Supplementary Materials for:
The Cognitive and Cultural Foundations of Moral Behavior

Benjamin Grant Purzycki[a,*], Anne C. Pisor[a], Coren Apicella[b], Quentin Atkinson[c,d], Emma Cohen[e,f], Joseph Henrich[g], Richard McElreath[a], Rita A. McNamara[h], Ara Norenzayan[i], Aiyana K. Willard[e], Dimitris Xygalatas[j]

[a]*Department of Human Behavior, Ecology and Culture, Max Planck Institute for Evolutionary Anthropology, DE*
[b]*Department of Psychology, University of Pennsylvania, USA*
[c]*Department of Psychology, University of Auckland, NZ*
[d]*Max Planck Institute for the Science of Human History, DE*
[e]*Institute of Cognitive and Evolutionary Anthropology, University of Oxford, UK*
[f]*Wadham College, University of Oxford, UK*
[g]*Department of Human Evolutionary Biology, Harvard University, USA*
[h]*School of Psychology, Victoria University of Wellington, NZ*
[i]*Department of Psychology, University of British Columbia, CA*
[j]*Department of Anthropology, University of Connecticut, USA*

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*Corresponding author
Email address: `benjamin_purzycki@eva.mpg.de` (Benjamin Grant Purzycki)

1. Protocols, Data, and R Code

The methodological protocols, data sets, and R code are publicly available at: `https://github.com/bgpurzycki/Moral-Models-Moral-Behavior`. The R code includes step-by-step instructions on how to analyze and restructure the free-list data according to the appropriate analyses including: 1) calculations of item salience for free-list data; 2) assessing universal and local models of good and bad; 3) extracting binary values for listing "honesty" and "dishonesty"; 4) adding the salience and binary values to the main data set; and 5) code for regressing these and other values on coin allocations for both main and supplementary analyses.

2. Sample

Below, we briefly detail the populations with whom we conducted our work. Details for the present study are in table S1. Further details of these sites and our sampling techniques can be found at [15, 18].

Site/Sample	Moralistic Deity	Distant Player	Language of Study
Coastal Tanna	Christian god	from another Christian village	Bislama
Hadza	*Haine*	another Hadza from another camp	Hadzane/Swahili
Inland Tanna	*Kalpapen*	from another *Kastom* village	Navhaal
Lovu, Fiji	Shiva	Hindu on Vanua Levu	Fiji-Hindi/English
Mauritians	Shiva	Hindu from La Gaulette	Mauritian Creole
Marajó, Brazil	Christian god	Christian from Rondon	Portuguese
Tyva Republic	*Buddha-Burgan*	Buddhist from Ak Dovurak	Tyvan
Yasawa, Fiji	Christian god	Fijian Christians from another island	Bauan Fijian

Table S1: **Further descriptive features of each field site.**

2.1. Coastal and Inland Tanna, Vanuatu

The inhabitants of Tanna Island in Vanuatu are traditionally swidden horticulturalists although a market-based economy plays an increasingly important role on the island [2, 4]. Religious beliefs are a mix of Christianity and the traditional "Kastom" pantheon, as well as millenarian "cargo cults." The study was conducted at two sites on Tanna: a cluster of three inland, predominantly Kastom hamlets that rely almost exclusively on subsistence farming for food production, and a wealthier coastal, Christian village in which home production accounts for about two thirds of food consumption. For the Inland Tanna site, the "moralistic god" used for the survey questions was the *Kastom* creator god and culture hero, *Kalpapen* while the Coastal site used the Christian god.

2.2. Hadza, Tanzania

Living in the savannah woodlands of western Tanzania, the Hadza are a population of hunter-gatherers who largely subsist on wild game, fruits, tubers, and honey [1, 11]. While the Hadza have been described as having a minimalist form of religion, this appears to be changing. Hadza camps exhibit fission-fusion organization and camp membership is quite fluid, with individuals moving frequently between camps. Labor is divided between the sexes; men hunt and extract honey while women typically focus on gathering plants.

2.3. Lovu, Fiji

On the south Pacific island of Vanua Levu, in main island in the Fijian archipelago, the Indo-Fijians are a diaspora population brought to Fiji from India by the British as indentured workers [9, 22]. They are primarily wage laborers or sugar cane farmers. The Indo-Fijians are mostly Hindus and Muslims with a minority of Sikhs and Christians. The present sample consisted of Hindu Indo-Fijians from Lovu village on the island of Viti Levu. The participants were all wage laborers or unemployed. Though there are many gods in the Hindu tradition, the participants believed that all gods are aspects of one single God (*Bhagwan*).

2.4. Marajó, Brazil

Pesqueiro is a small fishing village on the east side of Marajó Island at the mouth of the Amazon River [6]. Subsistence is primarily market-based, relying on fish sales in the nearby town of Soure and a growing tourism industry. The majority of inhabitants identify as Catholic, though there is a minority of Evangelical Protestants.

2.5. Pointe aux Piments, Mauritius

Mauritius is a cluster of islands about 1,200 miles off the coast of southeastern Africa [5, 23]. Though historically dependent largely on sugar exports, Mauritius has developed into a diversified, market-based, monetized economy in recent decades. The main employment sectors include manufacturing, tourism, financial services, information technology, fish processing, and construction. Rural areas continue to rely on horticulture and fishing for subsistence. The study was conducted in the coastal rural village of Pointe aux Piments, which lacks industrial development. The majority of the local population is of low or middle income, employed mainly in fishing, agriculture, tourism, and other services. The village has a religiously mixed population, with Christians and Hindus each making up approximately 45% of the total. Our sample for this study consisted of Hindus.

2.6. Kyzyl, Tyva Republic (Russia)

Part of the Russian Federation, the Tyva Republic lies in southern Siberia, in the center of Asia [17, 21]. Urban Tyvans subsist primarily on a market-based economy while rural Tyvans rely significantly more on produce provided by livestock (sheep, goats, cattle, yaks). The study was conducted in the capital city of Kyzyl primarily among urban Tyvans, though some were farmers. While the majority of Tyvans identifies as Buddhist, traditional religious practices associated with shamanism, animism, and totemism have a strong presence as well.

