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1 **Universal norm psychology leads to societal**  
2 **diversity in prosocial behavior and development**

3

4 Bailey R. House<sup>1,2\*</sup>, Patricia Kanngiesser<sup>4</sup>, H. Clark Barrett<sup>5</sup>, Tanya Broesch<sup>6</sup>, Senay Cebioglu<sup>6</sup>, Alyssa N.  
5 Crittenden<sup>7</sup>, Alejandro Erut<sup>5</sup>, Sheina Lew-Levy<sup>8</sup>, Carla Sebastian-Enesco<sup>9</sup>, Andrew Marcus Smith<sup>5</sup>, Süheyla  
6 Yilmaz<sup>4</sup>, Joan B. Silk<sup>2,3</sup>

7

8 <sup>1</sup> University of York, Department of Psychology.

9 <sup>2</sup> Arizona State University, Institute of Human Origins.

10 <sup>3</sup> Arizona State University, School of Human Evolution and Social Change.

11 <sup>4</sup> Freie Universität Berlin, Faculty of Education and Psychology.

12 <sup>5</sup> University of California, Los Angeles, Department of Anthropology.

13 <sup>6</sup> Simon Fraser University, Department of Psychology.

14 <sup>7</sup> University of Nevada, Las Vegas, Department of Anthropology.

15 <sup>8</sup> University of Cambridge, Department of Psychology.

16 <sup>9</sup> Universidad de La Rioja (Spain), Department of Education Science.

17

18 \* Corresponding author: Bailey R. House (bailey.house@york.ac.uk; ORCID: Q-2125-2017)

## 19 **Abstract**

20 **Recent work has proposed that social norms play a key role in motivating human cooperation, and in**  
21 **explaining the unique scale and cultural diversity of our prosociality. However, there has been little**  
22 **work directly linking social norms to the form, development, and variation in prosocial behavior**  
23 **across societies. In a cross-cultural study of eight diverse societies, we provide evidence that (1)**  
24 **adults' prosocial behavior is predicted by what other members of their society judge to be the correct**  
25 **social norm, (2) children's responsiveness to novel social norms develops similarly across societies,**  
26 **and (3) societally-variable prosocial behavior develops concurrently with children's responsiveness to**  
27 **norms in middle childhood. These data support the view that the development of prosocial behavior**  
28 **is shaped by a psychology for responding to normative information, which itself develops universally**  
29 **across societies.**

## 31 **Introduction**

32 Human cooperative abilities are core to our success as a species<sup>1,2</sup> and differ in at least two important  
33 ways from those of other animals. First, people orchestrate group-level cooperation with large numbers  
34 of unrelated individuals. Second, cooperative behaviors vary considerably across societies<sup>3,4</sup>, and this  
35 variation emerges during middle childhood<sup>5-9</sup>. Some have suggested that the evolution of both can be  
36 explained if human social preferences are at least partly shaped by local cultural norms<sup>5</sup>, which we  
37 acquire through an evolved psychology for learning and conforming to social norms<sup>6,7</sup>. According to this  
38 claim, we can explain what makes humans so successful by demonstrating (1) that our prosocial  
39 behavior is linked to social norms, and (2) that we have a universally-developing psychology for  
40 responding to these norms.

41  
42 Norms are central to numerous theoretical models of human sociality and development<sup>5,8-11</sup>, and are  
43 generally conceived of as phenomena that regulate behavior through prescriptions and proscriptions<sup>12</sup>.  
44 Following Bicchieri<sup>8,13</sup>, we define a social norm as a behavior rule that individuals conform to when they  
45 believe that: (a) a sufficiently large number of people in their community conforms to the rule (empirical  
46 expectation), and (b) a sufficiently large number of people in their community expects them to conform  
47 to the rule (normative expectations). A descriptive norm, in contrast, would focus on empirical  
48 expectations. There is already some evidence that norms underlie variation in prosociality across  
49 societies and groups<sup>4,14</sup>. However, most studies have only documented this variation across societies or

50 explained it using society-level variables<sup>3,15</sup>. What is needed is empirical evidence that societal variation  
51 in normative expectations gives rise to variation in prosocial behaviors. Such evidence would show that  
52 individuals' prosocial behavior is predicted by what members of their society believe to be normatively  
53 'correct' in a particular situation (social norms). We must also distinguish the influence of social norms  
54 from that of individuals' own beliefs about what is 'correct' (personal norms).

