-gatherer life, where collective action problems are faced daily. Games were played using an ecologically valid food item – sticks of honey. Honey is collected, shared and deemed a favorite food of the Hadza.[21] Subjects could contribute 0-4 honey sticks to the PG, and all subjects split the sum of contributions multiplied by 3. Each subject's contribution is a measure of her cooperativeness. Games were played between all adults of the same residence groups, herein called "camps". Basic demographic information and GPS locations were recorded (see Supplementary Information S1 for descriptive statistics). Figure 1 shows the location and mean levels of cooperation of camps in each year.

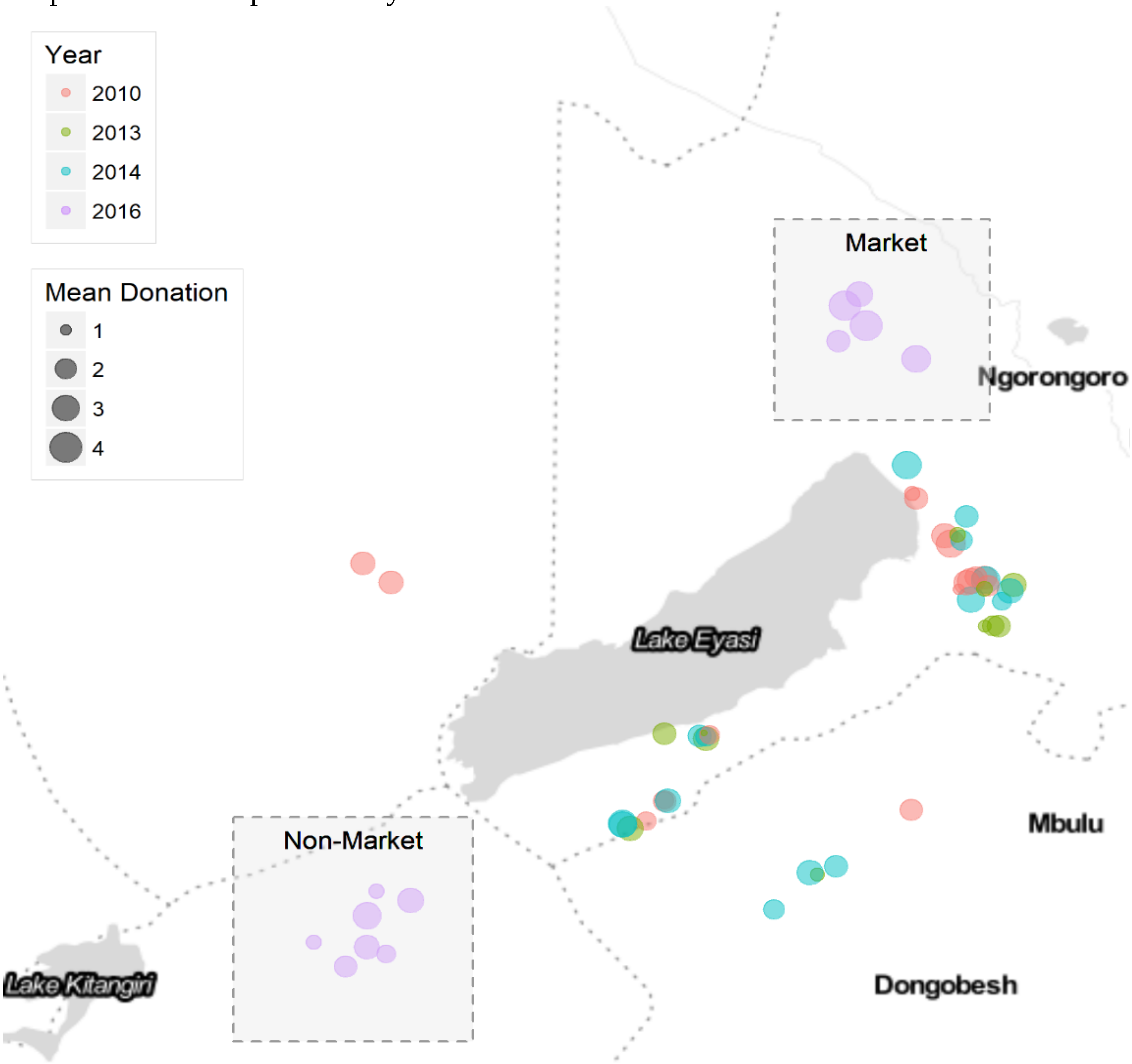

Figure 1. Map of the Hadza camps visited around Lake Eyasi in northern Tanzania. Circles represent the camps visited colored by year of data collection. The size of the point signifies the mean PG contribution in the camp. GPS data are not available in 2016 due to missing equipment. The camps in 2016 are grouped by whether they were located in the market vs non-market region but their placement, is otherwise, random.

We first tested if individuals' PG game contributions clustered within camps each year. We compared the observed variance in PG game contributions with variance from 1,000 simulations. The simulations randomized participants and their contribution to different camps, but kept the population structure fixed.[22] We then measured for each simulation and the actual data the mean variance in PG contributions between participants within each camp (within-camp variance) and the variance in mean camp PG contributions across all camps (between-camp variance). In each year, less variance was observed within-camps and more variance was observed between-camps than expected in a random population ($p < 0.05$, Fig. 2). The 2010 results have been previously reported.[22] Also, in each year the results remained significant after controlling for degree of market exposure, $p < 0.05$ (see Supplementary Fig. S3.4), which was a significant predictor of contributions (see Supplementary Table S3.1), with camps located in market regions donating more. Similar effects of market integration on cooperation have been reported for other societies.[23] The long-term data presented here suggest that assortment is a consistent feature of hunter-gatherer life, year after year.

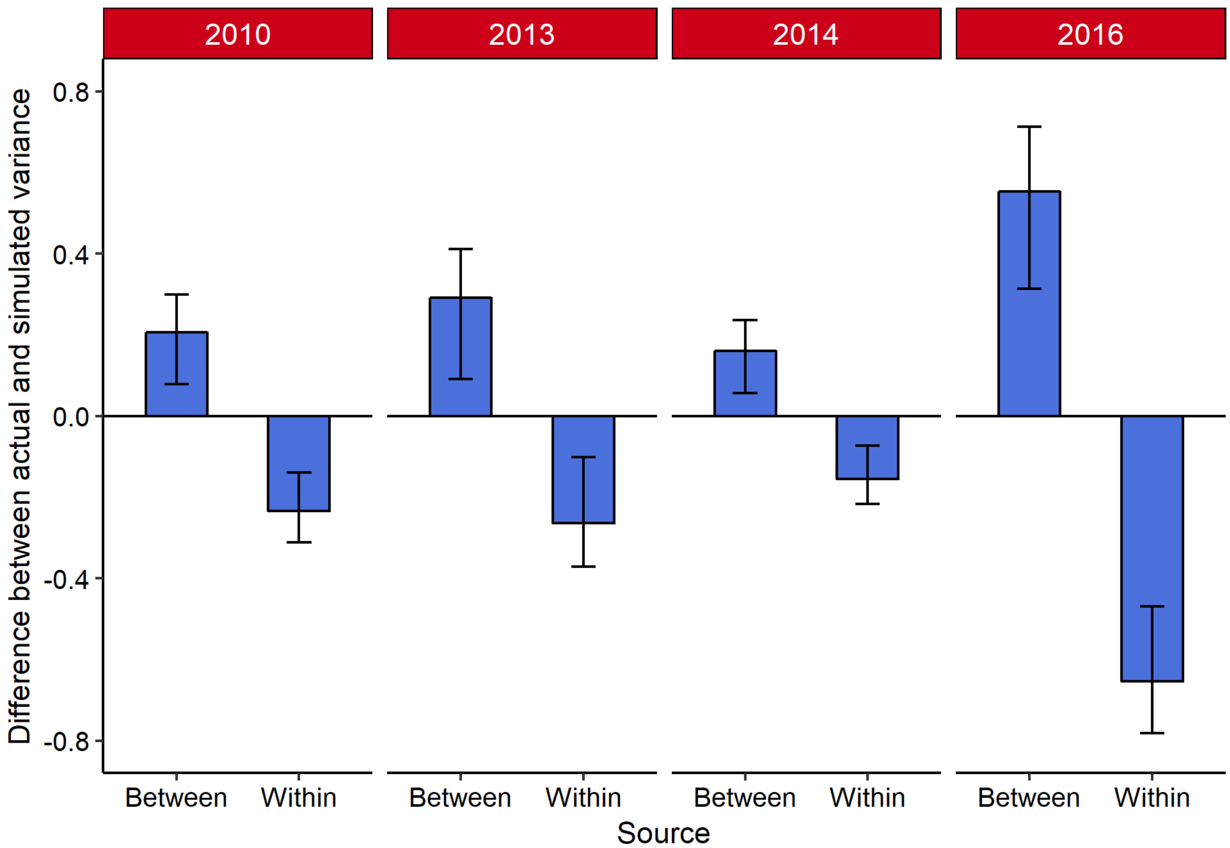

Figure 2. Difference between actual and simulated variance within and between residence camps in PG contributions. Error bars are 95% confidence intervals.