2.7. Yasawa, Fiji

Yasawa Island lies at the northwestern corner of the Fijian archipelago [8, 12]. Yasawans subsist primarily as fisher-horticulturalists. The present sample consists mainly of villagers living closest to the only resort on Yasawa Island as of July 2013. As such, this village has had the highest population of residents with the most extensive and frequent interaction with a resort. All Yasawans identify as Christian, with a majority practicing as Wesleyan Methodists and a large minority practicing as Assemblies of God evangelicals. Additionally, their Christian beliefs and practices coexist alongside beliefs about traditional deified ancestor spirits that can bring illness, misfortune, and death to those who deviate from proper traditional Fijian social norms, often at the behest of sorcerers.

3. Moral Models

3.1. Methods

For reasons expressed in the main article (e.g., difficulty with scale designs), the most straightforward and universally applicable way to ask participants about moral models was asking them to freely list things that they think are "good" and "bad." Our protocols instructed field researchers to ask:

- *Please list up to 5 behaviors that make someone a good/virtuous/moral person.*
- *Please list up to 5 behaviors that make a bad/immoral person.*

Because of local variation and the lack of lexical equivalents to "moral" and "immoral," we required some flexibility in design. Per site English translations of the good/bad questions are as follows with language of study in parentheses. Participants were asked to "Please list up to 5 behaviors that..."

- **Hadza (Hadzane and Swahili):** "...make someone with good/bad character or behavior."

- **Coastal Tanna (Bislama):** "...make someone good/not good."
- **Inland Tanna (Nivhaal):** "...make someone good/bad."
- **Lovu, Fiji (Fiji Hindi and English):** "...make a good, virtuous, moral person/bad, immoral person."
- **Marajó, Brazil (Portuguese):** "...make a good or virtuous person/bad or immoral person."
- **Mauritius (Mauritian Creole):** "...a good, moral, and virtuous person/bad or immoral person has."
- **Tyva Republic (Tyvan):** "...make a good/bad person."
- **Yasawa, Fiji (Bauan Fijian):** "...make a good/bad person."

3.2. Codebook for free-list data

The data set (the `CERC_Moral_Model_FL.csv` file) contains 15 variables. To provide a variety of ways to code the data and as a quality check, Purzycki and two research assistants (NC and TL henceforth) independently cleaned and coded the data. We strove to ensure that items with subtle lexical differences were the same (e.g., "thievery" and "theft" would be recoded as "theft"). Purzycki encouraged assistants to cluster items conservatively and to keep their own codes consistent across sites. One small chunk of this data set was coded in error and some individuals' data were recovered after the initial coding regime (see data set and codebook). We therefore use Purzycki's recoded data in the present analyses.

- `Culture`: Name of field site
- `CERCID`: ID number of participant
- `Order`: Order in which item was listed (1 = first listed)
- `GOOD_ORIG_NC`: Original in-English translated data for "good" data used by coder NC
- `GOOD_ORIG_TL`: Original in-English translated data for "good" data used by coder TL
- `MATCH_GOOD`: Match check of original items in "good" list. "Corrected" indicates where Purzycki found inconsistencies due to a sorting error, and subsequently corrected them. "Match" indicates consistency across coders. "NewCode" indicates data that were recovered after initial coding by NC and TL.
- `GOOD_SPEC_NC`: Specific coding scheme for "good" list by coder NC (unless `MATCH_GOOD` is coded as "NewCode," see below)
- `GOOD_SPEC_TL`: Specific coding scheme for "good" list by coder TL
- `GOOD_SPEC_BP`: Specific coding scheme for "good" list by Purzycki (used in present analyses)
- `BAD_ORIG_NC`: Original in-English translated data for "bad" data used by coder NC (unless `MATCH_BAD` is coded as "NewCode," see below)
- `BAD_ORIG_TL`: Original in-English translated data for "bad" data used by coder TL
- `MATCH_BAD`: Match check of original items in "bad" list. "Corrected" indicates where Purzycki found inconsistencies due to a sorting error, and subsequently corrected them. "Match" indicates consistency across coders. "NewCode" indicates data that were recovered after initial coding by NC and TL.
- `BAD_SPEC_NC`: Specific coding scheme for "bad" list by coder NC
- `BAD_SPEC_TL`: Specific coding scheme for "bad" list by coder TL
- `BAD_SPEC_BP`: Specific coding scheme for "bad" list by Purzycki (used in present analyses)

3.3. Results

Tables S2 and S3 detail item types listed cross-culturally for the “good” and “bad” lists respectively (see Tables 3 and 4 in the main text for truncated versions). In these tables, we report only those items where Smith’s S ≥ 0.10 for the sake of viewing ease. The R script includes code to view and reproduce full tables with all items where Smith’s S is <0.10. Smith’s S scores were calculated using the following sample sizes (good/bad lists): (1) Coastal Tanna-44/44; (2) Hadza-69/69; (3) Inland Tanna-74/78; (4) Lovu Fiji-79/79; (5) Mauritius-82/84; (6) Marajó-77/76; (7) Tyva Republic-115/117; (8) Yasawa Fiji-103/103.

Table S2: **Cross-cultural models for what makes a "good" person.** Mean (M) and sum (S) of salience scores. Only Smith's S ≥ 0.10 are reported. Recall that the denominator for M Salience is the number of Items listed, whereas the denominator in Smith's S is sample size. *Indicative of responses that include "good people" or "character" in their response.