55  
56 To connect societal variation in prosocial behavior to the development of a universal psychology for  
57 social norms, we must also show that across diverse societies children's tendency to respond to social  
58 norms is increasing during the same period that adult-like prosocial behavior is forming. Children are  
59 sensitive to normative information as young as 1.5-4 years of age<sup>16</sup>. At this age, they enforce norm  
60 conformity in others<sup>17</sup>, follow descriptive and injunctive norms<sup>18,19</sup>, are sensitive to moral and  
61 conventional rules<sup>20</sup>, and they know that different groups follow different norms<sup>17</sup>. Later, in middle  
62 childhood, children demonstrate an increasing responsiveness to novel social norms in experimental  
63 settings<sup>18</sup>, suggesting that children of this age are becoming increasingly committed to modifying their  
64 behavior to conform to social norms. Interestingly, this is the same age that societal variation in  
65 children's prosocial choices appears to emerge in costly sharing tasks (i.e. tasks which involve a choice  
66 between outcomes that benefit oneself and outcomes that benefit others)<sup>15,21-24</sup>. These findings suggest  
67 that middle childhood is a particularly important period for the adoption of locally-appropriate prosocial  
68 behaviors, and this could be the product of children's increasing responsiveness to social norms at this  
69 age. As children are already sensitive to norms by the time that they reach middle childhood, changes in  
70 behavior during middle childhood may be due to developmental changes in their willingness to conform  
71 to norms, particularly their willingness to conform to norms which impose costs on them.

72  
73 If societal variation in adults' prosocial behavior is linked to societal beliefs about correct prosocial  
74 choices, this provides evidence that prosocial behavior is motivated by social norms above and beyond  
75 personal norms (Prediction 1). If children's responsiveness to social norms is developing during  
76 childhood, then with increasing age their prosocial choices should become more adult-like and variable  
77 across societies (Prediction 2), and also more strongly influenced by novel social norms (Prediction 3).  
78 This would provide two independent sources of evidence for the hypothesis that social norms have  
79 increasing influence on children's prosocial behavior as they mature, and would be consistent with the  
80 results of prior studies. If children's willingness to respond to norms develops similarly across a wide  
81 range of different societies, it would provide evidence for a universally-developing human psychology

82 for responding to social norms (Prediction 4). If this societally-common responsiveness to norms  
83 develops concurrently with the development of adult-like prosocial behavior, it would provide evidence  
84 that a universally-developing psychology for social norms can explain the emergence of societal  
85 variation in prosocial behavior (Prediction 5).

86  
87 We conducted field experiments on prosocial behavior using the Dictator Game (DG) as a measure of  
88 costly sharing with 255 adults (131 female) and 833 children (414 female) aged 4-17, in eight  
89 populations ranging from foragers to small-scale horticulturalists to large urban communities (Table 1).  
90 The DG provides a well-validated test of an individual's willingness to share with others at a personal  
91 cost, and its standardized design facilitates direct comparison across populations (Figure 1)<sup>25</sup>. We used a  
92 binary-choice version of the DG in which subjects chose between two options: they could keep two  
93 rewards and give none to an absent anonymous peer (the "2/0", self-maximizing option), or they could  
94 keep one reward and give one to the peer (the "1/1", prosocial option). This version of the task is  
95 appropriate for children aged  $\geq 4$  years and adults<sup>15,26,27</sup>. All child and adult subjects included in the  
96 dataset passed three comprehension questions confirming they understood the DG procedure, the  
97 content of the norm prime videos, and that larger quantities of rewards resulted in higher payoffs  
98 (Supplementary Information pg.25).

99  
100 Before each subject made their choice in the DG, they viewed a short video in which an adult model  
101 verbalized novel normative information about the two options in the DG (we refer to this normative  
102 information as the 'norm prime')<sup>18</sup>. Videos used a standardized script, but were recorded at each  
103 fieldsite using local translations of the script and local adults as models. Across three between-subjects  
104 conditions participants were presented with different norm primes. In the GENEROUS condition, the  
105 norm prime indicated that 1/1 was 'right' and 'good to choose', while 2/0 was 'wrong' and 'bad to  
106 choose'. In the SELFISH condition, the norm prime indicated that 2/0 was 'right'/'good to choose' and  
107 1/1 was 'wrong'/'bad to choose'. Importantly, the videos did not show the model making a choice in the  
108 DG, they simply presented the norm prime as if musing about the choice between 1/1 and 2/0. In the  
109 BOTH OK condition, the model stated that 1/1 and 2/0 were both 'ok'/'ok to choose', language that isn't  
110 strongly normative but which could arguably be at least weakly normative. Regardless, BOTH OK  
111 provides a reference point about subjects' prosocial choices when they have been given information  
112 that does not preferentially bias them towards either 1/1 or 2/0 (as the GENEROUS and SELFISH  
113 conditions had done).

