Demography and ecology drive variation in cooperation across human populations

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Recent studies argue that cross-cultural variation in human cooperation supports cultural group selection models of the evolution of large-scale cooperation. However, these studies confound cultural and environmental differences between populations by predominantly sampling one population per society. Here, we test the hypothesis that behavioral variation between populations is driven by environmental differences in demography and ecology. We use a public goods game played with money and a naturalistic measure of behavior involving the distribution of salt, an essential and locally valued resource, to demonstrate significant variation in levels of cooperation across 16 discrete populations of the same small-scale society, the Pahari Korwa of central India. Variation between these populations of the same cultural group is comparable to that found between different cultural groups in previous studies. Demographic factors partly explain this variation; age and a measure of social network size are associated with contributions in the public goods game, while population size and the number of adult sisters residing in the population are associated with decisions regarding salt. That behavioral variation is at least partly contingent on environmental differences between populations questions the existence of stable norms of cooperation. Hence, our findings call for reinterpretation of cross-cultural data on cooperation. Although cultural group selection could theoretically explain the evolution of large-scale cooperation, our results make clear that existing cross-cultural data cannot be taken as empirical support for this hypothesis.

evolution of cooperation | cultural norms | common-pool resource | real-world measure | economic game

Several recent cross-cultural studies in small-scale (1–3) and large-scale (4–6) societies demonstrate variation in patterns of cooperation across cultural groups. This behavioral variation is attributed to culturally inherited cooperative norms and taken as support for cultural group selection models of large-scale cooperation (1, 2, 7). However, these studies have mostly sampled from one population per culture. Thus, they confound cultural and environmental differences between populations and cannot determine whether the behavioral variation across populations is driven by conformism to cultural norms or by environmental (demographic and ecological) differences. Crucially, the evolution of large-scale cooperation via cultural group selection (7–13) depends on behavior being acquired via cultural transmission, such that behavioral variation between populations is maintained by conformism to group norms.

We examine whether there are differences in levels of cooperation across discrete populations of the same endogamous cultural group, and we find that environmental drivers (local ecology and demography) are responsible for behavioral variation across our study populations. Moreover, variation between these populations of the same cultural group is comparable to that found between different cultural groups in previous studies. Our finding that behavioral variation is at least partly contingent on environmental differences between populations questions the existence of stable cultural norms of cooperation. Hence, although cultural group selection could theoretically explain the evolution of large-scale cooperation, our results make clear that existing cross-cultural data cannot be taken as empirical support for this hypothesis.

Our study populations are 16 villages of a small-scale forager-horticulturist society called the Pahari Korwa of central India (14) (details are provided in *SI Text*, Fig. S1, and Tables S1 and S2). Heavily reliant on gathered forest products, which are a primary source of food and income, Pahari Korwas also practice agriculture on small tracts of land. These economic resources are supplemented by opportunistic hunting, fishing, and wage labor. The Pahari Korwa live in mostly uniethnic villages that vary considerably in size, migration rates, and access to markets. They predominantly commute by foot, and there is no a priori reason to believe that current migration rates are significantly higher than they were in the past. The settlements have well-defined boundaries; tracts of forest and hills separate neighboring villages. In this endogamous, patrilineal, and patrilocal society, exogamous marriages usually incur severe penalties entailing ostracism and expulsion from the tribe and village. Pahari Korwa populations thus present an excellent model system for this study: a set of real-world uniethnic metapopulations of the same endogamous cultural group, with distinct population boundaries and considerable demographic and ecological variation across them. Table 1 presents summary statistics for our study populations.

We used two measures of cooperative behavior. The first is an anonymous one-shot public goods game (PGG). Participants were divided into groups of six players. Each player received an endowment of 20 Indian rupees (henceforth rupees) and decided how much of it she wished to contribute to a group pot in divisions of five rupees. Once all six players made their decisions, the total amount in the pot was doubled and then split equally between all six players. Each player's earnings consisted of the money she retained from her endowment plus an equal share of the earnings from the group pot. In this game, the income-maximizing strategy entails that a player contribute nothing to the group pot.

Our second measure is a naturalistic evaluation of behavior that involves taking a useful commodity from a common pool. We used salt, which is valued among the Pahari Korwa because it is an essential commodity that they cannot obtain directly from the forest or manufacture themselves, and one that they are most likely to buy at market (14). On concluding the PGGs in a village, when a participant collected her earnings at a private location, she was informed that one of the authors (S.L.) had brought along x kg of salt to distribute among the y individuals who participated in the games and that $z = x/y$ kg of salt was thus available per person. The participant could then take as much of the total amount of available salt (x kg) as she desired without her decision becoming public knowledge. The stated amount was

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Table 1. Summary statistics of demographic variables and sample sizes for the study populations

Village number	Village name	Population size*	Percentage of migrants in sample†	Percentage of non-Korwas‡	Distance from major town, km§	PGG players (*n*)	Salt takers (*n*)
1	Chipni Paani	27	92 (12)	0	24	12	11
2	Mahua Bathaan	61	32 (22)	16	44	18	22
3	Jog Paani	64	53 (19)	25	47	7	13
4	Semar Kona	64	29 (17)	17	24	9	13
5	Bihidaand	73	48 (21)	21	33	15	15
6	Khunta Paani	97	52 (31)	27	36	22	27
7	Kaua Daahi	102	41 (32)	0	46	18	24
8	Pareva Aara	111	44 (36)	14	42	24	34
9	Musakhol	117	37 (30)	26	35	16	16
10	Kharranagar	125	42 (38)	0	50	24	37
11	Tedha Semar	141	40 (30)	3	45	19	12
12	Vesra Paani	157	25 (44)	25	27	22	20
13	Barghat	194	31 (42)	10	41	24	9
14	Aama Naara	207	33 (43)	6	69	30	9
15	Bakrataal	254	54 (39)	7	26	15	28
16	Ghatgaon	957	15 (47)	5	13	26	12

A total of 301 individuals participated in the PGG, and 302 made the salt decision across 16 villages; 190 individuals participated in both. Not all PGG players received salt; they were not offered any salt if it ran out before they collected their payments. Not all those who received salt participated in the PGG.
*Includes all adults and children residing in the focal village.
†Numbers in parentheses indicate the size of the sample used to estimate the proportion of migrants. Migrants are individuals (Pahari Korwas) currently residing in the focal village but born in another village. Migration often follows marriage, particularly for females.
‡Percentage of the focal village population that was not Pahari Korwa.
§Distance from Ambikapur, the largest town in the study region.

given to her, along with her earnings from the game. In each village, we started with a total quantity of salt (in kg) equal to the total number of participants, such that the initial amount available per person was 1 kg. We then recalculated and updated the total amount available (x), the number of people remaining (y), and the amount available per person ($z = x/y$) for each person based on how much salt remained after the preceding person had taken her desired quantity of salt. We stopped distributing salt either when the penultimate person had taken salt or when the amount available per person fell below 100 g per person. Participants encountered the salt for the first time when they individually collected their payments and had no prior information about it. The income-maximizing strategy entails that a player take all the available salt. For each player, we use the deviation of the salt taken from the amount available per person as a measure of cooperative propensity. The more negative a player's salt deviation, the more selfish is the player's behavior.

The salt decision involves anonymously sharing large quantities of a desirable commodity outside an experimental context with a large group of people from an individual's village; hence, it provides a measure of large-scale cooperation in a real-world context that is comparable to behavior in anonymous one-shot economic experiments. We use these salt decisions to measure behavioral variance across villages and to assess whether behavior captured by a formal economic game, such as the PGG, correlates with a naturalistic measure of cooperation in a real-world context.

We use multilevel multivariate response models (15) to analyze variation explicitly at the village and individual levels in our data (structured as individuals within villages). Traditional regression models used in previous cross- and intracultural studies (e.g. 1–4, 16–19) treat the units of analysis as independent, an assumption that is severely violated if group membership, whether at the culture or population level, affects individual behavior. Also, previous intracultural studies (16, 19) sampled an inadequate number of populations to make reliable inferences about the extent of within-culture variation. Multilevel models correct for the nonindependence of clustered data, reducing the likelihood of type I errors. Multivariate response models let us simultaneously examine the effect of explanatory variables on our two response variables, PGG contribution and salt deviation. We can also partition the correlation between the two response variables into village and individual level components.

Results and Discussion

Distributions of both PGG contributions (Fig. 1) and salt deviations (Fig. 2) vary considerably across villages, including the modes and means. A total of 4.1% [95% Bayesian credible interval (BCI) = 1, 11.6] of the variance in PGG contributions and 18.2% (95% BCI = 7.3, 35.5) of the variance in salt deviations occurs between villages [Table S3, null model (multilevel)]. The between-village variation in salt deviation is remarkable; in some villages, the salt ran out before less than half of the players had taken any salt, whereas almost everyone received some salt in other villages. Once village and individual descriptors are included in the model, the unexplained between-village variance is reduced to 1.4% (95% BCI = 0.3, 4.7) in PGG contributions and 11.8% (95% BCI = 3.8, 26.5) in salt deviations [Table S3, full model (multilevel)].

Variance in ultimatum game offers between 15 small-scale societies was estimated at about 12% (1). Behavioral variance between 16 populations of the same small-scale society is therefore comparable to that between 15 populations of 15 different small-scale societies. Seven percent of the variance in average contributions in repeated PGG experiments run in 16 populations of 15 different large-scale societies was estimated to be between populations (4); mean contributions in the first round of the PGG varied between about 8 and 14 units of the initial endowment (also 20 units). Mean PGG contributions across 16 populations of the same society in this study vary between 7.2 and 14.7 units (Fig. 1). Hence, the variance in contributions and range of mean contributions across 16 populations of the same society are comparable to those across 16 populations of 15 different societies. By demonstrating significant within-culture, between-population variation, our findings challenge the existence of stable culturally inherited cooperative norms.

We tested whether the variation between and within populations is explained by properties of populations and individuals

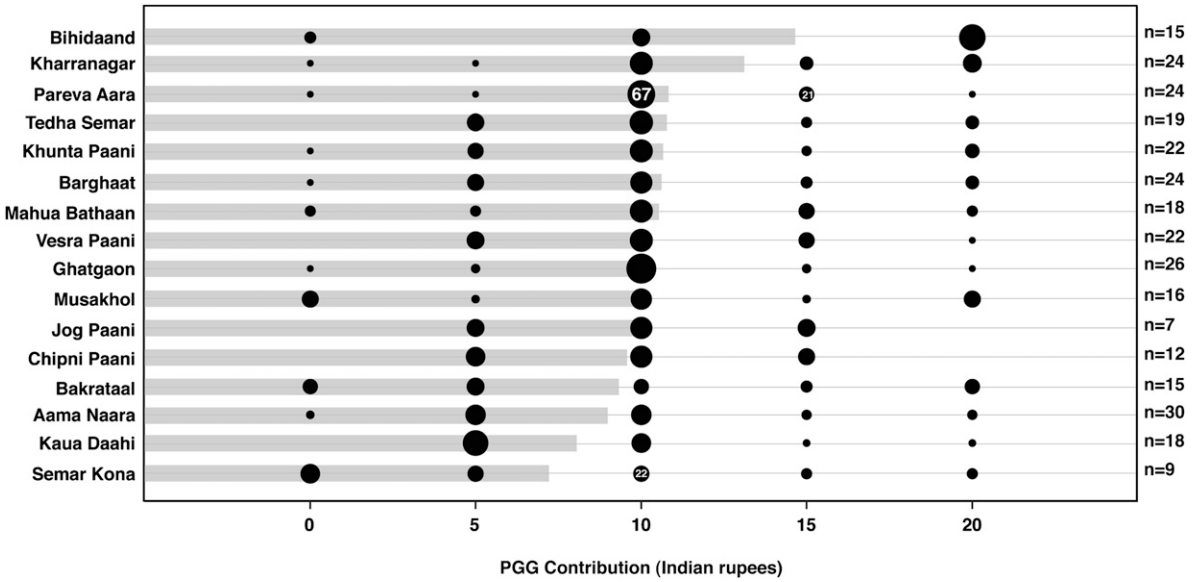

Fig. 1. Distributions of PGG contributions across 16 villages. For each village on the *y* axis, the areas of the black bubbles represent the proportion of individuals from the village that made a contribution of the value on the *x* axis. To indicate scale, the numbers in some bubbles are the percentage proportions represented by those bubbles. Gray horizontal bars indicate the mean contributions for villages. Villages are ordered by their mean contributions; the bottom village (Semar Kona) has the lowest mean. Counts on the right (*n*) represent the number of players from each village (total $n = 301$). The overall mode across villages is 10 rupees (mean ± SD = 10.40 ± 5.48).

