

1 Norm violations and punishments across human societies: 2 Supplementary information

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13 Identifying norm violations

14 The social scientific and evolutionary literature on norm violations and punishment is
15 extensive. There are many possible types of violations and punishments we could have
16 focused on. We chose the five norm violations and four punishment types because, in our
17 view, they are commonly discussed by evolutionary social scientists and we expected them
18 to be fairly well represented in the ethnographic record. Below we highlight just a few
19 references that influenced these decisions.

20 Much of the work on mate choice, gender relations, and the status of women also concerns
21 adultery (e.g., Apostolou, 2007; Betzig, 1989; Fisher, 2012; Smuts, 1992; Whyte, 1978). The
22 role of religious ideology or supernatural beings and their proscriptions has been widely
23 discussed with the evolutionary literature of cooperation (Bourrat, Atkinson, & Dunbar,
24 2011; Henrich et al., 2010; Johnson, 2005; Norenzayan, 2013; Norenzayan et al., 2016/ed;
25 Roes & Raymond, 2003; e.g., Singh, Kaptchuk, & Henrich, 2020). Food sharing is a hallmark
26 of humanity and food theft has also been investigated across primate species (Bird & Bliege
27 Bird, 2009; Hames, 2000; Hayden, 1996; Henrich & Henrich, 2010; Kaplan, Schniter, Smith,
28 & Wilson, 2018; Ringen, Duda, & Jaeggi, 2019; Wiessner & Schiefenhövel, 1996; Wrangham,
29 Jones, Laden, Pilbeam, & Conklin-Brittain, 1999). The forms and consequences of rape
30 across cultures and its potential evolutionary underpinnings have also received substantial
31 attention (e.g., Heise, Raikes, Watts, & Zwi, 1994; Malamuth, 1981; Thornhill & Palmer,
32 2000; Vandermassen, 2011). The role of warfare, its relationship to human societies and
33 societal norms, and the punishment associated with war cowardice has been extensively
34 investigated across disciplines (Ember & Ember, 1992; Glowacki, Wilson, & Wrangham,
35 2020; e.g., Mathew & Boyd, 2011; Wrangham, 1999)

36 Computational demands

37 We computed our analyses using a high-performance computing cluster (Intel(R) Xeon(R)
38 Gold 5218R CPU @2.1 Ghz using 1 node with 40 physical cores and 350GB memory) which
39 required 3 hours and 16 minutes run. We include a .RData file which contains all fitted
40 objects produced by the R script for the study. The script and .RData file are available in the
41 project SI repository (<https://osf.io/9kky5/>).

42 Data sources and coding procedures

43 The eHRAF is a digital subset of the HRAF and includes the digitized full text of over 6,000
44 primary ethnographic documents describing over 300 cultures. Each paragraph of each
45 document is subject-coded following the Outline of Cultural Materials (OCM) coding
46 scheme, a comprehensive classification system of human cultural and behavioral features
47 as well as codes for ecological and other content types. The eHRAF therefore provides
48 access to source ethnographic texts, which can be searched at the paragraph-level by
49 keyword and/or OCM code (Ember, 2007). The SCCS is a cross-cultural database of
50 researcher-coded variables on a random stratified sample of 186 societies selected for
51 their putative cultural independence (Murdock & White, 1969; but see Dow & Eff, 2008).
52 The SCCS database currently includes over 2,000 variables coded and published by various
53 researchers since the sample's development. The SCCS therefore provides culture-level,
54 mostly categorical measures for the 186 societies (although not all variables include data
55 for all 186 societies).

56 We selected one ethnographic document from the eHRAF document collection per culture
57 for our source ethnographic content (Table S2). Ethnographies were selected on the basis
58 of providing a comprehensive overview of the society with chapters on subsistence, social
59 structure and organization, and marriage based on descriptive information provided on
60 eHRAF's source document reviews. We attempted to exclude documents focused on a
61 narrow aspect of a culture or not ethnographically specific and attempted to target those
62 providing comprehensive coverage of the period closest to initial ethnographer contact.
63 Our sample consists of these 131 culture-documents. In our sample the mean number of
64 documents per culture (based on eHRAF's most recent data) is 18.33 (SD = 15.29) and the
65 mean number of total pages of ethnography for these societies (across all eHRAF
66 documents) is 2240.23 (sd = 2002.95)

67 Culture sample

68 The culture sample is given in Table S1.

69 *Table S1: Culture sample. Violation/Punishment evidence count colmuns indicate the number*
70 *of variables within each type which were supported by the culture-document.*

eHRAF Name	SCCS Name	SCCS ID	Violation evidence count	Punishment evidence count
Khoi	Nama or Namaqua	1	3	3
San	Kung	2	2	0

Mbuti	Mbuti or Bambuti	13	1	1
Hausa	Hausa	26	0	0
Mende	Mende	20	1	3
Bambara	Bambara or Bamana	22	2	3
Azande	Azande or Niam-Niam	28	1	2
Wolof	Wolof	21	1	2
Igbo	Ibo or Igbo	17	2	3
Akan	Ashanti	19	2	3
Tallensi	Tallensi	23	3	2
Tiv	Tiv or Munshi	16	1	1
Mongo	Nkundo Mongo	14	1	4
Ovimbundu	Mbundu or Ovimbundu	5	0	0
Bemba	Bemba or Awemba	7	1	2
Tsonga	Thonga or Bathonga	3	3	3
Lozi	Lozi	4	0	0
Ganda	Ganda or Baganda	12	4	3
Gikuyu	Kikuyu or Aikikuyu	11	4	4
Ngonde and Nyakyusa	Nyakyusa	8	2	3
Maasai	Masai	34	2	1
Teda	Teda	40	1	1
Shilluk	Shilluk	31	0	0
Kaffa	Kaffa	33	0	0
Somali	Somali	36	0	0
Gond	Gond	60	3	2
Toda	Toda	61	1	2
Saami	Lapps	52	1	1
Samoyed	Yurak Samoyed	53	0	0
Abkhazians	Abkhaz	55	1	1
Tuareg	Tuareg	41	1	1
Berbers of Morocco	Riffians	42	3	4
Amhara	Amhara	37	1	2
Fellahin	Egyptians	43	1	0
Rwala Bedouin	Rwala Bedouin	46	0	0
Kurds	Kurd	57	1	1
Basseri	Basseri	58	0	0
Burusho	Burusho	64	0	0
Vedda	Vedda	80	0	0
Uttar Pradesh	Uttar Pradesh	63	0	0

Albanians	Gheg Albanians	48	4	2
Imperial Romans	Romans	49	1	2
Haitians	Haitians	160	2	3
Saramaka	Saramacca	165	2	2
Andamans	Andamanese	79	1	0
Tiwi	Tiwi	90	1	1
Aranda	Aranda or Arunta	91	1	1
Kwoma	Kwoma	95	3	2
Orokaiva	Orokaiva	92	1	1
Kapauku	Kapauku	94	5	4
Turks	Turks	47	1	2
Kazakh	Kazak	65	1	2
Mongolia	Khalka Mongols	66	1	1
Manchu	Manchu	115	0	0
Nivkh	Gilyak	119	1	2
Korea	Koreans	116	1	0
Okayama	Japanese	117	1	0
Ainu	Ainu	118	0	0
Yi	Lolo or Nosu	67	0	0
Burmese	Burmese	71	0	0
Lepcha	Lepcha or Rong	68	3	2
Garo	Garo	69	1	3
Central Thai	Siamese/Central Thai	76	0	0
Santal	Santal	62	2	1
Semang	Semang	77	2	3
Vietnamese	Vietnamese	73	2	2
Cambodians	Khmer	75	1	1
Ifugao	Ifugao	112	3	2
Tanala	Tanala	81	0	0
Balinese	Balinese	84	3	1
Javanese	Javanese	83	0	0
Iban	Iban/Sea Dayak	85	0	0
Eastern Toraja	Toradja	87	3	3
Alorese	Alorese or Abui	89	3	4
Trobriands	Trobrianders	98	2	1
Lesu	New Ireland	97	0	0
Manus	Manus	96	1	0
Yapese	Yapese	110	2	3
Marshallese	Marshallese	108	1	0