114

115 To test Prediction 1, adult subjects in all eight societies received only the BOTH OK norm prime before  
116 they made their choice in the DG. We used these data to assess variation in the probability of adults' 1/1  
117 choices across societies. In seven of the eight societies we also elicited judgments about which norm  
118 prime was 'correct' (practical limitations required using an abbreviated procedure with the Hadza,  
119 precluding collection of data on judgments; Supplementary Information pg.28). In these seven societies,  
120 after subjects had made their choice in the DG, they were presented with both the GENEROUS and  
121 SELFISH norm prime videos (randomizing the order of presentation), and asked which of the videos they  
122 believed to be "more correct". This judgement could be influenced both by what participants believe is  
123 correct for them to choose (personal norms), and also by what they believe is correct for others to  
124 choose (social norms). If individuals' DG choices are influenced by social norms, then their choices are  
125 expected to be predicted by the judgments of others in their society (i.e. others' beliefs about what is  
126 the 'correct' norm) in addition to their own judgments. Subjects' judgments allow us to study how  
127 society-level beliefs influence prosocial behavior, without requiring subjects to explicitly report what  
128 they think other members of their community believe to be correct. This is important for a cross-cultural  
129 study, as comfort and familiarity with discussing others' thoughts or mental states varies across societies  
130 <sup>28</sup>.

131

132 To test Prediction 2, a subset of child subjects in all eight societies also received the BOTH OK prime, and  
133 we explored how the probability of children's 1/1 choices changes with age in the BOTH OK condition.  
134 To determine how adult-like prosocial behavior develops, we explored whether children's prosocial  
135 choices were predicted by the prosocial choices of adults from their own society, and whether this  
136 relationship changed as a function of children's age.

137

138 To test Prediction 3, in six of the eight societies two additional subsets of children were presented with  
139 either the GENEROUS or SELFISH norm primes (practical limitations prevented testing these additional  
140 samples in both Tanna and Hadza) in a between-subjects design. We explored whether the GENEROUS  
141 prime increased the probability of 1/1 choices relative to the BOTH OK prime, and whether the SELFISH  
142 prime decreased this probability relative to the BOTH OK prime. If subjects' prosocial choices in the DG  
143 were responsive to the normative information provided by the priming videos, then subjects are  
144 expected to be more likely to choose 1/1 in GENEROUS than in BOTH OK, and less likely to choose 1/1 in

145 BOTH OK than in SELFISH. To test Prediction 4, we then explored whether the development of children's  
146 responsiveness to the primes varied across societies.

147  
148 To test Prediction 5, we compared the development of adult-like DG choices in children, the  
149 development of children's responsiveness to novel social norms (e.g. GENEROUS, SELFISH norm primes),  
150 and the development of children's tendency to make choices consistent with adults' beliefs about social  
151 norms (i.e. the probability that adults in their society judged GENEROUS to be 'most correct'). If these  
152 different developmental trajectories align, and if children's responsiveness to novel social norms  
153 develops similarly across societies, this will suggest that societal variation in prosocial development is  
154 linked to the development of a universal psychology for responsiveness to social norms.

155

## 156 Results

157 **Prediction 1.** We explored whether adults DG choices varied across societies by comparing regression  
158 models using WAIC and AIC weight (Table 2). Model 1a represents the hypothesis that DG choices do  
159 not vary across societies. Model 1b represents the hypothesis that DG choices vary across societies and  
160 includes dummy parameters for each society. We had no predictions about Age and Gender for adult  
161 subjects, but Model 1c included interactions with these variables to consider whether they were  
162 important. Model 1b provides a better fit to the data than the other models (reflected by lower WAIC  
163 and higher AIC weight; Table 2), indicating that the probability of a 1/1 choice varied substantially across  
164 societies, and that this variation was not a by-product of variation in the distribution of Age or Gender  
165 across societies (the estimates of Models 1c and 1b are similar; Supplementary Figure 12).

166  
167 The probability that adults would choose the 1/1 option varied across societies (Model 1b; Fig.2a;  
168 Supplementary Table 3). Information about mean amounts given in a continuous DG were available for  
169 three of the societies in our sample (from a previous study), and the proportion of 1/1 choices in the  
170 present binary DG (Americans=.54, Shuar=.20, Hadza=.20) were similar to the mean amounts given in  
171 the continuous DG (Americans=.45, Shuar=.34, Hadza=.26; triangles in Fig.2a) <sup>4</sup>. This suggests that  
172 societal variation in choices is stable across different versions of the DG, and also that our experiment  
173 elicits a form of prosocial behavior that has been linked to cultural adaptations related to religious  
174 beliefs, market norms, and norms for living in large communities <sup>3-5,29</sup>. This also implies that the BOTH  
175 OK prime does not alter individuals' preferences in the DG.

176

177 The probability that adults judge the GENEROUS norm prime to be “more correct” also varied across  
178 societies (Model 2; Fig.2b; Supplementary Table 3). To determine whether societal differences in  
179 judgments about ‘correct’ norms predicted subjects’ DG choices, we constructed a two-stage model.  
180 The first stage of Model 3 was equivalent to Model 2, and estimated the probability that adults in each  
181 society would judge GENEROUS to be more correct. The second stage predicted adults’ 1/1 choices in  
182 the DG using: (1) the first-stage estimates of the probability that GENEROUS would be judged to be  
183 more correct in an adult subject’s society, and (2) adults’ own judgments as to whether GENEROUS was  
184 more correct. Both of these parameters predicted adults’ DG choices. Subjects’ were more likely to  
185 choose 1/1 if they themselves later judged the GENEROUS norm prime to be more correct (Fig.2c;  
186 Coef=1.61, StDev=0.33, 95%CIs=0.96,2.27; Supplementary Table 4). Subjects were also more likely to  
187 choose the 1/1 option if they lived in a society where people were generally more likely to judge the  
188 GENEROUS norm prime to be more correct (Fig.2c; Coef=0.46, StDev=0.22, 95%CIs=0.08,0.93;  
189 Supplementary Table 4).

