STRONG INSTITUTIONS, PATHOGEN STRESS AND THE EXPANDING SOCIAL NETWORK

Authors: Daniel Hruschka[1]*, Charles Efferson[2], Ting Jiang[3], Ashlan Falletta-Cowden[4], Sveinn Sigurdsson[5], Rita McNamara[6], Madeline Sands[1], Shirajum Munira[7], Edward Slingerland[6], and Joseph Henrich[6,8]

[1]School of Human Evolution and Social Change, Arizona State University, Tempe, AZ, USA.

[2]Department of Economics, University of Zurich, Zurich, Switzerland.

[3]Department of Economics, Tilburg University, Tilburg, Netherlands.

[4]The Field Museum, Chicago, IL, USA.

[5]Rush University, Chicago, IL, USA.

[6]University of British Columbia, Vancouver, BC, Canada.

[7]LAMB Project for Integrated Health and Development, Parbatipur, Bangladesh.

[8]Canadian Institute for Advanced Research.

*Correspondence to: Daniel.Hruschka@asu.edu.

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1 figure with 4 panels. 2 tables.

ABSTRACT

Anthropologists have documented substantial cross-society variation in people's willingness to treat strangers with impartial, universal norms versus favoring members of one's local community. Researchers have proposed several accounts for these differences. The pathogen stress hypothesis predicts that people will be more likely to favor local in-group members under greater infectious disease threat. The material security hypothesis proposes that in the face of weak institutions, people must rely on local community members to meet their basic needs, while strong institutions permit people to meet these needs by following impartial norms with strangers. Some studies have examined these hypotheses using self-reported preferences, but not with behavioral measures. We conducted behavioral experiments in 8 diverse societies that measure individuals' willingness to favor in-group members over following an impartial rule with out-group members. Consistent with the material security hypothesis, members of societies enjoying better quality government services and food security show a stronger preference for following an impartial rule over investing in their local in-group. Our data show no support for the pathogen stress hypothesis, and suggest that favoring in-group members more closely reflects a general adaptive fit with social institutions that have arisen in each society.

For most of their evolutionary history, humans have relied primarily on kin, friends, and a relatively small circle of community members to fulfill basic needs and to protect against physical and social threats. However, in the last 10,000 years, large-scale institutions, such as markets, have expanded access to non-local resources and created novel opportunities for productive interactions with people well outside of one's immediate social network (Bowles 2011, Bowles and Gintis 2004, Newson and Richerson 2009, Richerson and Boyd 2001). Given the limited scope for reputation and reciprocity in these situations, generalized norms of exchange and impartial allocation rules play an important role in making these interactions run smoothly. The emergence of these norms, and their subsequent codification and enforcement through formal institutions, can fundamentally alter the trade-offs between investing preferentially in one's in-group versus following impartial rules of exchange as one expands one's sphere of social interaction to relative strangers. Existing evidence suggests that human populations differ dramatically in how they trade off these two concerns, and both researchers and policy makers have shown great interest in understanding how this variation affects the functioning of such institutions as markets, courts, and meritocracies (Banfield 1958, Buchan et al. 2009, Gelfand 2011, Parsons and Shils 1951, Treisman 2000, Triandis 1995).

Two evolutionary approaches have sought to explain cross-population variation in how people tradeoff (1) investing in their in-group versus (2) extending impartial rules of allocation to relative strangers. The first approach proposes that population-level variation in in-group favoritism arises from an evolved response to environmental threats (Fincher and Thornhill 2012, Van de Vliert 2011). One version of this approach argues that the

threat of infection from outsiders invokes a behavioral immune response which leads people to consolidate their social group and to ignore, neglect, or fear outsiders (Fincher et al. 2008). Different mechanisms have been proposed to underlie this behavioral immune system, ranging from facultative responses at the individual level to adaptive cultural evolution at the group level (Schaller 2011). Nonetheless, all propose that preferential treatment of in-group members arise from cognitive mechanisms targeted specifically at the exogenous threat of infectious disease (Fincher and Thornhill 2012, Schaller 2011).

Alternatively, the material security hypothesis considers a general set of adaptive processes—including social learning and immediate facultative responses—geared toward managing a range of material threats. These threats can include pathogens (Fincher et al. 2008, Schaller 2011), but also environmental extremes (Van de Vliert 2011), food insecurity (Kaplan, Gurven, and Hill 2005), and inter-group conflict (Mathew and Boyd 2011), among others. In the face of weak institutions, people must rely on friends, family and local community members to mitigate these threats and to meet their basic needs (Hruschka 2010, Kranton 1996). Conversely, strong institutions which encourage impartial, beneficial interactions with strangers create novel opportunities for preventing and managing threats, through such mechanisms as trade, insurance, social welfare, and investment in education and human capital (Inglehart and Welzel 2005). In this way, strong institutions permit individuals to rely less on friends, family, and local community members to meet their basic, and thus modify the trade-offs between investing in an expansive network of kith and kin versus pursuing other forms of social insurance.

Methods and Results

To assess these two hypotheses—material security and pathogen stress—we selected eight societies which maximize variation in the degree to which their members can securely meet basic needs, including the quality of public services aimed at health, education, and public safety, as well as access to adequate food and monetary resources. Although material security and pathogen stress often strongly covary across societies, in our sample of 8 societies they are only moderately related. With this substantial variation on the independent variables, our sample of eight societies is thus well-suited to discriminate between these two hypotheses.

If in-group investment is an adaptive response to weak institutions and lack of material security, we would expect that citizens of countries with lower quality public services and less material security, will favor themselves and their immediate in-group over following impartial allocation rules. However, if in-group investment is a specific response to pathogen stress, then we should expect in-group investment to increase with increasing pathogen prevalence. The pathogen stress hypothesis predicts that investment in self will only increase in situations of extremely high pathogen stress (Fincher and Thornhill 2012).

In each fieldsite, we identified a salient in-group satisfying the following criteria: (1) members expect each other to cooperate and to help each other on a regular basis, and (2) the group should comprise 40 to 900 adults. Depending on the locale, in-groups consisted of villages, clans, neighborhoods, sororities, congregations, or college classes. Out-groups were defined as individuals in a generically defined location (e.g. another village, community, university, or island) within the same country and ethnic group, but at a substantial distance from participants' own in-group.

We ran two experimental tasks to capture the tradeoff between following an impartial rule of allocation between individuals and preferentially allocating to oneself or one's in-group. We implemented the Resource Allocation Game (RAG), a simplified variant of the Mind Game in which participants can follow or violate a rule of impartial allocation only in their minds (Greene and Paxton 2009, Jiang forthcoming). This makes it more than evident to the participant that whether one violates or follows the rule is invisible to others. To illustrate, each participant was allotted 30 monetary units (coins or bills equal in total to 50% of a day's wage) to divide between two cups. The participant was told that after the experiment, one cup (clearly marked for a non-specified in-group member) would be given to an anonymous in-group member and the other cup clearly (clearly marked for a non-specified out-group member) would be given to an anonymous out-group member. The participant was given a die with 3 black and 3 white sides, which would help her allocate the money. For each of the 30 monetary units, the participant had to allocate it to one of the two cups by rolling the die and then following a prescribed impartial rule. First, before allocating each unit, the participant had to choose a cup purely in her mind: the in-group cup or the out-group cup. Then, the participant rolled the die. In the last step, if the die turned up black, she was supposed to allocate that single monetary unit to the cup she initially chose in her mind. If the die turned up white, she allocated it to the other group, which she hadn't mentally targeted. She repeated these steps for each of the 30 units. Thus, she was confronted with a tradeoff between benefiting an in-group member and following an impartial rule of allocation. After the task, we gave the money allocated to in-group and out-group members to randomly chosen individuals from the respective groups.