This observed clustering of cooperators across space meets a fundamental requirement in all theories of the evolution of cooperation: it ensures that cooperators receive benefits from other cooperators whilst remaining insulated from defectors.[1] The findings also underscore the potential for cooperation to evolve due to selection acting on groups, which occurs when between-group variance is high relative to the within-group variance, as demonstrated in several models.[24,25]

The observed assortment on cooperation in Hadza society is remarkable because the Hadza, like other hunter-gatherers, have flexible living arrangements and high rates of migration.[7,26] Consistent with earlier reports, we too observe high rates of residential mixing in our data (Fig. 3). We calculated for each person the proportion of repeated campmates by summing the number of individuals a person lived with at times t and $t + 1$ and dividing by the total unique number of people that that individual lived with in times t and $t + 1$. Across the three intervals, the mean proportion of repeated campmates was 12.1%. Year after year, resident composition in the Hadza changes dramatically but despite this, we still see cooperators living with each other.

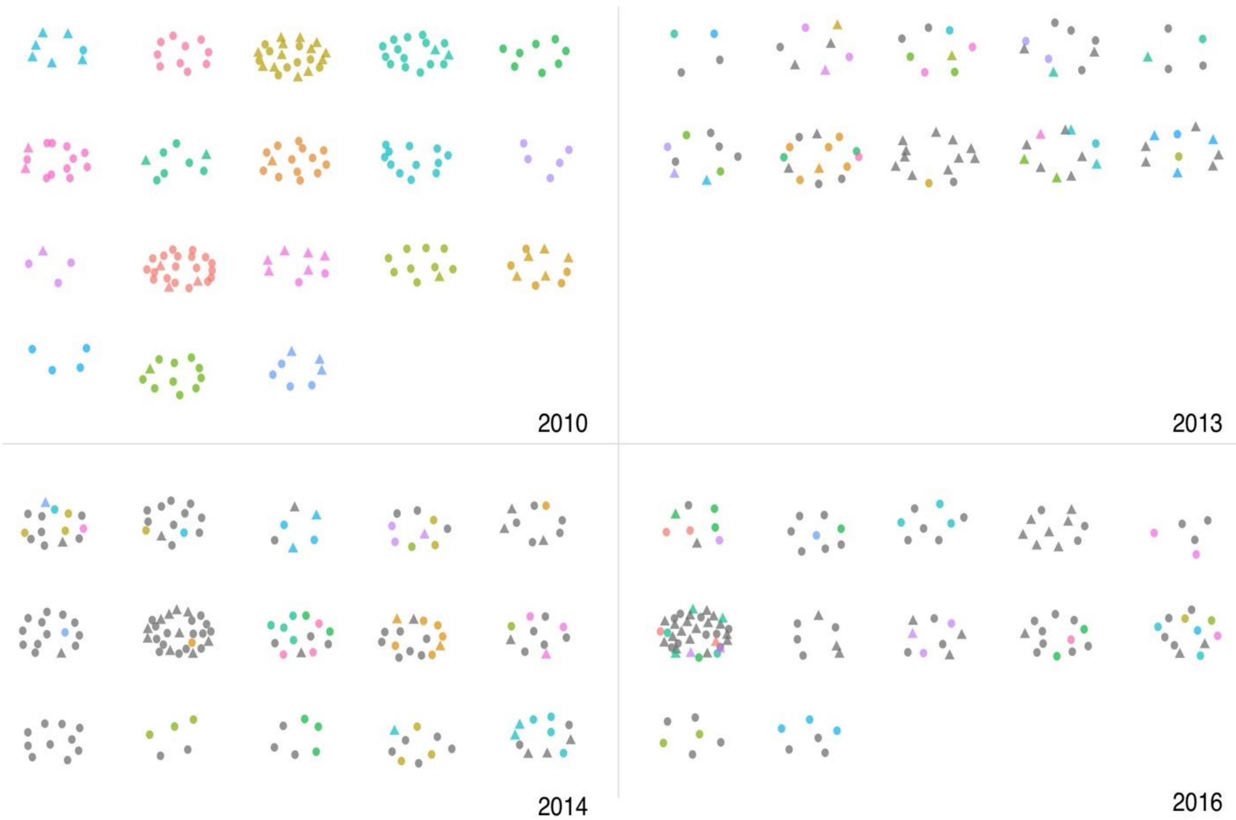

Figure 3. Camp residence, mixing and cooperative clustering across years. Points represent individuals grouped in space by their current camp. In 2010, individuals are colored based on current camp membership. In 2013, 2014, and 2016, individuals are colored based on camp membership in the prior wave of data collection; gray points indicate the individual was absent in the prior wave. Circles represent high cooperators (individuals who gave two or more honey sticks) and triangles represent low cooperators (individuals who gave less than two honey sticks). Camps are randomly placed in a grid.

While assortment provides an overall solution to the problem of altruism, the mechanisms responsible for real-world assortment remain unknown. One mechanism we explore is homophily on which models of partner choice are based. These models assume that individuals have a stable, often genetically determined, level of cooperation and individuals choose and reject partners based on this tendency.[15–17] Under these models then, we should expect Hadza individuals to exhibit stable cooperative behavior. Moreover, we should observe that individuals with similar levels of cooperation in a prior year will be more likely to live together in the next year. We do not observe either of these patterns in the current data.

We first examined whether individuals' PG contributions were related across years (Fig. 4). Specifically, we examined whether current and past contributions were correlated for individuals in contiguous samples (n = 143 observations) by regressing PG contributions at time t on contributions at time $t - 1$ controlling for year with robust standard errors clustered on individuals. There was no relationship between individuals' current and previous contributions, b = 0.00, 95% CI [-0.17, 0.18], t (139) = 0.05, p = 0.959; this remains nonsignificant even controlling for demographic variables and exposure to markets (see Supplementary Information S3.6 for robustness checks).

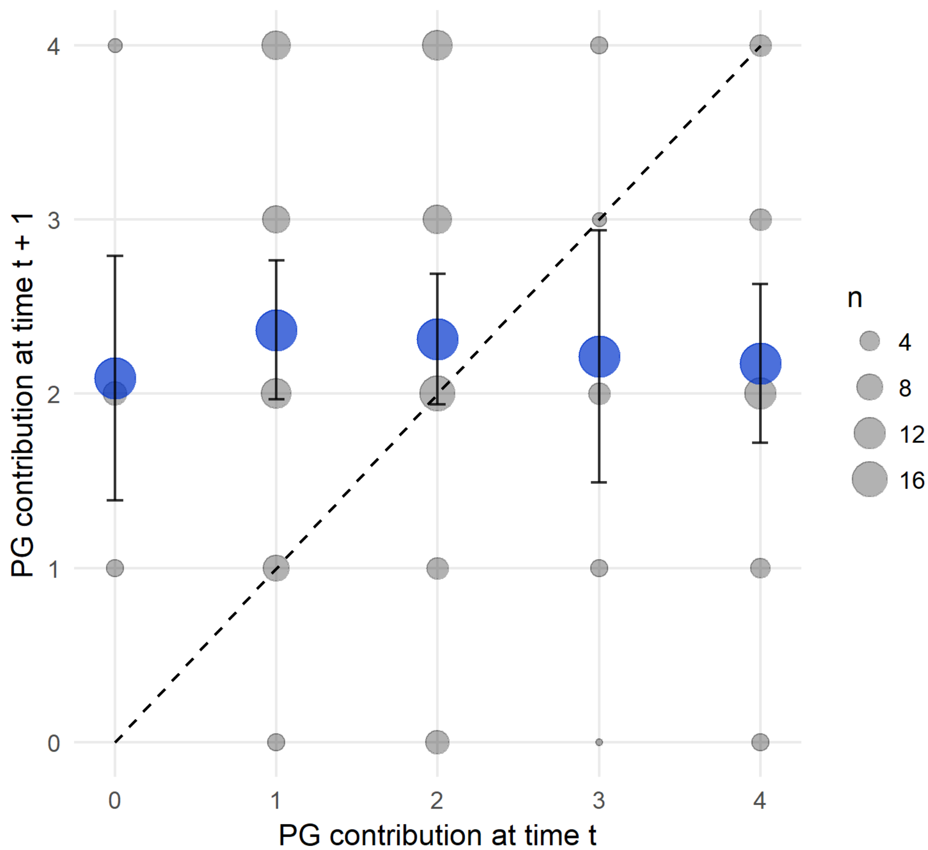

Figure 4. The graph plots current yearly contributions on the x-axis by contributions made in the next consecutive year on the y-axis. The unit of analysis is a participant year. Gray circles' size is proportional to the count of individuals. Blue circles represent the average of the contribution in the following year as a function of the contribution in the current year. Bars represent 95% CI. The 45-degree line represents the null hypothesis that people have cooperative types.