190

191 **Prediction 2.** We explored whether children’s DG choices changed with age in the BOTH OK condition  
192 (the same condition presented to adults) by again comparing models using WAIC and AIC weight (Table  
193 3). Model 4a included society dummy parameters only (the same structure as Model 1b), representing  
194 the hypothesis that DG choices vary across societies but do not change with age. Model 4b represents  
195 the hypothesis that children’s choices changed with age, by including interactions between society  
196 dummies and Child Age. Model 4c included an Age<sup>2</sup> parameter to explore whether a u-shaped effect of  
197 age would improve model fit, and Model 4d included interactions between society dummies and subject  
198 Gender. Model 4b provides a better fit to the data than the other models, reflected in a higher AIC  
199 weight (Table 3). There is a large standard error for the difference in WAIC for Model 4a, so we report  
200 the results for both Model 4a and 4b in Supplementary Table 5. These analyses suggest that children’s  
201 1/1 choices changed with age, which is illustrated by plotting Model 4b (Fig.3a). Plotting the estimates of  
202 Models 4c and 4d suggests they produce qualitatively similar results (see Supplementary Figures 13-14).

203

204 We explored whether children’s DG choices became increasingly like those of adults with age, using a  
205 two-stage model (Model 5). The first stage was similar to Model 1b, and estimated the probability that  
206 adults in each society would choose the 1/1 outcome. The second stage predicts each child’s DG choice  
207 using the first stage estimates of the probability that adults from their society would chose 1/1, and



208 included an interaction between the first stage estimates and child age. The interaction was reliable,  
209 indicating that with increasing age children's DG choices were increasingly predicted by the DG choices  
210 of adults (Coef=0.55, StDev=0.27, 95%CI=0.09,1.16; Supplementary Table 6). Plotting this relationship  
211 shows that the model predicts children's choices become positively related to adults' choices after  
212 about age 8, with this estimate becoming reliably different from zero after about age 10 (Fig.3b).

213  
214 **Predictions 3 and 4.** We explored whether children's DG choices were influenced by norm primes by  
215 comparing models of children's choices in all three conditions (BOTH OK, GENEROUS, SELFISH) in the six  
216 societies for which these data were available (excluding Tanna and Hadza), once more comparing  
217 models using WAIC and AIC weight (Table 4). Model 6b represents the hypothesis that children  
218 responded to norm primes, by including dummy parameters for the GENEROUS and SELFISH conditions.  
219 Model 6a represents the hypothesis that children did not respond to norm primes, by excluding these  
220 parameters (the same model structure as Model 4b). Model 6c represents the hypothesis that children's  
221 responsiveness to norm primes changes with age, by including interactions between Child Age and  
222 dummies for GENEROUS and SELFISH. Model 6d represents the hypothesis that the development of a  
223 responsiveness to norm primes varies across societies, by including three-way interactions with society  
224 dummies, Child Age, and dummies for GENEROUS and SELFISH.

225  
226 Model 6c provides a substantially better fit to the data than Model 6a or Model 6d (Table 4). This  
227 suggests that children were responsive to norm primes and that this responsiveness developed similarly  
228 across societies. Model 6c had a slightly larger AIC weight than Model 6b (Table 4), indicating that both  
229 models fit the data well, but the inclusion of parameters for Child Age improved model fit to some  
230 extent. In both Models 6b and 6c there are reliable effects for the GENEROUS dummy (Model 6b:  
231 Coef=1.47, StDev=0.20, 95%CI=1.07,1.86; Model 6c: Coef=1.47, StDev=0.20, 95%CI=1.07,1.86; note:  
232 nearly identical estimates; Supplementary Table 7) and also for the SELFISH dummy (Model 6b: Coef= -  
233 1.00, StDev=0.24, 95%CI= -1.48,-0.52; Model 6c: Coef= -1.03, StDev=0.25, 95%CI= -1.52,-0.54;  
234 Supplementary Table 7). This means that children were substantially more likely to choose 1/1 when  
235 they received the GENEROUS norm prime (relative to BOTH OK), and substantially less likely to choose  
236 1/1 when they received the SELFISH norm prime.