Task 2 closely paralleled task 1 except it captures the tradeoff between following an impartial rule and allocating to oneself versus an anonymous out-group individual. The order of tasks 1 and 2 were counterbalanced across individuals.

If a participant followed the rule for allocating based on the die roll, then we expect her allocation to represent a random draw from a binomial distribution (with an expected value of 50% of the total stakes). At a population level, the mean amount of money allocated to either the in-group or to the self provides measures of in-group and self investment, respectively, relative to out-group members. Individual allocations to in-group or self are reported as percentages of the total stake (a half day's wage). At the individual-level, there was a moderate correlation between self and in-group allocations ($n = 223$, $r = 0.40$, 95% CI = (0.21-0.55), $p < 0.001$).

We took a number of steps to ensure a high degree of anonymity of individual allocations. Only the participant knew the cup she chose in her mind. Participants made their choices in complete privacy. Cups had lids which prevented anyone, including researchers, from linking a given allocation with a given participant. Finally, the one researcher who counted the coins and made the final payments did so behind a screen which prevented him from seeing any of the participants (see SOM).

We performed these experiments with 223 individuals in eight diverse populations. All groups were sedentary and engaged in wage work, farming, fishing, or herding. Table 1 provides the location, environment, economic base, size of in-group, and sampling information for each population, as well as averages for key variables.

We compare the two hypotheses using multiple measures of both material security and pathogen stress. Material security is measured at both the local and national levels. At the national level, we used the World Bank's indicator of government effectiveness, which assesses the quality of public services including schools, roads, and healthcare (government effectiveness). At the local or community level, we used the average of individual responses to a four-question scale about participant anxiety over obtaining sufficient food for their household at various time scales (1 month to 5 years, food security). The community- and national-level variables encompass two important elements of material security, and are highly correlated ($r = 0.87$). The results we discuss are robust to different measures of material security (Table S8-9).

For pathogen stress, we use country-level estimates of non-zoonotic pathogen prevalence (Fincher and Thornhill 2012), as the pathogen stress argument focuses on responses to human-to-human diseases. The SOM analyzes all other published pathogen stress measures (Table S8-9).

[INSERT TABLE 1]

The two theories outlined above—material security and pathogen stress—make different predictions about in-group allocations in the experiments. The material security hypothesis proposes that people who have access to strong institutions that effectively buffer risk will be more inclined to follow the impartial rule. Meanwhile, in the face of weak institutions, people instead buffer risk by investing preferentially in in-group

178 members. Thus, the material security hypothesis predicts a negative relationship between
179 risk mitigating institutions/resources (food security, quality of public services and
180 monetary resources) and allocations to in-group members or self. The pathogen stress
181 hypothesis proposes that people exhibit increased in-group favoritism specifically in
182 response to the threat of infectious disease. Limited exposure to infectious disease, by
183 contrast, leads to decreased in-group favoritism. Thus, the pathogen stress hypothesis
184 predicts a positive relationship between pathogen prevalence in an area and in-group
185 allocations.

186 Figure 1 plots community means for in-group and self-allocations versus the material
187 security measures of government effectiveness and food security. Consistent with the
188 material security hypothesis: for in-group allocations, government effectiveness accounts
189 for two-thirds ($r = -0.81$, bootstrapped 95% CI = (-0.63,-0.95) $p = 0.007$) of the variance in
190 population means and food security for 64% of the variance ($r = -0.80$, bootstrapped 95%
191 CI = (-0.59,-0.98), $p = 0.009$); for self-allocations, government effectiveness accounts for
192 77% ($r = -0.88$, bootstrapped 95% CI = (-0.65,-0.98), $p = 0.002$) and food security for three
193 quarters of the variance ($r = -0.86$, bootstrapped 95% CI = (-0.72,-0.98), $p = 0.003$). By
194 contrast, for both self and in-group allocations, non-zoonotic pathogen stress accounts for
195 less than 5% of the variance ($\rho = -0.09$ & 0.21, $p = 0.30$ & 0.42, Figure S3 shows bivariate
196 scatterplot for pathogen stress)

197

198 [INSERT FIGURE 1]

To further analyze these data, we estimated six regression models. In the first three, we regress in-group allocations on government effectiveness, food security and pathogen stress, as well as four control variables. Control variables included one study design variable (task order: self or in-group allocation first) and three individual-level variables (age, sex, and years of schooling normalized by site). The second set of three regressions were identical to the first three, except allocation to self was the outcome variable.

Table 2 shows these regression results. Consistent with the relationship in Figure 1, and now controlling for individual-level sociodemographics and study design variables, the coefficients for government effectiveness, and community-level food security are large, negative, and significant at conventional levels. A standard deviation increase in government effectiveness is associated with a decrease of 0.88 and 0.89 monetary units in allocation to in-group and to self, respectively. A standard deviation increase in food security was associated with a decrease of 1.44 monetary units to in-group and a 1.51 decrease to self.

[INSERT TABLE 2]

Contrary to the prediction of the pathogen stress hypothesis, increasing pathogen stress was not associated with in-group allocations, and the estimated coefficient for in-group investment was in the opposite of the predicted direction. Using the other measures of pathogen stress yields similar results (Table S8-9).

We considered two other plausible explanations for these associations. First, the observed associations could be caused by confounding due to shared cultural or religious history.

However, this seems unlikely as the three societies with less material security (Bolivia, Bangladesh, and Fiji) have three very different cultural backgrounds and the three societies with greatest material security (China, Iceland, and U.S.) have two very different cultural backgrounds. This suggests that shared cultural heritage is unlikely to account for the observed association. Another possibility is that greater in-group allocations are due to smaller in-group sizes if people thought that their allocations would more directly return to them in smaller groups. However, in-group size accounted for less than 1% of the variance in either individual allocations or community mean allocations (Table S10). This suggests that in-group size is not a plausible account for individual or community-level variation in allocations in this data.

Discussion

Overall, based on data from an experimental protocol that pits following an impartial rule of allocation against giving to one's community in eight societies, our findings are more consistent variation in particularism-universalism as a general response to institutional quality and material security than a dedicated response to specific environmental threats, such as the risk of exposure to pathogens.