(details are presented in Table S4, and a discussion of these results is provided in *SI Text*). The only explanatory variables that have a significant association with PGG contribution are age and number of individuals from other villages invited to the annual harvest festival by a player's household; both have small positive effects on PGG contribution. We interpret the number of invitees to the annual harvest festival as a measure of social network size along the lines of another study (20); this festival is one of the biggest in the calendar year, during which people visit others' homes and invite their friends and relatives to eat and drink at their homes. Only two variables are significantly associated with player salt deviation, namely, village population size and the number of adult sisters residing in the village, both of which have negative effects; people in larger villages or with

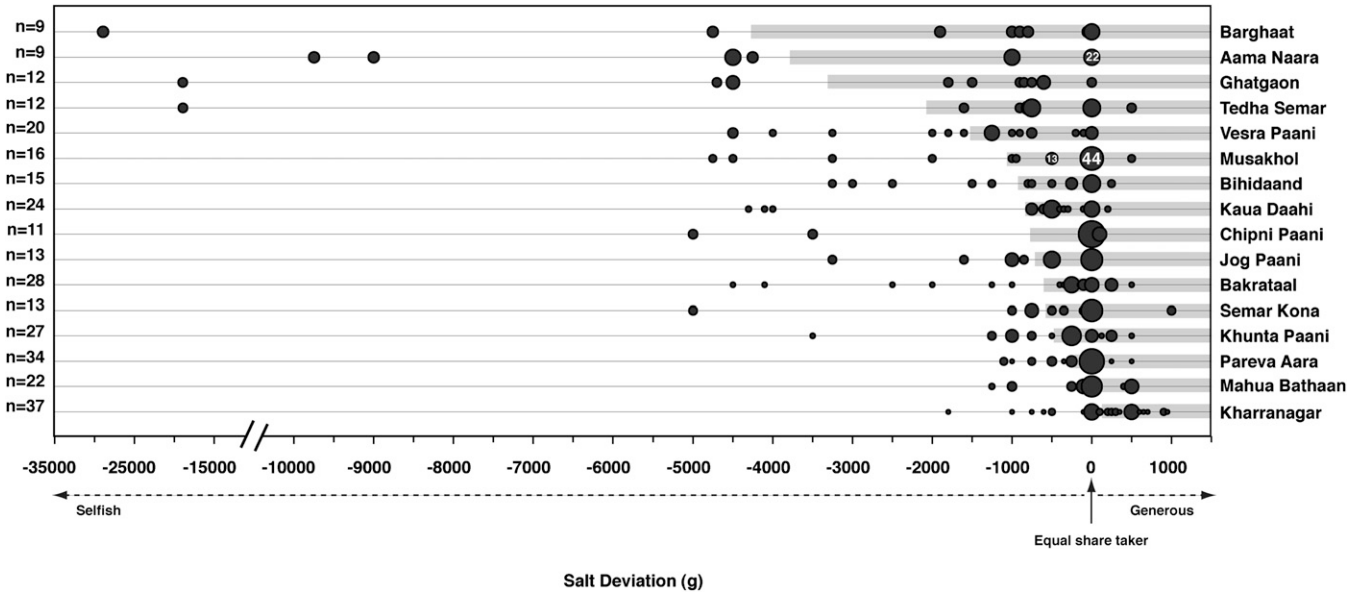

Fig. 2. Distributions of salt deviations (amount available per person − amount taken) across 16 villages. For each village on the *y* axis, the areas of the black bubbles represent the proportion of individuals from the village with salt deviation of the value on the *x* axis. Note the break in the *x* axis. To indicate scale, the numbers in some bubbles are the percentage proportions represented by those bubbles. Gray horizontal bars indicate the mean salt deviations for villages. Villages are ordered by their mean salt deviations; the bottom village (Kharranagar) has the highest mean. The dashed line below the *x* axis marks whether a value of salt deviation indicates an "equal share taker" (salt taken = amount available per person), a "selfish" individual (salt taken > amount available per person), or a "generous" individual (salt taken < amount available per person). Counts on the left (*n*) represent the number of salt takers from each village (total $n = 302$). The overall mode across villages is 0 g (mean ± SD = −913.33 ± 2,619.02).

more adult sisters residing in the village take more of the salt. Pseudo-R^2 values indicate that for PGG contribution, about 28% of variance between populations and 4% of variance within populations are explained by these explanatory variables. For salt deviation, about 32% of variance between populations and 9% of variance within populations are explained by these explanatory variables. Players' migration histories, frequency of market contact, and multiple measures of wealth have little effect on their PGG contributions or salt decisions.

The negative relationship between levels of cooperation and village population size is in the direction predicted by most evolutionary models. Two recent studies found that individuals from large populations are more willing to punish defectors (3, 17); they infer that the enforcement of norms promoting cooperation is stronger in large and more complex societies. Both of these studies sampled from one or a few populations per society and assumed that population size effects reflected the influence of societal complexity. Our results challenge this conclusion because we demonstrate an association between population size and cooperation that is independent of variation in structural features of populations, such as socio-political complexity and religion.

PGG contributions and salt deviations show a significant positive correlation across individuals (details are presented in Table S3); however, partitioning the correlation shows that most of the association is at the village level ($\rho = 0.397$), with only a weak correlation at the individual level ($\rho = 0.043$). Once explanatory variables are included in the model, residual correlation increases substantially at the village level ($\rho = 0.871$) and only marginally at the individual level ($\rho = 0.057$). This suggests that properties of the common village environment trigger similar cooperative propensities in the PGG and salt decisions but that individual variation in some aspect of personality does not determine behavior in these measures of cooperation.

In summary, we find significant variation in cooperative behavior across 16 populations of the same small-scale society, and this variation is partly explained by demographic differences between populations. Theory predicts that factors like population size and age structures affect the balance of cooperation and competition within a population (21, 22). It is possible that some of the behavioral variation between our study populations is driven by norms at the level of the population or village unit rather than at the level of the endogamous cultural unit; this hypothesis needs to be tested empirically. However, village-level norms can exist only if conformism to these norms is strong enough to counter any behavioral variation introduced within villages by the high levels of migration that we report (Table 1). Moreover, the fact that behavioral variation is at least partly contingent on environmental differences between populations questions the existence of stable norms of cooperation. Our findings call for reinterpretation of cross-cultural data on cooperation based on samples from one population (or a few populations) per culture (1–6); behavioral variation currently attributed to cultural norms may, in fact, be driven by ecological and demographic differences between populations. Thus, existing cross-cultural data do not provide support for cultural group selection models of the evolution of cooperation.

In cultural group selection models (7–10, 12), cultural transmission mechanisms, such as conformism, by definition, do not involve individuals computing the benefit of a behavior in a particular environment. Instead, individuals who conform simply copy the highest frequency behavior. Thus, conformism to group norms produces patterns of behavioral variation that are not solely contingent on the environment and maintains behavioral variation between populations despite genetic mixing and migration. The finding that behavior is correlated with the environment does not let us infer whether it is transmitted culturally or genetically; however, it also does not let us reject the hypothesis that behavior is solely contingent on the environment and not on group norms. Moreover, if cultural transmission produces environmentally contingent patterns of behavioral variation that are similar to those produced via the genetic transmission of behavior, it may simply be a proximate transmission mechanism and will not necessarily lead to cultural group selection as described in the models. Thus, our findings present an empirical challenge for cultural group selection as a general explanation for the evolution of large-scale cooperation and emphasize the central role of demography and ecology in shaping human social behavior.

Materials and Methods

This study has full approval from the Ethics Committee at University College London, and informed consent was obtained from all participants. The following is a summary of our methods and analyses. Further details are provided in *SI Text*.

PGGs. All games were played between February 2 and May 16, 2008. All games in most villages were administered on the third day after arrival in the village (the second day in four villages and the fourth day in one village) and completed in a single day. Mean age ± SD of participants was 34.59 ± 12.13 y, and 46% were female.

To summarize the key features of our standardized protocol:

i) Instructions were delivered from a standardized script (*SI Text* section 1.8) in Sargujia, and real money was used to demonstrate game rules and examples. Only individuals who correctly answered a set of questions played the game; the questions were designed to assess their understanding of the game and experimental set-up.
ii) Decisions were made individually at a private location, and no names were recorded; a player's only identification was a numbered token.
iii) Those who had played the games were prevented from interacting with those who had not yet played.
iv) All games in all villages were administered by one of the authors (S.L.), usually on the third day after arrival in the village (the second or fourth day in a few cases) and were completed in a single day. Before this study, the authors had no contact with any individual from any of the 16 villages included in this study.

Our study design therefore excludes the following confounding causes of variation across populations: (*i*) context and framing effects, (*ii*) experimenter variation, (*iii*) experimenter familiarity, (*iv*) differences in recruitment methods and time periods over which games were conducted in different populations, and (*v*) differences in protocols. Cross-cultural studies (1–4), mostly administered by multiple researchers, did not exclude and could not test for these confounding causes of variation between their study populations.

Participants collected their payments individually at a private location in exchange for their identification tokens, and the order in which they did so was randomized. All payments were made in real money in exact change.

Salt Decisions. Participants made their salt decisions on arriving to collect their payments at a private location. The salt decision was made before a player's earnings from the games were made known and given to her. The private location for the payments was chosen so that players could subsequently go home by a route unseen by the other waiting players. This ensured that each player could take away her desired salt quantity unseen by others and that waiting participants did not prematurely find out about the salt. Hence, participants encountered the salt for the first time when they individually collected their payments and possessed no prior information about it. They did not know how much salt was available to anyone else.

All information about the salt was delivered by one of the authors (S.L.) from a standardized script (*SI Text* section 1.8), and a research assistant weighed the desired quantity. The total amount available (x) and the amount available per person ($z = x/y$) were calculated to the nearest 100 g for each person.

Semiexperimental methods, as implemented with the salt decision, offer promise for modifying economic game methodology to obtain measures of human behavior outside an experimental context. Such measures are more likely to capture behavior in the real world. By definition, it is impracticable to obtain real-world observational data on individual behavior under one-shot anonymous conditions. Data on repeated and/or nonanonymous real-world behavior do not allow a fair evaluation of the real-world external validity of one-shot anonymous economic games because behavior under repeated

nonanonymous conditions may be driven by different factors from that under one-shot anonymous conditions.

Demographic and Individual Data. Demographic and other data on individuals were collected via a standardized questionnaire administered by a research assistant. Once all games in a village had been completed, a population census was conducted and the geographic coordinates for every house in the village were recorded using a global positioning system (Garmin GPS 12XL). Geographic information systems (GIS) data were processed and analyzed in ArcGIS (version 9.2; Environmental Systems Research Institute). Table S5 lists all village and individual descriptors that were included in the analyses and provides a description of each variable.

Analyses. Multilevel multivariate response models (15, 23, 24) were used to analyze variation explicitly at the village and individual levels in our structured data (individuals within villages) and the relationship of population and individual descriptors with the measure of cooperation (response variable). Multivariate response models allow us to model multiple response variables, PGG contribution and salt deviation in this case, simultaneously. They therefore allow simultaneous estimation of effects of explanatory variables on each response variable. Models contained two response variables, PGG contribution and salt deviation, for individuals (level 1) nested within villages (level 2). We also obtained the residual correlation between the two response variables, both at the individual (level 1) and village (level 2) levels, through an analysis of the covariance structure. Multivariate response models accommodate missing data for the response variables; individuals who had a response value for only PGG contribution or salt deviation were included in the analyses. All multilevel analyses were conducted in MLwiN, version 2.14 (23, 24). We mainly use an information-theoretic model-fitting approach (25, 26) to analyze data and interpret results. Analyses proceeded in four stages (details provided in *SI Text* section 1.6 and Tables S6–S8) and included a series of domain-wise (sets of related variables, such as those measuring wealth and kin, as described in Table S5) models in view of the large number of variables analyzed and the potential correlations between them.

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Supporting Information

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SI Text

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1.1. Study Populations. ***1.1.1. Ethnographic description.*** The Pahari Korwa (Hill Korwa) are a small-scale forager-horticulturist society, classified as a "primitive tribal group" by the Government of India (1), who live largely in the central Indian state of Chhattisgarh. They belong to the Kolarian ethno-linguistic group of tribes, and have a close affinity to the Austro-Asiatic Munda language family (2, 3). The introduction of forest protection laws by the Government of India in 1952 precipitated a shift from their traditional nomadic lifestyle completely reliant on hunting, gathering, and swidden agriculture to settled communities based around individually owned land (3). They remain heavily reliant on gathered forest products, which are a primary source of food and income, but they also practice agriculture on small tracts of land, usually adjoining forested areas. These economic resources are supplemented by opportunistic hunting and fishing as well as wage labor. Men hunt in groups with bows and arrows; with the exception of the shooter, who usually gets a larger share, the meat is shared equally. Typically hunted animals are wild boar, small deer species, and species of birds [e.g., kotri, also known as the rufous treepie (*Dendrocitta vagabunda*)]. Fishing may be conducted solitarily, in pairs (often a conjugal pair), or in small groups, and the catch is shared equally. Fields are always tended by family units, but families with larger fields may enlist the help of other village residents in exchange for a meal and liquor. The staple is rice, but maize, millet, pulses, potatoes, and small quantities of vegetables are also grown. Small numbers of goats, chickens, and pigs are reared by families, mostly for personal consumption.