237  
238 Model 6c also provides evidence of an interaction between Child Age and GENEROUS that is borderline  
239 reliable, as the lower CI is zero (Coef=0.40, StDev=0.21, 95%CI=0.00,0.81; Supplementary Table 7),

240 while the interaction between Child Age and SELFISH is clearly not reliable (Coef=0.29, StDev=0.25,  
241 95%CI= -0.19,0.78; Supplementary Table 7). This suggests a modest developmental increase in  
242 children's responsiveness to the GENEROUS norm prime but not to the SELFISH norm prime. Plotting  
243 these model estimates (Fig.4a) indicates that children are somewhat more likely to choose 1/1 in  
244 GENEROUS than in BOTH OK across the entire age range, but this responsiveness to GENEROUS is only  
245 reliable after about age 6-7, and increases through middle childhood. Plotted estimates also suggest  
246 that children are somewhat less likely to choose 1/1 in SELFISH across the entire age range, but this  
247 responsiveness to SELFISH is less pronounced, less consistently reliable, and shows little sign of change  
248 with age.

249  
250 The model comparison analysis in Table 4 implies that the development of children's responsiveness to  
251 norm primes did not vary substantially across societies. To confirm this, we plotted the results of Model  
252 6d separately for each of the six societies (Fig.4b-4g). All of the societies reveal a responsiveness to the  
253 norm primes. For four of the societies (La Plata, Shuar, Pune, and Wichí) the results are qualitatively  
254 consistent with the overall developmental pattern in Figure 4a: responsiveness to norm primes becomes  
255 reliable sometime around age 6-7 and thereafter increases, particularly for the GENEROUS norm prime.  
256 The developmental pattern for responsiveness to the SELFISH norm prime seems to be more  
257 inconsistent, plausibly due to a floor effect in some societies in which children are unlikely to choose 1/1  
258 in the BOTH OK condition. For the two other societies (Berlin and Phoenix), reliable differences between  
259 each of the conditions appear to emerge by age 4 or earlier, and children's responsiveness to the norm  
260 primes appears to change somewhat less with age (with the exception of reduced responsiveness to the  
261 SELFISH norm prime in older children in Phoenix).

262  
263 **Prediction 5.** We explored the relationship between children's DG choices and adults' DG choices (as for  
264 Prediction 2) in the six societies in which we investigated responsiveness to norm primes. This afforded  
265 the closest comparison between the development of adult-like DG choices and the development of a  
266 responsiveness to norm primes. Model 7 used the same two-stage structure as Model 5, and produced  
267 the same result: convergence between children's and adults' 1/1 choices increased with age (Coef=0.85,  
268 StDev=0.42, 95%CI=0.15,1.81; Supplementary Table 8). Using the same approach and model structure,  
269 Model 8 explored the relationship between children's DG choices and adults' judgments. This model  
270 shows that with age children's 1/1 choices were increasingly predicted by the estimated probability that  
271 adults from their society would judge GENEROUS to be more correct (Coef=0.61, StDev=0.24,

272 95%CI=0.20,1.16; Supplementary Table 9). Plotting both of these results shows that from about age 8  
273 children's choices are positively related to both adults' DG choices and adults' judgments, and this  
274 relationship was reliable from about age 9-10 (Fig.3c-3d). These analyses reveal that adults' DG choices  
275 and judgments both predict children's choices, but not whether these are independent effects (when  
276 both parameters are included in a single model, neither effect is reliable; Supplementary Table 10).

## 277 **Discussion**

278 This study presents three main findings: (1) cross-cultural variation in adults' prosocial behavior is  
279 related to what members of their society judge to be the 'correct' prosocial norm (Prediction 1); (2) in  
280 middle childhood and early adolescence children's prosocial behavior becomes increasingly similar to  
281 adults' prosocial behavior (Prediction 2), and also increasingly similar to adults' judgments about the  
282 'correct' prosocial norm; (3) by middle childhood children in very different societies develop a uniform  
283 tendency to respond to novel social norms about prosocial behavior, and this coincides with the  
284 development of adult-like societal variation in that behavior (Predictions 3, 4 and 5). Together, these  
285 findings link societal variation in prosociality to the development of a universal psychology for  
286 responding to social norms.

287  
288 Adults' DG choices were predicted by the probability that members of their society would judge the  
289 generous norm prime to be more correct. This effect was independent of the influence of individuals'  
290 personal norms, indicating that individuals' prosocial choices were related to local social norms (i.e.  
291 society-level beliefs about what is correct). We note that this need not have been the case: individuals'  
292 personal norms could have been the only factor predicting decisions, and other differences across  
293 communities (e.g. relatedness, community size, migration rates) could have created enough societal  
294 variation in prosocial choices to swamp the influence of societal-level norms.

295  
296 During middle childhood children's prosocial choices became increasingly predicted by the prosocial  
297 choices of adults from their own societies, with this relationship emerging by about age 8-10 at the  
298 latest. This is consistent with findings from prior studies showing that societal variation in prosociality  
299 and fairness emerges during middle childhood and early adolescence<sup>15,21,22</sup>. We extend this work to  
300 show that during middle childhood (by age 8-10) children's choices become increasingly predicted by  
301 the probability that adults from their society would judge generous norm primes to be more correct.  
302 This is consistent with our finding that adults' own prosocial choices were predicted by local beliefs

303 about what is 'correct', and it reinforces the idea that during this developmental period children's  
304 prosocial choices are becoming both more adult-like and more attuned to local prosocial norms. Future  
305 studies should explore whether these are independent developmental phenomena, and whether  
306 children's prosocial behavior is better predicted by adults' prosocial behavior or judgments about local  
307 norms.