These results show that individuals in materially secure environments are less likely to favor themselves and in-group members when this involves biasing an impartial rule of allocation to out-group members. The fact that most participants in most places allocated a substantial portion of funds to an anonymous out-group member suggests that people in these diverse societies value following rules for impartial allocations. However, the

241 strength of this motivation appears to vary in relation to the local environment. The
242 content of relevant material concerns appear to be quite general—including both food
243 insecurity and lack of quality social services—which is consistent with experimental
244 findings in industrialized societies (Heine, Proulx, and Vohs 2006, Mikulincer and Shaver
245 2001, Navarrete et al. 2004) and with observational cross-national studies (Cashdan and
246 Steele 2013, Hruschka and Henrich in press). These findings are more consistent with the
247 hypothesis proposing a general adaptive response to material security over that suggesting
248 a dedicated response to pathogens. They also provide novel behavioral confirmation of
249 cross-population findings based on self-report (Hruschka and Henrich in press) and
250 ethnographic reports (Cashdan and Steele 2013) of in-group preferences.

251 These results also potentially clarify a puzzle raised by prior studies of sharing in diverse
252 small-scale societies. Ethnographies worldwide have recorded how in societies with little
253 market integration, people place great importance on generosity, equality and sharing.
254 However, recent experimental studies have shown the opposite—members of less market-
255 integrated communities are also the least likely to share equally or be generous with an
256 anonymous individual (Henrich et al. 2010). Our results provide a potential resolution to
257 this puzzle that relies on the scope of sharing. If a lack of risk-buffering institutions shifts
258 investment inward toward oneself and one's local in-group then one is also less likely to
259 engage in the relatively anonymous interactions required for market integration. Thus in
260 situations with less effective risk-buffering institutions, we will observe both a higher value
261 placed on equal sharing and generosity locally in face-to-face situations, as well as less

generosity and equal sharing with less familiar individuals. One will also see less market integration.

Our study leaves open a number of questions about the mechanisms that give rise to our observed relationship. Potential mechanisms include individual cost-benefit responses to immediate threats, internalization of rules of thumb over the lifespan, and culturally acquired beliefs, values, habits and motivations (Bowles 1998, Navarrete and Fessler 2005, Sugiyama 2004, Van de Vliert 2011). For example, recent immigrant studies show that in-group favoritism can remain stable across generations exposed to new environments, suggesting that cultural learning plays a role (Giuliano and Alesina 2010) in addition to facultative behavioral responses to novel threats (Kranton 1996). The causal feedback that gives rise to the relationship between material security and expanding one's in-group also deserves further scrutiny. Existing models propose co-evolutionary feedbacks by which: (a) an expanding in-group permits the creation of novel, large-scale institutions while (b) new institutions make expanding one's in-group a viable strategy (Greif 1994). It is also possible that lower levels of in-group favoritism foster economic growth (Fukuyama 1995, Gelfand 2011, Kranton 1996) and the development of institutions that mitigate material threats. Altogether, these hypotheses suggest the important possibility that in-group favoritism and material insecurity can be mutually reinforcing.

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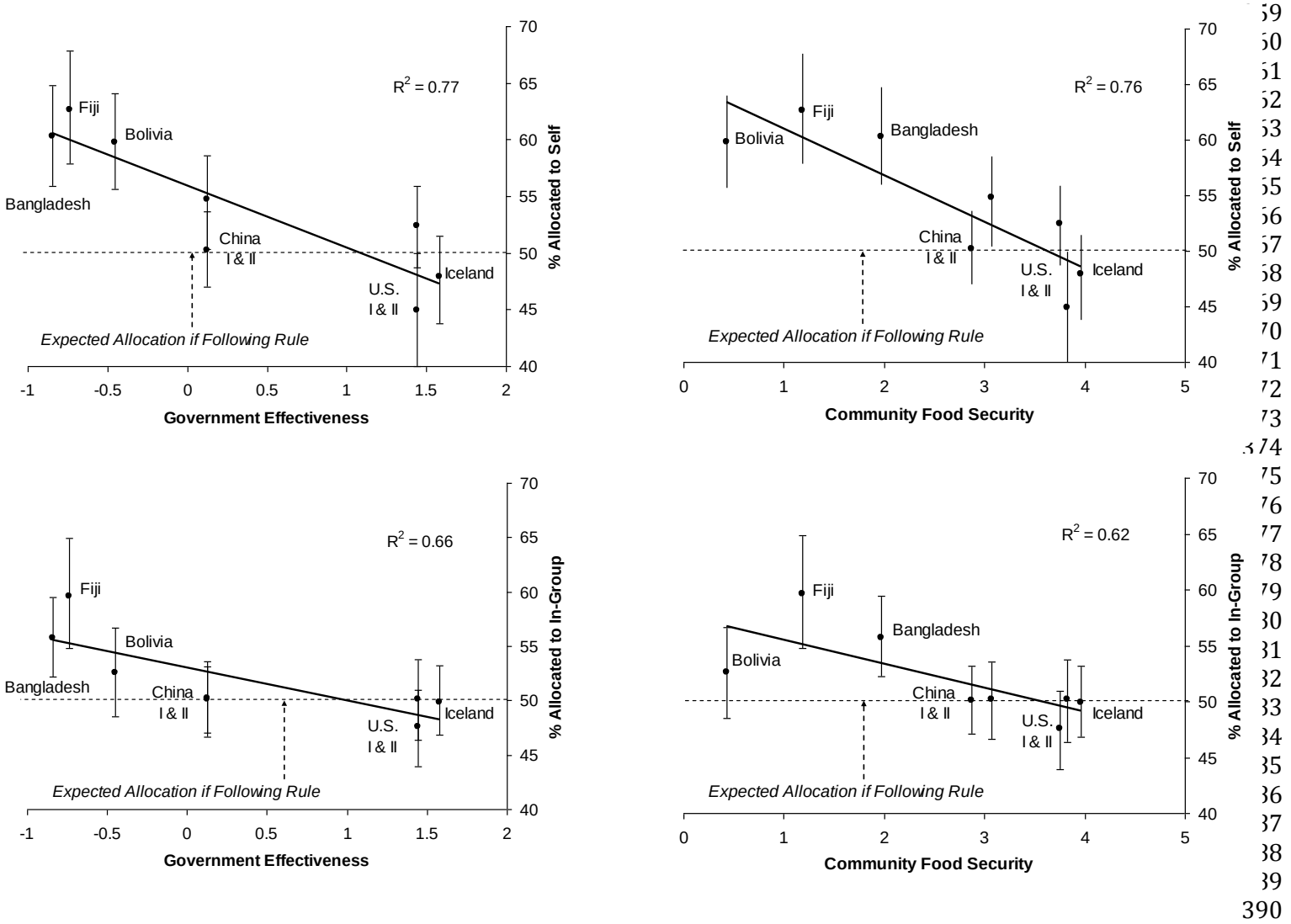

Figure 1. Increasing Government Effectiveness and Food Security Associated with Decreasing Allocation to Self and In-group. Error bars are bootstrapped 95% CIs. Dotted line indicates expected allocation when following blind, impartial rule for allocation.