Culture	Item	M Salience	S Salience	Smith's S
Coastal Tanna	Generous/Shares	0.74	17.67	0.40
Coastal Tanna	Respectful	0.61	13.35	0.30
Coastal Tanna	Helpful	0.71	12.00	0.27
Coastal Tanna	Loving	0.65	9.82	0.22
Coastal Tanna	Kind	0.77	6.93	0.16
Coastal Tanna	Obedient	0.56	6.75	0.15
Coastal Tanna	Hospitable	0.49	5.35	0.12
Coastal Tanna	Honest	0.75	5.25	0.12
Coastal Tanna	No Stealing	0.58	5.20	0.12
Hadza	Good*	0.84	32.60	0.47
Hadza	Loving	0.62	27.48	0.40
Hadza	Generous/Shares	0.56	23.32	0.34
Hadza	Peaceful	0.60	13.27	0.19
Hadza	Hospitable	0.64	10.25	0.15
Hadza	Intelligent	0.65	7.83	0.11
Hadza	Respectful	0.58	7.53	0.11
Inland Tanna	Hospitable	0.74	33.08	0.45
Inland Tanna	Generous/Shares	0.69	31.97	0.43
Inland Tanna	Kind	0.87	26.17	0.35
Inland Tanna	Respectful	0.49	23.98	0.32
Inland Tanna	No Stealing	0.66	18.52	0.25
Inland Tanna	Obedient	0.52	14.63	0.20
Inland Tanna	Loving	0.81	10.47	0.14
Inland Tanna	Helpful	0.41	9.38	0.13
Inland Tanna	No Swearing	0.49	8.88	0.12
Lovu Fiji	Honest	0.73	30.02	0.38
Lovu Fiji	Helpful	0.58	16.88	0.21
Lovu Fiji	Good*	0.74	15.58	0.20
Lovu Fiji	Religious Faith	0.78	10.85	0.14
Lovu Fiji	Speaking Well	0.81	8.07	0.10
Mauritius	Speaking Well	0.84	26.87	0.33
Mauritius	Helpful	0.62	24.00	0.29
Mauritius	Good*	0.71	15.70	0.19
Mauritius	Generous/Shares	0.72	15.12	0.18
Mauritius	Manners	0.73	10.90	0.13
Mauritius	Hard-working	0.65	9.80	0.12
Mauritius	Respectful	0.60	8.45	0.10
Pesqueiro	Helpful	0.70	14.07	0.18
Pesqueiro	Caring	0.68	13.65	0.18
Pesqueiro	Generous/Shares	0.65	11.03	0.14
Pesqueiro	Honest	0.65	10.47	0.14
Pesqueiro	Happy	0.69	9.63	0.13
Pesqueiro	Manners	0.77	9.20	0.12
Pesqueiro	Good*	0.68	8.87	0.12
Pesqueiro	Friendly	0.47	8.43	0.11
Pesqueiro	Humble	0.58	8.15	0.11
Tyva Republic	Good*	0.72	43.42	0.38

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Table S2 – *"Good" models continued from previous page*

Culture	Item	M Salience	S Salience	Smith's S
Tyva Republic	Honest	0.74	31.95	0.28
Tyva Republic	Helpful	0.61	26.25	0.23
Tyva Republic	Hard-working	0.58	24.90	0.22
Tyva Republic	Respectful	0.63	15.22	0.13
Tyva Republic	Kind	0.64	12.80	0.11
Tyva Republic	Intelligent	0.53	11.60	0.10
Tyva Republic	Humane	0.66	11.20	0.10
Yasawa Fiji	Church	0.68	40.10	0.39
Yasawa Fiji	Attitude	0.80	25.60	0.25
Yasawa Fiji	Obedient	0.64	21.60	0.21
Yasawa Fiji	Merciful	0.64	20.60	0.20
Yasawa Fiji	Good*	0.64	20.40	0.20
Yasawa Fiji	Listens	0.81	18.60	0.18
Yasawa Fiji	Hard-working	0.53	18.40	0.18
Yasawa Fiji	Generous/Shares	0.54	10.20	0.10

Table S3: **Cross-cultural models for what makes a "bad" person.** Mean (M) and sum (S) of salience scores. Only Smith's S $\geq$ 0.10 are reported. Recall that the denominator for M Salience is the number of Items listed, whereas the denominator in Smith's S is sample size. *Indicative of responses that include "bad people" or "character" in their response.

Culture	Item	M Salience	S Salience	Smith's S
Coastal Tanna	Theft	0.76	20.40	0.46
Coastal Tanna	Disrespectful	0.64	14.15	0.32
Coastal Tanna	Violent	0.66	12.57	0.29
Coastal Tanna	Disobedient	0.64	8.27	0.19
Coastal Tanna	Selfish	0.74	6.70	0.15
Coastal Tanna	Bad Language (Swearing)	0.47	5.70	0.13
Coastal Tanna	Drugs/Alcohol/Substance	0.69	4.80	0.11
Hadza	Murder	0.52	23.60	0.34
Hadza	Greedy	0.77	22.45	0.33
Hadza	Theft	0.60	21.63	0.31
Hadza	Violent	0.65	21.35	0.31
Hadza	Bad*	0.81	17.87	0.26
Hadza	Angry	0.66	6.63	0.10
Hadza	Troublemaker	0.82	6.60	0.10
Inland Tanna	Theft	0.76	28.72	0.37
Inland Tanna	Inhospitable	0.78	22.72	0.29
Inland Tanna	Disrespectful	0.47	21.20	0.27
Inland Tanna	Bad Language (Swearing)	0.63	18.25	0.23
Inland Tanna	Disobedient	0.59	15.88	0.20
Inland Tanna	Unkind	0.75	13.58	0.17
Inland Tanna	Violent	0.73	12.35	0.16
Inland Tanna	Not Feeding Others	0.64	8.35	0.11
Inland Tanna	Unhelpful	0.47	7.58	0.10
Lovu Fiji	Theft	0.82	28.73	0.36
Lovu Fiji	Dishonest	0.64	26.97	0.34
Lovu Fiji	Jealous	0.68	16.42	0.21
Lovu Fiji	Violent	0.70	14.03	0.18
Lovu Fiji	Drugs/Alcohol/Substance	0.81	8.92	0.11
Lovu Fiji	Betrayal/Backbiting	0.62	8.70	0.11
Lovu Fiji	Bad Company/Peers	0.84	8.42	0.11
Mauritius	Violent	0.65	25.28	0.30
Mauritius	Drugs/Alcohol/Substance	0.70	25.07	0.30
Mauritius	Theft	0.62	14.90	0.18
Mauritius	Doesn't Speak Well	0.70	13.98	0.17
Mauritius	Disrespectful	0.65	10.98	0.13
Mauritius	Selfish	0.64	10.85	0.13
Mauritius	Bad*	0.60	9.53	0.11
Pesqueiro	Ignorance/Stupidity/Uncultured	0.69	10.30	0.14
Pesqueiro	Bad*	0.77	10.03	0.13
Pesqueiro	Selfish	0.55	9.93	0.13
Pesqueiro	Envious	0.74	8.85	0.12
Pesqueiro	Unhelpful	0.85	8.47	0.11
Tyva Republic	Dishonest	0.70	41.25	0.35
Tyva Republic	Bad*	0.75	20.90	0.18
Tyva Republic	Drugs/Alcohol/Substance	0.63	19.02	0.16
Tyva Republic	Cruel	0.56	15.65	0.13
Tyva Republic	Envious	0.71	15.55	0.13

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Table S3 – *"Bad" models continued from previous page*