308  
309 Although children's prosocial choices generally became more adult-like with age, there were exceptions  
310 to this pattern. For example, in Pune and Tanna older children were less likely to choose 1/1 than were  
311 adults. In both of these sites, adults chose 1/1 with a probability close to 0.5, and they also judged the  
312 GENEROUS norm prime to be 'more correct' with a probability close to 0.5. This suggests that adults in  
313 these communities held a variety of beliefs about correct norms for behavior in the DG, and this  
314 heterogeneity could complicate children's attempts to navigate towards adult-like patterns of behavior.  
315 This interpretation is supported by the pattern of variation in the Phoenix sample. In Phoenix, adults  
316 chose 1/1 with a probability close to 0.5, but they were much more likely to judge the GENEROUS norm  
317 prime to be 'more correct'. This suggests that there was a greater consensus in beliefs about prosocial  
318 norms in the DG in Phoenix than in Pune and Tanna, and it may explain why children in Phoenix seemed  
319 to follow the overall trend towards adult-like behavior. The lack of clearly adult-like choices for children  
320 in Berlin may be an artifact of the composition of the sample. In Berlin, the oldest children in our BOTH  
321 OK sample are only about age 10, the age at which reliably adult-like choices begin to emerge.

322  
323 In prior studies with the DG, we found that children were more generous in early childhood than in  
324 middle childhood<sup>15,27</sup>, a u-shaped pattern that we did not replicate here. This may be due to different  
325 experimental procedures. Previously, subjects were face-to-face with their partners, while in the present  
326 study subjects were alone and anonymous. By about age 5, children are more likely to be selfish when  
327 they are unobserved<sup>30,31</sup>, but it is unlikely that children younger than age 5 use anonymity strategically  
328 as they are not very good at managing their reputation<sup>32</sup>. It is more plausible that the lack of face-to-  
329 face contact with a partner in our study reduced social factors, such as empathy<sup>33</sup> and a desire to  
330 interact with others<sup>34</sup>, factors that are more likely to motivate prosociality at this age. Future work  
331 should directly compare the influence of these factors (as well as motivations such as strategic  
332 reciprocity<sup>23,35-37</sup>, kin biases<sup>38</sup>, and group biases<sup>39</sup>) with the influence of norms on costly prosocial  
333 behavior in early and middle childhood.

334

335 Our experiments show that novel social norms influenced children's prosocial choices. Children's  
336 responsiveness to novel norms developed similarly across societies, generally increasing with age and  
337 becoming a reliable effect by about age 6-8. This suggests that children's sensitivity to novel norms is  
338 growing at the same age at which their choices are also becoming more adult-like and more consistent  
339 with adults' judgments about correct behavior. Evidence for a developmental increase in children's  
340 responsiveness to generous norm primes was modest, but this nonetheless provides evidence for  
341 developmental changes in children's willingness to pay a cost to conform to a norm.

342  
343 Developmental changes may have been obscured by children's responsiveness to norms emerging  
344 somewhat earlier in some societies than in others. For four societies (La Plata, Shuar, Pune, Wichí),  
345 responsiveness to generous norm primes became reliable by about age 6-8, and seemed to increase  
346 through middle childhood. However, for two societies (Berlin and Phoenix) reliable responsiveness  
347 emerged by age 4. This implies broad cross-cultural similarity in development, but also some variation in  
348 timing. This is consistent with prior work showing that the foundations of moral evaluation<sup>40</sup>, prosocial  
349 behavior<sup>41</sup>, and normative behavior are present early in childhood<sup>16-20</sup>. It also supports the proposal  
350 that adult-like prosocial behavior emerges due to increases in children's responsiveness to normative  
351 information, rather than fundamental changes in their ability to conform to norms (given that in at least  
352 some societies this is present earlier).

353  
354 Our studies suggest that the emergence of adult-like prosocial behavior is linked to the development of  
355 children's responsiveness to normative information. Future research should explore in detail how  
356 children's willingness to respond to norms changes during middle childhood, and how the development  
357 of this willingness predicts children's tendency to behave like adults. In Phoenix and Berlin, children  
358 younger than age 6-8 were willing to pay a cost to conform to norms, but they did not make very adult-  
359 like choices in the BOTH OK condition. In these societies, children's responsiveness to norms in early  
360 childhood may be based less on a general interest in behaving normatively, and more on a tendency to  
361 interpret normative information as 'what adults want them to do'. If adults in these societies tend to  
362 strongly encourage and enforce normative behavior at young ages, children may have learned to simply  
363 do whatever adults say the right thing to do is. This highlights that the critical developmental change in  
364 middle childhood is likely an increasing willingness to pay a cost to behave normatively, and it will be  
365 crucial for future studies to ask how this is shaped by other aspects of psychological development, such

366 as increases in perspective taking or mental state reasoning, emotional development and cognitive  
367 inhibition <sup>42</sup>.