Chuuk	Trukese	109	1	2
Samoa	Samoans	106	2	2
Tikopia	Tikopia	100	2	1
Maori	Maori	104	3	3
Marquesans	Marquesans	105	1	1
Chukchee	Chukchee	121	4	1
Aleut	Aleut	123	1	0
Copper Inuit	Copper Eskimo	124	0	0
Eastern Apache	Chiricahua Apache	148	5	2
Kaska	Kaska	129	2	1
Nuxalk	Bellacoola	132	1	4
Mi'kmaq	Micmac	126	0	0
Yurok	Yurok	134	0	0
Ojibwa	Northern Saulteaux	127	0	0
Innu	Montagnais	125	3	1
Gros Ventre	Gros Ventre	140	2	4
Omaha	Omaha	143	2	2
Pawnee	Pawnee	142	3	1
Inka	Inca	171	2	2
Aymara	Aymara	172	2	0
Mapuche	Mapuche	184	1	2
Yaghan	Yaghan	186	1	1
Tukano	Cubeo	167	2	4
Barama River Carib	Barama Carib	164	2	1
Tehuelche	Tehuelche or Patagon	185	0	0
Jivaro	Jivaro	169	1	1
Goajiro	Goajiro	159	3	1
Island Carib	Callinago	161	0	0
Mundurucu	Mundurucu	166	0	0
Nambicuara	Nambicuara	174	2	1
Trumai	Trumai	175	1	1
Tupinamba	Tupinamba	177	0	0
Siriono	Siriono	173	2	1
Guarani	Cayua	181	0	0
Yokuts	Yokuts	136	0	0
Klamath	Klamath	138	0	0
Creek	Creek	145	2	4
Zuni	Zuni	149	0	0
Abipon	Abipon	183	2	2

Northern Paiute	Paiute	137	2	2
Comanche	Comanche	147	3	3
O'odham	Papago	151	3	4
Warao	Warrau	162	1	1
Chachi	Cayapa	168	1	0
Canela	Timbira	176	3	1
Xokleng	Aweikoma	180	2	1
Pomo	Pomo	135	0	0
Havasupai	Havasupai	150	1	1
Miskito	Miskito	156	1	2
Yanoama	Yanomamo	163	2	1
Talamancans	Bribri	157	1	1
Kuna	Cuna (Tule)	158	1	1

71

72 Culture-document search strategy

73 Within each of the 131 culture documents (See Methods section) we used the eHRAF
 74 “Advanced search” function to identify supporting evidence for our operationalized
 75 variables. Specifically, we used conducted an advanced Boolean search which would return
 76 all paragraphs associated with any of the OCM codes *Social Control 626, Sanctions 681, Sex*
 77 *and marital offenses 684, Property offenses 685, Offenses against the state 687, Religious*
 78 *offenses 688*; or which contained the terms “cowardice”, “desertion”, “adultery”, “rape”,
 79 “theft of food” “religious taboo”, or “religious violation.”

80 Coding scheme

81 Returns of the culture-document searches were used to code for supporting evidence of
 82 norm violations across five social domains – *Adultery, Food violations, Rape, Religious*
 83 *violations, and War cowardice* – and evidence for four punishment types – *Reputational,*
 84 *Physical, Material, and Execution.*

85 We developed and used an initial coding scheme, coding each document for evidence of
 86 norm violations as *violation not discussed in ethnographic materials* or *Violation discussed in*
 87 *some context in ethnographic materials.* For each punishment type we coded each
 88 document as *No discussion of sanction, Evidence for, and does not involve any subcategory,* or
 89 *Direct mention of no sanction for category of violation.* We only documented one case of
 90 evidence for *Direct mention of no sanction for category of violation* for material sanctions
 91 for adultery among the Turks. The punishment type subcategories we coded for were as
 92 follows: *Ambiguous* (n=1, 0.2% of supporting evidence), *Colonial or non-traditional*
 93 *institutions* (n=7, 1.5%), *Reference older or traditional former punishments* (n=23, 5.1%), or
 94 *Reference that the punishment or lack of is new and not in former context* (n=7, 1.5%).
 95 Following this scheme, two coders independently coded all documents and paragraphs and
 96 resolved any discrepancies. Because the majority of coded evidence did not include any of

97 these sub-codes (n=407, 91%) and the most common coded sub-code was traditional or
 98 former punishment, we therefore ignored sub-coding in analyses. Therefore, for each of the
 99 131 documents each of these nine variables were assigned a value of 1 if any returned
 100 paragraph provided supporting evidence for that variable and 0 if no returned paragraphs
 101 provided supporting evidence. See Table S3 for operational definitions of punishment and
 102 norm violation measures.

103 **Variable operationalizations**

104 Table S2 provides operational definitions for all coded variables.

105 *Table S2: Coded variables*

Variable	Type	Operational definition
Adultery	Violation	Explicit mention of violation of marital or relational exclusivity, monogamy, or sexual or romantic expectations in other sexual or romantic interactions.
Religious	Violation	Explicit mention of violation of religious traditions or taboos.
Food	Violation	Explicit mention of food theft by adults in a non-religious context.
Rape	Violation	Explicit mention of rape, sexual assault, or other non-consensual sexual activity.
Warfare	Violation	Explicit mention of displays of cowardice in warfare, battle, or inter-group conflict, or desertion of conflict by warriors.
Physical	Punishment	Generally expected or specific instance of community endorsed outcome that results in a specific instance of physical harm or restraint as a result of their violation (not revenge).
Material	Punishment	Generally expected or specific instance of community endorsed outcome that imposes direct economic or material costs on violator as a result of their violation.
Execution	Punishment	Generally expected or specific instance of community endorsed outcome that results in the death of the violator as a result of their violation (not murder).

Reputational	Punishment	Generally expected or specific instance of community endorsed reputational damage (more than gossip, results in net cost or general devaluation of violator)
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106

107 Note, regarding reputational punishment, we imagine there could be evidence of gossip
 108 which does not include evidence of reputational damage or devaluation. These instances
 109 would not count as reputational punishment.

110 **Ethnographic examples**

111 Below we include a few representative examples of ethnographic descriptions from our
 112 search strategy to illustrate the coding process and content of ethnographic documents.
 113 Exerts and bibliographic source information including page number, for all coded
 114 paragraphs are available via the “Ethnographic_texts_coding.xlsx” file in the OSF SI
 115 repository (<https://osf.io/9kfy5/>).

116 *Evidence for execution punishment for adultery norm violation among the San:*

117 From Schapera (1930, p. 252):

118 Infidelity on the part of the husband is not recognized as a ground for divorce, nor
 119 is adultery on the part of the wife. In the old days, according to Kolb, the Cape
 120 Hottentots regarded the latter as a capital offence, punishable by death without
 121 further question and without the least regard for the status of the adulterer. The
 122 Naman also, according to Kohler’s informant, would kill the adulterer if caught
 123 red-handed. Otherwise the matter had to be referred to the tribal council, which
 124 would fine the adulterer and perhaps order him to be thrashed. It seems,
 125 however, that in more recent times at least, the injured husband could altogether
 126 overlook the offence, if he wished. Vedder even goes so far as to say that adultery,
 127 though regarded as improper, is not subject to punishment. 33 Kohler, op. cit.,
 128 354; Kolb, op. cit., 71; Wandres, “Ueber das Recht der Naman,” 669; Vedder, “The
 129 Nama,” 144.

130 *Evidence for material punishment for adultery norm violation among the Mongo:*

131 From Hulstaert & Vizedom (1938, p. 290):

132 a) The usual sanction for adultery is, for the man, an indemnity to pay. But such a
 133 payment cannot be made since no financial transaction — strictly speaking at least
 134 — may be made within a group of close kin, seeing that, from a certain standpoint,
 135 property belongs to all the members, each sooner or later receiving or inheriting
 136 from the other. But in cases where other sanctions can be imposed, they are
 137 considered legitimate. 309

138 *Evidence for reputational punishment for adultery norm violation among the Vietnamese:*

139 From Tran-van-Trai & Messner (1942, p. 181):

140 An adulterous wife must be repudiated because she “brings disorder into the
141 family” (22) 22. Compare René Crayssac, Kim-Van-Kéou, Foreword, p. LV: “By
142 committing adultery the wife becomes guilty not of a misdemeanor but of a crime.
143 She in fact risks introducing someone of foreign blood under the family roof.” .
144 Confucian morality requires women to observe many duties towards their
145 husbands and the first of these duties is chastity and fidelity, two conditions
146 indispensable for strengthening a conjugal bond. Even at the present time, in
147 many parts of Annam a husband who discovers that his wife is not chaste may
148 send her back to her family the third day after marriage. Besides chastity,
149 morality and law require fidelity. Once united to her husband a woman will never
150 have another. This rule is strictly proclaimed, and the law punishes with nameless
151 atrocity any adulterous wife, as well as her accomplice (23) 23. A description of
152 the penalties inflicted on an adulterous wife and her accomplice may be seen in
153 Tavernier’s *La famille annamite*, p. 33. See also Marini Romain, *Relation du*
154 *Royaume du Tunquin...*, op. cit., p. 137. . [182]