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395 **Table 1. Summary information for study populations.** The column Economic Base classifies the production systems. In-Group
396 describes the generic term for the in-group. N = number of participants. Size of In-Group is number of adults in specific in-group. In-
397 Group and Self Allocation is % of stake allocated to in-group and self, respectively. GE = government effectiveness (2010).
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Population	Location	N	Environ	Economic base	In-group type	In-group size	In-group share	Self share	GDP per capita	Pathogen Stress	Food secure	World Bank GE
village	Bangladesh	32	alluvial plain	farming/wage	neighborhood	332	55.7	60.3	1,485	0.07	1.97	-0.84
community	Bolivia	32	montane valley	farming/wage	community	41-126	52.6	59.8	4,353	1.85	0.43	-0.45
village	Fiji	32	tropical coastal	fishing/ farming	clan	142	59.6	62.6	4,060	-1.13	1.19	-0.74
village	China	30	temperate plain	wage	neighborhood	900	50.2	54.8	6,810	1.85	3.07	0.12
university	China	32	urban	wage	class	40	50.1	50.2	6,810	1.85	2.88	0.12
rural village	Iceland	24	temperate coastal	wage	village	175	49.9	47.9	32,962	-1.87	3.96	1.58
urban church	U.S.	23	urban	wage	congregation	100	50.1	44.9	42,642	-0.69	3.83	1.44
university	U.S.	18	urban	wage	sorority/ fraternity	150	47.6	52.4	42,642	-0.69	3.75	1.44

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Table 2. Linear regression models for in-group and self-allocations. Ordinary least-squares models include four additional control variables (sex, age, education, and order). Standardized coefficients reported with *p*-values in parentheses (*n*= 223).

Variables	Models predicting in-group allocations			Models predicting self allocations		
	GE	**FS**	**PS**	**GE**	**FS**	**PS**
Government Effectiveness (GE)	-0.25 (0.015)	---	---	-0.41 (0.001)	---	---
Community Food Security (FS)	---	-0.23 (0.048)	---	---	-0.39 (0.001)	---
Pathogen Stress (PS)	---	---	-0.09 (0.49)	---	---	0.04 (0.47)
R^2	0.07	0.06	0.02	0.18	0.18	0.02

Adjusted for years of schooling (normalized by site), gender, age, and task order.
*We calculated bootstrapped standard errors clustered on field sites (10000 iterations) to adjust inferences for non-independence of cases within sites (Harden 2011). P-values are 1-sided given model predictions.

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SUPPORTING ONLINE MATERIALS FOR MATERIAL SECURITY, INSTITUTIONS AND THE EXPANDING IN-GROUP

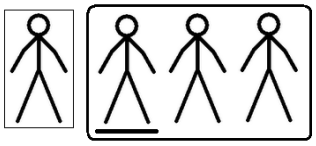
CONTENTS

EXPERIMENT METHODS

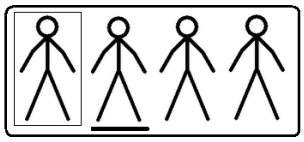
In this section, we outline our experimental procedures and protocols.

BASIC GAME DESCRIPTIONS

We deploy a simplified variant of the Mind Game (Jiang 2012) in which participants can cheat purely in their minds so that it is more than evident that cheating is invisible to others. In the task 1, each participant is allotted 30 monetary units (coins or bills equal to 50% of a day's wage) to divide between two empty cups using a die. The die is tailor-made into one with 3 black and 3 white sides. The participant was told that after the experiment one cup will be given to an in-group member and the other to an out-group member corresponding to the marks on the cups. Graphic illustrations were also put on the cups since some of our subjects are illiterate (as shown below).



Person from [Out-Group]



Person from [In-Group]

For each of the 30 monetary units, the participant had to allocate it in one of the two cups by rolling a die and following a prescribed unbiased rule consisting of three steps:

Step 1: Please choose one of these two cups in your mind.

Step 2: Roll the die once.

Step 3: The die has 6 sides: 3 sides black and 3 sides white. If the die lands with a black side facing up, you will put ***[one yuan]*** in the cup you chose in your mind in Step 1. If the die does not land with the black face up, you will put ***[one yuan]*** in the cup **that you did not choose in Step 1.**

Thus, we confronted the participants directly with the tradeoff of benefiting an in-group member at the cost of an out-group member. Since the choice is made in their minds, they can still disregard the prescribed rule and cheat, for instance, by allocating the unit to the in-group cup even when they are supposed to allocate it to the out-group cup.

We also ran a within-subject control treatment for the propensity to cheat for self at the cost of an out-group member in Task 2. Task 2 closely paralleled Task 1 except now a participant allocates between one cup for herself and one for an anonymous out-group individual. Each participant completed Task 1 and 2 in a counterbalanced design. Thus, the total stakes for a single participant was 100% day's wage (50% for task 1 and 50% for task 2).
In the task 1, a participant is allotted 30 monetary units to divide sequentially between two cups—one for an anonymous in-group member and one for an anonymous out-group member. The 30 monetary units are equal to 50% of a day's wage. The rule for allocating each monetary unit to a cup is as follows. The participant is given a die with 3 black and 3 white sides, which will help her allocate the money. Before allocating each unit the participant must think in her mind, "if I roll a black, then I will allocate to [group X]." She mentally picks X (in-group or out-group). Then the participant rolls the die. If the die turns up black, she is supposed to allocate the single unit to group X. If the die turns up white, she allocates to the other group which she hadn't mentally targeted. She repeats these steps for each of the 30 units. After the task, we gave the money allocated to in-group and out-group members to randomly chosen individuals from the respective groups. Task 1 measures a tradeoff between: (1) allocating money to one's in-group and (2) following a rule that would blindly and without bias allocate money between a member of one's in-group and a member of the out-group.

Task 2 closely paralleled Task 1 except now a participant allocates between one cup for herself and one for an anonymous out-group individual. This measures the trade-off between allocating money to oneself and following a blind allocation rule. A purely self-interested participant would allocate all money to her self-cup.

Each participant completed Task 1 and 2 in a counterbalanced design. Thus, the total stakes for a single participant was 100% day's wage (50% for task 1 and 50% for task 2).

Our standardized protocols and scripts aimed for uniformity across sites on several criteria. Many of our procedures follow guidelines set forth in earlier cross-cultural experimental projects. First, we calibrated the stake to a day's wage in the local economy to encourage motivation and attention. Second, we back-translated and implemented all game scripts in the local language by fluent speakers. Third, to prevent contagion, we restricted those waiting to play from talking about the game and from talking with players who had just played during a game session. Fourth, we individually instructed each participant using fixed scripts, sets of examples, and pre-play test questions. This guaranteed that all participants received the same instructions and understood the activities well enough to correctly answer the test scenarios (Henrich et al. 2010). Fifth, the protocol involved no deception. Sixth, it involved random adult samples from most communities.

In addition to these controls, we also took several steps to ensure anonymity of individuals allocations. Here, we describe these and other controls in more detail.