Individuals in all populations visited during this study speak Sargujia, a regional dialect of Hindi; the Korwa language is infrequently used on an everyday basis. Villages differ in their access to markets. Most individuals attend a local weekly market with varying frequency, where they buy, sell, and barter goods. The weekly market usually assembles in one of the larger multiethnic villages in the plains and is visited by people of various ethnicities from surrounding villages. Korwas often have to walk several kilometers downhill to the nearest market site. Settlements have well-defined boundaries; large tracts of forest and hills generally separate neighboring villages. Both uniethnic and multiethnic villages of varying sizes exist, although uniethnic settlements predominate.

The Pahari Korwa typically live in nuclear households. Lineally extended households in which a married couple lives with their married children are also seen. In this endogamous, patrilineal, and patrilocal society, exogamous marriages usually incur severe penalties, typically entailing ostracism and expulsion from the tribe and village. The expulsion can sometimes be reversed by what amounts to a substantial fine imposed on the offenders; they sponsor a large ritual feast. The majority of Korwas marry monogamously, but polygyny is practiced by some, usually more affluent, men (2, 3). The Korwa practice bride-price. Although the woman usually moves to the home of the man following marriage, couples often cohabit at the home of either's parents and a woman may even have a first child before the formalities of the marriage are completed. There is no caste system. Korwas live in either temporary huts made of sal (*Shorea robusta)* tree branches with thatched roofs or more permanent mud houses with a roof constructed from baked mud tiles (2, 3). Korwa settlements are dispersed, with large distances between houses, often spanning a kilometer or more. Clustered settlements are rare.

Across villages, sources of water include small streams and rivers, natural springs, wells, and hand pumps constructed by the Indian government. People sometimes walk up to a kilometer to their primary source of water. Electricity has not reached most villages. None of the 16 villages included in this study had electricity. Sal tree wood is the primary source of fuel, used essentially for cooking and to provide warmth in the winter.

The Korwa practice ancestor worship (2). They also worship indigenous gods and goddesses, often associated with the forest, hunting, or a prominent local geographic site, such as a big hill or cave in the region. They have recently started adopting Hindu practices and deities in some villages, although these still tend to coexist with their indigenous divinities. Korwa festivals are usually centered around the sowing or harvest of certain crops, the harvest of seasonal forest products, or protection and prosperity during particular seasons (e.g., the monsoon season) (3). One of the biggest festivals in the calendar year is the harvest festival called "Cherta," which is usually celebrated in the month of January. The festival is celebrated with gusto and involves the slaughter and consumption of chickens and goats as well as the consumption of special foods and vast quantities of "hadiya" (rice beer) and "mahua" (potent alcohol manufactured from a flowering tree of the same name). People visit others' homes and invite their friends and relatives, both from the village and from other villages, to wine and dine at their homes.

1.1.2. Distribution. A hill tribe, the Pahari Korwa are mainly found in four northern districts of the central Indian state of Chhattisgarh (17.46° to 24.5° north, 80.15° to 84.20° east) in India, namely, Sarguja, Jashpur, Raigarh, and Korba (3–5). The region contains the eastern edge of the Satpura Range and the western edge of the Chotanagpur Plateau. Defined by table-land interspersed with hills and plains, the area is partly drained by the Mahanadi River basin. The district of Sarguja contains the largest numbers of Korwas; here, they are dispersed in about 260 villages and number at around 20,000 individuals (6). Villages show considerable variation in population size, ranging from about 10 to several hundred individuals, and are located at a range of distances from the region's main town, Ambikapur, which has a population of ~66,000 (as per the Indian population census conducted in 2001).

1.1.3. Village details. Fig. S1 displays the geographic distribution of the 16 study villages and the town of Ambikapur. Village means for participants from each study population are presented for basic individual descriptors, residence, and migration variables in Table S1 and for measures of wealth, market contact, and social networks in Table S2 (descriptions of these variables are provided in Table S5).

1.2. Sampling and Logistics. One of the authors (S.L.) obtained a list of Pahari Korwa villages with their population sizes as estimated in the most recent Indian population census conducted in the year 2001 from the Hill Korwa Development Agency, a department of the Chhattisgarh State Government. She also obtained more recent census data for a subset of these villages, which were collected in 2004 and 2005 by a local nongovernment organization called Chaupal. Information from the lists was combined with that obtained from members of Chaupal to identify a set of villages incorporating reasonable variation in population size and distance from Ambikapur and each other. Our sample of villages is therefore not strictly random. Given that demographic variation in the village sample is a crucial feature of our study design, we could not have used a fully randomized sampling strategy and been certain of obtaining a dataset with reasonable demographic variation without sampling a very large number of villages. Constraints on resources and time necessitated adoption of the sampling strategy for villages described above; this allowed us to obtain the minimum recommended sample size suitable for the application of multilevel analyses (*SI Text* section 1.6.1).

The research team consisted of one of the authors (S.L.) and two research assistants. On our arrival in a village, we would make contact with the village head or other senior person in the village and describe the purpose of our visit. We informed him that we were a group of researchers from a university (a big school) and were conducting a study with the Pahari Korwa. We stated that we would stay in the village for about a week, the first 3 d of which we would conduct a program in which we sought the participation of village residents, both adult men and women. We further informed him that all participants in our study would receive 30 rupees and a meal for each day they attended and that they would have the opportunity to earn more money based on their performance in certain games we would play with them. We assured him that participation was completely voluntary and that the games were thought-based and did not involve physical exertion. Once the village senior was convinced of our credentials, we enlisted his help and that of any other assembled individuals to advertise the study in the rest of the village via door-to-door visits. Individuals who willingly gathered on the day of the games participated in the study. Note that any non-Korwa residents in a village did not participate in the study.

Korwas usually live atop hills amid forest with no road infrastructure; access to most villages is therefore by foot. Since we provided a meal to every participant on the day of the games, we transported rations catering meals for about 50 people, 50 kg of salt, and various other supplies and equipment by car up to the closest motorable point, from where we trekked by foot, sometimes for several hours, up to the Korwa village. We often enlisted the help of residents of a nearby village accessible by car to help us carry the heavy rations from the vehicle to our destination village. Alternatively, two of us would trek to the Korwa village under investigation and bring back residents from there to help us carry the rations to their village. During our stay in each village, we resided in the home of one of the village residents, who generously provided us space inside the house or in the verandah that is attached to most houses. We cooked our meals separately on a wood fire (our hosts provided us with firewood), and our hosts typically invited us to at least one meal at their hearth. We presented a gift to our hosts in the form of food rations and some money when we departed.

1.3. PGGs. ***1.3.1. Anonymity.*** Participants made all game decisions once and anonymously, and they were made explicitly aware of the one-shot anonymous set-up of each game. A player made her decisions individually at a private location, and apart from the player and one of the authors (S.L.), no other individual was present when she made her decisions. Player names were not recorded; a player's only identification in the study was a numbered token. Each player retained the same token throughout the study to facilitate the comparison of individuals' decisions across the multiple measures of cooperative behavior. Players were unaware of the identity of the individuals they played with and remained so even after the study was completed. No village resident could therefore know the decision of a player or what she earned in the game, either during or after the study.

1.3.2. Game instructions and testing. Instructions were delivered from a standardized script in Sargujia. Game scripts (*SI Text* section 1.8) were first translated from English to Hindi by one of the authors (S.L.) and then from Hindi to Sargujia by research assistants. The back-translation method was used to ensure accuracy of translation. Players were instructed about the game rules and given examples both collectively and then individually at the private location where they played the game. The PGG is a more complicated game than the ultimatum game. From prior experience piloting the ultimatum game in similar populations, we estimated that if we explained the PGG rules and examples to each player one at a time only, the total time required to obtain adequate sample sizes in each village would have been in the order of several days. This would have created ample opportunity for individuals who had played the game to discuss it with other village residents who were yet to play. To avoid such inevitable contamination, we first instructed all participants collectively (this usually took about 45 min) and then individually so as to complete the games in a single day.

Real money was used to demonstrate game rules and examples, and the instructions explicitly demonstrated the complete anonymity of decisions. Players were tested both collectively and individually for their understanding of the game rules and the anonymity of their decisions. Only players who individually answered a set of test questions correctly played the game. The questions were designed to assess their understanding of the game and features of the experimental set-up, such as anonymity.

1.3.3. Administration. All games in all villages were administered by one of the authors (S.L.). Before this study, we had no contact with any individual from any of the 16 villages included in this study. This protocol minimized experimenter familiarity with the players. On the day of the games, all participants collected at a common location in the village that was usually outdoors. We then designated three sites: the first for players who were waiting to play the game, the second for those who had played, and the third as a private location where the players made their game decisions. The locations were at least 10–20 m apart from each other, typically further, and always out of earshot. The private location was often in the village school building, in a village resident's hut, or, on occasion, at an isolated outdoor site. Individuals who had played the game were prevented from interacting with those who had not yet played the game; participants who had played the game were seated at a separate location from those who had yet to play, and research assistants monitored the two groups to ensure there was no discussion about the game. Participants were forbidden from discussing the game during the study period and warned that the games would be discontinued if they did. We provided rations, which were cooked and consumed on the day of the games, for a full meal for each player. The meal was cooked by the waiting participants themselves; this kept them occupied for a few hours. They prepared a full meal for 25–30 people and manufactured plates and bowls from sal tree leaves for everyone.

Play order was randomized. Participants made their game decisions by physically manipulating real 5-rupee coins and depositing their contributions into a money box. Groups of six were constituted by randomly matching token numbers. Of the 52 games played across 16 villages, the total number of players was indivisible by 6 in nine games; six games had a group size less than six (n = 3 or 4), and three games had a group size greater than six (n = 7 or 8). These differences in group size do not change the relative payoff structure of the game. Players always thought they were in a group of six players, including individuals who were actually in smaller or larger groups, because they were unaware of the number of people who did not play the game because of a failure to answer all test questions correctly.

1.3.4. Payments. All participants received a show-up fee of 30 rupees, which is just under a single day's local wages. From demographic data collected on 784 adults, we estimated mean local wages in the region at 38.68 ± 12.05 rupees per day.

The stakes of the game were determined as an approximate multiple of mean local wages estimated by sampling several villages in the study region. Individuals across all villages participate in similar economic activities and visit the same markets. Moreover, previous studies suggest that stake size does not significantly affect behavior in the PGG and ultimatum game (7, 8). For all the above reasons, the stakes were kept constant across villages.

1.4. Salt Decisions. We used salt as the currency of the decision frame because it is an essential commodity that is valued by the Pahari Korwa (they cannot obtain it directly from the forest or manufacture it themselves), can be measured on a continuous scale, is transported and stored without spoiling, and is unlikely to cause social repercussions after the games. The other obvious choice, rice, is often traded for or converted into alcohol if acquired in excess by the Pahari Korwa. A recent ethnography confirms that salt is one of the commodities that the Pahari Korwa are most likely to buy at market (2). It is very unlikely that limitations on physical strength affected the amount of salt that individuals took because both Korwa women and men regularly carry large amounts of weight (tens of kilograms), in the form of wood, forest products, rice, and other commodities, for long distances in hilly terrain to and from the forest, markets, and town.

Participants would have been unaware that the research team had brought large quantities of salt to the village because the salt was brought in opaque sacks with the other food rations distributed during the games.

1.5. Demographic and Individual Data. Five village descriptors were included in this study. The village descriptors "population size" and "proportion of migrants" (a measure of migration rates between populations) are of interest because they are directly linked to the evolutionary stability of cooperation in a population; the theoretical literature demonstrates that large populations and high rates of migration work against the evolution of cooperation (reviewed in 9, 10). The village descriptor "proportion of non-Korwas" is used to examine whether any variation between villages is explained by the coresidence of other ethnic groups; theoretical and empirical studies demonstrate that intergroup competition can promote within-group cooperation (e.g., 11–15). The variables "household dispersion" and "distance from major town" allow investigation of whether residence patterns show an association with levels of cooperation.