Culture	Item	M Salience	S Salience	Smith's S
Tyva Republic	Lazy	0.60	15.50	0.13
Tyva Republic	Theft	0.57	15.40	0.13
Yasawa Fiji	Theft	0.80	33.80	0.33
Yasawa Fiji	Disobedient	0.64	22.95	0.22
Yasawa Fiji	No Church	0.53	18.60	0.18
Yasawa Fiji	Dishonest	0.69	15.13	0.15
Yasawa Fiji	Doesn't Listen	0.64	14.07	0.14
Yasawa Fiji	Bad Language (Swearing)	0.67	12.80	0.12
Yasawa Fiji	Proud	0.66	11.25	0.11
Yasawa Fiji	Lazy	0.61	11.00	0.11
Yasawa Fiji	Drugs/Alcohol/Substance	0.79	11.00	0.11
Yasawa Fiji	Greedy	0.62	10.00	0.10

3.4. Notes on the experiment's effects on free-lists

The fact that we interviewed participants after they played games may raise suspicions that the experiments somehow influenced the content of moral models. There are a few reasons why participants were probably not more inclined to say "honest" and "dishonest" after playing a game measuring (dis)honest behavior. First, participants answered demographic questions before answering the free-list questions. This process took about 10-15 minutes. Second, the game check variable we hold constant should account for–at the very least–explicit recognition of the game's purpose. A logistic regression without considering the game check variable shows that the probability of listing "honesty" is 18% (logistic transform of -1.52). The mean estimate for the game check question was 0.62. Logistic transforming this summation yields a 29% probability of listing "honesty." Adding the mean estimate for the game check question (0.62) therefore suggests an increase of 11% (29% - 18% = 11%). Note, however, that only 9 individuals who listed "honesty" recognized that the game was about it (397 did not list honesty *and* did not indicate they understood what the game was measuring, and 22 recognized the purpose of the game, but did not list honesty). Third–as per Table 5 in the main text–there are a few sites where few individuals listed (dis)honesty, suggesting that if the game was priming the free-listing of (dis)honesty, it was not occurring systematically. Fourth, previous research [19] assessing what it means to be good shows that across seven societies, "honest" is highly salient in most contexts.

Fifth, a previous case study [13] using a similar free-list method with a different sample who didn't play the game (in the Tyva Republic) suggests there is some consistency in content across these studies. There, items were coded independently of the present project, and participants were encouraged to list 10-15 items of what makes specifically a good or bad *Tyvan* person, rather than the capped-at-5 general description of (im)moral people as was the case here. Moreover, for the present study, to ensure that recipients and players were of the same religion, Purzycki recruited participants who self-identified as Buddhist. In the previous study, recruitment was open to any ethnic Tyvan. In the previous study, the eight-most salient items for what it means to be a "good Tyvan" were: hard-working (S = 0.40), helpful (0.30), kind (0.29), modest (0.28), respectful (0.26), honest (0.22), intelligent (0.22) and having love for family (0.19). "Bad Tyvans" were: untrustworthy (S = 0.66), alcohol abusers (0.53), lazy (0.34), envious (0.20), greedy (0.19), disrespectful (0.18), cruel (0.17), and ignorant (0.14). In terms of content, both are quite similar to the present results (see Table S2). In the present Tyvan sample, "honest" had a Smith's S of 0.28 (vs. 0.22 in the previous study), a negligible difference. However, "dishonest" had an S of 0.35 (vs. 0.66 for "untrustworthy"), much lower than the previous study. This would suggest that at least in the case of Tyvans, the game could potentially reduce the salience of items, at least in the "bad" subdomain. However, "honesty" (after ignoring "good" in the good free-list task) and "dishonesty" were the *most* salient items listed for the present sample. In summary, despite methodological, coding, and sampling differences, even if the game reduced the salience of dishonesty for Tyvans, these items still had the highest salience across both studies.

4. Moral Behavior

4.1. Methods

A summary [15] of our focal data set provides all variable definitions, sampling strategies, and code for analyzing experimental data in a variety of ways. Data sets and images of experimental conditions are also available online [14] and at `https://github.com/bgpurzycki/Moral-Models-Moral-Behavior`. The following variables represent a distillation of models published elsewhere [16, 18]:

1. **Moralistic gods' punishment** was the composite mean value of two questions with binary response values (no = 0; yes = 1): *Does* [DEITY NAME] *ever punish people for their behavior?* and *Can* [DEITY NAME] *influence what happens to people after they die?*
2. **Moralistic gods' knowledge** was the mean value of two binary-response questions (no = 0; yes = 1) about the breadth of deities' knowledge: *Can* [DEITY NAME] *see into peoples hearts or know their thoughts and feelings?* and *Can* [DEITY NAME] *see what people are doing if they are far away in [a distant town or city familiar to locals]?*
3. **Number of children** was self-reported number of children "fathered or given birth to."
4. **Treatment condition** is an indicator variable denoting whether (= 1) or not (= 0) participants played games in the presence of an image or object with local religious significance. This was a manipulation in which these objects were selected on the basis of having no visual indices of agency (i.e., no eyes).
5. **Game order** is an indicator variable tracking which game participants played first. This is denoted with a "1" if participants played the Local Community Game first and a "0" if they played the Self Game first.
6. **Game was about honesty?** denotes whether responses to post-experimental questions asking participants what they thought the games were about included "honesty," "fairness," and/or "cheating."

Recall from the main text that some sites had religious prime conditions. These sites were: Lovu (Fiji), Mauritius, Marajó, Tyva Republic, and Yasawa. Lovu Fijians in the treatment condition played games on a table with a statue that abstractly represented Shiva (a *lingam*). Mauritians in the treatment condition played in a Hindu temple. Brazilian participants played near a Bible and crucifix necklace, the Tyvan condition included playing near a Buddhist luck charm (*kamgalal*), and Yasawans in the treatment condition played on a cloth with a cross, Bible, and Bible verse (Mark 9:23) printed on it. Further descriptions and images of prime conditions can be found at: `https://github.com/bgpurzycki/Evolution-of-Religion-and-Morality`. Again, we found no overall relationship between playing in treatment conditions and game outcome. We nevertheless hold this factor constant in our models.

Note that the Hadza were not asked what they thought the game was about. In the main models, we imputed this and all other missing data from prior distributions (see Supplementary section 3.2.3. for distributions and R script for implementation). For the frequentist models, we used a couple of different imputation techniques (see below).