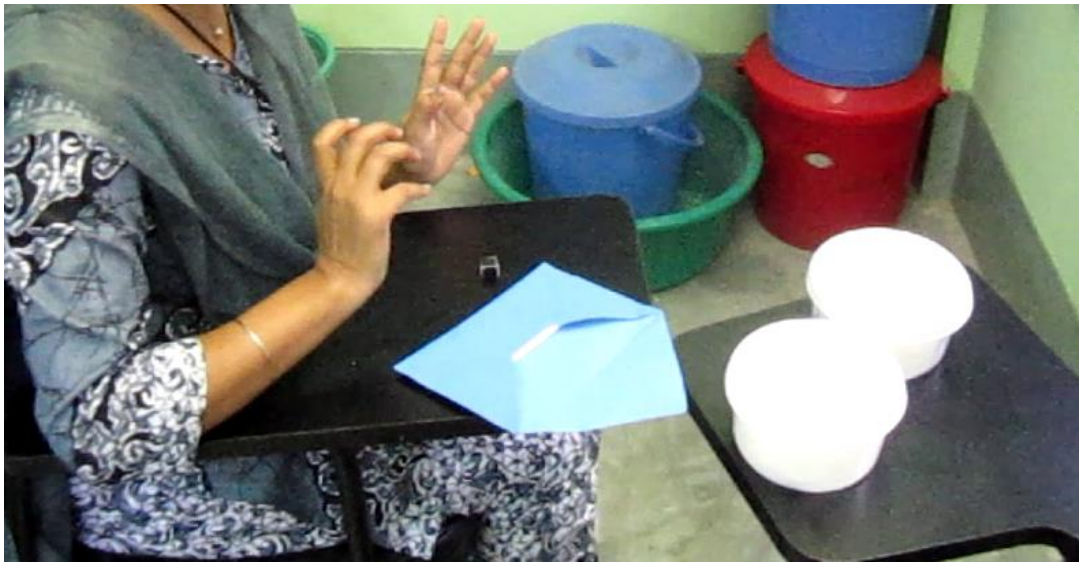


FIGURE S1. MOCK TASK 1 IN BANGLADESH. PHOTOS OF ACTUAL ALLOCATIONS NOT TAKEN TO PRESERVE ANONYMITY. (PHOTO BY ASHLAN FALLETTA-COWDEN).

ANONYMITY

As it is clear from the protocols above, the allocation on any specific roll of the die is unknowable to all but the participant, since the participant made the choice of the cup only in his or her mind. Second, every effort was made to make overall allocations transparently unknown to experimenters, researchers, or anyone except for the participant. Specifically, allocations were made alone in a room outside of the view of researchers and others. Opaque cups with tops were used to carry the allocations between rooms. Players carried their own cups on a tray, and at the end of the experiment, cups were submitted to a researcher behind an opaque screen, so that the researcher could not link the allocations with a specific person. Such anonymity means that participants lacked cues about their specific relationships such as those based on kinship, reciprocity, or status differences, with the exception of the in-group/out-group distinction. It also means that participants would be unable to signal their generosity or fairness to the researchers or to others in their community. It is still possible that participants do not fully accept the experimental situation or believe that the task was truly anonymous. However, people would have to: (1) believe that the experimenter could read their minds or (2) the experimenter could link the participant with his or her allocation AND could determine whether the participant had deviated from a truly random allocation.

SAMPLING

Participants were randomly chosen from community/group censuses that existed prior to the study or were generated for the specific purpose of this study. Almost all invited individuals did participate unless they were away during the experimental sessions. In societies where large numbers of residents were involved in inflexible work schedules that might preclude attendance, an effort was made to schedule games at times that would be convenient to more people. At the two U.S. sites—university Greek organizations and a congregation—participants were sampled on a first-come-first-serve basis after advertisements and announcements were made to the organizations. We did not have a sampling strategy for choosing organizations within sites; each researcher was left to their own discretion. Overall, our randomly drawn samples are highly representative of the communities from which they are drawn, since it was rare that someone who was selected declined to participate if they were present. People were generally enthusiastic about participating.

COLLUSION AND CONTAGION

Prior cross-cultural studies identified collusion and contagion among closely-knit communities as potential risks for our experimental protocols. We took several steps to address this issue. First, we were careful not to describe the specifics of the activities until participants had gathered for the actual activities. Second, we ran experiments for a given community as swiftly as possible, often within one day, and almost always within two days. Third, we assessed whether allocations changed across days in those communities where allocations were made in the same community over several days.

INFORMED CONSENT

We knew in advance that many of the subjects would be illiterate and would not be able to read descriptions of the research and sign consent forms. So in place of this, at the start of each session, the participants were read a simple description of what would happen, and told that if at any point they became uncomfortable with any aspect of the games they were being asked to play they were free to leave at any time.

GATHERING AND WAITING

All invited participants were told where and when to show up for the activities. In some situations, we provided transportation to the location. Where possible, we used community structures like schools or clinics; otherwise we used clusters of local homes. Numerous local research assistants were employed to control the logistical flow once the game began, to monitor the groups to prevent discussion of the game, and to conduct the requisite surveys. Each site involved two waiting rooms—one for intake to the experiment and one for waiting between the experiment and post-experiment interviews. These waiting rooms were separated so that participants who had completed the experiments could not consult with those waiting to do the experiments. After finishing the experiment and the interview and receiving payment, participants were told they could go and directed along a path that did not pass by the first waiting room. Participants were allowed to talk amongst themselves, but they were monitored constantly and not permitted to talk about the game.

BACK TRANSLATION AND ADMINISTRATION OF SCRIPTS

Each researcher had the game scripts translated and back-translated into the appropriate local language. This involved having one bilingual assistant with no knowledge of the game translate the game instructions into the local language, and a second translate it back, thus identifying any problems in translation. All game instructions were read by native speakers unless the project researcher was fluent in the local language. Game administrators went through training in pilot experiments prior to actual experimental runs.

SHOW-UP FEE

Before the game began, participants were given a "show-up" fee paid in cash of approximately 20-30% of one day's wage in the local economy. It was made clear to the player that this money was strictly for their *participation* in the game, and it was not part of the activity. Participants who failed to pass the required tests of game understanding were allowed to keep the show-up fee—which made it somewhat easier to reject them, if the need arose.

STAKES

Total stakes across the two activities played by a participant were set at roughly one day's minimum wage in the local community (i.e. the rate ordinarily paid for casual wage labor work if it were available). For an urban U.S. congregation, this amounted to $60 while in many of the developing societies the stakes were in the range of $2. Because stakes had to be divisible by thirty, some sites wound up with stakes that were marginally higher or lower than the daily wage rate.

TEACHING EXAMPLES AND TEST QUESTIONS

In both teaching and testing the participants, researchers used actual coins, paper currency, dice and cups to illustrate the game. By presenting the arithmetic visually, people with limited or no arithmetic skill could still understand the game. If necessary, players could manipulate piles and count coins or bills during decision-making and testing. Specific teaching examples were scripted in the written protocols. Analyses indicate that the number of examples a player required does not predict decisions.

OTHER CHECKS

In each fieldsite, we tested activity dice to verify that they were 50/50.

GAME LOGISTICS

Once all participants had arrived, the game area was secured by the experimental team from the eyes and ears of non-participants, and each participant was given an unmarked envelope with a show-up fee (20%-30% of the stake/one-day's wage) and a card with a unique ID number. The introductory script was then read to the whole group. The script included the following points (1) participation was purely optional and people should feel free to leave at any time, (2) people's decisions were entirely private and there would be no way for anyone to find out what they had decided (3) all games would be played only once, (4) players must not discuss the game (research assistants monitored the group for compliance), and (5) all the money was real and people would receive payment to take home at the end of the session.