155 *Evidence for execution punishment for rape among the Kapauku.*

156 From Pospisil (1958, p. 167):

157 The husband also has the exclusive right to sexual relations with his spouse. Since
158 marriage, as a result of the bride price, is an economic as well as a social matter,
159 and since most wars start because of violations of the husband’s exclusive sexual
160 rights, the delict of adultery, as well as the rape of a married woman, is considered
161 the most heinous of crimes. The penalty for it is execution. The latter may be
162 avoided by payment of a large indemnity to the husband who may or may not
163 accept it. Because of this uncertainty, most of the culprits do not make an offer,
164 thus precipitating an execution or, if from another political unit than the husband,
165 a war. Since intent is obvious on the man’s part in both adultery and rape, there is
166 no difference in punishment for the two offences. On the other hand, a woman,
167 while often executed like her adulterous partner, may escape with a beating even
168 if she has willingly submitted to sexual intercourse. Because intent, rather than
169 the effect, is of importance, she is safe and not punished if raped. She has, though,
170 the duty to report it immediately to her husband.

171 *Evidence for material punishment for violation of religious norms among the Creek.*

172 From Swanton (1928, p. 168):

173 A similar etiquette extended to objects connected with the clan, particularly the
174 animal from which it was named. I was told that if a person killed a totem animal
175 the people belonging to the clan from which it derived its name would compel
176 him to make them a payment. A man of the Bird clan would say to one who had
177 been shooting birds, “You have killed my parents; you will have to pay me for it,”
178 and the other would give him something. The duty of a member of the Wind clan

179 to protect the skunk and rabbit from injury and ridicule has already been
180 mentioned. 56a 56a See p. 112.

181 *Evidence for physical punishment for violation of religious norms among the Mongolians.*

182 From Bold (2001, p. 132):

183 However, Mongols did not detach themselves from traditional Shamanism. The
184 reports of European travellers of this period such as W. Rubruck, G. Carpini,
185 Marco Polo, etc., show that Mongols, from common livestock keepers to the
186 Khaan, had faith in their shamans. From the various legends concerning the
187 history of Mongolian Shamanism it can be seen that shamans strongly opposed
188 the spread of Buddhism in Mongolia (Badamkhatan 1956: 226–27, 234). During
189 the rule of Khublai Khaan, Buddhism was especially supported owing to the
190 political interests of those governing Buddhist populations; consequently
191 Buddhist monks were granted privileges. Khublai Khaan decreed that if anybody
192 were to touch a Tibetan lama or a pupil of a lama, his hand would be cut off; if
193 anybody insulted a Tibetan lama or a pupil of a lama by word, his tongue would
194 be pulled out (Dalai 1992: 164). Succeeding Mongolian Grand Khaans of the Yüan
195 dynasty always had Tibetan lamas as advisers in their courts, not only Sa-skyas
196 pas and Karma-pas 3 3. Sa-skyas: Sa-skyas was a Tibetan grand monastery
197 founded in 1073 in the vicinity of Lhasa; Sa-skyas-pa is the name of a hierarchy
198 and one of the four schools or orders of Tibetan Buddhism. but also followers of
199 the ancient rNimma-pa school 4 4. rNimma-pa school: one of the four schools or
200 orders of Tibetan Buddhism: Lamaist school connected with Padmasambhava. In
201 particular, the friendship of Khublai Khaan with the nephew and successor of Sa-
202 skyas Pandita, Phags-pa Lama, laid the foundation for 'state-religious' development
203 (Kaschewsky 1986: 89).

204 *Evidence for reputational punishment for war cowardice among the Masai.*

205 From Merker (1910, p. 286):

206 There is no special punishment for cowardice in war. The warriors, however,
207 mock the coward in front of the girls and make him ridiculous in their eyes. One
208 who makes anyone ill through sorcery pays a head of cattle to the one bewitched.
209 If the latter dies, the sorcerer must pay the fine levied for murder and is himself
210 driven away.

211 *Evidence for material punishment for food norm violations among the Riffians (Berbers Of*
212 *Morocco).*

213 From Coon (1931, p. 99):

214 The cases tried by this body and the matters it is required to regulate are as
215 follows (the fines listed are only approximate): Theft of eggs and of poultry. The
216 thief must pay a fine of thirty dollars. If the culprit is a child, his father appears
217 and pays it. Theft of maize. Boys who steal early ripening maize are collectively
218 fined five dollars. The injured farmer has the right to pick ripened ears from the

219 terraces of the thieves' parents to the number which he has lost. Cutting maize in
220 adjoining terraces. Sometimes maize growing in adjoining terraces, owned by
221 different men, ripens at different times. The owner of the later ripening maize
222 may wish to prevent the owner of the other field from cutting his crop until both
223 are ready, through fear that his own maize may be trampled in the process. This
224 situation arises when it is necessary to enter one terrace by passing through the
225 other. In this case the village council enjoins the owner of the early maize to wait
226 until the other is ready. Breaking branches of fruit trees. If goats or children break
227 branches from a fruit tree, the owner of the tree brings the branch or branches to
228 the mosque, where the village council counts the number of buds on the branch or
229 branches. A girch (about five cents) is charged for each bud, the recompense to be
230 paid the owner of the tree, and in addition a fine of twenty dollars must be paid.
231 Trampling vegetable gardens. This offense is punished by a fine of one to two
232 dollars, with no restitution. Policing orchards. During the harvest season the
233 members of this body police the orchards of the bone during the night to prevent
234 thefts. Starting the grape picking. The village council, which has charge of allotting
235 poor families to rich ones for the grape picking, exacts a fine of twenty dollars
236 from anyone guilty of picking grapes before the signal is given. Picking windfall
237 olives. Similarly, the head of each family must pay a quarter of a dollar for each
238 member of his family who starts picking up windfalls before the signal is given.
239 Theft of olives. The outright theft of olives is punished by a fine of ten dollars.
240 Trespassing in order to pick grass. If a man catches a woman picking or cutting
241 grass for her cow on his land, he may report her, and her husband will be fined
242 one dollar. But to make such a report is considered mean and few are willing to do
243 so. Stray goats and cattle in the cemetery. When goats or cattle, either with or
244 without the intention of their guardian, enter a cemetery, their owner is fined a
245 quarter of a dollar for each goat, and a dollar for each bull or cow which entered.
246 Repair of irrigation ditches. If any farmer fails to send a man or men to work on a
247 ditch, when he is required to do so, he is fined between two and three dollars per
248 day per man. Taking water illegally from irrigation ditches. This is considered a
249 serious offense, and although it incurs but a five dollar fine, it always breeds bad
250 feelings and often incites to murder. Regulating attendance at prayer. To explain
251 this function it is necessary to anticipate the discussion of religion. Each bone in
252 the canton is required to send twenty-five men once a week to the common
253 mosque of the canton to pray. The village council of each bone lists the names of
254 all married men in the bone: a day is set for each bone to attend the mosque, and
255 the bone keeps that day permanently. The first week the first twenty-five men on
256 the list must go, the second week the second twenty-five, and so on until the list
257 has been exhausted, when the procedure starts all over again. If the number of
258 married men in the bone is not evenly divisible by twenty-five, those forming the
259 remainder at the foot of the list are supplemented by enough at the head of it to
260 fill the number, and the rotation starts anew. It is the task of the village council in
261 whose territory the cantonal mosque is situated to see that twenty-five men
262 appear from each bone on the allotted day. If a bone is so small that it does not
263 contain twenty-five, it is combined with another bone for this purpose.