Individual descriptors included in this study were chosen in five domains; two of these domains, namely, "basic individual descriptors" and "wealth, markets, and social networks," provide essential information on socio-economic characteristics of individuals, such as age, sex, household size, education, marital status, and wealth, that may affect their behavior. These domains also include measures of individual market contact, since recent studies propose that market integration has a major impact on levels of cooperation (16, 17). Variables in the domain "residence and migration" capture the migratory history of each individual, and thus allow analyses of whether or not, and to what extent, migrating to another population affects the behavior of an individual. The domain "children and grandchildren" measures the number of living offspring individuals have. Finally, the domain "kin" measures the number of living relatives that an individual has and also records how many of these relatives reside in the same village as the individual. Variables in the latter two domains are used to investigate whether there is any support for kin selection (18) models of cooperation in these populations. Note that because of an oversight, data on the number of kin who participated in the PGG (Table S5) were not collected in the first three villages visited, namely, Kharranagar, Chipni Paani, and Pareva Aara.

1.6. Analyses. ***1.6.1. Multilevel models.*** Multilevel models are used to analyze hierarchically clustered units of analysis, for instance, individuals within villages within cultural groups. These models account for the possibility that units within a cluster, such as individuals from a village, may be more alike than units across clusters, such as individuals across villages. Ignoring the potential correlation of units within a cluster (i.e., the multilevel structure of data) can result in an underestimation of SEs. Multilevel models correct for such nonindependence of clustered data, reducing the likelihood of type I errors. They also allow us to estimate the effects of groups along with group-level predictors accurately.

Analyses proceeded in four stages. In the first stage, null models (with intercept terms only) were constructed with and without a multilevel structure and these were compared to establish whether the multilevel model provided a significantly better fit to the data. The deviance information criterion (DIC) was used to compare models (19). The DIC is a Bayesian measure of model fit and complexity; it accounts for the change in degrees of freedom between nested models. Models with a lower DIC value provide a better fit to the data, and a difference in DIC values of 5–10 units or more is considered substantial (19, 20). In the second stage, a series of multilevel univariate models were constructed to explore the relationship between each explanatory variable in the dataset and the outcome variable. A Wald test (21) was used to establish the statistical significance level of an explanatory variable. In the third stage, a series of domain-wise (sets of related variables, such as those measuring wealth and kin, as described in Table S5) models were produced to identify the important explanatory variables within each domain. Once again, a Wald test was used to establish the statistical significance of variables.

The full model was constructed in the fourth stage, implementing a step-wise procedure with three serially entered blocks of variables. The first block entered contained all those variables from the domains of village descriptors; basic individual descriptors; residence and migration; and wealth, markets, and social networks that reached significance at $P < 0.10$ within their domains (in the third-stage domain-wise analyses); the block additionally contained age and sex even if they did not reach significance. The model obtained was then reduced by a backward procedure eliminating predictor terms that did not reach significance in a Wald test at the $P < 0.05$ level. However, reduced and nonreduced models were compared for fit using their DIC values, and the model with the lower DIC value was always retained, whether or not the variables in it reached significance at $P < 0.05$. All variables that were not discarded at this stage were carried forward, and the next block of variables was added into this model. The second block added contained all those variables from the domain of children and grandchildren that reached significance at $P < 0.10$ within this domain. The backward step-wise procedure was repeated with the new block of variables. The third block added contained all those variables from the domain of kin

that reached significance at $P < 0.10$ within this domain. The variables age and sex were carried forward to the last block even if they did not reach significance at $P < 0.05$. They were only eliminated at the very end if they did not reach significance at the $P < 0.05$ level. Hence, the three blocks of variables were added in a forward step-wise procedure; however, within each block, variables were eliminated in a backward step-wise procedure to obtain the full model. Table S6 and Table S7 present the univariate and domain-wise models respectively, and Table S8 presents a step-wise summary of the full model-fitting process implemented in the fourth stage.

Iterative generalized least squares estimation with a second-order predictive (or penalized) quasilikelihood approximation was used to fit all univariate (second stage) and domain-wise (third stage) models. The null (first stage) and full (fourth stage) models were fitted using Markov chain Monte Carlo estimation (22) run for 10,000 iterations and a burn-in period of 500 iterations.

The small sample sizes in some villages are a reflection of the small populations in these villages (e.g., Chipni Paani had only 12 adults, all of whom participated in this study). Multilevel models account for sample size differences between populations when computing the variance components and parameter estimates. A total of 70–100% of households had at least one household member participate in the games in all villages except Ghatgaon, Bakrataal, and Tedha Semar, where this proportion was 17%, 55%, and 55%, respectively. The latter three villages are among those with the largest populations in our dataset (Table 1). Although we estimated how many households were represented by at least one individual once all games had been completed, we did not collect data on which household each individual belonged to so as to avoid compromising players' anonymity. Hence, we cannot include households as an additional level in our models.

1.6.2. GIS analyses. GIS data were processed and analyzed in ArcGIS version 9.2 (23). All maps (Fig. S1) were created and analyzed using the World Geodetic System (WGS) 1984 Geographic Coordinate System with a transverse Mercator projection. A 30-m digital elevation model (ASTER Global Digital Elevation Model V001) was used for the relevant map area; this was obtained from the National Aeronautics and Space Administration Land Processes Distributed Active Archive Center (https://wist.echo.nasa.gov). The base map [Environmental Systems Research Institute, Inc. (Esri) Street Map World 2D (old) 2009 Esri, Automotive Navigation Data, Tele Atlas North America, Inc., Esri Japan, United Nations Environment Programme-World Conservation Monitoring Centre] used in Fig. S1*A* was obtained from the ArcGIS Online Resource Centre. The nearest neighbor index (24), calculated for households in each village, is used as the measure of household dispersion for each village (village descriptors are provided in Table S5).

1.7. Additional Discussion. ***1.7.1. Correlates of cooperative behavior.*** In the full model, two variables have a significant positive association with PGG contributions, namely, age and the number of individuals from other villages invited to the annual harvest festival by a player's household, representing a measure of social network size [Table S4, full model (multilevel)]. Note that the number of invitees to the annual harvest festival from a player's own village or other villages does not covary with any of three measures of wealth recorded in this study (Table S5). An increment of 10 y in an individual's age corresponds to an increase in her PGG contribution by 3.7% of the initial endowment of 20 rupees. Ten additional people in a player's social network correspond to contributions that are higher by 5.8% of the initial endowment. With a few exceptions (25, 26), age effects have seldom previously been reported in the PGG, perhaps because most experimental work is conducted with undergraduate students of similar age. A study (27) implementing a PGG among a wider cross-section of individuals from The Netherlands found that age was not a robust predictor of PGG contribution but was positively associated with the allocation of punishment in a PGG. Age had a small positive association with ultimatum game offers among the Sangu, a population of agro-pastoralists in southwest Tanzania (28). It is notable that, specifically, the number of individuals invited to the harvest festival from other villages, as opposed to the player's village, is associated with PGG contributions. This finding raises the possibility that particular features of an individual's social network, such as its width or composition, influence levels of cooperation. Indeed, many authors suggest that the structure of the social network should have an impact on levels of cooperation between members of the network, largely by increasing communication and/or allowing cooperators to interact selectively (29–35). Among the Pahari Korwa, festival invitees from other villages often comprise affinal kin between whom the maintenance of reciprocal relationships may be important. A recent study demonstrates that more connected individuals in a network of interacting players make higher contributions to an anonymous PGG (36). Specific structural parameters of an individual's social network may indicate characteristics of other individuals in the network and whether they are likely cooperators.

Only two variables significantly affect player salt deviation, population size and the number of full sisters over the age of 15 y (adult sisters) residing in the village, both of which have negative effects [Table S4, full model (multilevel)]. Ten additional individuals in the village population are associated with salt deviations that are 29 g lower on average; players were more selfish in larger villages. The number of adult sisters residing in the village has a large effect on salt deviation; each additional adult sister living in the village corresponds to salt deviations that are lower by 624 g on average.

Previous studies based on considerably smaller samples have either found no effect (37) or a positive effect (16) of population size. Population size is negatively correlated with the proportion of migrants in our study populations. One possibility is that ecological and resource constraints (e.g., quality of forest cover) drive both these relationships, making cooperation more costly in larger populations and also making larger populations less attractive to migrants. The negative effect on salt deviation of sisters over the age of 15 y residing in the village, as opposed to other siblings, may also be related to the cost of cooperation. The average age of marriage for women is about 15 y(4); thus, most of these adult sisters are probably women who married within their natal villages in a predominantly patrilocal society. A total of 66.5% of all women ($n = 388$) in our survey sample moved to a village other than their natal village after marriage, as opposed to 15.6% of all men ($n = 392$). The additional pressure of competing for material or other resources (e.g., grandmaternal care) with kin who usually move out of the local group may make cooperation more costly, tipping the balance from kin-biased cooperation to competition (38). Frequencies of particular kin may cue individuals' likely average genetic relatedness to others in the local group and may indicate the intensity of competition experienced within the group at large and not just from direct kin. A similar and symmetrical effect was found in a matrifocal community, where men are the predominantly migrating sex; women made lower offers in an ultimatum game when they had more brothers in the village (39).

The total amount of salt available (pie size) has a small negative effect on salt deviation; people took more salt when more was available (Table S6). However, the association of behavior with population and individual descriptors is independent of this pie-size effect.

There may be several reasons why salt decisions and PGG contributions are affected by different explanatory variables, including differences in the decision structure, the use of a commodity as opposed to money, or the less game-like and more

real-world context of the salt decision. However, further work is required to ascertain whether or not and why cooperation in different contexts may be sensitive to different explanatory variables. A large number of predictor variables were included in this study. Although there are theoretical grounds for why we might expect associations between these variables and cooperative behavior (*SI Text* section 1.5), replications of this study will establish whether the associations we find are stable and consistent across varied ecologies.

1.7.2. Unique measure of cooperative behavior. Semiexperimental methods, as implemented with the salt decision, offer promise for modifying economic game methodology to obtain measures of human behavior outside an experimental context. Such measures are more likely to capture behavior in the real world (i.e., they have greater external validity) (40). This study examines whether cooperative behavior as captured by one-shot anonymous economic games reflects real-world behavior under comparable conditions. Wiessner (41) compared one-shot anonymous game behavior with nonanonymous, probably repeated, real-life interactions and, unsurprisingly, found little association.

1.8 Game Scripts. This section contains the English language versions of the standardized scripts used in this study. These scripts were translated to and administered in Sargujia.

1.8.1. PGG. Script read collectively to participants. Thank you for attending this study. For the time that you are taking off from work to spend here, we will give each of you 30 rupees. This money is yours to keep, is being given to you in place of your day's wages, and will be given to you at the end of the program. We have also made arrangements for a meal for you.

Please remember that if, at any time, you feel you do not wish to participate in this study, you are free to leave whether we have started the program or not.

We would like to play a game with every person assembled here. Please play this game seriously because you can earn more money in this game. The money earned in this game, along with your 30 rupees, will be given to you one at a time at the end of this program. Hence, at the end of the program, you will receive 30 rupees, but on top of that, you will also receive the money that you have earned in the game.

For this program, you must remember four points:

The first point is that the game we will play today is different from the game played earlier. For this game, you will be divided into groups of six players. These six players will play the game with each other. However, you will never know who the other five players in your group are, either during or after the game. These other five players will also never know who you are, either during or after the game. You will never meet the other players in your group or be able to know their names, either during or after the game.

I will give you a token like this. Every token has a different symbol (number) on it. In this program, this token will be your only identity. Even I will not ask you your name. Your complete identity will be in this token. Other than me and the research assistant, do not show this token to anyone assembled here. Even I will not be able to tell anyone what decisions you have taken because I only know your token numbers and not your names. Other than me, no one will know your token numbers. Which six people from the village play the game with each other will be determined by randomly matching token numbers.*

The second point is that all the decisions you will make in the game will be for real money. You will receive real money at the end of the program in accordance with the decisions you have made and how much you have earned.

The third point is that the money you are receiving today does not belong to me. It has been given to me by the school to conduct this program. It does not matter to the school whether this money is spent or not.

The fourth point is that once I have told you the rules of the game, please do not discuss the game among yourselves and also do not discuss it with other people from the village who are yet to play the game. This is very important. You cannot ask questions or talk about the game until this program is over. You will get a chance to ask questions when you are in the private room. Please be sure that you obey this rule, because even one person defaulting can spoil the game for everyone. If even one person starts talking about the game while sitting here, we will not be able to play the game in your village. Once you have played the game, you will not be able to talk to or meet with all the remaining people assembled here who have not yet played the game.

I will now tell you the rules of this game.† It is important that you listen carefully and understand these rules, because only those people who understand the rules will be able to play.