4.2. Main model specifications

The statistical analysis is essentially a binomial regression with varying effects used to manage repeat observations on individuals and groups. The additional feature of the model is that we use group-level predictors to express average norms and beliefs in each group. However, these predictors are not directly observable and must be estimated themselves. Therefore, simultaneous models are run to: (1) estimate those predictors, and (2) plug the resulting variable distributions directly into the individual-level regression. This method retains all uncertainty arising from sample size and variance in each group. Below, we explain the full model in pieces.

4.2.1. Coin model

To model the coin allocations y out of 30, we use a binomial regression:

$$
\begin{aligned}
y_i &\sim \text{Binomial}(30, p_i) && (1)\\
\text{logit}(p_i) &= \alpha + \sigma_{\text{id}} z_{\text{id[i]}} + a_{\text{group[i]}} && (2)\\
&\quad + b^h_{\text{group[i]}} h_i + b^H H_{\text{group[i]}} && (3)\\
&\quad + b^p_{\text{group[i]}} p_i + b^P P_{\text{group[i]}} && (4)\\
&\quad + b^o_{\text{group[i]}} o_i + b^O O_{\text{group[i]}} && (5)\\
&\quad + b^{\text{children}} k_i + b^{\text{condition}} t_i + b^{\text{order}} r_i + b^{\text{check}} \chi_i + b^{\text{game}} g_i && (6)
\end{aligned}
$$

The linear predictor $\text{logit}(p_i)$ measures partial associations between the amount allocated to the distant cup and both group and individual variables. Line (2) includes an intercept α for the full sample and varying intercepts for individual and group[1]. The next three lines express the three cultural variables of interest, at both individual and

[1]Efficient sampling is made possible by the use of the non-centered prior for the individual varying effects, the $\sigma_{\text{id}} z_{\text{id[i]}}$ construction in the coin model where z_{id} represents the varying effect by individual; $z_{id} \sim$ Normal(0, 1), $\sigma_{id} \sim$ Exponential(1). We attempted the model first with a traditional centered parameterization, where the scale parameter σ_{id} was in the prior for z_{id}, but that made analyses fail. We therefore put it directly in the linear model.

group levels: honesty (h/H), gods' punishment (p/P) and knowledge breadth (i.e., omniscience) (o/O). Individual responses are given lowercase letters whereas group averages are given capital letters. Each group has its own varying slope for individual variables, allowing the relationship between individual response (e.g., whether they listed (dis)honesty) and behavior to vary across groups. The last line, (6), contains simple (i.e., fixed) effects for number of children, the experimental treatment condition, game order, game check, and an indicator for game (Self Game = 1), respectively.

All simple effects above are assigned weakly-regularizing Normal(0, 1) priors. These guard against finding strong effects in small samples or those that vary considerably in responses, but are easily overwhelmed in large or consistent samples.

The varying intercepts for individuals are given a prior scale of:

$$\sigma_{\text{id}} \sim \text{Exponential}(1)$$

This is likewise weakly regularizing. The varying effects for group are bound together in a common variance-covariance matrix:

$$\begin{bmatrix} a_j \\ b_j^h \\ b_j^p \\ b_j^o \end{bmatrix} \sim \text{MVNormal}\left(\begin{bmatrix} 0 \\ \beta^h \\ \beta^p \\ \beta^o \end{bmatrix}, \mathbf{SRS} \right)$$

where $\mathbf{S}$ is a diagonal matrix of standard deviations of the intercept and the three cultural variables of interest:

$$\mathbf{S} = \begin{bmatrix} \sigma_a & 0 & 0 & 0 \\ 0 & \sigma_{b^h} & 0 & 0 \\ 0 & 0 & \sigma_{b^p} & 0 \\ 0 & 0 & 0 & \sigma_{b^o} \end{bmatrix}$$

and $\mathbf{R}$ is a full rank correlation matrix of the same variables. Each standard deviation is assigned an independent Exponential(1) prior as before, and $\mathbf{R}$ is given a weakly regularizing prior from the LKJ family [10] as implemented by RStan 2.14.1 [20]:

$$\mathbf{R} \sim \text{LKJCorr}(4)$$

This is necessary because, unlike the four standard deviations, the six individual correlations inside $\mathbf{R}$ cannot be independent of one another. The constraint that the correlation matrices be positive definite severely constrains possible combinations of the six parameters. The LKJCorr family manages this by composing symmetric Beta distribution shapes, that is, symmetric distributions of potential correlations. As the dimension of such a matrix and the shape parameter η grow, the prior is increasingly concentrated on the identity matrix (i.e., all numbers on the diagonal are 1 and all other values are 0). The value we use here, $\eta = 4$, regularizes by penalizing extreme correlations (e.g., 1 or -1). Sometimes strong regularization is needed to fit such a model, but we found the model sampled just fine even with no regularization imposed on this matrix. We retain the regularization because it is best practice.

4.2.2. Group belief models

Three of the predictor variables above are unobserved: H_{group}, P_{group}, and O_{group}. These are average honesty, punishment, and omniscience beliefs for each group. Since these cannot be observed, we infer them from the sample of individual statements in that group. We simultaneously fit these three models and the coin model above using the posterior distribution of each in the coin model. This retains all uncertainty so that we do not impart false precision to the estimates.

In each of the three cases, we treat the unobserved variables as varying intercepts for each group. For example, the honesty model is:

$$\begin{aligned} h_i &\sim \text{Binomial}(2, p_i) \\ \text{logit}(p_i) &= H_{\text{group[i]}} \\ H_j &\sim \text{Normal}(\mu^H, \sigma^H) \\ \mu^H &\sim \text{Normal}(0, 5) \\ \sigma^H &\sim \text{Exponential}(1) \end{aligned}$$

The observed h_i values take the values 0, 1, or 2, where the values represent neither, one, or both honesty and dishonesty were listed. The above is therefore a binomial GLMM with two trials. The latent estimate H_{group} is our target of inference, and H_j defines the priors for each group. The models for P_{group} and O_{group} are constructed analogously.