264 **Missing data**

265 As discussed in the main text, data imputation was used to account for 24 missing values in
 266 the socio-ecological predictor variables. The missing values which were imputed are given
 267 in Table S3

268 Table S3: Missing values which were imputed.

eHRAF name	SCCS ID	Variable name
Ovimbundu	5	trade
Teda	40	storage
Samoyed	53	soc_strat
Samoyed	53	storage
Samoyed	53	husb
Samoyed	53	hunt
Samoyed	53	comm_size
Samoyed	53	trade
Haitians	160	hunt
Mongolia	66	soc_strat
Mongolia	66	storage
Mongolia	66	husb
Mongolia	66	hunt
Mongolia	66	comm_size
Mongolia	66	trade
Garo	69	hunt
Cambodians	75	storage
Eastern Toraja	87	trade
Lesu	97	soc_strat
Lesu	97	storage
Lesu	97	husb
Lesu	97	hunt
Lesu	97	comm_size
Lesu	97	trade

269

270

271 **The multi-outcome, multi-predictor Bayesian phylogenetic model**

272 The multivariate-outcome model, discussed in the main text is specified below.

273 For each society $i \in N$ and each punishment type $j \in J = 4$:

274
$$y_{[i,j]} \sim \text{Bernoulli}(p_{[i,j]})$$

275
$$\text{logit}(p_{[i,j]})$$

276
$$= \alpha_{[j]} + \alpha_{[\text{RES}[i],j]} + \alpha_{[\text{PHY}[i],j]} + \beta_{\text{Page}[j]} \log(\text{PageCount}[i]) + \beta_{\text{Strat}[j]} \sum_{k=1}^{\text{Strat}[i]} S_{\text{Strat}[j]}^{[k]}$$

277
$$+ \beta_{\text{Storage}[j]} \text{Storage}[i] + \beta_{\text{Husb}[j]} \sum_{k=1}^{\text{Husb}[i]} S_{\text{Husb}[j]}^{[k]} + \beta_{\text{Hunt}[j]} \sum_{k=1}^{\text{Hunt}[i]} S_{\text{Hunt}[j]}^{[k]}$$

278
$$+ \beta_{\text{Comm}[j]} \sum_{k=1}^{\text{Comm}[i]} S_{\text{Comm}[j]}^{[k]} + \beta_{\text{Trade}[j]} \text{Trade}[i]$$

279 Where α represents a global intercept and β represents a fixed effect. For ordinal
 280 predictors (social stratification, animal husbandry, hunting, mean community size) the
 281 effects of moving between ordered categories are represented by a simplex S (Bürkner &
 282 Charpentier, 2020). $\alpha_{[\text{RES}]}$ denotes a society-level random effect that captures the residual
 283 covariance between punishment types. $\alpha_{[\text{PHY}]}$ denotes a society-level phylogenetic random
 284 effect, where the covariance between societies is proportional to phylogenetic (patristic)
 285 distance.

286 The residual random effects, A , are correlated across response variables (punishment
 287 types) where $A[i, j]$ is the residual random effect for punishment type j in society i :

288
$$A \sim \text{MVNormal} \left(\begin{bmatrix} 0 & \dots & 0 \\ \vdots & & \vdots \\ 0 & \dots & 0 \end{bmatrix}, \Sigma_{[\text{RES}]} \right)$$

289
$$\Sigma_{[\text{RES}]} = \begin{bmatrix} \sigma_{[\text{RES}[1]]} & 0 & 0 & 0 \\ 0 & \sigma_{[\text{RES}[2]]} & 0 & 0 \\ 0 & 0 & \sigma_{[\text{RES}[3]]} & 0 \\ 0 & 0 & 0 & \sigma_{[\text{RES}[j]]} \end{bmatrix} \Omega \begin{bmatrix} \sigma_{[\text{RES}[1]]} & 0 & 0 & 0 \\ 0 & \sigma_{[\text{RES}[2]]} & 0 & 0 \\ 0 & 0 & \sigma_{[\text{RES}[3]]} & 0 \\ 0 & 0 & 0 & \sigma_{[\text{RES}[j]]} \end{bmatrix}$$

290 The phylogenetic random effects are correlated using the expected variance-covariance
 291 matrix (D of traits evolving under a Brownian motion model):

292
$$\begin{bmatrix} \alpha_{[\text{PHY}[i],j]} \\ \vdots \\ \alpha_{[\text{PHY}[N],j]} \end{bmatrix} \sim \text{MVNormal} \left(\begin{bmatrix} 0 \\ \vdots \\ 0 \end{bmatrix}, \sigma_{[\text{PHY}[j]]} \times D \right)$$

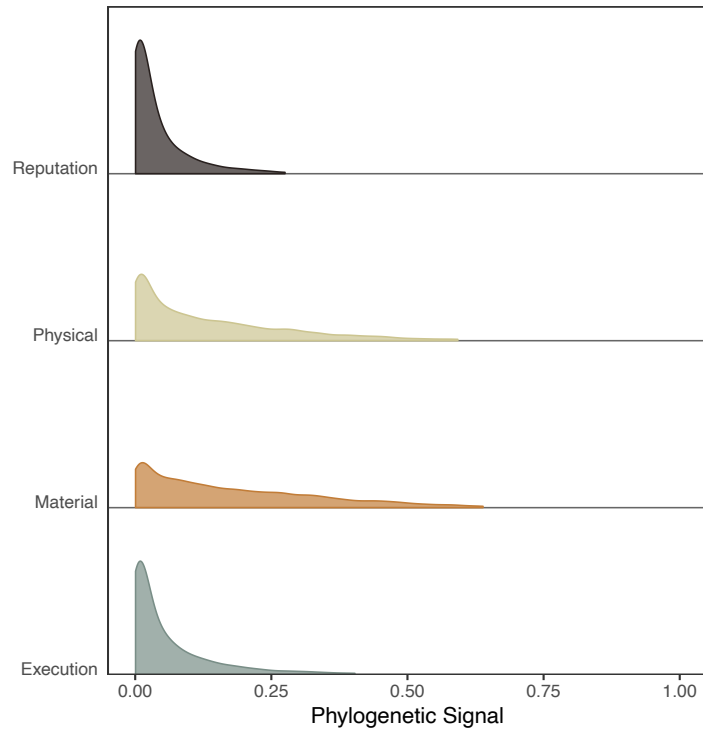
293 The weakly regularizing priors are given as:

294
$$\alpha, \beta \sim \text{Normal}(0,2)$$

295
296
297
298
299

$$S \sim \text{Dirichlet}(2, \dots, 2)$$
$$\sigma_{\text{RES}}, \sigma_{\text{PHY}} \sim \text{Exponential}(1)$$
$$\Omega \sim \text{LKJ}(2)$$

Phylogenetic signals



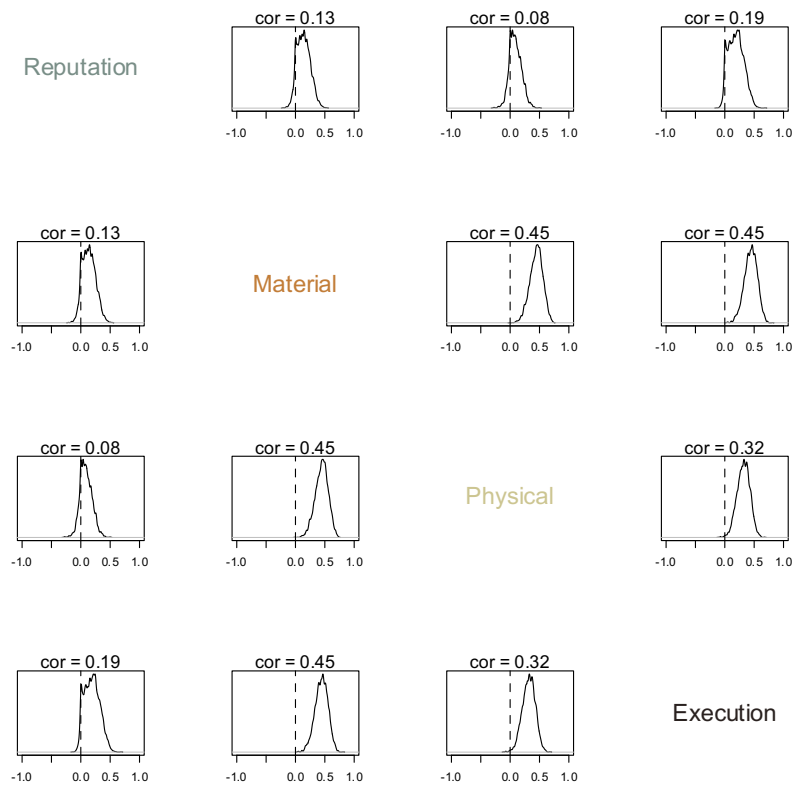
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306

Figure S1: Posterior distribution of phylogenetic signal in evidence for punishment types. Values represent the proportion of variance captured by phylogeny.

Correlations between sanctions

Below we report the variance explained by the residual correlated random effects from the multi-variate multi-response model, where the correlation of punishment type x and y is $cor(x, y) = cov(x, y) / (SD(x) \times SD(y))$.