For this game, you will all be divided into groups of six players and each group will be given a group pot. Each individual in the group will receive an endowment of 20 rupees (meaning 1 kori‡) in 5-rupee coins. These 20 rupees (1 kori) are yours. Now, you can deposit as much of these 20 rupees (1 kori) as you wish in the group pot, in 5-rupee increments. This means that you can deposit nothing in the group pot if you wish or you can deposit 5, 10, 15, or 20 rupees (1 kori) in your group pot. The money that you do not deposit in the pot will be yours to keep and to take home. Once each of the six people in your group have decided how much of their 20 rupees they want to deposit in the group pot, I will count the money deposited in your group pot, double the total amount of money deposited, and then divide this doubled amount equally between the six people in your group. Hence, at the end of the game, you will receive the amount of money that you did not deposit in the group pot, plus an equal share of double the total amount of money accumulated in the group pot. Therefore, in this game, you have to decide how much of your 20 rupees (1 kori) you wish to keep for yourself and how much you wish to deposit in your group pot. Note that you will make your decision independently and in private so that none of the other members of your group can ever know your decision. All decisions will only be taken once.

Now, I will give you some examples so that you can understand the game properly.

The first example is if all the women and men in your group deposit their whole 20 rupees (1 kori) in the group pot, the pot will accumulate a total of 20 multiplied by 6, meaning 120 rupees (6 koris). One hundred twenty rupees (6 koris) doubled is 240 rupees (12 koris). If 240 rupees (12 koris) are divided into six equal shares, one share will contain 40 rupees (2 koris). Therefore, each group player will receive 40 rupees (2 koris). If no one in your group deposits anything in the pot, you will each receive only your endowment of 20 rupees (2 koris).

The second example is if everyone in your group deposits nothing in the group pot, the pot will contain nothing and each of your group players will receive only your endowment of 20 rupees (2 koris).

The third example is if one group player does not deposit anything in the pot and the remaining five group players deposit

*Since the PGG was played in each village after the ultimatum game had already been played, participants were familiar with the use of tokens to make identities anonymous as well as to match players randomly in the games. This procedure had been demonstrated in great detail with real tokens and models pulled up from among the participants. Participants were also familiar with procedural details, such as the facts that the games were all played individually at a private location and that the tokens would be exchanged for earnings in the game.

†All game rules and examples were demonstrated with real money and a money box.

‡1 kori = 20 units.

their whole 20 rupees (1 kori) in the group pot, the pot will accumulate a total of 20 multiplied by 5, meaning 100 rupees (5 koris). One hundred rupees (5 koris) doubled is 200 rupees (10 koris). If 200 rupees (10 koris) are divided into six equal shares, one share will contain 33 rupees (1 kori and 13 units). Therefore, each of the five group players who deposited their whole 20 rupees (1 kori) into the pot will receive 33 rupees (1 kori and 13 units), and the one group player who deposited nothing in the pot will receive 33 rupees (1 kori and 13 units) plus her endowment of 20 rupees that she kept for herself. Therefore, she will receive a total of 53 rupees (2 koris and 13 units). Hence, if one group player does not deposit anything in the pot and the remaining five group players deposit their whole endowment of 20 rupees (1 kori), this first player will earn more money than the remaining five players and will also earn more money than she would have earned if all six players had deposited their whole endowment of 20 rupees into the group pot as illustrated in the first example.

The fourth example is if one group player deposits 20 rupees (1 kori) in the group pot and all the other players deposit nothing, the pot will accumulate a total of 20 rupees (1 kori). Twenty rupees (1 kori) doubled is 40 rupees (2 koris). If the 40 rupees (2 koris) are divided into six equal shares, each share will contain 6.5 rupees (6 rupees and 8 annas). Hence, the group player who deposited her whole endowment of 20 rupees (1 kori) in the group pot will receive 6.5 rupees (6 rupees and 8 annas) and the remaining five group players will receive 6.5 rupees (6 rupees and 8 annas) plus their endowments of 20 rupees that they kept for themselves. Therefore, they will each receive a total of 26.5 rupees (1 kori, 6 rupees and 8 annas). Hence, if only one group player deposits her whole endowment of 20 rupees (1 kori) into the group pot but the remaining five group players do not deposit anything, this first player will earn less money than the remaining five players and will also earn less money than she would have earned in the other three examples given so far.

Hence:

i) If all six group players deposit some money in the group pot, they will earn more money than if no one deposits anything in the pot.
ii) If most group players deposit some money in the group pot but a few group players do not deposit any money, the few players who did not deposit any money will earn more than the players who did deposit money.
iii) If most group players do not deposit any money in the pot and a few players do deposit some money, these few group players earn the least amount of money.

Now, I will ask you some questions to check whether you have understood the rules of the game or not.

i) How many players are there in each group?
ii) Can you ever know who the other players in your group are?
iii) Can the other players in your group ever know your identity?
iv) What is the endowment that each player of the group receives at the beginning of the game?
v) What decision must each player take about these 20 rupees (1 kori)?
vi) If you so wish, can you take the decision to deposit nothing in the group pot?
vii) If you so wish, can you take the decision to deposit the whole 20 rupees (1 kori) into the group pot?
viii) Once all six group players have decided how much money they want to deposit in the group pot, what will I do?
ix) What will your total earnings consist of?
x) Will you be given your earnings in real money at the end of the game?
xi) Why is each of you being given a token?
xii) Will I ask for your name while you are playing this game?
xiii) Can I tell any other person in the village what decision you made in the game? Why not?

Does anybody want to leave this program? Is everyone happy to participate?

Now, we will begin. You will each pick a number out of this bowl to determine the order in which you will play the game. You will come into the private room one by one. The research assistant will tell you when it is your turn to come into the room. Then, I will ask you some questions to check whether you have understood the rules of the game or not. If you answer my questions correctly, you will play the game. Arrangements for a meal have been made for you all.

Script and test questions read individually to participants. Now, I will explain the rules of this game to you one more time.§ For this game, you will all be divided into groups of six players and each group will receive a group pot. Each player in the group will receive an endowment of 20 rupees (1 kori) in 5-rupee coins. Each person has to decide how much of her 20 rupees (1 kori) she wants to deposit in the group pot and how much she wants to keep for herself. The money that you do not deposit in the pot will be yours to keep.

This means:

If you deposit five rupees in the group pot, how much money remains?
If you deposit 10 rupees in the group pot, how much money remains?
If you deposit 15 rupees in the group pot, how much money remains?
If you deposit 20 rupees in the group pot, how much money remains?
If you deposit nothing in the group pot, how much money remains?

So, the money that you do not deposit in your group pot, the money that remains, will be yours to keep. On top of that, once each of the six people in your group has decided how much money she wants to deposit in the group pot and how much she wants to keep for herself, I will count the money deposited in your group pot, double the total amount of money deposited, and then divide this doubled amount equally between the six people in your group. Hence, at the end of the game, you will receive the amount of money out of your endowment of 20 rupees (1 kori) that you did not deposit in the group pot, plus an equal share of double the total amount of money accumulated in the group pot. You cannot know what decisions the remaining five people in your group have taken, and they cannot know what decision you have taken.

Now, I will ask you some questions to check whether you have understood the rules of the game or not.

The first question is if all the six players in your group want to keep their 20 rupees (1 kori) for themselves and do not want to deposit any money in the group pot, no money will accumulate in the group pot. If nothing accumulates in the pot, no one gets any share out of the pot but all you six group players have kept your endowment of 20 rupees (1 kori) for yourselves. So:

i) How much money will you earn?
ii) How much money will each of the other players in your group earn?

The second question is if each of the six players in your group deposits her endowment of 20 rupees (1 kori) into the group pot,

§All game rules and test question examples were demonstrated with real money and a money box. Participants made their decisions by physically manipulating real money.

the group pot will accumulate 120 rupees (6 koris). One hundred twenty rupees (6 koris) doubled is 240 rupees (12 koris). If I divide 240 rupees (12 koris) equally between six people, each share will contain 40 rupees (2 koris). So:

i) How much money will you earn?
ii) How much money will each of the other players in your group earn?

The third question is if all the other five players of your group want to keep their 20 rupees (1 kori) for themselves and do not want to deposit anything in the group pot and you want to deposit your 20 rupees (1 kori) in the group pot, the group pot will accumulate only 20 rupees (1 kori). Twenty rupees (1 kori) doubled is 40 rupees (2 koris). If I divide 40 rupees (2 koris) equally between six people, each share will contain 6.5 rupees (6 rupees and 8 annas). So:

i) How much money will you earn?
ii) How much money will each of the other players in your group earn?

Therefore, if all the six players in your group keep their 20 rupees (1 kori) for themselves and do not deposit anything in the group pot, the group pot will accumulate no money and each player will only receive her endowment of 20 rupees (1 kori). If all six players in your group deposit their 20 rupees (1 kori) in the group pot, the group will accumulate 120 rupees (6 koris). One hundred twenty rupees (6 koris) doubled is 240 rupees (12 koris), and if I divide 240 rupees (12 koris) equally between six people, each share will contain 40 rupees (2 koris). Thus, all your six group players will receive 40 rupees (2 koris) each. However, you cannot know whether the remaining five players in your group have deposited anything in the group pot or not. If the remaining five players do not deposit anything in your group pot and you deposit your whole endowment of 20 rupees (1 kori), you will earn less money and they will earn more money.

Now, tell me, can you know who the other five players in your group are or what decision they have made?

Can any of the other players know your name or the decision you have made?

Now, you will play the game. Remember that you must take your decision independently and there is no right or wrong answer in this game. Here are your 20 rupees (1 kori) in four 5-rupee coins. You must decide how much of these 20 rupees (1 kori) you want to deposit in your group pot and how much of it you want to keep for yourself. Remember that you can deposit nothing in the pot if you wish or you can deposit 5, 10, 15, or the whole 20 rupees. Please put the amount you want to deposit in the pot into the pot and keep the rest on this side. Thank you.

1.8.2. Salt decision. Script read individually to each participant when collecting her payment. I have brought some salt with me to give to everyone who participated in this study. I have a total of x kg of salt remaining, and there are y people remaining. Therefore, I have got z kg of salt per person. However, you can take as much of this x kg of salt as you wish. Now, tell me how much of this x kg of salt you would like to take home, and I will give you that much salt.

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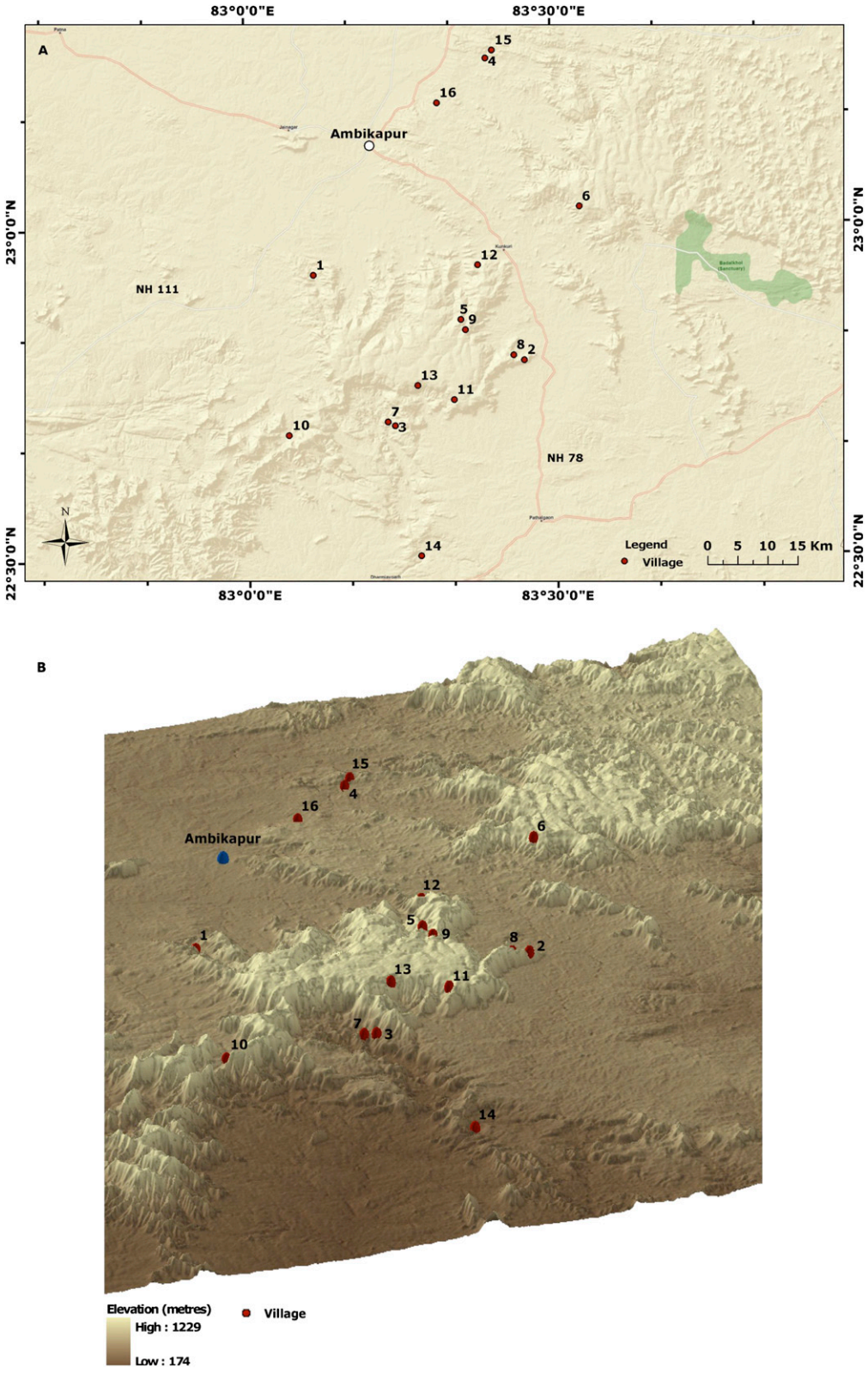

Fig. S1. Maps displaying the distribution of the 16 study villages and the town of Ambikapur (*A*) and the elevation of the 16 study villages and Ambikapur (*B*). Displayed numbers indicate relative population size (1 = lowest) and correspond to the "Village number" column in Table 1. Two national highways intersect the region (NH 78 and NH 111).