Similar to the data presented here, no correlation was found in dictator game play measured two years apart in a small sample (n = 12) of Tsimane' forager-horticulturalists.[27] Both the Hadza and Tsimane' findings contrast with laboratory studies using Western samples illustrating medium-sized correlations in cooperative game play over time.[18, 28] The discrepant results could be due to the longer interval between testing in our study. Also, unlike the laboratory studies, the Hadza are playing the game with different, but familiar, individuals each year. In laboratory settings, individuals are playing within the same anonymous or unfamiliar group setting each year, where little information is known about the other players outside of the experiment. Finally, cultural differences in dispositional consistency may explain the divergent results. Compared to individuals from more collectivist societies, Westerners tend to describe themselves in terms of underlying psychological traits, have a demonstrated stronger preference for self-consistency and are more willing to incur costs to maintain that consistency.[29]

We next tested if similarity in PG contributions in a past year predicted whether Hadza will live together in a future year. We created a dataset for 2010, 2013, and 2014 of every possible dyad in each year, removing dyads if neither individual was present in the next sample. This resulted in 21,086 observations with 18,126 unique dyads across years. Of these observations, 789 (3.9%) of dyads were in the same camp. Using a binary logistic regression, we regressed whether the dyad lived in the same camp at time $t + 1$ on the similarity of PG contributions at time t and whether the dyad lived in the same camp at time t with robust standard errors clustered on the dyads. Individuals who contributed similar amounts were not more likely to live in the same camp in future years, $b = 0.01$, $SE = 0.04$, $OR = 1.01$, $Z = 0.24$, $p = 0.814$, which remained nonsignificant after controlling for demographics variables (see Supplementary Information S3.10).

Partner choice models assume that cooperative individuals are more desirable. One possible manifestation of this is that cooperators retain more of their partners over time. We tested whether individuals with higher PG contributions were more likely to continue living with their campmates in the future. To test this, for 2010, 2013, and 2014, we calculated for each individual who was in the sample at time t and time $t + 1$ the sum of campmates from time t that lived in the same camp as the individual at time $t + 1$ divided by the sum of every unique individual ego lived with in times t and $t + 1$. We regressed PG contributions at time t on the proportion of repeated campmates. Robust standard errors were clustered on the individual and the camp. There was, in fact, a negative, but nonsignificant, relationship. Individuals who contributed more at time t had fewer repeated campmates at time $t + 1$, $b = -0.02$, $SE = 0.01$, $t(141) = -1.91$, $p = 0.059$ (see Supplementary Information S3.13). One possible explanation for this is that individuals who give more than the camp mean are leaving their campmates; however, when we control for the mean contribution of campmates, there is no relationship between an individual's contribution and their proportion of repeated campmates, $b = 0.00$, $SE = 0.01$, $t(140) = -0.04$, $p = 0.971$. A second possible explanation is that individuals living with more primary kin (i.e. siblings, parent-child relationships and spouse) contribute less to the PG (see Supplementary Information S3.7) and also continue living with more of their campmates, because they are kin. To test this, in 2010, for which we have kinship data, we found that the relationship between an individual's PG contribution and number of repeated campmates became weaker after controlling for primary kin, $b = -0.01$, $SE = 0.01$, $t(43) = -1.66$, $p = 0.104$ (see Supplementary Information S3.13). Overall, the data suggest that cooperative Hadza do not retain more campmates.

The results presented thus far suggest that the assortativity observed in cooperation each year is unlikely to be due to partner choice. Also, prior interview data suggest that when given the choice, the Hadza do not choose the most cooperative individuals as their campmates[22]– a finding also incompatible with partner choice models. That said, in laboratory studies using Western samples, participants do display a preference for more cooperative partners.[11,28] It is likely that natural selection favored individuals who selected partners based on the benefits that they could provide to the relationship.[11] Cooperativeness is only one element that governs how much one will give to another person. Wealth and ability to help are other determinants. Since there is a strong norm of sharing of resources within Hadza camps,[18] foraging or hunting ability may be a more important criterion than cooperativeness for selecting one's campmates. Indeed, it is difficult to imagine a world in which inept but obliging partners, would be selected in favor of skillful, but grudgingly cooperative partners.

To explore the role of social context on cooperative behavior we tested whether an ego's contribution can be predicted by the mean contribution of their current campmates, controlling for various demographic variables. First, we calculated for each person a camp mean contribution excluding ego's own contribution. We regressed PG contributions of ego on the mean contribution of other camp members controlling for year with errors clustered on the individual and camp. Corroborating the analyses simulating between and within-camp variation, we find that for each additional honey stick contributed by camp members, ego contributed on average another half-stick of honey, $b = 0.55$, $SE = 0.15$, $t\,(138) = 3.60$, $p < 0.001$. This remained significant when controlling for various demographic variables, market effects, and for the number of primary kin present in the camp (see Supplementary Information, S3.4 - S3.7).

For participants in which we have overlapping data across years, we also examine whether the mean contribution of an ego's current campmates is a better predictor of ego's current contribution, than ego's own past contribution. For each year, we regressed ego's current contribution on the mean contribution of their current campmates and ego's contribution in the previous year with robust standard errors clustered on the individual and camp. For each additional honey stick given by camp members, ego again contributed an additional half-stick of honey, $b = 0.50$, $SE = 0.16$, $t\,(132) = 3.11$, $p = 0.002$. There was still no effect of previous contribution on current contribution, $b = -0.01$, $SE = 0.08$, $t\,(132) = -0.15$, $p = 0.879$. Controlling for demographic effects did not change the results (see Supplementary Information S3.6).

Finally, we find no evidence that prior play or learning effects predicts subsequent contributions. We regressed contributions at time t on the number of previous times the subject participated in the study, controlling for year with errors clustered on the individual. More experience with the game did not affect PG contributions, $b = 0.09$, $SE = 0.08$, $t\,(392) = 1.24$, $p = 0.216$. We also examined whether a participant's experience in a previous game affected her later contributions. That is, we examined whether giving more or less relative to other camp members predicts contributions in subsequent years. We regressed contributions at time t on the difference between ego's contribution and their camp members' mean contribution at time $t - 1$ controlling for year with errors clustered on the individual. Again, previous play relative to other camp members did not predict future year contributions, $b = 0.00$, $SE = 0.09$, $t\,(139) = 0.02$, $p = 0.981$.

In summary, the findings presented here suggest that cooperative behavior in a given year is best predicted by the cooperativeness of one's current social group rather than demographics and past behavior. While we cannot isolate the exact mechanism(s) generating the within-group homogeneity on cooperation, our results are consistent with social learning and reciprocity theories of cooperation. The findings also concur with laboratory experiments demonstrating that cooperative and selfish play in economic games is contagious.[30,31]

By using an economic game as our measure of cooperation, as opposed to measuring naturally occurring levels of cooperation, we traded-off some ecological validly for increased experimental control. This raises the question of how much anonymous "lab-in-the-field" games extrapolate to real behavior. Indeed, cross-cultural data situate the Hadza on the lower end of ultimatum game offers,[32] the lowest end of dictator game offers[23] and the highest end of selfish rule-bending[33] even though cooperation is a fundamental feature of Hadza life. We chose the PG game due to its direct relevance to hunter-gatherer life where collective action problems are a daily occurrence. Remarkably, we observe that across years, the Hadza, on average, contribute 56% of their endowment to the PG. These results provide some reassurance that local institutions are mapping onto game play.

While we attempted to create maximal experimenter control, it is difficult to establish the same degree of control in field settings that are found in the laboratory. Thus, the problem of omitted variable bias is a genuine concern as there may be other influences on cooperation that were unobserved. Future work would benefit from more in-depth examinations into the factors that influence Hadza cooperative decision-making, possibly through the use of interviews.

A third limitation of the study is that we collected data at discrete points far apart in time. As a result, we are limited by how much we can say about the formation and breakdown of camps and how much of a role cooperation plays in it. Indeed, hunter-gatherer residence is determined by multiple and complex demographic, economic, ecological and personal factors – all phenomena outside the purview of the current study.[22,26] Future work examining the role of cooperation in camp formation and dissolution would be an interesting and important avenue of research to pursue with the Hadza.

Studying the conduits of norm establishment and reinforcement in hunter-gatherers may also hold particular promise. For instance, storytelling may be an effective way to teach and establish norms.[34] Recently, it has been documented that among Agta foragers, groups with more skilled storytellers are more cooperative.[34] Moreover, there is a large literature demonstrating how ritual activities, which are thought to enable the expression of shared beliefs and norms, can impact cooperation and fairness.[35] Indeed, Hadza life is replete with important public and private ritualistic activities – including song, dance, meat-eating, storytelling and puberty initiation practices –which are thought to play an important role in cementing relationships and, possibly, promoting cooperation.[26]

Differences in norm enforcement too may help generate differences in cooperativeness[36] between Hadza camps. Across societies, individuals' willingness to engage in costly punishment positively covaries with observed levels of cooperation.[37] Compared to other societies however, the Hadza stand out with their low rates of third-party punishment, though second-party punishment is more frequent.[37] Future work might consider examining third-party punishment in the Hadza within the context of a PG game. In so far that PG games are mapping onto local institutions governing communal sharing, low contributions in the game may be more strongly punished as compared to low offers made in dictator and ultimatum games.

A basic requirement of solutions to the problem of cooperation is the condition of positive phenotypic assortment.[1,2] Yet, data on assortment in real biological systems is scarce and presumed to be incompatible with high levels of mobility and inter-group mixing. Here we show that assortment on cooperation is a characteristic feature of hunter-gatherer life, despite their high-levels of residential mixing. Importantly, the observed assortment in cooperation is not accounted for by demographics, kinship or homophilic interactions based on cooperativeness. Instead, we find that the best predictor of an individuals' level of cooperation is the mean cooperativeness of their current group. The findings are consistent with evolutionary models stressing the importance of contingent reciprocity, cultural learning and social norms[14,38,39] and underscore the remarkable capacity of humans to respond adaptively and quickly to their social environments.