4.2.3. Imputation models

For the main model, we relied on the following distributions for the imputation of missing data:

$$
\begin{aligned}
\text{children} &\sim \text{Normal}(\mu_{\text{children}}, \sigma_{\text{children}}) \\
\mu_{\text{children}} &\sim \text{Normal}(1, 1) \\
\sigma_{\text{children}} &\sim \text{Exponential}(10) \\
\text{order} &\sim \text{Bernoulli}(0.5) \\
\text{check} &\sim \text{Bernoulli}(\phi_{\text{check}}) \\
\phi_{\text{check}} &\sim \text{Beta}(1, 1) \\
\sigma_{\text{punishment}} &\sim \text{Exponential}(1) \\
\sigma_{\text{omniscience}} &\sim \text{Exponential}(1)
\end{aligned}
$$

4.2.4. Sampling and diagnostics

We took 500 samples from each of the 4 chains with a target acceptance rate of 0.99 and all other settings the default as of RStan 2.14.1. Sampling was very efficient. All $\hat{R}$ values were below 1.01 and effective sample sizes were greater than 50% of the actual sample count.

5. Supplementary Analyses

In addition to the primary Bayesian models in the main text and above, we also ran a variety of model specifications using standard multi-level binomial logistic regressions for the sake of comparison and robustness checking. All models were fit using the lme4 package [3] for use in R.

Note again that the Hadza were not asked what they thought the game was about (the "game check" variable discussed above). In these models, we imputed these missing values in two ways. One method relied on an imputation function that randomly selects data points from the rest of the sample [7, p. 534]. These results are reported here. We also used a dummy value for the missing Hadza game check data and also ran the same models without the Hadza, and the qualitative results hold (results are not reported here, but procedures are included in the R script). In general the individual-level results are qualitatively the same as the main model, but we do highlight some important modeling differences throughout the discussion.

Table S4 reports full models, all of which vary gods' punishment and knowledge breadth across sites. They also vary moral model values (i.e., summation of (dis)honesty, and the salience of honesty and dishonesty). Table S5 reports results from models that tease apart the specific components of the free-list data and assesses the role that, for instance, listing honesty or dishonesty individually play. As participants played two games, all models have varying intercepts for individuals.

5.1. Varying cultural variables across sites

Table S4 reports five model specifications. The first is a reduced model that only includes moralistic deities' knowledge and punishment as varied effects across sites. The second model (model mS4.full in the R script) includes varying effects for the three cultural variables—summation of (dis)honesty, moralistic gods' punishment and knowledge breadth—across sites; each site has its own intercept and each effect has its own slope. The next model (model mS4.1) varies all of the cultural variables independently by site, where site has only a single intercept associated with (dis)honesty. The next two models are the same, but instead of the summations of (dis)honesty, we consider cognitive salience.

Does cognitive salience or accessibility of (dis)honesty predict honest play? We would expect that the degree to which individuals can access task-relevant components to moral models will also play a role in motivating individuals to behave in accordance with their moral prescriptions. In order to test this, we assume that for all instances where participants' free-lists lack honesty and/or dishonesty, salience is zero. Because *not* listing these items translates to

	No Moral Model	**Sum of (Dis)honesty**	**Sum of (Dis)honesty**	**Honesty (Sal.)**	**Dishonesty (Sal.)**
Predictor	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Moral model variable	—	1.05 [0.98, 1.13]	1.05 [0.99, 1.12]	1.11 [0.93, 1.33]	1.12 [0.99, 1.28]
Moralistic gods' punishment	1.15 [1.02, 1.29]	1.15 [1.02, 1.29]	1.14 [1.03, 1.28]	1.15 [1.03, 1.28]	1.14 [1.02, 1.27]
Moralistic gods' knowledge	1.30 [1.02, 1.65]	1.34 [1.04, 1.72]	1.23 [1.04, 1.45]	1.24 [1.05, 1.46]	1.22 [1.04, 1.42]
Number of children	1.00 [0.98, 1.01]	1.00 [0.98, 1.01]	1.00 [0.98, 1.01]	1.00 [0.98, 1.01]	1.00 [0.98, 1.01]
Condition (Prime = 1)	0.98 [0.91, 1.06]	0.98 [0.91, 1.06]	0.97 [0.90, 1.05]	0.97 [0.90, 1.05]	0.97 [0.90, 1.05]
Local Game played first = 1	1.04 [0.97, 1.11]	1.04 [0.97, 1.11]	1.04 [0.98, 1.11]	1.04 [0.98, 1.11]	1.05 [0.98, 1.12]
Game about honesty? (Yes = 1)	0.94 [0.82, 1.08]	0.93 [0.81, 1.07]	0.93 [0.81, 1.07]	0.93 [0.81, 1.07]	0.93 [0.81, 1.07]
Game (Self Game = 1)	0.98 [0.94, 1.03]	0.98 [0.94, 1.03]	0.98 [0.94, 1.03]	0.98 [0.94, 1.03]	0.98 [0.94, 1.03]
Intercept	0.63 [0.47, 0.83]	0.60 [0.44, 0.81]	0.65 [0.54, 0.78]	0.65 [0.54, 0.78]	0.66 [0.55, 0.79]
log likelihood	-2727.3	-2725.2	-2727.0	-2727.4	-2726.2
AIC	5484.7	5490.4	5484.1	5484.8	5482.3
Model convergence?	no	no	no	no	no
Model name in R script	mS4.red	mS4.full	mS4.1	mS4.2	mS4.3

Table S4: **Exponentiated coefficients (OR) and 95% confidence intervals (CI) of simple effects for full models varying gods' punishment, knowledge breadth, and moral model variables by site.** Target moral model simple and varying effects are listed across the top row where "Sal." refers to individual salience of honesty or dishonesty. Across all models, $N = 508$.

missing values in data processing, we replaced these missing values with zero for all participants who did free-lists tasks, but did not list honesty or dishonesty.

Again, as these lists were intended to be capped at a maximum of 5 items listed, these results should be interpreted with caution. Moreover, recall that in some sites, few individuals listed (dis)honesty (see Table 5 in main text). This may create by-site interpretations difficult. The R script nevertheless provides code for examining these differences. Using the same model as mS4.1, but instead using item salience to predict game outcome, the order in which individuals list honesty or dishonesty has an effect; on average, listing these items earlier predicts greater odds of allocating coins to the distant cup. Note, however, that the effect is both better estimated and stronger for the salience of dishonesty (mS4.3; and the model properly converged) than honesty (mS4.2). If this effect is real, it suggests that how salient or accessible these items are matters in game outcome as well. In other words, *how quick* individuals are to equate good and bad people with such virtues when prompted also plays an important role on human behavior. With the aforementioned caveats in mind, these results suggest that conceptual salience matters in the production of moral behavior.