Table S1. Village means for basic individual descriptors and residence and migration variables for participants from each study population

Village no.	Village name	Age, y	Proportion female	Household size*	Proportion ever married	No. living children	Proportion illiterate and literate†	Proportion born in village	Time lived in village, y	No. migrations since birth‡	Sample size
1	Chipni Paani	31.75 (14.49)	0.42	4.17 (1.40)	0.92	1.92 (2.11)	1 = 0.67, 2 = 0.25	0.08	17.46 (12.73)	1.17 (0.39)	12
2	Mahua Bathaan	33.07 (7.77)	0.50	5.14 (2.12)	0.95	2.45 (2.02)	1 = 0.77, 2 = 0.14	0.68	25.09 (12.18)	0.68 (0.78)	22
3	Jog Paani	32.87 (15.05)	0.47	6.20 (3.08)	0.80	2.27 (2.12)	1 = 0.53, 2 = 0.27	0.53	24.00 (13.10)	0.47 (0.52)	15
4	Semar Kona	35.43 (16.46)	0.43	4.79 (1.89)	0.93	2.07 (1.59)	1 = 0.71, 2 = 0.14	0.64	28.79 (21.63)	0.64 (0.84)	14
5	Bihidaand	32.53 (11.38)	0.58	6.32 (2.47)	0.84	2.26 (2.02)	1 = 0.47, 2 = 0.21	0.58	25.53 (14.72)	0.53 (0.70)	19
6	Khunta Paani	34.33 (10.24)	0.57	6.30 (3.59)	1.00	1.73 (2.26)	1 = 0.70, 2 = 0.17	0.50	24.75 (15.09)	0.63 (0.72)	30
7	Kaua Daahi	36.44 (13.66)	0.39	4.90 (1.90)	0.97	2.45 (2.34)	1 = 0.52, 2 = 0.19	0.58	27.92 (17.31)	0.58 (0.67)	31
8	Pareva Aara	40.19 (15.37)	0.40	5.51 (2.54)	0.89	1.94 (2.04)	1 = 0.60, 2 = 0.09	0.57	32.67 (17.86)	0.49 (0.56)	35
9	Musakhol	33.08 (8.75)	0.71	5.33 (2.12)	1.00	2.63 (2.14)	1 = 0.71, 2 = 0.08	0.63	26.57 (11.43)	0.38 (0.49)	24
10	Kharranagar	29.51 (7.84)	0.42	7.05 (2.25)	0.79	2.61 (2.60)	1 = 0.32, 2 = 0.18	0.58	22.47 (11.17)	0.74 (1.06)	38
11	Tedha Semar	36.65 (10.98)	0.39	5.52 (1.73)	0.91	2.43 (1.67)	1 = 0.74, 2 = 0.13	0.61	30.61 (12.95)	0.57 (0.90)	23
12	Vesra Paani	36.59 (15.60)	0.45	5.86 (2.46)	0.97	2.03 (1.66)	1 = 0.55, 2 = 0.21	0.72	31.72 (15.22)	0.38 (0.56)	29
13	Barghat	39.63 (11.00)	0.46	6.14 (2.72)	1.00	3.39 (1.97)	1 = 0.46, 2 = 0.04	0.64	33.57 (16.10)	0.39 (0.57)	28
14	Aama Naara	33.77 (13.05)	0.28	6.66 (2.27)	0.91	2.59 (2.03)	1 = 0.44, 2 = 0.13	0.66	28.34 (15.13)	0.53 (0.80)	32
15	Bakrataal	32.22 (10.41)	0.59	5.59 (1.88)	1.00	2.34 (1.90)	1 = 0.72, 2 = 0.07	0.48	23.19 (13.50)	0.62 (0.78)	29
16	Ghatgaon	33.06 (9.09)	0.41	6.53 (3.35)	0.97	3.09 (2.10)	1 = 0.38, 2 = 0.22	0.81	29.63 (11.23)	0.28 (0.58)	32

Values in parentheses are SDs.

*Number of people residing in the house and eating at a common hearth.

†1, illiterate; 2, literate. Illiterate individuals did not read, write, or go to school. Literate individuals could read and write but did not go to school. The remaining proportion of individuals had some schooling.

‡Migration is defined as a change of residence to another village.

Table S2. Village means for measures of wealth, market contact, and social networks for participants from each study population

Village no.	Village name	Proportion of earners in household	Rice months*	Outstanding loans in Indian rupees	Bazaar visits†	Town visits‡	Festival invitees from own village§	Festival invitees from other villages¶
1	Chipni Paani	0.55 (0.24)	2.04 (0.89)	362.50 (351.70)	1.67 (0.78)	6.03 (7.22)	4.25 (3.33)	1.42 (1.83)
2	Mahua Bathaan	0.53 (0.21)	1.99 (3.07)	109.09 (365.03)	2.82 (0.96)	11.36 (5.37)	5.68 (3.51)	0.91 (3.24)
3	Jog Paani	0.68 (0.29)	3.53 (3.56)	1,613.33 (1,792.79)	1.53 (0.64)	0.60 (0.58)	5.07 (3.26)	1.53 (1.85)
4	Semar Kona	0.59 (0.16)	3.36 (3.23)	35.71 (133.63)	1.79 (0.80)	1.52 (0.81)	4.57 (3.32)	0.50 (1.29)
5	Bihidaand	0.51 (0.25)	1.92 (1.30)	273.68 (1,145.08)	2.16 (0.69)	1.07 (0.65)	14.21 (8.94)	9.89 (7.17)
6	Khunta Paani	0.62 (0.24)	1.51 (0.84)	1,116.67 (3,561.49)	1.03 (0.69)	0.51 (0.49)	6.53 (3.46)	1.53 (1.78)
7	Kaua Daahi	0.63 (0.25)	2.27 (2.12)	1,877.42 (1,847.83)	1.67 (0.84)	0.96 (0.58)	5.06 (2.86)	3.65 (3.36)
8	Pareva Aara	0.59 (0.20)	1.89 (1.84)	3,428.57 (4,500.23)	2.12 (0.89)	2.50 (1.24)	5.46 (4.60)	1.23 (1.82)
9	Musakhol	0.56 (0.23)	2.95 (2.39)	1,002.08 (2,787.10)	1.50 (0.51)	1.23 (1.07)	47.13 (19.96)	8.21 (14.85)
10	Kharranagar	0.50 (0.21)	2.89 (1.22)	3,900.00 (3,354.68)	1.92 (0.71)	0.21 (0.46)	7.87 (5.59)	6.87 (7.96)
11	Tedha Semar	0.55 (0.25)	1.48 (1.09)	43.48 (144.05)	1.48 (0.78)	0.78 (0.38)	6.39 (3.33)	1.22 (1.78)
12	Vesra Paani	0.59 (0.22)	2.26 (2.72)	0.00 (0.00)	1.99 (0.94)	7.81 (4.22)	13.00 (7.38)	1.03 (1.66)
13	Barghat	0.44 (0.18)	3.27 (1.32)	1,732.14 (2,119.06)	1.54 (0.68)	1.46 (1.14)	5.36 (3.07)	1.21 (1.87)
14	Aama Naara	0.54 (0.24)	3.02 (1.97)	325.00 (695.14)	1.91 (0.78)	5.13 (4.05)	7.13 (4.19)	0.69 (1.45)
15	Bakrataal	0.55 (0.24)	2.62 (2.25)	0.00 (0.00)	1.43 (0.53)	1.11 (1.00)	5.34 (3.18)	0.24 (0.91)
16	Ghatgaon	0.45 (0.22)	2.73 (3.80)	12,500.00 (61,894.93)	1.70 (0.75)	2.72 (5.02)	3.31 (2.55)	0.75 (1.83)

Values in parentheses are SDs.

*Number of months per year the household eats self-grown rice.

†Number of monthly visits to the local bazaar.

‡Number of monthly visits to the nearest town.

§Number of people invited to harvest festival from own village, a measure of social network size.

¶Number of people invited to harvest festival from other villages, a measure of social network size.

Table S3. Village and individual level variance components for salt deviation and PGG contributions respectively in the null and full models (see Table S4 for β parameters of these models)*

	Village level		Individual level	
	Variance ± SE	95% BCI	Variance ± SE	95% BCI
Null model (multilevel)				
Salt deviation	1,409,354.625 ± 764,246.813	491,858.500, 3,282,888.500	6,099,303.5 ± 506,483.656	5,179,439.000, 7,151,700.500
PGG contribution	1.284 ± 0.97	0.290, 3.815	29.487 ± 2.464	25.023, 34.597
Residual covariance†	512.024 ± 551.762	−374.911, 1808.605	580.97 ± 829.541	−1027.803, 2207.266
Residual correlation†	0.397 ± 0.314	−0.310, 0.863	0.043 ± 0.061	−0.077, 0.161
Full model (multilevel)				
Salt deviation	830,317.813 ± 513,355.531	241,699.516, 2,154,373.500	6,010,546.000 ± 510,689.003	5,088,691.000, 7,072,213.500
PGG contribution	0.427 ± 0.380	0.092, 1.425	29.196 ± 2.439	24.825, 34.352
Residual covariance†	495.605 ± 334.386	90.628, 1,349.136	749.763 ± 838.424	−889.288, 2,399.088
Residual correlation†	0.871 ± 0.188	0.271, 0.991	0.057 ± 0.063	−0.067, 0.177

The variance partition coefficient [VPC = village level variance/(village level variance + individual level variance)] ± SE is 0.182 ± 0.074 (95% BCI = 0.073, 0.355) for salt deviation and 0.041 ± 0.029 (95% BCI = 0.010, 0.116) for PGG contributions in the null model, and 0.118 ± 0.060 (95% BCI = 0.038, 0.265) for salt deviation and 0.014 ± 0.012 (95% BCI = 0.003, 0.047) for PGG contributions in the full model. The overall Spearman rank correlation between salt deviation and PGG contributions across all individuals is $\rho = 0.196$, $P = 0.007$, $n = 190$.

*For the two multilevel models (null and full), Table S3 presents the village and individual level variances in salt deviations and PGG contributions for each model, respectively, whereas fixed effect parameters in each model are specified in Table S4. For instance, the variance components for salt deviation and PGG contribution in the full model (multilevel) can be read in the 9th and 10th rows of Table S3, respectively; column 2 represents the village level variance with its 95% BCI (column 3), and column 4 represents the individual level variance with its 95% BCI (column 5) for the corresponding rows. The last two rows of Table S3 present the residual covariance and residual correlation between salt deviation and PGG contribution in the full (multilevel) model, respectively; the associated values at the village level (column 2) and their 95% BCI (column 3), and at the individual level (column 4) and their 95% BCI (column 5) can be read in the corresponding rows. The full model (multilevel) has six fixed effects, including the intercept, presented in Table S4; for each fixed effect (column 1), the associated β value for salt deviation (column 2) and its 95% BCI (column 3) and the β value for PGG contribution (column 4) and its 95% BCI (column 5) can be read in the corresponding row. The DIC value (*SI Text* section 1.6.) for the model is presented in column 6 of Table S4. The fixed effect parameters for the single level null model are presented in Table S4; this model does not have variance components.

†Between salt deviation and PGG contribution.