Methods

Study Site

The Hadza are nomadic foragers occupying the Lake Eyasi basin within the Great Rift Valley in Northern Tanzania. They sleep outside under the stars or in makeshift huts constructed of grass and tree branches. Approximately 1,000 individuals identify as Hadza, but only 200-300 individuals obtain the majority of their calories by hunting and gathering. It is this latter group that is the focus of this research.

Men hunt birds and mammals using bows and poison-tipped arrows and collect honey. Women gather plant foods including baobab fruit, berries, and tubers. Food is shared widely within camps, especially big game but producers of the food can channel the food in ways that benefit their kin.[40] Childcare is also shared.[41]

The Hadza live in temporary camps that average about 30 individuals. Camps generally consist of several unrelated nuclear families. Relatedness within camps is low with primary kin comprising, on average, 1.43 and 1.93 of men and women's campmates respectively.[26] Typical of most contemporary hunter-gatherers, residence patterns are fluid and are best described as fission-fusion grouping.[42] Camps can merge or split. Individuals too, can freely relocate to new camps. Every 4-8 weeks entire camps shift location usually in response to resource availability. Because the Hadza have few capital goods and personal possessions, the physical costs associated with moving remain low.

While there is striking diversity among forager societies, it is thought that the social, economic and political arrangements of the Hadza are similar to other hunter-gatherer societies. A study of hunter-gatherer social life using ethnographic data from 437 past and present foraging societies and found that the vast majority of forager societies, including the Hadza, live in small groups, practice central place foraging and food sharing.[42] The Hadza also fall at or near the median value on a variety of key demographic traits such as the percentage of calories contributed to the diet by men and women, infant mortality rate, fertility rate, inter-birth intervals and so on.[42] Thus, apart from the fact the Hadza still maintain a subsistence lifestyle, there is good reason to believe that they are not outliers in other major respects.

Ethno-tourism, which largely began about 10-15 years ago has had the largest impact on Hadza life. And tourists visiting the Hadza continue to rise each year. While tourists can now be found in every region of Hadzaland, the vast majority of visits take place in camps on the north-eastern side of Lake Eyasi, close to the village Mangola, due to its proximity to paved roads that lead to Arusha and safari parks (Fig. 1). Tours usually last a couple of hours and culminate with a cash payment to the camp which then the Hadza can spend in the village.

The Hadza have been described as having little belief in omniscient, moralizing gods[42,33] but they do engage in a number of important rituals including a sacred epeme dance and meat-eating rituals.[42] These rituals are thought to bond participants to one another.[26]

Sample Characteristics

Across years, we visited 56 Hadza camps collecting data from 383 unique individuals. For 137 participants, we have data from at least two years (see Supplementary Information S1.1 for sample sizes for each year). The mean age was similar across the years, ranging from 37 to 40 and women comprised 51%, 42%, 49% and 46% of the sample in 2010, 2013, 2014, and 2016, respectively. Further summary statistics can be found in the supplementary materials (see Supplementary Information S1.2 for descriptive statistics of demographic variables).

Data collection

Data was collected in four separate years – usually during the dry season – over a six-year period (2010, Aug/Sept; 2013, July; 2014, Oct/Nov; 2016, Aug/Sept). Data collection was supervised by different authors in different years: (CLA in 2010, 2013; IM in 2014 and KMS in 2016). In 2014 and 2016 Tanzanian researchers blind to the hypotheses collected the data. In each year, camps were visited using a technique not unlike snowball sampling. After establishing contact with the first camp, Hadza would direct the researchers to the next nearest camp. GPS coordinates were recorded for all camps in each year, with the exception of 2016 when the GPS receiver met an unfortunate end. Nevertheless, we were able to divide the camps in 2016 into market and nonmarket groups based on their proximity to the village (see Fig. 1).

We used a public goods game as our measure of cooperation. This game is directly applicable to hunter-gatherer life where collective action problems are faced by groups on a daily basis. We used a food item instead of money since explanations for the evolution of cooperation have highlighted the importance of food sharing.[43,44] The methods for the PG game elicitation in the Hadza have been described previously[22] and are also fully explained in the Supplementary Information.

Age, marital status, spouse's names and reproductive histories were recorded each year. In 2013 and 2016, we also asked participants about the size of their current household and the estimated their number of years of formal education. In 2010 and 2016, we asked participants to provide the names of their biological parents, which allowed us to identify primary kin (siblingships and parent-child relationships) living together (see Supplementary Information S3.7). In 2013, we also asked participants whether they were concerned with their being enough food for them to eat and the number of days they spent trading in a market (S3.16*)*.

Ethical Permissions

Institutional approvals were obtained prior to conducting this study from the Committee on the Use of Human Subjects at Harvard University, The University of Pennsylvania Institutional Review Board and the Tanzanian Commission for Science and Technology (COSTECH). Verbal informed consent was obtained from all participants due to low literacy rates.

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Author contributions

CLA and KMS contributed to study design and writing. CLA, KMS, TL analyzed the data. CLA, IAM, KMS collected data. All authors commented on drafts of the manuscript.

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SUPPLEMENTARY INFORMATION

Hunter-gatherers maintain assortativity in cooperation despite high-levels of residential change and mixing

Contents (with links)

S1 Sample

Table S1.1 Sample Sizes Within and Across Years

	2010	2013	2014	2016
2010	191	46	69	42
2013		99	57	31
2014			170	40
2016				127

Note. Total number of participants in each year on the diagonal. Other cells indicate number of participants in both years.

Table S1.2 Descriptive Statistics by Year

	2010	2013	2014	2016
Camps	*N* = 18	*N* = 11	*N* = 15	*N* = 12
Hadza in market region	*n* = 106	*n* = 53	*n* = 63	*n* = 37
Females	*n* = 97	*n* = 42	*n* = 84	*n* = 58
Married	*n* = 152	*n* = 76	*n* = 130	*n* = 90
Age in years	37.0 (11.1)	40.0 (12.9)	39.6 (13.4)	37.6 (14.6)
Number of living children	3.1 (2.3)	3.3 (2.4)	3.5 (2.6)	3.2 (2.6)

Note. Mean values are displayed for age and living children. Values in parentheses are standard deviations.

S2 Methods

S2.1 Public goods game

We used a public goods game as our measure of cooperation. This game is directly applicable to hunter-gatherer life where collective action problems are faced by groups on a daily basis. We used a food item instead of money since explanations for the evolution of cooperation have highlighted the importance of food sharing.[1–3] The methods for the PG game elicitation in the Hadza has been described previously.[4]

Cooperation was elicited by examining participants' voluntary contributions in a public goods game played with adult members of their camp. All games were conducted in Swahili and inside a vehicle for privacy. All adults in each camp were invited to participate with the exception of the very elderly and infirm. In 2010, 2013 and 2014 the game was played on the last day the researcher was in camp in order to limit possible discussion. Participants were also told that the game was secret. Since decisions were made in private, any assertions made by participants regarding their decision need not be truthful.

In 2016, the game was played throughout the researcher's stay in the camp. Importantly, we find the same pattern of results.

Participants were endowed with four straws of 100% pure honey (2010, Honeystix, GloryBee foods Inc. 2013, 2014, Honey Stix, Stakich Inc.), a prized food of the Hadza.[5] Each honey stick contains roughly 15 calories. Participants then faced the decision of how to divide their honey sticks into a private account and a public account. Participants were told that the goods would be distributed evenly with all other adult camp members who also played the game. They were instructed that they could keep any amount from 0-4 sticks of the honey or donate them to the public good by inserting them into an opaque cardboard box with an opening at the top. Subjects were told that for every stick of honey they donated, the researcher, would donate an additional 3 sticks of honey to the public pot, and that, after all adult campmates played the game, the honey would be divided equally among them. Participants were also told that they would receive their undonated honey at the same time as the public honey was distributed to avoid confounding generosity with patience. Participants were also told that the game was a secret. Before subjects made their decision, the researcher simulated all their possible choices so that subjects were shown the additional amount of honey added to the box for each decision.

The Hadza have had experience playing various games to measure economic (e.g. endowment effect and risk) and social preferences (e.g. dictator, ultimatum, third-party punishment) with researchers over the last decade.[6–9]

S2.2 Script in English and Swahili

This is the basic script used each year in both English and Swahili.

English:

We are playing a game with honey. This game is voluntary. You do not have to play this game. You will not be punished if you choose not to play. This study is a secret. I will not tell anyone the decision you make. Also, I will not tell you the decision that anyone else makes. All adults living in your camp will have the opportunity to play this game.

This game involves honey (*show them 4 honey sticks*). Inside these sticks is honey to eat. The decisions you make and the decisions other people make will affect how much honey you get and how much honey your other camp members get. You will only receive your share of honey after everyone has had a chance to the play the game. Any honey you receive will be given to you in secret, and nobody will see how much honey you get.
Here are 4 sticks of honey (*hand it to them*). You need to choose how many sticks to keep and how many sticks to put inside this box. You can choose to:

keep all of the sticks of honey
keep 3 of the sticks
keep 2 of the sticks
keep1 stick
keep zero sticks.