These models failed to converge and have removed all cases with missing data. Nevertheless, the results suggest that moral models, gods' punishment and knowledge breadth increase the odds that players put a coin into the cup reserved for geographically distant co-ethnic, co-religionists, qualitatively similar to the results reported in the main text.

5.2. Varying only moral models across sites

5.2.1. Model specifications

Table S5 reports a variety of model specifications designed to examine in the role honesty and dishonesty specifically play as individual variables. Model 1 is based on a reduced model reported elsewhere [18]. Its main differences from those models are: (1) here we use the imputed game check values for the Hadza, and (2) we ignore group-level variation (i.e., it is a fully pooled model ignoring groups, but does vary intercepts for individuals). Model 2 is the same basic model, but varies the intercept for individuals *and* field sites. Note that while the qualitative effects are the same, there is a slight decrease in the odds ratio and a shift in the range of the confidence intervals for the influence of moralistic gods' punishment. This further emphasizes the importance of the effects of cross-site variation in gods' punishment values have on game outcome.

Model 3 builds on Model 2 by adding the summation of listing "honesty" and "dishonesty." The model varies the intercepts for both individuals (as the two game outcomes are repeated measures) and field sites. Though slight, the content of individuals' moral models does have an effect on allocations in the predicted direction; when individuals report that "honesty" and "dishonesty" are indicative of moral or immoral people respectively, they have a greater chance of allocating a coin to the distant co-ethnic, co-religionist. Though relatively slight, the effect remains stable across model specifications.

Model 4 builds on Model 3 by varying the slopes by site for the honesty and dishonesty summation values. We reasoned that when more people in these sites list honesty and dishonesty, individual allocations should more likely go to the geographically distant players. In other words, individuals from communities where honesty and dishonesty are more salient moral values should play more fairly. As such, the effect of group-level honesty and dishonesty should vary across sites. The estimates of all simple effects are consistent with the other models.

Models 5-7 tease apart the free-list summations and include only "honesty" (Model 5), "dishonesty" (Model 6), and both as individual variables (Model 7). Across models, when someone lists honesty and/or dishonesty, the chances of allocating a coin to the distant cup increases by ∼5%, the highest upper bound of the confidence interval across these models was 19%.

5.2.2. Group-level projections

Based on Model 4 in Table S5, Figure S1 models the cross-site effects of listing honesty and dishonesty on the probability of allocating a coin to the distant player. Baseline trends (modeled by the gray lines) are the logistic transformed summations of the simple intercept coefficient (-0.42) and the coefficient for moral models (0.05) times the possible moral model values (0, 1, or 2, therefore 0.40, 0.41, and 0.42 respectively). Hollow points are logistic transformed summations of the simple intercept coefficient (-0.43), the site-specific intercept, the simple, individual-level effect on moral models (0.05), and the by-site slope coefficients for moral models times their possible values of 0, 1, or 2. Defined in this fashion, these points model the group-level contributions of moral models: when x-axis values are zero, this is akin to modeling the individual-level probability of giving to a distant individual when group members mentioned *neither* honesty nor dishonesty on average; when x-axis values are two, this is akin to modeling the probability of giving a coin to the distant player if group-level moral models were to include *both* honesty and

Predictor	**Model 1** OR [95% CI]	**Model 2** OR [95% CI]	**Model 3** OR [95% CI]	**Model 4** OR [95% CI]	**Model 5** OR [95% CI]	**Model 6** OR [95% CI]	**Model 7** OR [95% CI]
Honesty (Present = 1)	—	—	—	—	1.05 [0.94, 1.19]	—	1.05 [0.94, 1.17]
Dishonesty (Present = 1)	—	—	—	—	—	1.06 [0.97, 1.16]	1.05 [0.96, 1.15]
(Dis)honesty summation	—	—	1.04 [0.98, 1.09]	1.05 [0.98, 1.12]	—	—	—
Moralistic gods' punishment	1.23 [1.10, 1.37]	1.15 [1.03, 1.28]	1.15 [1.03, 1.28]	1.15 [1.03, 1.28]	1.15 [1.03, 1.28]	1.14 [1.02, 1.27]	1.15 [1.03, 1.28]
Moralistic gods' knowledge	1.20 [1.02, 1.40]	1.22 [1.04, 1.42]	1.21 [1.04, 1.42]	1.22 [1.04, 1.43]	1.22 [1.04, 1.43]	1.22 [1.04, 1.43]	1.22 [1.04, 1.43]
Number of children	0.99 [0.98, 1.01]	1.00 [0.98, 1.01]	1.00 [0.98, 1.01]	1.00 [0.98, 1.01]	1.00 [0.98, 1.01]	1.00 [0.98, 1.01]	1.00 [0.98, 1.01]
Condition (Prime = 1)	0.99 [0.92, 1.07]	0.98 [0.90, 1.05]	0.97 [0.90, 1.05]	0.97 [0.90, 1.05]	0.97 [0.90, 1.05]	0.97 [0.90, 1.05]	0.97 [0.90, 1.05]
Local Game played first = 1	1.05 [0.98, 1.12]	1.04 [0.98, 1.12]	1.04 [0.98, 1.12]	1.04 [0.98, 1.12]	1.04 [0.98, 1.11]	1.05 [0.98, 1.12]	1.04 [0.98, 1.12]
Game about honesty? (Yes = 1)	0.90 [0.78, 1.04]	0.94 [0.82, 1.08]	0.94 [0.81, 1.08]	0.93 [0.81, 1.07]	0.93 [0.81, 1.08]	0.94 [0.81, 1.08]	0.93 [0.81, 1.07]
Game (Self Game = 1)	0.98 [0.94, 1.03]	0.98 [0.94, 1.03]	0.98 [0.94, 1.03]	0.98 [0.94, 1.03]	0.98 [0.94, 1.03]	0.98 [0.94, 1.03]	0.98 [0.94, 1.03]
Intercept	0.66 [0.56, 0.78]	0.67 [0.56, 0.80]	0.66 [0.55, 0.79]	0.65 [0.54, 0.79]	0.66 [0.55, 0.79]	0.66 [0.55, 0.79]	0.65 [0.54, 0.79]
Vary intercept for field site?	no	yes	yes	yes	yes	yes	yes
Vary slope for free-list value?	no	no	no	yes	yes	yes	yes*
log likelihood	-2738.6	-2728.6	-2727.8	-2727.1	-2728.0	-2727.4	-2727.1
AIC	5495.3	5477.1	5477.6	5480.2	5482.0	5480.8	5482.2
Model convergence?	yes	yes	yes	no	yes	no	no
Model name in R script	mS5.1	mS5.2	mS5.3	mS5.4	mS5.5	mS5.6	mS5.7

Table S5: **Odds ratios and 95% confidence intervals for hierarchical binomial logistic regressions for both games.** In all models, intercepts varied by participant ($N = 494$). Varied slopes for free-list values are the same as corresponding simple effect except for *, where the summation value was used (as in Models 3 and 4). We imputed Hadza values for the game check ("Game about honesty?") for all models.

dishonesty. Solid points indicate where the site-specific mean of (dis)honesty summations are along the x-axis, placed on the regression line for reference.