368  
369 Equally important will be understanding the role of social environment, which has a crucial influence on  
370 prosocial behavior in infancy <sup>43</sup>, and may also affect prosocial behavior later in childhood. For example,  
371 children's choices in costly sharing tasks become markedly more egalitarian if they have been exposed  
372 to civil warfare between the ages of 7 and 12, but not if the exposure occurred earlier in development  
373 (age 3-6) <sup>44</sup>, and these effects seem to persist across the lifespan. Although the results of the present  
374 study are most informative about the development of children's responsiveness to normative  
375 information in personally-costly cooperative dilemmas, it will also be important to explore how  
376 children's responsiveness develops differently across domains or contexts.

377  
378 Future work should also explore other strategies for modeling the nature of social norms within  
379 communities. Our strategy was based on the estimated probability with which individuals in a society  
380 judged generous norms to be 'most correct', an approach similar to what has been used in prior studies.  
381 In a study of costly punishment in 15 societies, individuals' decisions about whether to punish  
382 selfishness in third-parties were predicted by the mean amount that members of their society gave in a  
383 DG <sup>4</sup>. Similarly, in a study of cooperation across camps of Hadza foragers, individuals' contributions in a  
384 public goods game were predicted by the mean contribution of members of their camp in the same  
385 game <sup>14</sup>. This suggests that modeling norms using the frequency of a behavior (or the probability of  
386 particular normative judgments) is an effective strategy, but other approaches may be even better, for  
387 example a more conformist approach <sup>6,45</sup>. Future experiments should also explore the content of norms  
388 in other ways, for example by eliciting judgments from subjects about what others in their society do or  
389 expect them to do, or judgments about how similar the game is to real-world situations.

390  
391 Our findings show that societal variation in prosocial behavior is linked to beliefs about 'correct' social  
392 norms. They also demonstrate that prosocial behavior becomes increasingly adult-like and normative  
393 during middle childhood, and that during this same period children across societies develop a tendency  
394 to respond (at a personal cost) to social norms about prosocial behavior. In so doing, this project  
395 illustrates how the development of a universal norm psychology can lead to the emergence of societal  
396 variation in prosociality, and it adds to the growing evidence that humans' unique forms of cooperation  
397 are highly dependent on acquired cultural norms and institutions.

## 399 **Methods**

400 All research and consent procedures were approved by the appropriate university ethical review boards  
401 at: Arizona State University (IRB ID: STUDY00001591), Cambridge Psychology Research Ethics Committee  
402 (PRE.2016.026), Simon Fraser University Office of Research Ethics (Study Number: 2013s0335; Study  
403 Title: Prosocial Development in Vanuatu and Canada). All appropriate national and community bodies  
404 also gave consent for the research, at all of our fieldsites. The authors affirm that human research  
405 participants provided written informed consent, for publication of the images in Figure 1. Images of  
406 participants were taken by experimenters from video recordings of experimental trials. The authors also  
407 affirm that human research participants provided written informed consent for video recordings.

408

409 **Participants:** See Table 1 and Supplementary Table 1.

410

411 **Dictator Game:** Children participated in a binary choice Dictator Game (DG), in which the experimental  
412 Subject decided between two pre-determined payoff distributions, referred to below as “ratios”. Test  
413 ratio #1: 1 for Subject, 1 for Recipient (i.e., 1/1). Test ratio #2: 2 for Subject, 0 for Recipient (i.e., 2/0).

414

415 **Apparatus and procedure:** Where between-subjects conditions were used, subjects were randomly  
416 assigned to conditions. Data was collected by fieldworkers familiar with the research design and  
417 hypotheses, and so was not blind. The apparatus consisted of two laminated paper trays, each with a  
418 red and a blue circle on them, which were placed in front of the Subject (Supplementary Information,  
419 pg.23). Each tray corresponded to one of the two DG test ratios, with tokens placed in the red circle  
420 going to the Subject, and tokens placed in the blue circle going to the Recipient. The Recipient wasn’t  
421 present during the study, but was represented by a small wooden person-shaped figurine. Recipients  
422 and Subjects were anonymous. The experimenter placed tokens on the trays, and the Subject then  
423 selected one of the trays. Recipients were real, and rewards were delivered to them at a later time. For  
424 every choice during the study, different colored meeples was used to indicate that the choices impacted  
425 a different Recipient. See SI Movie S5 for an example of the full study procedure. The procedure was  
426 modified for the Hadza due to the practical need to shorten the study for subjects, details of the full  
427 procedure and the modified Hadza procedure are available in the Supplementary Information (pg.25,  
428 28). All scripts were translated and then back-translated.