No one will know how many sticks you choose to keep. Any honey that you do not keep will be put in this box and shared equally with all the people who played this game, including yourself. For every stick of honey you put in this box, I will add 3 sticks.

If you put in 1 stick, I will add 3 sticks.
If you put in 2 sticks, I will add 6 sticks.
If you put in 3 sticks, I will add 9 sticks.
If you put in 4 sticks, I will add 12 sticks.
If you keep all 4 honey sticks for yourself, I will not add any honey to the box.

If everyone puts honey in the box, then the box will fill up and everyone will get a lot more honey. If no one or only a few people put honey in the box, then there will be very little honey to share.

Swahili:

Tunaenda kucheza mchezo wa asali. Mchezo huu ni hiari. Unaweza kuamua usicheze mchezo huu. Hautaadhibiwa kama utaamua kutocheza. Somo hili ni siri. Sitamwambia mtu yeyote maamuzi utakayofanya. Pia, sitakwambia maamuzi ambayo mwingine amefanya. Watu wazima wote wanaoishi kwenye kambi yako watakuwa na nafasi ya kucheza mchezo huu. Mchezo huu unahusisha asali (waoneshe fimbo 4 za asali). Ndani ya fimbo hizi ni asali unaweza kuila. Maamuzi ambayo unafanya na maamuzi ambayo watu wengine wanafanya yanaathiri jinsi wewe unavyopata asali na watu wengine pia kambini. Utapata tu sehemu yako ya asali baada ya kila mtu kupata nafasi ya kucheza mchezo. Na asali utakayopata utapewa kwa siri na hakuna yeyote atakayeona umepata asali ngapi.

Hizi ni fimbo 4 za asali (mkabidhi). Unatakiwa uchague ni fimbo asali ngapi ubakiwe nazo na asali ngapi uweke ndani ya boksi hili. Unaweza kuchagua:

Kubakiwa na fimbo zote za asali
Kubakiwa na fimbo 3
Kubakiwa na fimbo 2
Kubakiwa na fimbo 1
Kutobakiwa na fimbo, sifuri

Hakuna mtu ambaye atajua umeamua kubakiwa na fimbo ngapi

Na asali yeyote ambayo hutobakiwa nayo itawekwa ndani ya boksi hili na zitagawanywa sawa kwa sawa na kila mtu ambaye amecheza mchezo huu, ukiwemo wewe

Kwa kila fimbo ya asali utakayoweka ndani ya boksi hili, nitaongeza fimbo 3.

Ukiweka fimbo 1, nitaongeza fimbo 3
Ukiweka fimbo 2, nitaongeza fimbo 6
Ukiweka fimbo 3, nitaongeza fimbo 9
Ukiweka fimbo 4, nitaongeza fimbo 12
Kama utabakiwa na fimbo zote 4 za asali kwa ajili yako, sitaongeza asali yeyote ndani ya boksi

Kama kila mtu ataweka asali kwenye boksi, hivyo boksi litajaa na kila mtu atapata asali nyingi sana. Kama hakuna mtu au watu wachache wataweka asali kwenye boksi, kutakuwa na asali kidogo sana za kugawana/shirikiana

S2.3 Controls

Age, marital status, spouse's names and reproductive histories were recorded each year. In 2013 and 2016, we also asked participants about the size of their current household and the estimated number of years of formal education they had. In 2010 and 2016, we asked participants to provide the names of their biological parents, which allowed us to identify primary kin (sibships and parent-child relationships) living together (See S4.7). In 2013, we also asked participants whether they were concerned with their being enough food for them to eat and the number of days they spent trading in a market (*S4.14)*.

S2.4 Data analysis

S2.4.1 Variance in PG contributions

To test if PG contributions clustered within camps, we measured variance between camps and variance within camps in PG contributions. Variance between camps was the variance in camp mean contributions between camps, and variance within camps was the mean variance within each camp between individuals in PG contributions. For each year, we then simulated the population distribution of these values. PG contributions were randomly re-assigned without replacement within the population structure. For each run, the variance between and within camps in PG contributions was saved. The actual variances were compared to the distribution of simulated variances; if the actual variances fell within the extreme tales of the distribution (2.5% or 97.5%) the variances were determined to be significantly different from chance.

S2.4.2 Regression analyses

For regression analyses that did not involve variables from previous years, all observations in 2010, 2013, 2014, and 2016 were used. All models had robust standard errors clustered on the individual. For models that include mean camp PG contribution, we calculated for everyone the mean of other camp members' contribution such that an individual's mean camp PG contribution did not include ego's own contribution. For these analyses, robust standard errors were also clustered on the camp. For regression analyses that involved variables from previous years, observations in 2013, 2014, and 2016 were included only if the individual was in the previous sample year. For these analyses, robust standard errors were clustered on the individual, and if the analysis include mean camp PG contribution, they were clustered on the camp as well.

S3 Extended Results and Robustness Checks

S3.1 Demographic effects on public good contributions

We analyzed the relationship between demographic variables and PG contributions. We regressed contributions on sex, age, relationship status, number of living children, and exposure to market across the years while controlling for sample year. Robust standard errors were clustered on the individual level. The overall model was significant, F (8, 539) = 5.51, $p < 0.001$, adjusted $r^2 = 0.06$. Table S3.2 presents the results for each coefficient. There was a significant difference in contributions across years; contributions in 2013 were less than contributions in 2010, contributions in 2014 were greater than contributions in 2010. There was also an effect of market exposure; Hadza living in the market region contributed more to the public good than Hadza outside of the market region. Similar effects of market integration on cooperation have been reported for other societies.[10] No other demographic effects were significant.

Table S3.2 OLS Regression of PG Contributions on Demographic Variables Across Years

	b (SE)	95% CI	*t*	*p*
2013	-0.56 (0.15)	-0.84 – -0.27	-3.82	< 0.001
2014	0.29 (0.13)	0.03 – 0.54	2.17	0.030
2016	0.05 (0.15)	-0.25 – 0.35	0.32	0.750
Male	0.03 (0.11)	-0.18 – 0.24	0.27	0.785
Age	0.01 (0.005)	0.00 – 0.02	1.87	0.062
Married	-0.03 (0.15)	-0.31 – 0.26	-0.18	0.855
Number of living children	-0.03 (0.02)	-0.08 – 0.02	-1.24	0.216
Exposure to market	0.39 (0.11)	0.17 – 0.60	3.56	< 0.001

Note. Coeffecients are unstandardized. Age was centered at the mean. The degrees of freedom for each test was $df = 539$.

S3.3 Variance in PG contributions controlling for market exposure

Given that Hadza in market camps gave more than Hadza in non-market camps, it could be that PG contributions clustered within camps only because of the market effect. To rule out this alternative explanation, we ran the simulation analyses controlling for exposure to market. Within each year, we regressed contributions on market exposure; the residuals of this analysis were analyzed using the same simulation procedure. Even when controlling for market exposure, variance between camps in PG contributions was greater than expected in a random population, and variance within camps in PG contributions was less than expected in a random population (see Figure S3.4). The results suggest that markets do not explain all the group-level differences in Hadza cooperation.