Each individual was taken into a private room where a game administrator described the experimental situation and then followed with a fixed set of examples, which were illustrated to the participant by visually manipulating bills or coins in the local currency. If the player confirmed that he or she understood the game, and the experimenter, the participant was given test questions that required them to state the amount of money that each player would receive under various hypothetical circumstances. Players had to correctly answer five consecutive test situations to pass and be allowed to participate in the experiment. If a player could not correctly answer the questions, they were given the set of examples again, and they were tested again. After passing the test, the participant was left alone in the private room, and asked to allocate the 30 units of money using the die.

After the first counter-balanced task was finished, the participant covered her cups and called the experimenter into the room. The experimenter followed the same protocol with the second task.

Participants knew everything about the experimental game, except who was matched with whom. Our script specified that money allocated to the cups would be given to a relevant individual: (1) to the participant for the self cup, (2) to a randomly chosen, anonymous individual

in the in-group for the in-group cup, and (3) to a randomly chosen, anonymous individual in an out-group for the out-group cup.

Researchers were encouraged to supply food and drink to keep players comfortable while waiting.

POPULATIONS

In our project proposal we drew from literature in anthropology, sociology, psychology and economics to hypothesize that individuals would show greater preference for investing in their in-group over following a blind, unbiased procedure for allocation in situations of greater material uncertainty. To assess this hypothesize, we selected a set of fieldsites that met several criteria: (1) they maximized variation in our key independent variable—material uncertainty—as measured by World Bank measures of government effectiveness, (2) within the high and low ends of material insecurity, there was diversity in the cultural backgrounds of the fieldsites to mitigate concerns about spurious results from shared cultural heritage, and (3) we could identify and recruit seasoned field researchers with long-term engagement in those fieldsites who woud be able to complete the protocol in the project's limited time window.

The populations are also relatively uniform on two other variables of potential theoretical importance. All of the societies: (1) have had long-term historical exposure to a major world religion, (2) are sedentary (see table S1).

In each fieldsite, we identified a salient in-group satisfying the following criteria: (1) members are expected to cooperate with each other and to help each other on a regular basis, and (2) the group should comprise 40 to 400 adults. In two societies, these in-groups were named neighborhoods within larger villages (Bangladesh and China village). In Iceland, the in-group was an entire village (Iceland), and in Bolivia, the in-group was a "community." In Fiji, the in-group was a clan within a village. In the U.S., the congregation consisted of individuals on the church rolls, which could include individuals from different parts of the city. In the university

contexts, in-groups were either fraternities/sororities (U.S.) or classes which stay together over the course of their college careers (China).

Out-groups were defined as individuals in a generically defined location (e.g. another village, another community, another university, another island) within the same country and ethnic group, but at a substantial distance from participants' own in-group.

Table S1. Ethnographic Outline of Fieldsites.

Population	Country	Environ	Economic base	Language	Predominant Religion	Researcher
village	Bangladesh	alluvial plain	farming/ wage	Bangla	Islam	Hruschka
community	Bolivia	montane valley	farming/ wage	Spanish	Christian	Efferson
village	Fiji	tropical coastal	fishing/ farming	Oceanic	Christian	Henrich
village	China	temperate plain	wage	Teochew Chinese	Buddhist/Confucian	Jiang
university	China	urban	wage	Teochew Chinese	Buddhist/Confucian	Jiang
rural village	Iceland	temperate coastal	wage	Icelandic	Christian	Falletta-Cowden/Sigurdsson
urban church	U.S.	urban	wage	English	Christian	Hruschka
university	U.S.	urban	wage	English	Christian	Hruschka

COLLECTION AND OPERATIONALIZATION OF KEY VARIABLES

At each site we collected data on age, sex, education, food security, "event security," and income (6 sites for income). We also outline derivation of material security and pathogen stress variables.

AGE, GENDER, AND EDUCATION

We followed similar protocols as prior cross-cultural experimental studies to assess age in years, gender, and number of years of education completed (Henrich et al. 2010). Since one year of formal education is not equivalent across sites, we standardized our education measures by subtracting the mean value of education in the population and dividing by the standard deviation in education for each population. This allows us to make the best use of within population variation we have in education for most of our sites. However, since number of years of education at the site level is an alternative proxy for government effectiveness, we use it in supplementary analyses as an alternative measure of material security.

INCOME

Income was collected for each individual who played an task, and it was that specific individual's income that we used in the regression analyses. The one exception was for U.S. university students for whom we used their parent's income. Income was defined as the flow of revenue available to the individual from legal, illegal, formal, and informal sources. Given the likely flux in income seasonally, each researcher attempted to get an estimate of annual income taking into account seasonal fluctuations. Income is a challenging variables to collect under the best of circumstances. In the U.S. and Iceland, we used income categories for aggregate income. In Bolivia, Bangladesh, and Fiji, we disaggregated by local categories and relevant time periods to be as inclusive as possible, and to facilitate recall. Surveys were created locally that disaggregated all known sources of income and wealth and requested amounts in easily known time periods. Income sources on a weekly, monthly, or one-off basis were then aggregated by the researcher into an annual figure. Most of the income we did record derived from wage work (casual and professional), trading profits, sale of home production, rental income, and remittances.

MATERIAL SECURITY

Based on our original project proposal, material security was the major independent variable. We assessed this in several ways. Our original measure was a World Bank measure of government effectiveness used in prior cross-national analyses of self-report data (Hruschka 2010). At the national-level, we also used log(GDP per capita in 2010, PPP) as a related measure.

At the community-level, we asked individuals to report on two common sources of insecurity—ability to access adequate food (food security) and ability to fund major household events, including illness, weddings, births, funerals (event security). For food security, we asked each participant to answer four questions:

- Do you worry that in the **next month** your household will have a time when it is not able to buy or produce enough food to eat? Yes or No? Mark here if the person said they guessed____
- Do you worry that in the **next six months** your household will have a time when it is not able to buy or produce enough food to eat? Yes or No? Mark here if the person said they guessed____
- Do you worry that in the **next year** your household will have a time when it is not able to buy or produce enough food to eat? Yes or No? Mark here if the person said they guessed____
- Do you worry that in the **next five years** your household will have a time when it is not able to buy or produce enough food to eat? Yes or No? Mark here if the person said they guessed____

To construct the scale, we assigned 1 to each No response, 0 to each Yes response, and summed the responses. The questions for event security followed the same pattern, but used the following question wording.

- Do you worry that your household will have to pay for a big event (such as a wedding, funeral, festival, or illness in the family whether planned or not) in the **next month** that your household will not be able to pay for alone? Yes or No? Mark here if the person said they guessed____

The Cronbach's alpha for the food security scale is 0.89 and for the event security scale is 0.83. Another potential measure of material security, is individual-level income. We were only able to collect this variable from 6 sites.

PATHOGEN STRESS

Estimates of contemporary pathogen prevalence were used from Fincher and Thornhill (in press). To assess Fincher and Thornhill's hypothesis about a dedicated psychological response to human-to-human pathogens, we use their measure of non-zoonotic pathogens. We also assess the hypothesis with Fincher and Thornhill's measure of total and zoonotic pathogen prevalence as well as Schaller and Murray's historical measure of pathogen prevalence (Murray and Schaller 2010).