Table S4. Associations of each predictor term (fixed effect) with salt deviation and PGG contribution respectively in the null (intercept only) and full models (see Table S3 for variance components of these models and instructions on how to read this table)

	Salt deviation (g)		PGG contribution (Indian rupees)		
Fixed effect	β ± SE	95% BCI	β ± SE	95% BCI	DIC
Null models					
Intercept (single level)	−913.646 ± 152.037***	−1209.508, −618.018	10.394 ± 0.321***	9.767, 11.021	12,890.544
Intercept (multilevel)	−1210.605 ± 345.050***	−1887.124, −534.183	10.413 ± 0.436***	9.553, 11.285	12,832.153
Full model (multilevel)					12,821.456
Intercept	−513.409 ± 585.370	−1683.305, 616.786	7.618 ± 1.085***	5.484, 9.764	
Population size	−2.866 ± 1.390**	−5.587, −0.133	0.000 ± 0.002	−0.003, 0.003	
Age, y	−9.363 ± 12.108	−32.871, 14.418	0.073 ± 0.027***	0.020, 0.126	
Sex: female (reference: male)	516.599 ± 288.477	−56.843, 1078.635	0.383 ± 0.647	−0.882, 1.655	
People invited to harvest festival from other villages	21.103 ± 25.984	−29.257, 71.955	0.116 ± 0.055**	0.008, 0.226	
Full sisters aged ≥ 15 y living in village	−623.783 ± 261.295**	−1138.715, −107.139	−0.139 ± 0.534	−1.172, 0.908	

**$P < 0.05$; ***$P < 0.01$.

Table S5. List of village and individual descriptors included in all analyses

Level	Domain	Variable name	Variable description
Village	Village descriptors	Population size	Total number of individuals residing in the focal village, including all adults and children
		Proportion of migrants	Proportion of migrants in the sample of study participants from the focal village; migrants are individuals currently residing in the focal village but born in another village
		Proportion of non-Korwas	Proportion of the focal village population who were not Pahari Korwas
		Household dispersion	Nearest neighbor index, calculated for households in each village using ArcGIS (*SI Text* section 1.6.2); values <1 represent a clustered distribution pattern, and values >1 represent a dispersed distribution pattern
		Distance from major town, km	Distance in kilometers from Ambikapur, the largest town in the study region (*SI Text* section 1.1.2)
Individual	Basic individual descriptors	Age, y	Individual's age, y
		Sex: female, male	Individual's sex
		Education: illiterate, literate, some schooling	Individual's level of education: "illiterate" individuals could not read and write and did not go to school, "literate" individuals could read and write but did not go to school, and individuals with "some schooling" had completed at least one grade in primary school (grades 1–5)
		Household size (individuals)	Number of people residing in the individual's house and eating at a common hearth
		Marriage: ever married, never married	Individual's marital status (i.e., whether she has ever been married); individuals who were divorced or separated at the time of the interview were recorded as "ever married"
Individual	Residence and migration	Birthplace: this village, other village	Individual's place of birth; this was recorded either as the focal village or other village
		Time resident in this village, y	Number of years the individual has been resident in the focal village
		Number of times migrated	Total number of times the individual has migrated (changed residence to another village)
		Postmarital residence: natal village, other village	A married individual's place of residence postmarriage; this was recorded either as her natal village or other village
Individual	Wealth, markets, and social networks	Proportion of earners in household	Proportion of people in the individual's household (variable household size) who make a major contribution to the household income by gathering forest products sold in the market, practicing agriculture, undertaking waged labor, or other employment, such as in the local school
		Months per year household eats self-grown rice	Number of months per year the individual's household eats rice grown on land owned by the individual's household
		Outstanding loans (Indian rupees): yes, no	Whether the individual had any outstanding loans at the time of the interview
		Number of monthly visits to local bazaar	Number of times a month that the individual visits the weekly local market held in a neighboring village; individuals were asked to recall the number of visits they had made in the month preceding the month of the interview
		Number of monthly visits to nearest town	Number of times a month that the individual visits the nearest town in the region to buy or sell goods; individuals were asked to recall the number of visits they had made in the month preceding the month of the interview
		People invited to harvest festival from own village	Number of people from the focal village that the individual invited to wine and dine at her home for the harvest festival (Cherta) (*SI Text* section 1.1.1) held in the year of the interview; in all study villages, Cherta had been celebrated within 1–4 mo before the time of the interview
		People invited to harvest festival from other villages	Number of people from other villages that the individual had invited to wine and dine at her home for the harvest festival (Cherta) (*SI Text* section 1.1.1) held in the year of the interview; in all study villages, Cherta had been celebrated within 1–4 mo before the time of the interview
Individual	Children and grandchildren	Children living	Number of living children the individual has
		Children living together	Number of the individual's children who are living in the individual's household
		Grandchildren living	Number of living grandchildren the individual has
		Grandchildren living in village	Number of the individual's grandchildren who are living in the focal village

Table S5. Cont.

Level	Domain	Variable name	Variable description
Individual	Kin	Mother living: yes, no	Whether the individual's mother is living
		Mother living in village: yes, no	Whether the individual's mother lives in the focal village
		Mother participated in PGG: yes, no	Whether the individual's mother participated in the PGG on the same day as the individual
		Father living: yes, no	Whether the individual's father is living
		Father living in village: yes, no	Whether the individual's father lives in the focal village
		Father participated in PGG: yes, no	Whether the individual's father participated in the PGG on the same day as the individual
		Full siblings living	Number of living siblings the individual has who are born of the same mother and father as the individual (i.e., full siblings)
		Full brothers living	Number of living brothers the individual has who are born of the same mother and father as the individual (i.e., full brothers)
		Full brothers living in village	Number of full brothers the individual has coresiding in the focal village
		Full brothers aged <15 y living in village	Number of full brothers the individual has aged under 15 y and coresiding in the focal village
		Full brothers aged ≥15 y living in village	Number of full brothers the individual has aged 15 y or more and coresiding in the focal village
		Full brothers living in other villages	Number of full brothers the individual has residing in a village other than the focal village
		Full brothers aged <15 y living in other villages	Number of full brothers the individual has aged under 15 y and residing in a village other than the focal village
		Full brothers aged ≥15 y living in other villages	Number of full brothers the individual has aged 15 y or more and residing in a village other than the focal village
		Full brothers participated in PGG	Number of the individual's full brothers who participated in the PGG on the same day as the individual
		Full sisters living	Number of living sisters the individual has who are born of the same mother and father as the individual (i.e., full sisters)
		Full sisters living in village	Number of full sisters the individual has coresiding in the focal village
		Full sisters aged <15 y living in village	Number of full sisters the individual has aged under 15 y and coresiding in the focal village
		Full sisters aged ≥15 y living in village	Number of full sisters the individual has aged 15 y or more and coresiding in the focal village
		Full sisters living in other villages	Number of full sisters the individual has residing in a village other than the focal village
		Full sisters aged <15 y living in other villages	Number of full sisters the individual has aged under 15 y and residing in a village other than the focal village
		Full sisters aged ≥15 y living in other villages	Number of full sisters the individual has aged 15 y or more and residing in a village other than the focal village
		Full sisters participated in PGG	Number of the individual's full sisters who participated in the PGG on the same day as the individual

Table S6. Univariate associations between each predictor term (fixed effect) and salt deviation and PGG contribution, respectively (models include constants)

Model	Fixed effect	Salt deviation (g) β ± SE	PGG contribution (Indian rupees) β ± SE	Residual correlation†		−2 Log likelihood			
				Village level	Individual level	Current model	Null model	Δ‡	*n*
	Village descriptors								
1	Population size	**−3.245 ± 1.188****	−0.001 ± 0.002	0.480	0.046	7,461.692	7,467.740	6.048	413
2	Proportion of migrants	**3165.609 ± 1669.468***	0.799 ± 2.461	0.455	0.044	7,464.459	7,467.740	3.281	413
3	Proportion of non-Korwas	2300.910 ± 2966.843	2.069 ± 3.994	0.432	0.042	7,467.020	7,467.740	0.720	413
4	Household dispersion	1388.781 ± 1141.639	0.020 ± 1.559	0.476	0.044	7,466.227	7,467.740	1.513	413
5A	Distance from major town, km	−0.006 ± 0.024	0 ± 0	0.463	0.042	7,467.658	7,467.740	0.082	413
5B	Distance from major town:			0.373	0.043	7,465.421	7,467.740	2.319	413
	25–35 km (reference: 0–25 km)	532.815 ± 903.75	1.622 ± 1.192						
	35–45 km (reference: 0–25 km)	322.370 ± 870.015	1.357 ± 1.11						
	45+ km (reference: 0–25 km)	412.317 ± 909.118	0.790 ± 1.174						
	Individual descriptors								
	Basic individual descriptors								
6	Age, y	−12.019 ± 11.946	**0.075 ± 0.027*****	0.473	0.058	7,458.949	7,467.740	8.791	413
7	Sex: female (reference: male)	**542.688 ± 289.246***	0.213 ± 0.639	0.439	0.042	7,464.179	7,467.740	3.561	413
8	Education:			0.315	0.053	7,462.818	7,467.740	4.922	413
	Illiterate (reference: some schooling)	−276.510 ± 349.900	1.012 ± 0.701						
	Literate (reference: some schooling)	−704.591 ± 485.786	285 ± 0.919						
9	Household size (individuals)	−52.645 ± 59.464	−0.108 ± 0.126	0.411	0.040	7,466.310	7,467.740	1.430	413
10	Marriage: ever married (reference: never married)	−469.919 ± 575.016	1.134 ± 1.184	0.419	0.044	7,466.148	7,467.740	1.592	413
	Residence and migration								
11	Birthplace: this village (reference: other village)	−231.720 ± 291.530	0.118 ± 0.640	0.470	0.043	7,467.065	7,467.740	0.675	413
12	Time resident in this village, y	−9.485 ± 9.509	**0.044 ± 0.022****	0.557	0.048	7,462.624	7,467.740	5.116	413
13	Number of times migrated	−56.339 ± 192.869	0.161 ± 0.430	0.433	0.045	7,467.512	7,467.740	0.228	413
14	Postmarital residence: natal village (reference: other village)	−250.573 ± 310.788	0.166 ± 0.657	0.869	0.048	6,971.787	6,973.534	1.747	385
	Wealth, markets, and social networks								
15	Proportion of earners in household	814.478 ± 612.807	0.268 ± 1.380	0.474	0.038	7,465.961	7,467.740	1.779	413
16	Months per year household eats self-grown rice	**111.572 ± 66.553***	−0.144 ± 0.137	0.454	0.041	7,463.755	7,467.740	3.985	413
17	Outstanding loans: yes (reference: no)	−550.810 ± 365.483	−0.327 ± 0.684	0.437	0.034	7,465.479	7,467.740	2.261	413
18	Number of monthly visits to local bazaar	−73.300 ± 193.511	−0.270 ± 0.371	0.467	0.041	7,467.100	7,467.740	0.640	413
19	Number of monthly visits to nearest town	43.051 ± 49.455	−0.019 ± 0.077	0.499	0.040	7,466.877	7,467.740	0.863	413
20	People invited to harvest festival from own village	22.057 ± 17.414	−0.001 ± 0.033	0.423	0.047	7,466.133	7,467.740	1.607	413
21	People invited to harvest festival from other villages	15.584 ± 25.830	**0.125 ± 0.054****	0.699	0.042	7,463.002	7,467.740	4.738	413
	Children and grandchildren								
22	Children living	**−141.195 ± 67.358****	0.047 ± 0.152	0.513	0.042	7,463.276	7,467.740	4.464	413
23	Children living together	**−124.866 ± 71.553***	−0.027 ± 0.165	0.491	0.037	7,464.708	7,467.740	3.032	413

Table S6. Cont.