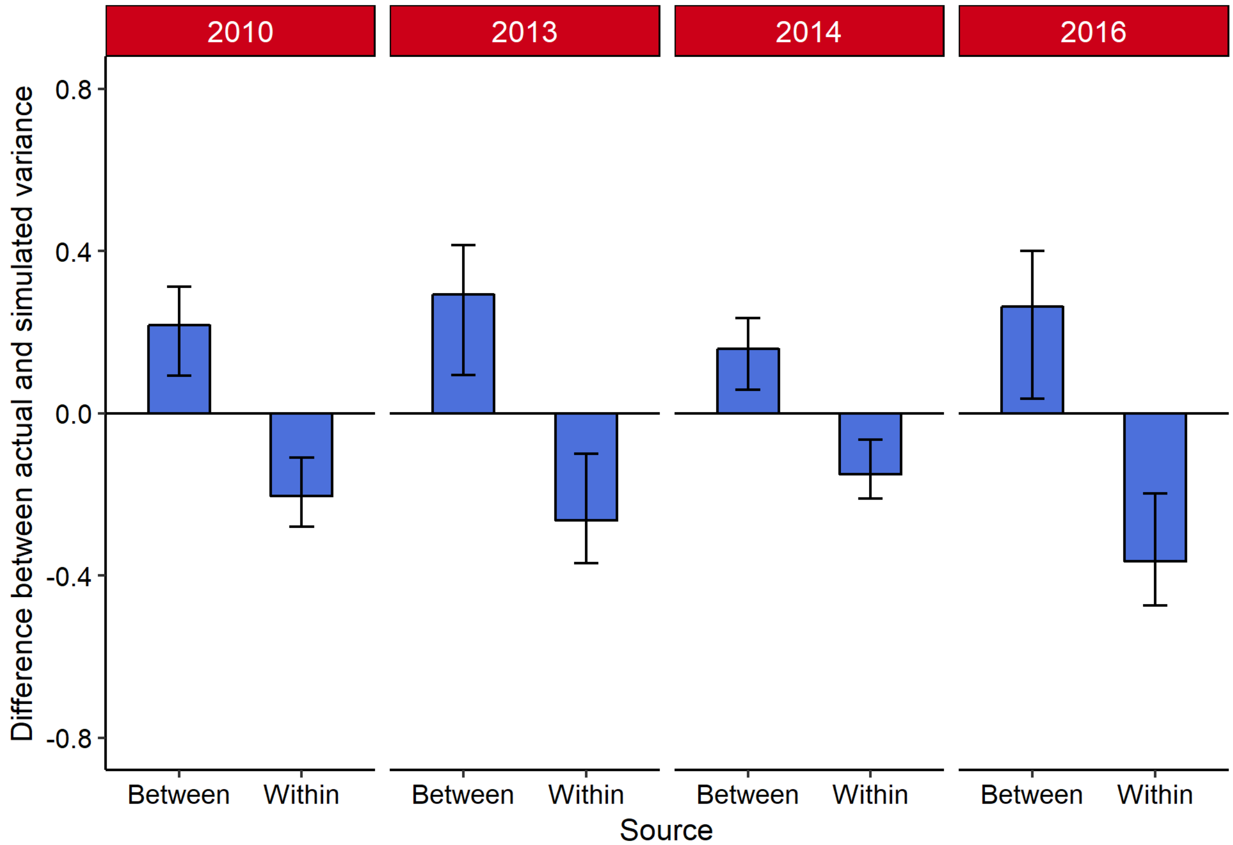

Figure S3.4. Difference between actual and simulated variance within and between residence camps in public good game contributions controlling for market effects. Error bars are 95% confidence intervals.

S3.5 Regression Analyses with Demographic Controls

We analyzed the relationship between individuals' current PG contributions and the mean contribution of campmates and previous contributions, with and without controls. In the main text, analyses with mean camp contribution but without previous contributions in the model were analyzed with the full samples across all four years. However, for better comparison across models, here we restricted all analyses to the 2013, 2014, and 2016 samples that had contributions in the current and the previous year. This included 143 observations. In each model, robust standard errors were clustered on the individual and camp and included year of observation. Table S3.6 includes the coefficients for five different models.

In Model 1, we regressed individual PG contributions at time t on the mean contribution of camp members. For each honey stick that camp members on average gave, ego gave approximately another half-stick of honey. This effect remained significant when controlling for demographic effects (Model 2). In Model 3, we regressed PG contributions at time t on contributions at time $t - 1$. This effect was not significant; individuals who contributed more at time $t - 1$ did not contribute more at time t. This result did not change when controlling for demographic effects (Model 4). Finally, Model 5 regressed ego's contribution at time t on mean camp contribution, ego's contribution at time $t - 1$, and demographic variables. Again, mean camp contribution was significant, whereas there was no relationship between previous contributions and current contributions.

Table S3.6 OLS Regressions of PG Contribution on Mean Camp Contribution and Previous Contributions

	Model 1	Model 2	Model 3	Model 4	Model 5
Mean camp	0.55***	0.50***			0.50**
contribution	(0.15)	(0.16)			(0.16)
Previous			0.00	-0.02	-0.01
contribution			(0.09)	(0.08)	(0.08)
2014	0.44*	0.43*	0.75**	0.71**	0.42*
	(0.19)	(0.19)	(0.24)	(0.23)	(0.20)
2016	0.50	0.52	0.76	0.80*	0.52*
	(0.25)	(0.26)	(0.39)	(0.35)	(0.26)
Male		0.16		0.17	0.16
		(0.18)		(0.18)	(0.18)
Age		0.00		0.01	0.00
		(0.01)		(0.01)	(0.01)
Married		0.17		0.24	0.18
		(0.32)		(0.31)	(0.32)
Number of living		-0.01		-0.03	-0.01
children		(0.03)		(0.03)	(0.03)
Exposure to market		0.10		0.20	0.10
		(0.15)		(0.25)	(0.16)

Note. Values are unstandardized OLS regression coefficients with standard errors in parentheses. All analyses are restricted to contributions in 2013, 2014, and 2016, and to individuals with a previous contribution in the sample year prior.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

S3.7 PG Contributions and Relatedness Among Camp Members

In 2010 and 2016, we asked participants the names of their biological parents and from these data we constructed primary kin relationships among campmates. Individuals were counted as primary kin if they had a parent-child relationship or if they were full siblings. For each individual, we then calculated the proportion of their campmates that were primary kin or a spouse as a measure of "close relationships." In 2010, the mean proportion of close relationships was 12.0% and for 2016 it was 14.4%. We regressed individual PG contributions on the proportion of close relationships within the camp, controlling for year. Robust standard errors were clustered on the individual and camp. There was no relationship between an individual's PG contributions and the proportion of their close relationships, b = -0.30, SE = 0.96, t (315) = -0.31, p = 0.758.

However, the proportion of close relationships was correlated with other variables. Specifically, the number of residents in the camp. We calculated for each camp the mean proportion of campmates that were close relationships. This value was negatively correlated with the number of camp residents, r (28) = -0.47, p = 0.008; people living in larger camps had less close relationships in their camp than people in smaller camps. Because of this, we regressed individual PG contributions on proportion of close relationships, controlling for camp size and year. Robust standard errors were again clustered on the individual and the camp. Though the point estimate is larger, the relationship was still nonsignificant, b = -1.34, SE = 0.79, t (314) = -1.69, p = 0.091. Examining the scatterplot of individual PG contributions by proportion of close relatives (see Figure S3.8), one individual living with almost exclusively close relationships is having undue influence on the regression.

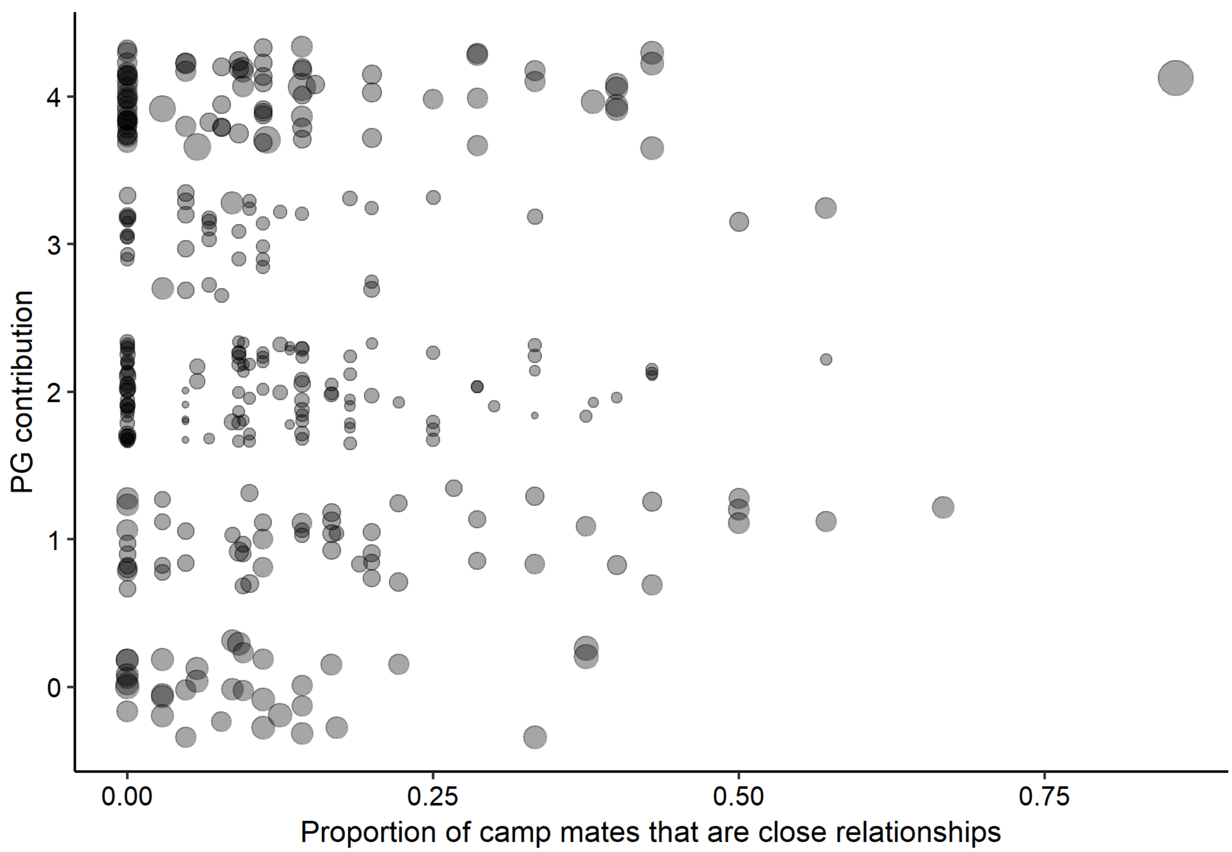

Figure S3.8 Proportion of campmates that were close relationships (primary kin or spouse) and contributions in the public good game in 2010 and 2016. Points are jittered vertically for clarity. Larger points are having more influence on a linear regression. The individual in the top right quadrant is having the most influence on the regression.