SUPPLEMENTARY ANALYSES

COMPARISON OF MATERIAL INSECURITY AND PATHOGEN STRESS MEASURES

Table S2. Bivariate correlations between site-level material insecurity.

	National Level Measures		Community Level Measures		
	World Bank GE	**Log(GDP per cap)**	**Food Security**	**Event Security**	**Log(income)**
Log(GDP per cap)	0.98**				
Food Security	0.87**	0.80*			
Event Security	0.93**	0.85**	0.98**		
Log(income)	0.95**	0.96**	0.75	0.83*	
Years of Schooling	0.89**	0.91**	0.78*	0.76*	0.81

Income not collected in two Chinese sites.

Table S3. Bivariate correlations between material insecurity proxies within sites.

	FS-ES	FS-INC	FS-SCH	ES-INC	ES-SCH	INC-SCH
Bangladesh	0.35	0.20	0.14	0.04	-0.04	0.18
Fiji	0.54**	0.38	-0.13	-0.02	0.06	-0.35
Bolivia	0.68**	0.00	0.07	0.12	0.19	0.30
China College	0.44*	--	-0.41*	--	-0.18	--
China Village	0.64**	--	0.61**	--	0.64**	--
Iceland	0.39	0.06	0.00	-0.36	-0.07	0.05
U.S. University	0.72**	0.71*	0.09	0.71*	0.38	0.25
U.S. Congregation	-0.19	0.25	0.46*	0.37	0.20	0.45*

Income not collected in two Chinese sites.

Figure S2. Distribution of Allocations by Site. Ban = Bangladesh, Bol = Bolivia, Ch(V) = China Village, Ch(C) = China University, Ice = Iceland, Phx = U.S. Congregation , ASU = US University

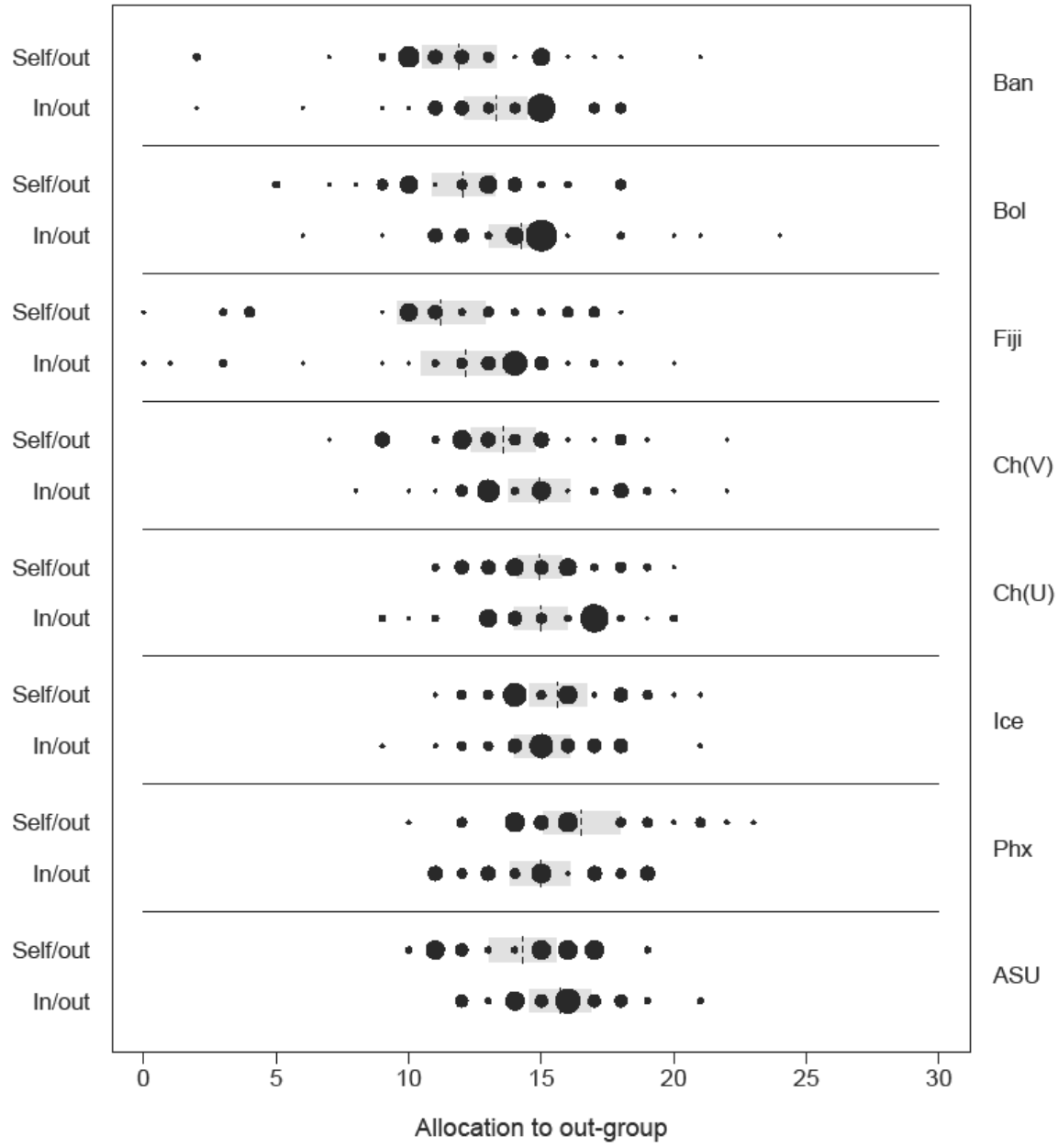


Table S4. Primary Data. Means and Standard Deviations (in parentheses) of Key Variables Across Sites

Population	Country	In Allocation (%)	Self Allocation (%)	Age (years)	Schooling (years)	Annual Income (1000 USD)
village	Bangladesh	55.7 (11.5)	60.3 (13.1)	38.8 (13.7)	3.0 (3.0)	0.75 (0.30)
community	Bolivia	52.6 (11.5)	59.8 (11.5)	45.0 (16.2)	4.7 (4.9)	9.4 (10.5)
village	Fiji	59.6 (16.0)	62.6 (15.8)	39.2 (13.5)	8.9 (2.2)	1.3 (1.0)
village	China	50.2 (10.6)	54.8 (11.4)	48.3 (15.4)	7.2 (2.6)	--
university	China	50.1 (9.9)	50.2 (8.2)	18.4 (1.2)	11.1 (0.7)	--
rural village	Iceland	49.9 (8.8)	47.9 (8.9)	50.5 (16.5)	16.0 (2.0)	54.3 (26.3)
church	U.S.	50.1 (9.0)	44.9 (11.4)	63.2 (12.4)	18.3 (2.6)	77.8 (40.7)
university	U.S.	47.6 (8.0)	52.4 (8.8)	20.4 (0.9)	12.9 (1.7)	120.0 (36.5)

WITHIN-SITE ANALYSES OF ALLOCATIONS BY INCOME, FOOD SECURITY, EVENT SECURITY AND SCHOOLING.