307



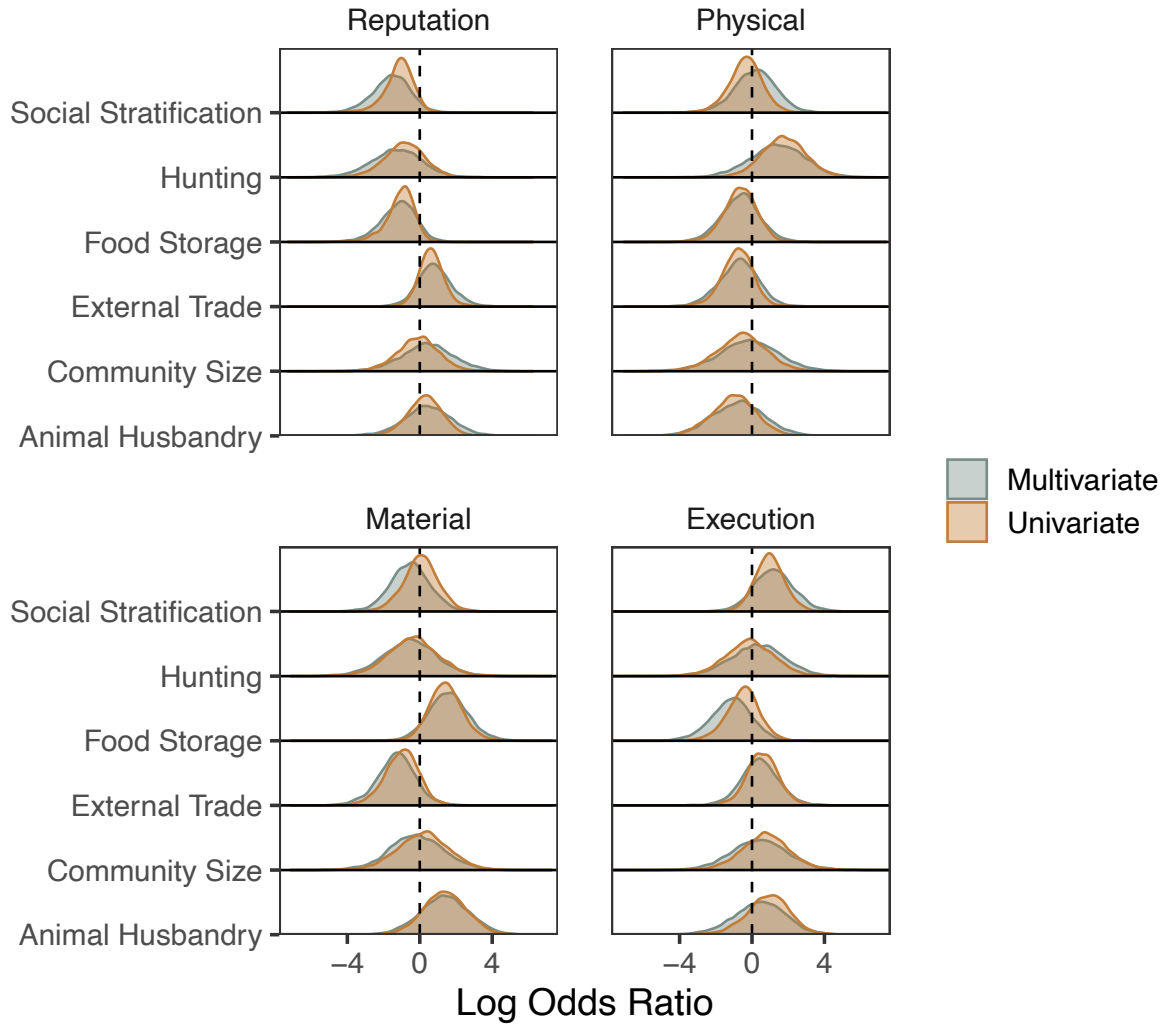
308

309 *Figure S2: Residual correlated random effects of punishment types from the multi-variate*
310 *multi-response model.*

311 Predictors of punishment types

312

313



314

315 *Figure S3: Predictors of evidence for punishment types. Univariate-response model posterior*
316 *distributions plotted alongside the multivariate-response model posterior distributions*
317 *reported in the main text.*