We ran the regression again removing the problematic individual. In this model, individuals with more close relationships had lower PG contributions, *b* = -1.67, *SE* = 0.65, *t* (313) = -2.48, *p* = 0.010 (see Figure S3.9). However, individuals with more campmates also gave less to the public good, *b* = -0.04, *SE* = 0.01, *t* (313) = -4.27, *p* < 0.001. People who lived in large camps tended to live with fewer close relationships, and these variables had conflicting relationships with PG contributions. We next tested if this explained the relationship between ego's contribution and ego's campmates' mean contribution. We regressed ego's contribution on close relationships, number of other campmates, and campmates' mean contribution controlling for year. Robust standard errors were clustered on the individual and camp. Controlling for close relationships and camp size, people still contribute significantly more when their campmates contributed more, *b* = 0.69, *SE* = 0.08, *t* (312) = 9.20, *p* < 0.001. Nevertheless, individuals with more close relationships contributed less relative to the camp mean, *b* = -1.23, *SE* = 0.51, *t* (312) = -2.43, *p* = 0.016. Previous research on foraging returns found that Hadza hunter attempt to preferentially share food within their household;[11] it is possible that individuals with more kin contributed less to the public good so they could preferentially share with kin members.

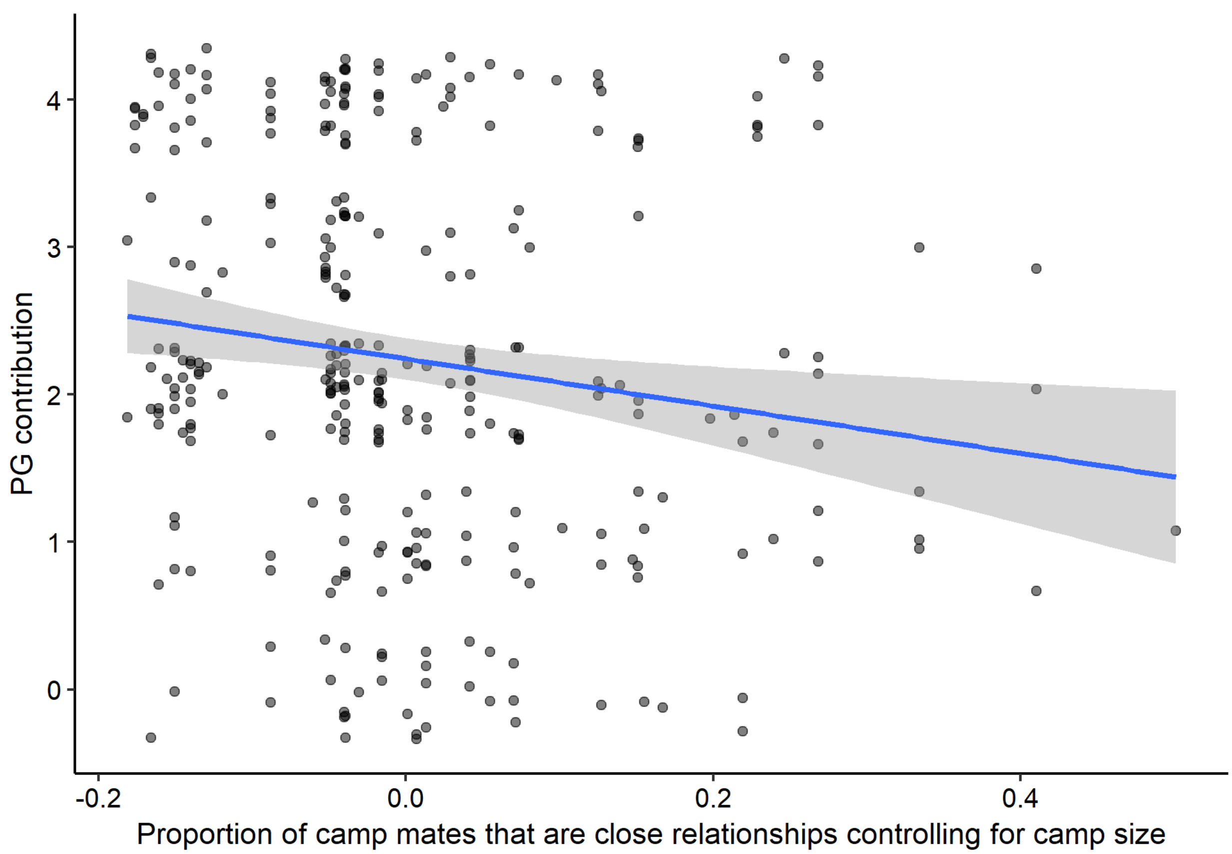

Figure S3.9 Proportion of campmates that were close relationships (primary kin or spouse) controlling for camp size and contributions in the public good game in 2010 and 2016. Points are jittered vertically for clarity. The regression line is the OLS regression with the shaded region representing the standard errors.

S3.10 Analysis of Dyads Living Together in Future Years

We constructed a dataset of dyads to analyze who lives with whom in each year. To do this, we went through 2010, 2013, and 2014 and for each individual *i* in the sample at time *t* and time *t* + 1, we went through each individual *j* at time *t* and recorded whether *i* and *j* lived in the same camp at time *t*, at time *t* + 1, and their similarity in PG contributions at time *t*, as well as their similarity on demographic variables at time *t*. Similarity scores were calculated by finding the absolute value of the difference between *i* and *j* on the variable and multiplying that value by -1 so that greater values indicate more similarity on the variable. We used a binary logistic regression and regressed whether *i* and *j* lived together at time *t* + 1 on the other variables with robust standard errors clustered on dyads. Table S3.11 presents the regression results.

Table S3.11. Binary Logistic Regression on Dyads Living in the Same Camp

	b (*SE*)	*OR*	*Z*	*p*
Intercept	-3.51 (0.17)	0.03	-20.37	< 0.001
Lived together previously	0.37 (0.14)	1.44	2.56	0.010
Similarity in PG contributions	0.01 (0.04)	1.01	0.24	0.814
Both male	0.18 (0.11)	1.20	1.71	0.087
Both female	0.28 (0.10)	1.33	2.74	0.006
Both married	-0.01 (0.09)	0.99	-0.10	0.922
Both single	-0.67 (0.33)	0.51	-2.03	0.042
Similarity in age	0.01 (0.004)	1.01	1.65	0.099
Similarity in number of living children	0.05 (0.02)	1.05	2.47	0.014
Both lived in market region previously	0.13 (0.11)	1.13	1.10	0.273
Both lived in non-market region previously	0.48 (0.10)	1.62	4.75	< 0.001

Note. Whether the dyad lived in the same camp at time *t* + 1was regressed on variables in the model. All variables in the model are taken from time *t*.

S3.12 Cohesion of Campmate Bonds

We found that individuals living with more close relationships contribute less to the public good (see S3.7). If individuals are more likely to repeatedly live with close relationships, then the negative relationship between PG contributions and repeatedly living with others as a side-effect of the relationship between PG contributions and living with close relationships. To test this, we limited the data to individuals who were in 2010 and 2013. We regressed 2010 contributions on repeated campmates in 2013 with robust standard errors clustered on the camp and found that people who contributed more had fewer repeated campmates, $b = -0.02$, $SE = 0.01$, $t(44) = -2.80$, $p = 0.008$. However, when controlling for close relationships in 2010 this relationship was nonsignificant, $b = -0.01$, $SE = 0.01$, $t\ (43) = -1.66$, $p = 0.104$, but close relationships in 2010 related to the proportion of repeated campmates in 2013, $b = 0.28$, $SE = 0.10$, $t\ (43) = 2.68$, $p = 0.010$.