Within-site analyses presented in tables 4S and 5S indicate few if any substantive associations between individual demographic variables and allocation to in-group or self. The lack of between-individual associations within sites could result from two factors. First, there may be too much error in individual measurements (due to the injection of randomness with the die rolling protocol). Second, observed allocations may result for population-level norms rather than individual adaptations to the current economic situation.

Table S5. Bivariate Association between Individual In-group Allocations and Food Security, Event Security, Income, Gender, Age, and Schooling within sites.

	FS	ES	INC	GENDER	AGE	SCHOOL
U.S. University	0.23	0.24	0.20	-0.12	0.08	-0.24
U.S. Congregation	0.06	0.12	0.32	-0.08	0.25	0.43*
Iceland	0.08	0.16	-0.29	-0.28	-0.14	-0.27
Fiji	0.23	0.21	0.25	-0.15	-0.28	-0.21
Bangladesh	0.25	0.25	-0.15	-0.07	-0.15	-0.06
Bolivia	-0.04	0.16	0.13	0.20	-0.27	0.26
China College	-0.14	0.12	--	-0.05	-0.0	0.34
China Village	0.25	0.13	--	-0.11	0.13	-0.06

Table S6. Bivariate Association between Individual Self Allocations and Food Security (FS), Event Security (ES), Income (INC), Gender, Age, and Schooling within sites.

	FS	ES	INC	GENDER	AGE	SCHOOL
U.S. University	-0.17	0.11	0.12	0.17	0.32	-0.05
U.S. Congregation	-0.31	0.26	0.11	-0.06	0.35	-0.26
Iceland	-0.05	-0.19	0.13	0.56**	-0.12	0.20
Fiji	0.10	-0.08	0.38	0.03	-0.22	-0.16
Bangladesh	0.38*	0.32	0.01	-0.14	-0.23	-0.09
Bolivia	-0.39*	-0.18	0.07	-0.03	-0.01	-0.20
China College	-0.13	-0.18	--	-0.13	0.01	-0.10
China Village	-0.08	0.02	--	-0.21	-0.11	-0.01

BASE MODEL PREDICTING ALLOCATIONS BY GENDER, SCHOOLING, AGE, AND CONDITION ORDER

Table S7. Regression of individual allocations on gender, site-normalized schooling, age, and condition order (p-values based on bootstrap clustered standard errors clustered on field site).

	In-group Allocation		Self Allocation	
	Standardized Beta	**p-value**	**Standardized Beta**	**p-value**
Gender	-0.04	0.36	0.01	0.69
Schooling	0.05	0.72	-0.38	0.02
Age	-0.05	0.52	-0.08	0.41
Order	-0.10	0.001	-0.05	0.15

Table S8. Individual-level regression of community mean allocations on alternative community-level measures of material security and pathogen stress, controlling for age, gender, site-normalized schooling, and order of condition.

Variables	Models predicting in-group allocations		Models predicting self allocations	
	logGDP	**Schooling**	**logGDP**	**Schooling**
LogGDP	-0.22	---	-0.38	---
	(0.03)		(0.003)	
Schooling	---	(0.07)	---	-0.39
				(0.001)
R^2	0.06	0.04	0.16	0.17

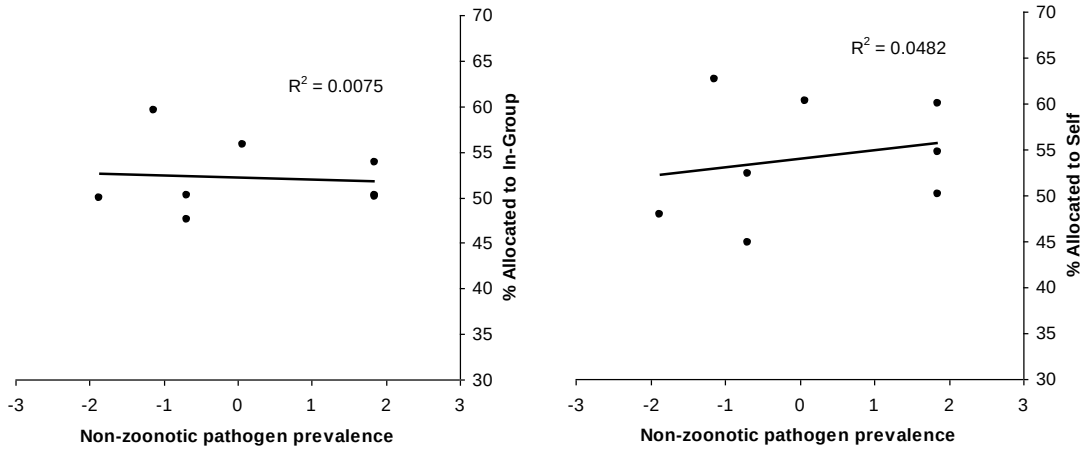
Variables	Models predicting in-group allocations			Models predicting self allocations		
	ZP	**TP**	**HP**	**ZP**	**TP**	**HP**
Zoonotic pathogen stress (ZP)	-0.23	---	---	-0.25	---	---
	(0.04)			(0.12)		
Total pathogen stress (TP)	---	-0.04	---	---	0.17	---
		(0.49)			(0.18)	
Historical pathogen stress (HP)	---	---	-0.03	---	---	0.10
			(0.46)			(0.30)
R^2	0.06	0.01	0.01	0.08	0.05	0.03

Table S9. Site-level bivariate correlation of community mean allocations with measures of material security and pathogen stress.

	In-group Allocation	Self-Allocation
Material Security		
Government Effectiveness	-0.81*	-0.88**
Food security	-0.79*	-0.86**
Log(GDP per capita)	-0.74*	-0.82*
Schooling	-0.52	-0.87**
Pathogen Stress		
Non-zoonotic disease	-0.09	0.22
Zoonotic disease	-0.06	0.42
Total disease	0.18	0.46
Historical pathogen prev	0.12	0.36

SCATTERPLOTS OF NON-ZOONOTIC PATHOGEN STRESS AND ALLOCATIONS

Figure S3. Relationships of Self and In-group Allocations to Non-zoonotic pathogen prevalence



ANALYSIS BY IN-GROUP SIZE

Table S10. Bivariate correlation of Allocations with in-group size

	Individual-level correlation	Correlation between site-level means
Self Allocation	-0.07	0.15
In-group Allocation	-0.04	0.05

ANALYSIS BY COMPATRIOTISM

An alternative hypothesis for increasing allocation to in-group and self relative to out-group members is decreasing motivation to allocate to compatriots. This is a concern, as out-group members were described to participants as coming from the same country. Thus, in those places where people have less social motivation to give to compatriots, they will be more likely to bias allocations toward themselves or their in-groups. Using a national-level measure of compatriotism from Van der Vliert (Van de Vliert 2011), we see precisely the opposite (values for Bolivia or Fiji were not available). In those societies with less compatriotism, people are *less* likely to bias allocations to their in-groups and to themselves. This fits with a view that preferences guiding in-group bias at the local community level are also related to those driving in-group bias at the national level.

Table S11. Bivariate correlation of Allocations with in-group size

	Correlation between site-level means
Self Allocation	0.72
In-group Allocation	0.83

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