Two sites allocate coins far below sample-baseline allocations, the Hadza and Yasawans. Lovu Fijians and Tyvans largely play fairly, as indicated by their values closer to 0.5 and having greater-than-baseline allocations overall. As illustrated in Figure S1, the probability of Yasawan and Hadza allocations to the distant player would dramatically increase as a function of increasing the group-level ubiquity of honesty and dishonesty in moral models. The Lovu Fijians and Tyvans show barely noticeable effects, but they remain positive. In other words, compared to contexts with low probabilities of allocating coins to distant players and infrequent cases of listing (dis)honesty, extrapolating from this model adds little in the way of projection for contexts where honesty and dishonesty are already prevelent. Nevertheless, it does show that increasing prevelence of (dis)honesty can have an impact on game play.

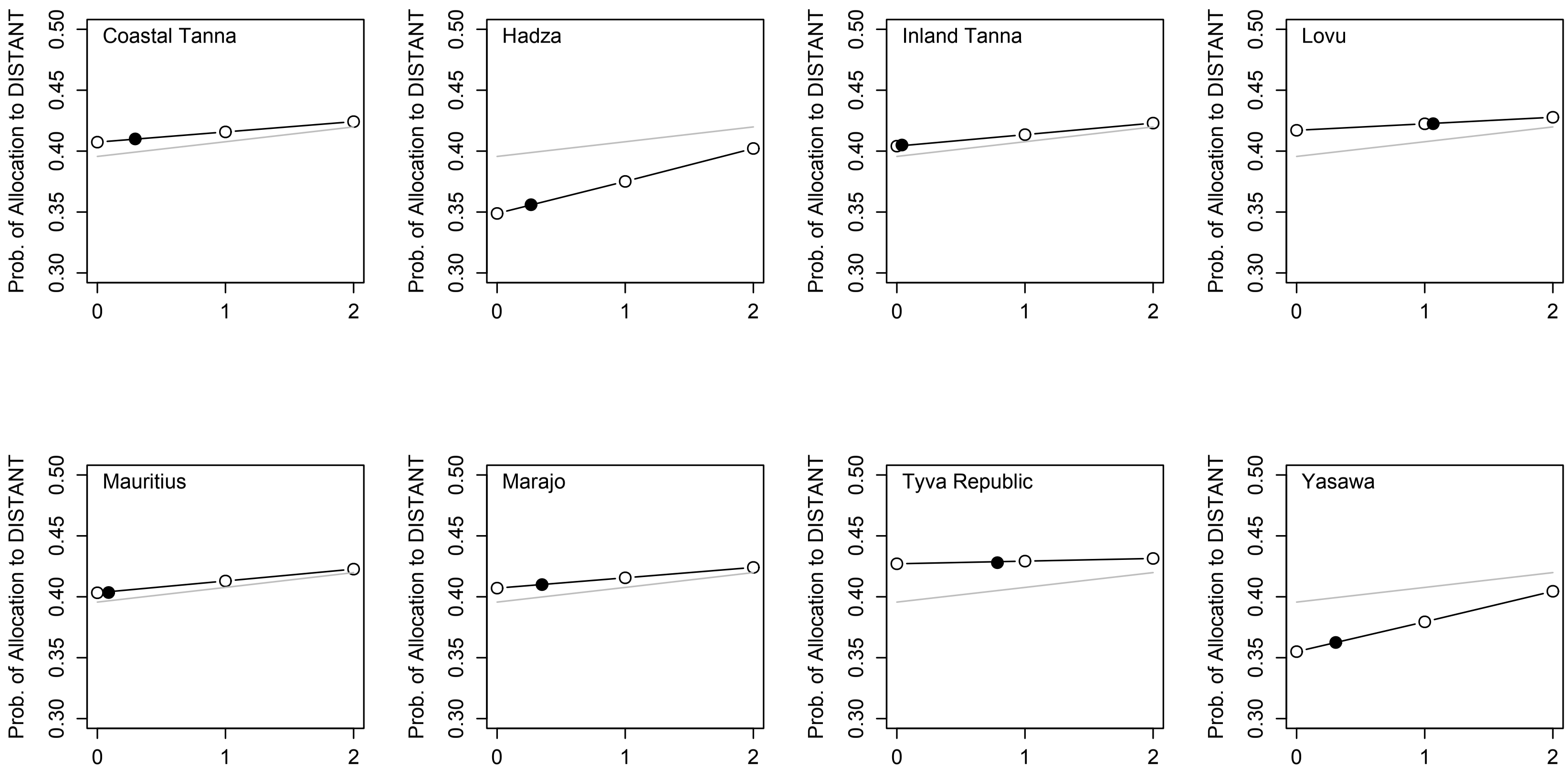

Figure S1: **Projected group-level effects of moral models on the probability of allocating a coin to geographically distant players across eight field sites.**. Projections are generated from Model 4 in Table S5. X-axes are the possible summation values of the presence of honesty and dishonesty in free-list tasks (0, 1, or 2). Values of 0.50 on y-axes indicate an unbiased allocation. Points are logistic transformed summations of the simple intercept coefficient, the site-specific intercept, the simple effect on moral models, and the by-site varied slope coefficients for moral models times their possible values of 0, 1, or 2. Gray lines are the baseline effects of moral models on the probability of allocating a coin to distant players (the same across all plots). Black lines indicate direction and magnitude of projected effect of increasing ubiquity of "honesty" and "dishonesty" on game play in each population. Solid points indicate location of site-specific mean of the (dis)honesty summations placed on the regression line.

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