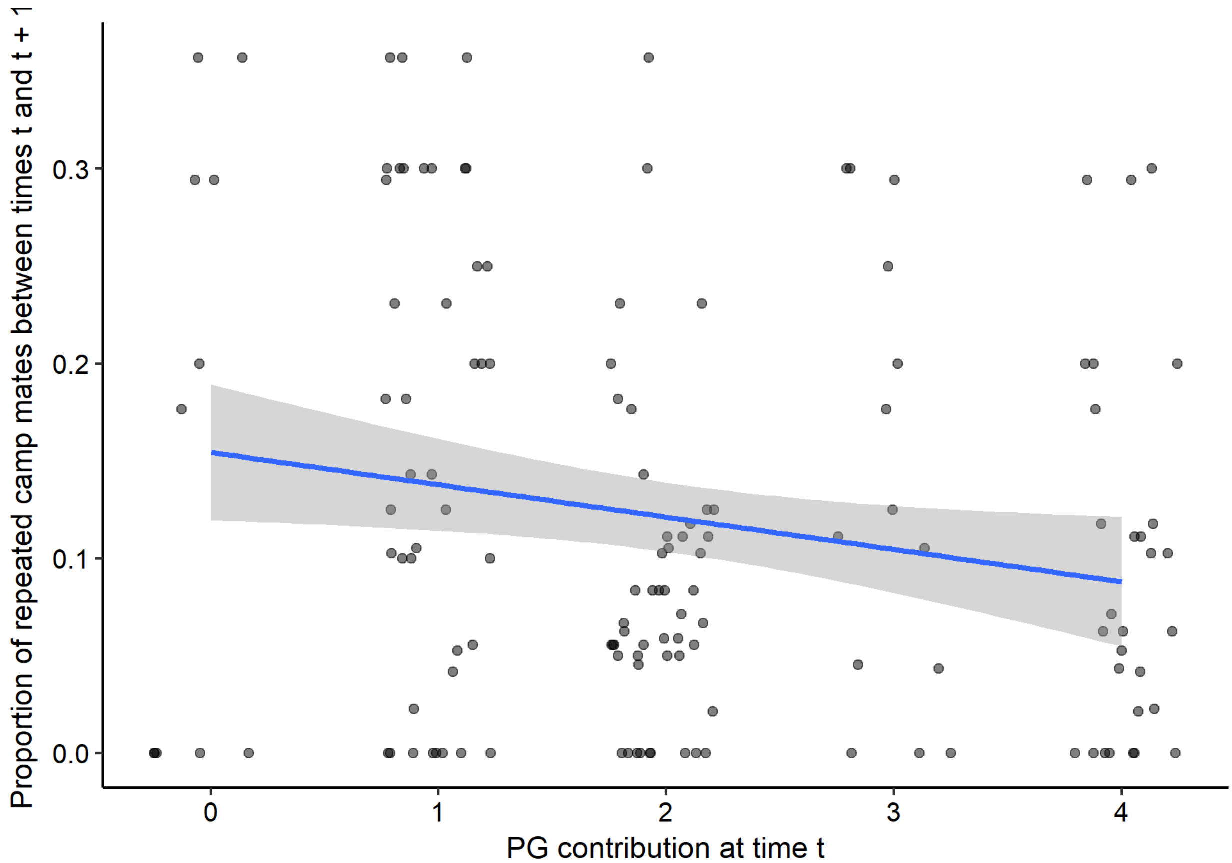

Figure S3.13. Proportion of repeated co-residents at time $t + 1$ by individual's PG contribution at time *t*. Points are jittered horizontally for clarity. Line is regression with 95% confidence interval.

Previous research among Agta hunter-gatherers in the Phillipines found that more stable, cohesive camps were cooperative on a variety of measures.[12] The researchers in this study were able to identify camps and measure how much change in membership occurred over time; those with less change, whether it was members leaving or new members joining, were more cooperative. Hadza camps have too much change over time in residents and location to identify discrete Hadza camps. However, we can test if individuals who live with a greater percentage of prior campmates are more or less cooperative. We regressed an individual's PG contributions at time *t* on the proportion of repeated campmates between times *t* and $t - 1$, controlling for year. Standard errors were clustered on the individual. We found no relationship between the proportion of repeated campmates and PG contributions at time *t*, $b = -0.73$, $SE = 0.83$, $t\ (139) = -0.87$, $p = 0.386$. Given the differences between the two populations and the different measures used, it is difficult to know why the results differ. However, our results indicate that, at least among Hadza, living with prior campmates is not associated with greater cooperation in the public goods game. It is important to note that we observe residency at discrete points in time and cannot account for whether participants lived together between periods of data collection.

S3.14 Differences Between Individuals in Later Samples (Selective Attrition)

We tested whether Hadza not present in future samples behaved differently from Hadza present in future samples. This was to rule out that any cross-year effects, or lack thereof, was due to selective attrition. We regressed PG contributions at time t on whether the individual was in the sample at time $t + 1$ controlling for year. Standard errors were clustered on the individual. There was no selective attrition; Hadza in future samples did not differ from Hadza not present in future samples, $b = -0.10$, $SE = 0.13$, $t\ (456) = -0.82$, $p = 0.415$. We also tested if Hadza who were not in future samples were from camps that contribute more to the PG by regressing mean camp PG contribution (excluding ego's contribution) at time t on whether ego was in the sample at time $t + 1$ controlling for year. Robust standard errors were clustered on the individual and the camp. Again, there was no difference between individuals in the future sample and those who were not in the future sample, $b = -0.09$, $SE = 0.08$, $t\ (456) = -1.17$, $p = 0.241$. Finally, we regressed ego's PG contributions at time t on whether the individual was in the sample at time $t + 1$ controlling for year and mean camp PG contribution at time t. Robust standard errors were clustered on the individual and the camp. There was no difference in ego's contribution relative to the camp between individuals who were in future samples and those who were not, $b = -0.04$, $SE = 0.09$, $t\ (455) = -0.49$, $p = 0.627$.

S3.15 Time of Day Analysis in 2016

In 2010, 2013, and 2014, the public good game was played after all other data were collected and was played in a short time period so we could not separate camp effects from time of day. In addition, time was not recorded in these three sample years. However, in 2016, the public good game was played throughout the study period so that the time the game was played varied within camps. Time of day was categorized into three periods: morning if the game was played between 8:00 and 12:00, afternoon if played between 12:00 and 16:00, and evening if played between 16:00 and 18:00. The mean (and standard deviation) of contributions for each time period was 2.3 (1.4), 2.1 (1.3), and 2.5 (1.7) for the morning, afternoon, and evening, respectively. An ANOVA revealed that there was no difference between the three-time periods in PG contributions, $F\ (2, 120) = 0.36$, $p = 0.70$.

S3.16 Additional Controls in 2013 and 2016

Additional questions were asked in 2013 and 2016. Specifically, in 2013 and 2016, we asked about formal education and household size. In addition, in 2013, we asked about concerns of having enough to eat and days spent trading with the market. We conducted additional regression analyses testing the relationship between these variables and public good contributions. For the education and household size analyses, models controlled for year and had robust standard errors clustered on the individual.

Education. Participants were asked the number of years that they attended school in 2013 and 2016. PG contributions were regressed on the number of years of formal education. There was no relationship between PG contributions and formal education, $b = 0.01$, $SE = 0.05$, $t\ (191) = 0.21$, $p = 0.798$.

Household size. We asked participants the number of other individuals living in their household in 2013 and 2016. This typically includes children and spouse and occasionally other close family members. We regressed PG contributions on household size. There was no relationship between PG contributions and household size, $b = 0.00$, $SE = 0.05$, $t\ (191) = 0.03$, $p = 0.980$.

Concerns about food. In 2013, participants were asked two forced choice questions about whether they were worried there would be enough food for their family in 1) over the next month or 2) over the year. Participants answered yes or no to both questions, such that a "yes" indicated participants were worried about having enough food. PG contributions were regressed on the food concern questions separately with "yes" coded as 1. There was no relationship between PG contributions and food concerns for the next month, $b = -0.74$, $SE = 0.44$, $t\ (64) = -1.70$, $p = 0.094$, or for the next year, $b = -0.51$, $SE = 0.39$, $t\ (64) = -1.30$, $p = 0.198$.

Trade. In 2013, participants were asked to estimate how many days out of the past seven they personally went to a market or trade center to buy or sell something. We regressed PG contributions on the number of days of trade. There was no relationship between PG contributions and an individual's market activity, $b = 0.15$, $SE = 0.19$, $t\ (66) = 0.83$, $p = 0.411$.

S3.17 Ordered Logit Regressions of PG Contributions

Given the limited range possible in PG contributions, it could be argued that these data should be analyzed as if they were ordinal. Here, we re-run the key analysis regressing individual PG contributions on mean camp contributions and previous contributions using an ordered logit to test the robustness of our results. Again, we limit the analysis to contributions in 2013, 2014, and 2016 including only participants who also had contributions in the previous year. Again, we clustered the robust standard errors on the individual and camps. Table S3.18 presents the results of the five models.

Results were largely consistent and crucially, mean camp contributions remained significant. In the full model, the odd-ratio was $OR = 2.46$; for each additional honey stick on average contributed by camp members, ego was approximately two-and-half times more likely to give an additional honey stick. Ego's previous contribution was still not significant using the ordered logit regression.

Table S3.18. Ordered Logit Regressions of PG Contribution on Mean Camp Contribution and Previous Contributions

	Model 1	Model 2	Model 3	Model 4	Model 5
Mean camp	0.96***	0.90**			0.90**
contribution	(0.28)	(0.30)			(0.30)
Previous			0.00	-0.05	-0.06
contribution			(0.13)	(0.12)	(0.12)
2014	0.54*	0.61*	1.00**	1.05**	0.58
	(0.27)	(0.29)	(0.34)	(0.34)	(0.29)
2016	0.71	0.85*	1.12	1.33*	0.87*
	(0.38)	(0.42)	(0.62)	(0.57)	(0.40)
Male		0.18		0.30	0.20
		(0.32)		(0.30)	(0.32)
Age		0.00		0.01	0.00
		(0.01)		(0.02)	(0.01)
Married		0.21		0.46	0.23
		(0.56)		(0.50)	(0.56)
Number of living		-0.02		-0.04	-0.02
children		(0.05)		(0.05)	(0.05)
Exposure to market		0.15		0.23	0.13
		(0.25)		(0.39)	(0.26)

Note. Values are unstandardized logit regression coefficients with standard errors in parentheses. All analyses are restricted to contributions in 2013, 2014, and 2016, and only to individuals with a previous contribution in the sample year prior.
$^{*}\,p < 0.05$, $^{**}\,p < 0.01$, $^{***}\,p < 0.001$

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