Model	Fixed effect	Salt deviation (g) β ± SE	PGG contribution (Indian rupees) β ± SE	Residual correlation†		–2 Log likelihood			
				Village level	Individual level	Current model	Null model	Δ‡	*n*
24	Grandchildren living	29.056 ± 67.334	0.248 ± 0.197	0.445	0.039	7,466.022	7,467.740	1.718	413
25	Grandchildren living in village	23.401 ± 91.542	0.311 ± 0.280	0.461	0.041	7,466.463	7,467.740	1.277	413
	Kin								
26	Mother living yes: (reference: no)	280.509 ± 293.872	−0.658 ± 0.633	0.520	0.043	7,465.704	7,467.740	2.036	413
27	Mother living in village: yes (reference: no)	−133.129 ± 315.666	−0.522 ± 0.655	0.462	0.045	7,466.953	7,467.740	0.787	413
28	Mother participated in PGG: yes (reference: no)	349.917 ± 696.689	**−2.464 ± 1.196****	0.257	0.043	5,647.886	5,652.436	4.550	328
29	Father living yes: (reference: no)	57.966 ± 287.120	−0.679 ± 0.628	0.411	0.045	7,466.559	7,467.740	1.181	413
30	Father living in village: yes (reference: no)	−176.809 ± 322.733	−0.270 ± 0.670	0.436	0.043	7,467.292	7,467.740	0.448	413
31	Father participated in PGG: yes (reference: no)	411.534 ± 650.924	−1.507 ± 1.158	0.069	0.048	5,650.278	5,652.436	2.158	328
32	Full brothers living	81.218 ± 128.101	−0.168 ± 0.273	0.390	0.044	7,466.961	7,467.740	0.779	413
33	Full brothers living in village	−106.153 ± 143.357	−0.010 ± 0.304	0.467	0.044	7,467.195	7,467.740	0.545	413
34	Full brothers aged <15 y living in village	98.398 ± 318.446	−0.339 ± 0.731	0.457	0.043	7,467.421	7,467.740	0.319	413
35	Full brothers aged ≥15 y living in village	−152.268 ± 157.041	0.057 ± 0.326	0.494	0.045	7,466.770	7,467.740	0.970	413
37	Full brothers living in other villages	218.516 ± 148.075	−0.309 ± 0.361	0.408	0.048	7,464.785	7,467.740	2.955	413
36	Full brothers aged <15 y living in other villages	45.137 ± 311.478	**−1.184 ± 0.636***	0.419	0.046	7,464.288	7,467.740	3.452	413
38	Full brothers aged ≥15 y living in other villages	286.578 ± 173.034	0.117 ± 0.452	0.409	0.044	7,464.981	7,467.740	2.759	413
39	Full brothers participated in PGG	−493.519 ± 383.162	−0.109 ± 0.678	0.047	0.042	5,650.721	5,652.436	1.715	328
40	Full sisters living	−89.077 ± 118.029	0.069 ± 0.269	0.466	0.043	7,467.089	7,467.740	0.651	413
41	Full sisters living in village	−290.202 ± 180.151	0.244 ± 0.413	0.539	0.045	7,464.757	7,467.740	2.983	413
42	Full sisters aged <15 y living in village	62.580 ± 272.562	0.554 ± 0.688	0.462	0.039	7,467.054	7,467.740	0.686	413
43	Full sisters aged ≥15 y living in village	**−682.429 ± 261.379*****	0.054 ± 0.536	0.587	0.043	7,461.019	7,467.740	6.721	413
44	Full sisters living in other villages	49.205 ± 141.726	−0.044 ± 0.323	0.468	0.042	7,467.599	7,467.740	0.141	413
45	Full sisters aged <15 y living in other villages	238.391 ± 370.545	−0.268 ± 0.920	0.454	0.045	7,467.230	7,467.740	0.510	413
46	Full sisters aged ≥15 y living in other villages	18.423 ± 159.939	−0.014 ± 0.360	0.462	0.042	7,467.725	7,467.740	0.015	413
47	Full sisters participated in PGG	**−2121.181 ± 687.743*****	0.694 ± 1.286	0.030	0.032	5,642.745	5,652.436	9.691	328
48	*Total amount of salt available*§	**−1.233 ± 0.498*****				5,588.363	5,593.843	5.480	302

A Bonferroni correction has not been applied to these models because they were used for exploratory analyses. Values in bold are significant. *$P < 0.10$; **$P < 0.05$; ***$P < 0.01$.

†Correlation between salt deviation and PGG contribution.

‡Δ = −2 log likelihood of null model − (−2 log likelihood of current model).

§This is a univariate response model; salt deviation is the response variable, and total amount of salt available is the only fixed effect.

Table S7. Multivariate associations between domains of predictor terms (fixed effects) and salt deviation and PGG contribution, respectively (models include constants)

Model	Fixed effect	Salt deviation (g) β ± SE	PGG contribution (Indian rupees) β ± SE	Residual correlation†		−2 Log likelihood			*n*
				Village level	Individual level	Current model	Null model	Δ‡	
1	*Village descriptors*								
A	Population size	**−6.626 ± 2.035****	−0.001 ± 0.003	0.663	0.039	7,454.254	7,467.740	13.486	413
	Proportion of migrants	1,486.957 ± 1,706.084	1.746 ± 3.509						
	Proportion of non-Korwas	865.413 ± 2,475.859	3.659 ± 5.127						
	Household dispersion	**−3,239.822 ± 1,459.157***	−1.813 ± 2.724						
	Distance from major town (km)	**−0.062 ± 0.027***	0 ± 0						
B	Population size	**−6.279 ± 2.503****	0.004 ± 0.004	1.072	0.045	7,452.569	7,467.740	15.171	413
	Proportion of migrants	2,622.388 ± 1,773.903	2.062 ± 3.23						
	Proportion of non-Korwas	4,854.912 ± 3,352.811	−2.764 ± 5.918						
	Household dispersion	**−4,211.28 ± 2,223.623***	2.015 ± 3.381						
	Distance from major town:								
	25–35 km (reference: 0–25 km)	−1,708.313 ± 1,185.381	3.322 ± 2.044						
	35–45 km (reference: 0–25 km)	−2,046.77 ± 1,253.946	3.133 ± 2.057						
	45+ km (reference: 0–25 km)	−2,027.191 ± 1,322.038	2.488 ± 2.183						
	Individual descriptors								
2	*Basic individual descriptors*								
	Age, y	−0.592 ± 14.083	**0.070 ± 0.032****	0.373	0.055	7,451.441	7,467.740	16.299	413
	Sex: female (reference: male)	**680.289 ± 329.782****	0.371 ± 0.695						
	Education:								
	Illiterate (reference: some schooling)	−470.939 ± 410.184	0.187 ± 0.802						
	Literate (reference: some schooling)	−526.473 ± 506.037	0.515 ± 0.981						
	Household size (individuals)	−55.824 ± 59.494	−0.081 ± 0.126						
	Marriage: ever married (reference: never married)	−504.254 ± 626.889	−0.174 ± 1.267						
3	*Residence and migration*								
	Birthplace: this village (reference: other village)	−87.644 ± 763.658	−0.394 ± 1.844	1.154	0.058	6,965.558	6,973.534	7.976	385
	Time resident in this village, y	−5.654 ± 12.372	**0.056 ± 0.026****						
	Number of times migrated	−281.327 ± 264.675	0.517 ± 0.609						
	Postmarital residence: natal village (reference: other village)	−341.197 ± 797.520	0.254 ± 1.880						
4	*Wealth, markets, and social networks*								
	Proportion of earners in household	930.744 ± 615.681	0.273 ± 1.383	0.483	0.027	7,450.606	7,467.740	17.134	413
	Months per year household eats self-grown rice	**124.113 ± 67.654***	−0.133 ± 0.139						
	Outstanding loans: yes (reference: no)	−594.728 ± 374.409	−0.527 ± 0.683						
	Number of monthly visits to local bazaar	−216.445 ± 202.518	−0.158 ± 0.384						
	Number of monthly visits to nearest town	52.431 ± 52.454	−0.004 ± 0.079						
	People invited to harvest festival from own village	20.248 ± 18.665	−0.021 ± 0.033						
	People invited to harvest festival from other villages	15.453 ± 27.291	**0.136 ± 0.06****						

Table S7. Cont.

Model	Fixed effect	Salt deviation (g) β ± SE	PGG contribution (Indian rupees) β ± SE	Residual correlation† Village level	Residual correlation† Individual level	−2 Log likelihood Current model	−2 Log likelihood Null model	Δ‡	*n*
5	*Children and grandchildren*								
	Children living	**−560.996 ± 266.918****	0.482 ± 0.644	0.466	0.037	7,457.890	7,467.740	9.850	413
	Children living together	449.501 ± 283.232	−0.511 ± 0.694						
	Grandchildren living	323.256 ± 202.462	−0.013 ± 0.436						
	Grandchildren living in village	−278.531 ± 240.7	0.189 ± 0.489						
6	*Kin*								
A	Mother living: yes (reference: no)	468.45 ± 553.937	−0.138 ± 1.138	0.190	0.055	5,642.114	5,652.436	10.322	328
	Mother living in village: yes (reference: no)	−514.912 ± 717.56	−0.658 ± 1.368						
	Mother participated in PGG: yes (reference: no)	522.792 ± 827.285	−1.865 ± 1.419						
	Father living: yes (reference: no)	242.37 ± 585.558	−0.904 ± 1.162						
	Father living in village: yes (reference: no)	−792.477 ± 818.813	0.976 ± 1.426						
	Father participated in PGG: yes (reference: no)	870.913 ± 822.807	−0.636 ± 1.409						
B	Full siblings living	−230.256 ± 164.268	0.104 ± 0.322	−0.139	0.058	5,642.497	5,652.436	9.939	328
	Full brothers aged <15 y living in village	468.845 ± 522.5	−0.632 ± 1.014						
	Full brothers aged ≥15 y living in village	116.896 ± 357.981	−0.072 ± 0.62						
	Full brothers aged <15 y living in other villages	423.853 ± 482.909	**−1.464 ± 0.843***						
	Full brothers aged ≥15 y living in other villages	**567.546 ± 324.858***	0.335 ± 0.727						
	Full brothers participated in PGG	−301.817 ± 482.11	−0.210 ± 0.913						
C	Full siblings living	−25.604 ± 187.973	−0.230 ± 0.354	−0.337	0.047	5,634.698	5,652.436	17.738	328
	Full sisters aged <15 y living in village	438.874 ± 472.594	0.898 ± 0.987						
	Full sisters aged ≥15 y living in village	**−1,388.38 ± 576.35****	−0.444 ± 0.926						
	Full sisters aged <15 y living in other villages	133.034 ± 537.277	−0.222 ± 1.177						
	Full sisters aged ≥15 y living in other villages	59.674 ± 293.866	0.339 ± 0.540						
	Full sisters participated in PGG	−756.291 ± 868.241	1.305 ± 1.540						

Values in bold are significant. *$P < 0.10$; **$P < 0.05$.

†Correlation between salt deviation and PGG contribution.

‡Δ = −2 log likelihood of null model − (−2 log likelihood of current model).

Table S8. Summary of model-fitting process in the fourth stage of analyses

Model	Fixed effect	*n*	*P*	DIC	NM DIC*	ΔDIC†
Block 1						
1	**Population size**	413	**<0.05**	12,832.04	12,832.15	0.11
	Age‡		>0.05			
	Sex‡		>0.05			
	Household dispersion		>0.05			
	Distance from major town		**<0.05**			
	Time resident in this village		>0.05			
	Months per year household eats self-grown rice		>0.05			
	People invited to harvest festival from other villages		**<0.05**			
2	**Population size**	413	**<0.05**	12,827.67	12,832.15	4.48
	Age		**<0.05**			
	Sex‡		>0.05			
	Distance from major town		>0.05			
	People invited to harvest festival from other villages		**<0.05**			
3	**Population size**	413	**<0.05**	12,825.40	12,832.15	6.75
	Age		**<0.05**			
	Sex‡		>0.05			
	People invited to harvest festival from other villages		**<0.05**			
Block 2						
4	**Population size**	413	**<0.05**	12,824.89	12,832.15	7.26
	Age		**<0.05**			
	Sex‡		>0.05			
	People invited to harvest festival from other villages		**<0.05**			
	Children living		>0.05			
Block 3						
5	**Population size**	413	**<0.05**	12,826.00	12,832.15	6.15
	Age		**<0.05**			
	Sex‡		>0.05			
	People invited to harvest festival from other villages		**<0.05**			
	Full brothers aged <15 y living in other villages		>0.05			
	Full brothers aged ≥15 y living in other villages		>0.05			
	Full sisters aged ≥15 y living in village		**<0.05**			
6	**Population size**	413	**<0.05**	12,821.46	12,832.15	10.69
	Age		**<0.05**			
	Sex		>0.05			
	People invited to harvest festival from other villages		**<0.05**			
	Full sisters aged ≥15 y living in village		**<0.05**			
7	**Population size**	413	**<0.05**	12,822.35	12,832.15	9.8
	Age		**<0.05**			
	People invited to harvest festival from other villages		**<0.05**			
	Full sisters aged ≥15 y living in village		**<0.05**			

Variables in bold are significant predictors of either PGG contribution or salt deviation at $P < 0.05$ and were retained in the next listed model. NM, null model.

*DIC value for the NM with only an intercept.

†ΔDIC = NM DIC − model DIC.

‡The variables age and sex were carried forward to the last block even if they did not reach significance at $P < 0.05$. They were only eliminated at the very end if they did not reach significance at the $P < 0.05$ level (*SI Text* section 1.6.1).