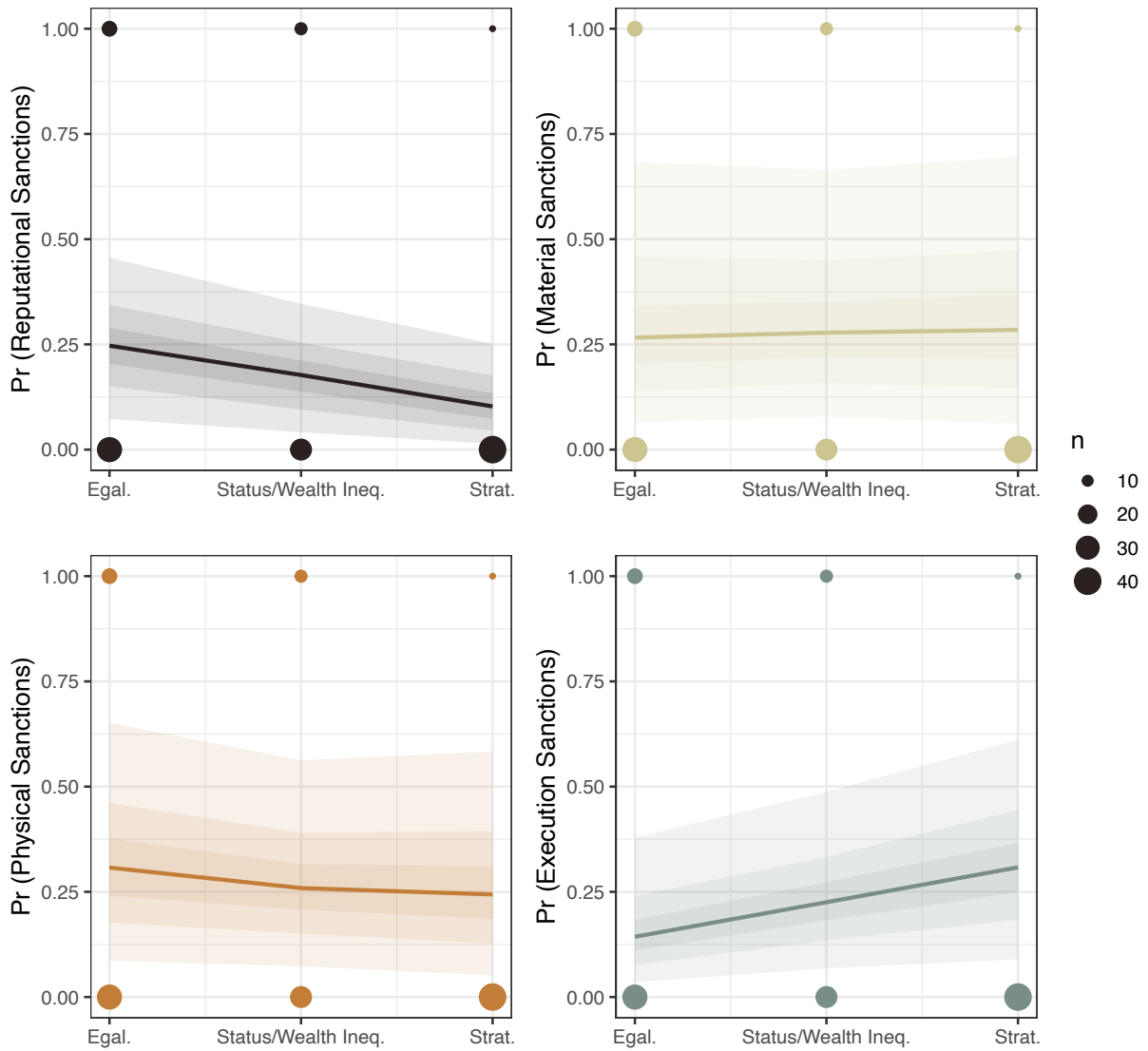
318

319 Table S4: Effects table

Response	Predictor	Model type	Posterior median	Probability of direction	Lower 90% HPDI	Upper 90% HPDI
Execution	Animal Husbandry	Multivariate	0.45	pd = 0.62	-1.95	2.72
Execution	Animal Husbandry	Univariate	0.87	pd = 0.78	-0.97	2.89
Execution	Community Size	Multivariate	0.41	pd = 0.61	-2.04	2.97
Execution	Community Size	Univariate	0.72	pd = 0.71	-1.48	2.91
Execution	External Trade	Multivariate	0.41	pd = 0.66	-1.28	2.00
Execution	External Trade	Univariate	0.59	pd = 0.76	-0.88	2.09
Execution	Food Storage	Multivariate	-1.13	pd = 0.88	-2.94	0.55
Execution	Food Storage	Univariate	-0.48	pd = 0.71	-2.00	1.01
Execution	Hunting	Multivariate	0.33	pd = 0.59	-2.14	2.72
Execution	Hunting	Univariate	-0.11	pd = 0.53	-2.32	2.09
Execution	Social Stratification	Multivariate	1.25	pd = 0.88	-0.44	3.20
Execution	Social Stratification	Univariate	0.96	pd = 0.89	-0.39	2.41
Material	Animal Husbandry	Multivariate	1.40	pd = 0.85	-0.82	3.57
Material	Animal Husbandry	Univariate	1.44	pd = 0.88	-0.60	3.35
Material	Community Size	Multivariate	-0.12	pd = 0.54	-2.63	2.13
Material	Community Size	Univariate	0.23	pd = 0.57	-2.15	2.58
Material	External Trade	Multivariate	-1.27	pd = 0.9	-2.88	0.50
Material	External Trade	Univariate	-0.98	pd = 0.86	-2.56	0.64
Material	Food Storage	Multivariate	1.54	pd = 0.93	-0.24	3.28
Material	Food Storage	Univariate	1.42	pd = 0.95	-0.11	2.93
Material	Hunting	Multivariate	-0.53	pd = 0.64	-2.98	1.86
Material	Hunting	Univariate	-0.38	pd = 0.61	-2.67	1.87
Material	Social Stratification	Multivariate	-0.49	pd = 0.69	-2.23	1.19
Material	Social Stratification	Univariate	0.08	pd = 0.53	-1.56	1.58
Physical	Animal Husbandry	Multivariate	-0.74	pd = 0.71	-3.08	1.67
Physical	Animal Husbandry	Univariate	-0.96	pd = 0.8	-3.02	0.99
Physical	Community Size	Multivariate	-0.13	pd = 0.53	-2.70	2.29
Physical	Community Size	Univariate	-0.57	pd = 0.67	-2.87	1.53
Physical	External Trade	Multivariate	-0.66	pd = 0.74	-2.54	1.03
Physical	External Trade	Univariate	-0.78	pd = 0.83	-2.24	0.62
Physical	Food Storage	Multivariate	-0.62	pd = 0.74	-2.49	1.06
Physical	Food Storage	Univariate	-0.60	pd = 0.77	-2.03	0.78
Physical	Hunting	Multivariate	1.38	pd = 0.82	-1.03	3.87
Physical	Hunting	Univariate	1.71	pd = 0.92	-0.41	3.68
Physical	Social Stratification	Multivariate	0.20	pd = 0.57	-1.78	1.91
Physical	Social Stratification	Univariate	-0.35	pd = 0.66	-1.82	1.05
Reputation	Animal Husbandry	Multivariate	0.43	pd = 0.64	-1.61	2.55
Reputation	Animal Husbandry	Univariate	0.26	pd = 0.61	-1.36	1.92
Reputation	Community Size	Multivariate	0.40	pd = 0.61	-1.94	2.81
Reputation	Community Size	Univariate	-0.04	pd = 0.51	-2.00	1.82
Reputation	External Trade	Multivariate	0.76	pd = 0.82	-0.63	2.43
Reputation	External Trade	Univariate	0.59	pd = 0.83	-0.52	1.69
Reputation	Food Storage	Multivariate	-1.04	pd = 0.9	-2.73	0.29
Reputation	Food Storage	Univariate	-0.95	pd = 0.93	-2.21	0.23
Reputation	Hunting	Multivariate	-1.26	pd = 0.84	-3.69	0.88
Reputation	Hunting	Univariate	-0.87	pd = 0.79	-2.83	0.85
Reputation	Social Stratification	Multivariate	-1.51	pd = 0.95	-3.20	0.12
Reputation	Social Stratification	Univariate	-1.07	pd = 0.95	-2.27	0.26

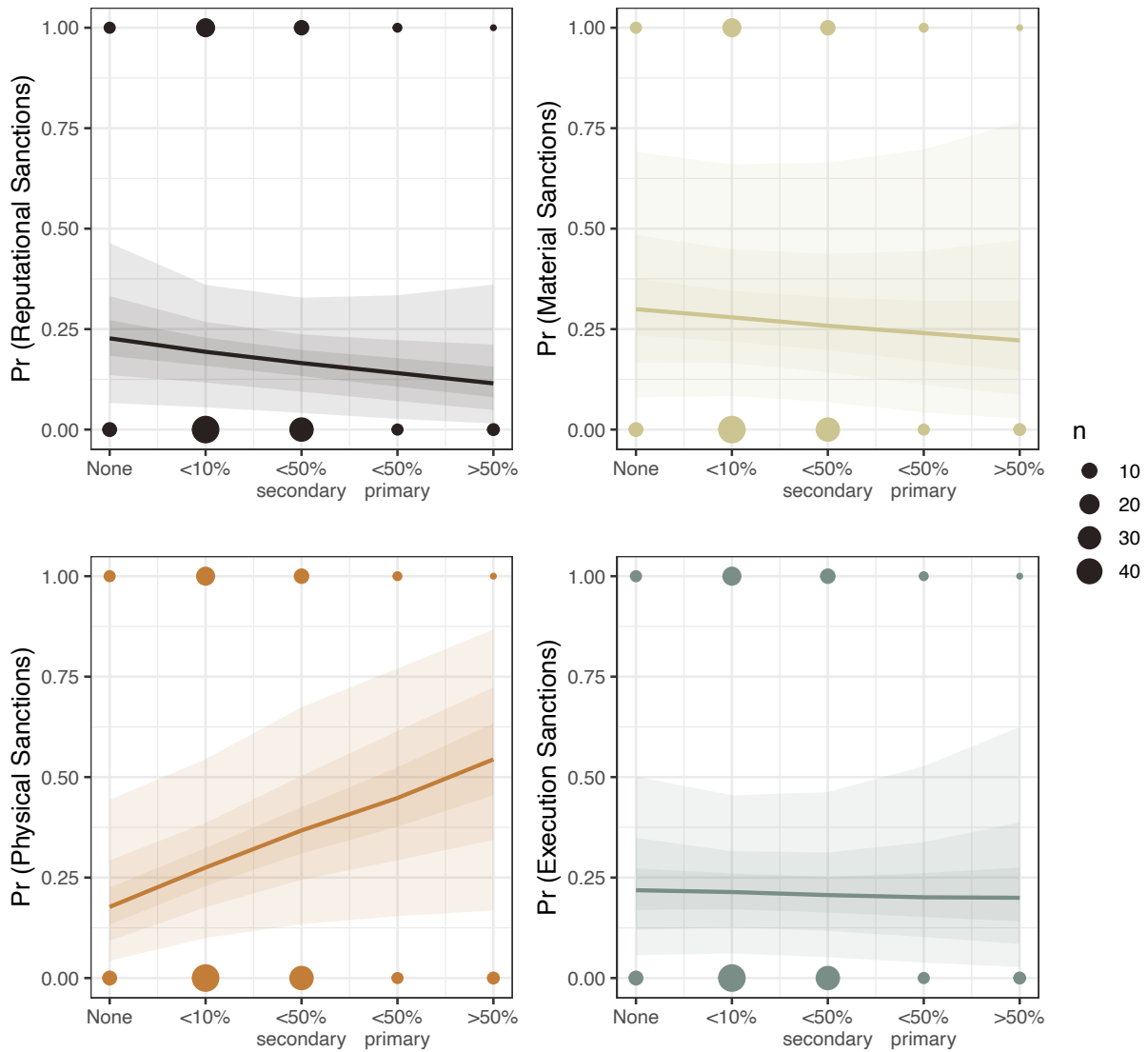
320

321 Counterfactual plots



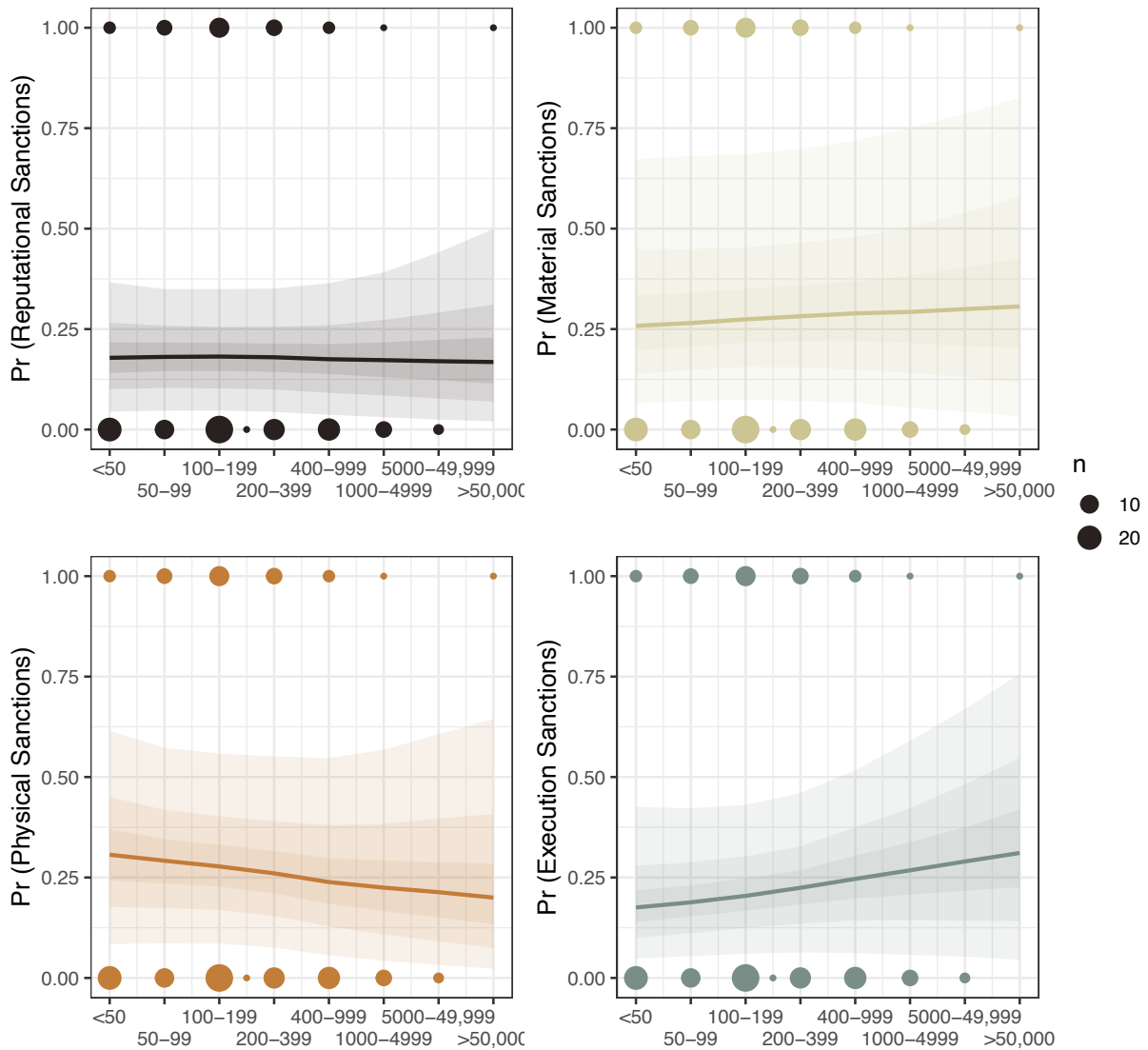
322

323 *Figure S4: Posterior-predictive plots of the probability of different types of sanctions as a*
 324 *function of social stratification level. Shaded intervals of increasing opacity represent*
 325 *quantiles of the 90% credible interval, with darker shades reflecting the relative increase in*
 326 *probability mass. Point size is proportional to number of societies with that combination of*
 327 *sanction present/socioecological predictor. 'Z-score' axes indicate standard deviations.*
 328 *Predictions draw from a model where social stratification was the only socioecological*
 329 *predictor, thus marginalizing over all the other measures of socioecology.*



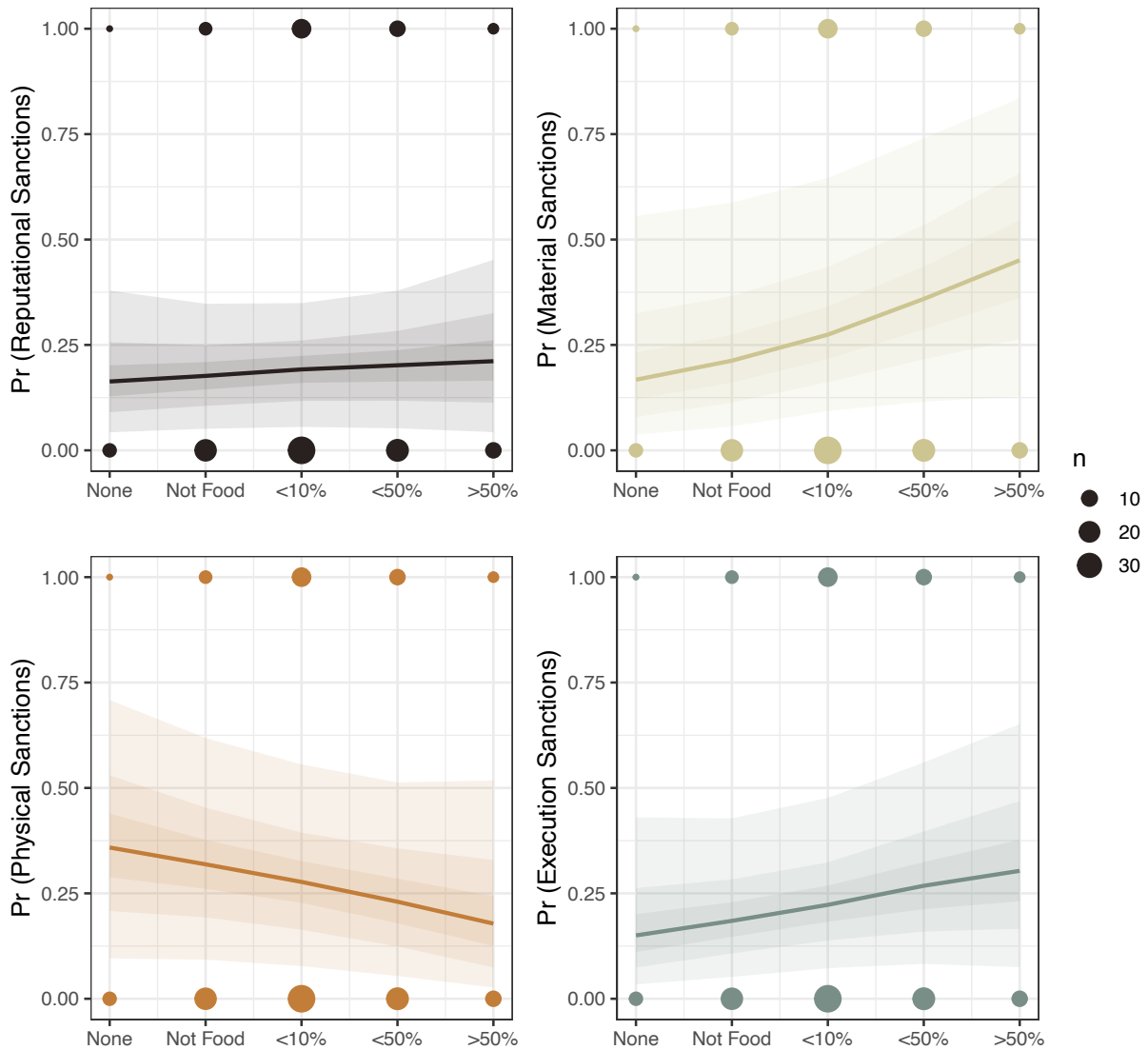
330

331 *Figure S5: Posterior-predictive plots of the probability of different types of sanctions as a*
 332 *function of community size. Shaded intervals of increasing opacity represent quantiles of the*
 333 *90% credible interval, with darker shades reflecting the relative increase in probability mass.*
 334 *Point size is proportional to number of societies with that combination of sanction*
 335 *present/socioecological predictor. 'Z-score' axes indicate standard deviations. Predictions*
 336 *draw from a model where community size was the only socioecological predictor, thus*
 337 *marginalizing over all the other measures of socioecology.*



338

339 *Figure S6: Posterior-predictive plots of the probability of different types of sanctions as a*
 340 *function of the percentage dependence on animal husbandry. Shaded intervals of increasing*
 341 *opacity represent quantiles of the 90% credible interval, with darker shades reflecting the*
 342 *relative increase in probability mass. Point size is proportional to number of societies with*
 343 *that combination of sanction present/socioecological predictor. 'Z-score' axes indicate*
 344 *standard deviations. Predictions draw from a model where animal husbandry was the only*
 345 *socioecological predictor, thus marginalizing over all the other measures of socioecology.*



346

347 *Figure S7: Posterior-predictive plots of the probability of different types of sanctions as a*
 348 *function of the percentage dependence on hunting. Shaded intervals of increasing opacity*
 349 *represent quantiles of the 90% credible interval, with darker shades reflecting the relative*
 350 *increase in probability mass. Point size is proportional to number of societies with that*
 351 *combination of sanction present/socioecological predictor. 'Z-score' axes indicate standard*
 352 *deviations. Predictions draw from a model where hunting was the only socioecological*
 353 *predictor, thus marginalizing over all the other measures of socioecology.*

354 **Bias assessment model**

355 Our bias assessment model was structured similarly to the main model described in the SI
 356 and discussed in the main text. It differs in: (1) the omission of all socioecological
 357 predictors and phylogenetic random effects, and (2) the inclusion of random effects for

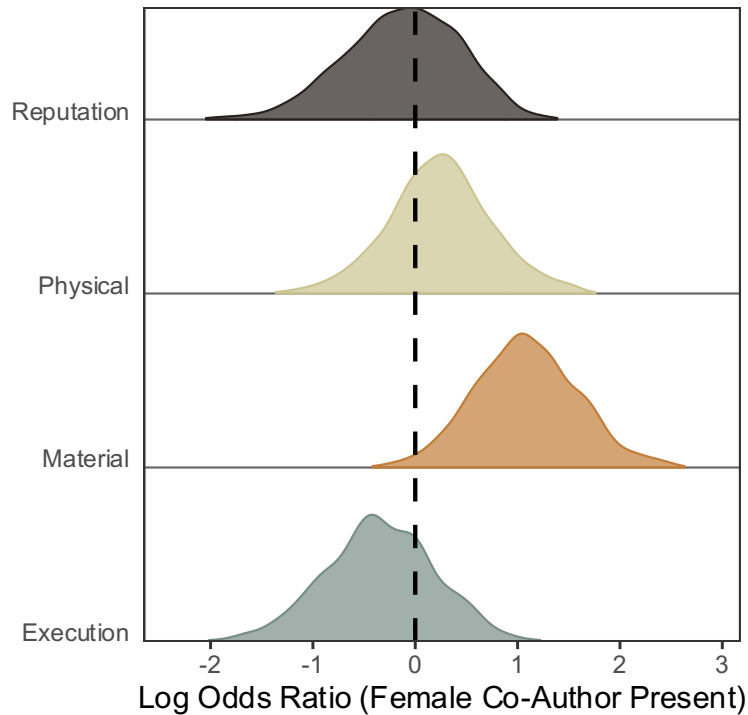
358 date of publication ($\alpha_{[DATE]}$) and fixed effects for the natural log of page count (β_{Page}) and
 359 the presence/absence of female co-authors (β_{Female}).

360 For each society $i \in N$ and each punishment type $j \in J = 4$:

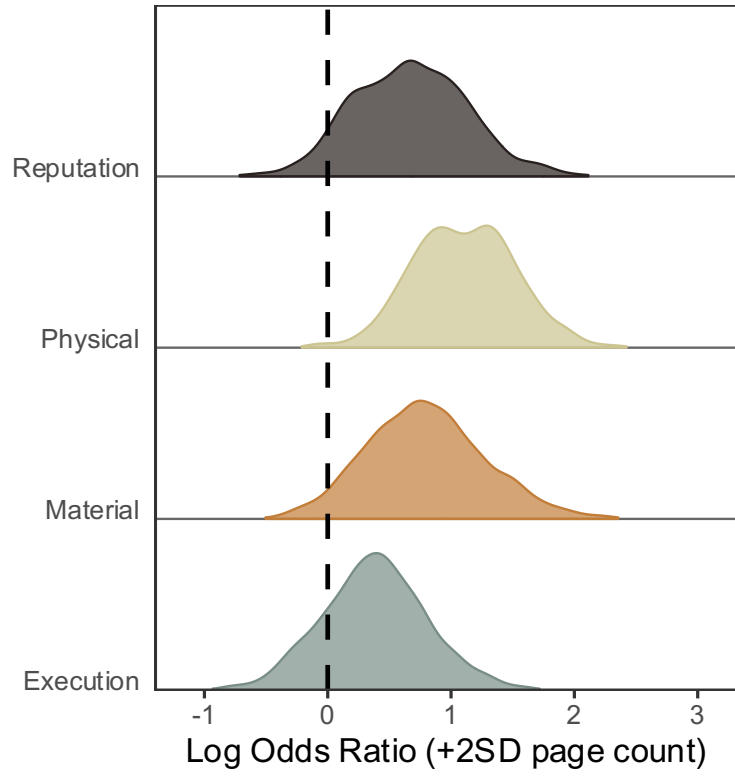
$$\begin{aligned}
 361 \quad & y_{[i,j]} \sim \text{Bernoulli}(p_{[i,j]}) \\
 362 \quad & \text{logit}(p_{[i,j]}) \\
 363 \quad & = \alpha_{[j]} + \alpha_{[RES[i,j]]} + \alpha_{[DATE[i,j]]} + \beta_{Page[j]} \log(\text{PageCount}[i]) + \beta_{Female[j]} \text{Female_Coauthor}[i] \\
 364 \quad & \begin{bmatrix} \alpha_{[DATE[i,j]]} \\ \vdots \\ \alpha_{[DATE[N,j]]} \end{bmatrix} \sim \text{MVNormal} \left(\begin{bmatrix} 0 \\ \vdots \\ 0 \end{bmatrix}, \sigma_{[DATE[j]]} \times D_{[DATE]} \right) \\
 365 \quad & \alpha, \beta \sim \text{Normal}(0,2) \\
 366 \quad & \sigma_{DATE} \sim \text{Exponential}(1)
 \end{aligned}$$

367 Where $D_{[DATE]}$ is the expected covariance matrix of for a Brownian motion model (i.e.,
 368 covariance is proportional to temporal distance).

369 *Bias assessment model results*

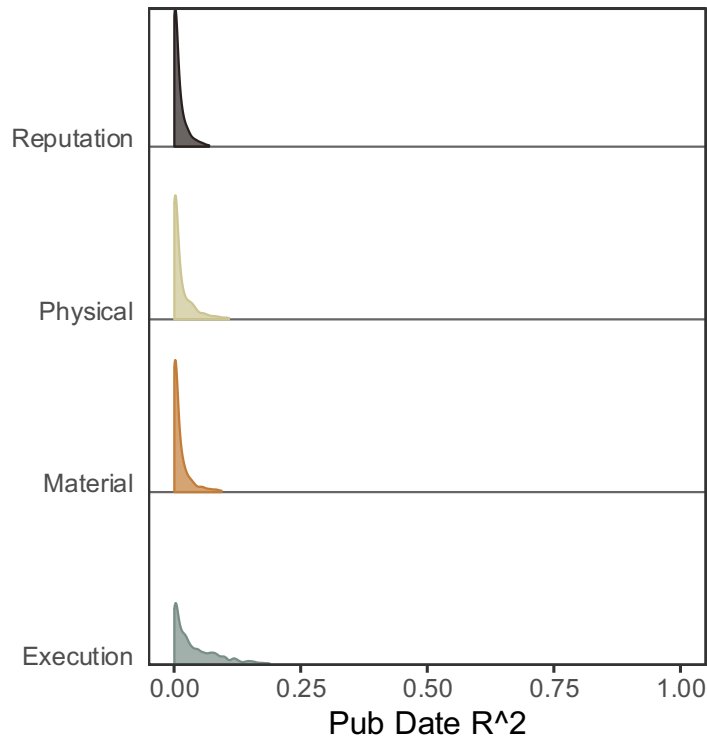


370
 371 *Figure S8: Posterior distribution of phylogenetic signal in evidence for female co-author*
 372 *present count.*



373

374 *Figure S9: Posterior distribution of phylogenetic signal in evidence for page count.*



375

376 *Figure S10: Posterior distribution of phylogenetic signal in evidence for document*
 377 *publication date.*

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