429

430 **Comprehension checks:** At the start of the study, subjects demonstrated that they understood that a  
431 larger quantity of tokens would produce the most rewards, and all participants answered questions to  
432 indicate that when watching the videos they attended to the location of tokens, and remembered the  
433 content of the norm primes (for example, the experimenter pointed to 1/1 and asked “is this right or  
434 wrong?”, then pointed to 2/0 and asked “is this right or wrong?”) (Supplementary Information pg.24-  
435 25). No participants who passed these comprehension questions were excluded from the sample.

436

437 **Rewards:** Within the study, rewards were represented as tokens (e.g. glass beads, stones, etc.). Subjects  
438 were informed that “the more tokens they received, the more rewards they would receive”, but the  
439 precise nature of the rewards or the exchange rate was not communicated to child participants. The  
440 exception to this was for the Hadza, where the use of tokens was not understood by participants, and  
441 small candies were used directly within the study in place of tokens (see the descriptions of the modified  
442 Hadza procedure, below). For children, rewards were sourced locally, and usually consisted of candy or  
443 small food items, or small items like stickers, glow in the dark bracelets, or pens/pencils. Adult  
444 participants were in most cases told what the nature of the rewards would be (e.g., money), and the  
445 general amount usually obtained by participants, but they also understood that the exact amount would  
446 be determined by their choices in the study. At one site (Pune), adults were not told what the reward  
447 would be, they were simply told that they would be obtaining “prizes”. After the study, tokens were  
448 exchanged for rewards. This either occurred immediately for each participant, or it occurred later after  
449 all subjects had participated, with the rewards being distributed to all participants at the same time.

450

451 **Statistical modeling approach:** All data were binary choices taking the form of “0” (choice of 2/0) or “1”  
452 (choice of 1/1), so we model subjects’ choices using regression with a binomial link function. For  
453 multilevel models, the posterior distribution of the model can be most easily estimated using Markov  
454 Chain Monte Carlo. When using Markov chain Monte Carlo, we generate model predictions by  
455 processing many samples from the posterior distribution of the model. Each sample of parameter values  
456 from the posterior can be plugged into the model, producing a predicted value for any observable  
457 variable. Since the distribution of the samples approximates the posterior distribution of the  
458 parameters, the distribution of predictions generated from a large number of samples will approximate  
459 the target predictive distribution. Examples of this approach can be found throughout <sup>46</sup>.

460



461 Data was analyzed in the R Environment for Statistical Computing<sup>47</sup>, with most models specified using  
462 the function ‘MAP’ (R package ‘rethinking’)<sup>46</sup>, a convenience tool for fitting a large number of different  
463 regression models. Multilevel models were specified and run using a variant of Hamiltonian Monte Carlo  
464 (an algorithm particularly good with high dimension models) implemented in RStan<sup>48</sup>. Models were  
465 specified using weakly informative priors, which reduce overfitting and also help the Markov chain to  
466 converge to the posterior distribution more effectively than flat priors. The posterior distribution we  
467 present here is based on 5000 samples from three chains (after 1000 adaptation steps), for a total of  
468 12000 samples. These samples were sufficient to establish convergence to the target posterior  
469 distribution. We assessed convergence through the R-hat Gelman and Rubin statistic (R-hat values  
470 greater than 1.01 can indicate that the chain did not converge), and the effective number of samples for  
471 all parameters were substantial (effective numbers of samples much smaller than the actual number of  
472 samples can suggest that the chain was not efficient). Readers unfamiliar with diagnosing chain  
473 convergence can find an introduction in Chapter 8 of<sup>46</sup>.

474

## 475 **Data Availability**

476 The authors declare that all data supporting the findings of this study are available within the  
477 Supplementary Information files: “Supplementary\_Information\_R\_code\_and\_data.zip”

478

## 479 **Code Availability**

480 The authors declare that all code supporting the findings of this study are available within the  
481 Supplementary Information files: “Supplementary\_Information\_R\_code\_and\_data.zip”

482

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574

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583

## 584 **Author Contributions**

585 B.R.H. and J.B.S. conceived the project and designed the study. P.K., H.C.B., T.B., A.E., S.L.L., C.S.E., and  
586 A.M.S. also contributed to study design. B.R.H., P.K., H.C.B., T.B., S.C., A.E., S.L-L., C.S-E., A.M.S., S.Y. and  
587 A.N.C. collected data. B.R.H. analyzed the data, B.R.H. and J.B.S. wrote the manuscript, P.K. and H.C.B.  
588 also contributed significantly to writing. All authors contributed to writing the Supplementary  
589 Information.

590

## 591 **Figure Legends**

592

593 **Figure 1: Arrangement of the apparatus and testing area.** From left: Pune, India; Phoenix, USA; La Plata,  
594 Argentina.

595 **Figure 2: Results of Models 1b, 2, and 3. 2a:** Results of Model 1b, estimating the probability that adults  
596 chose 1/1 in the eight societies. Horizontal lines and shaded regions represent regression estimates and  
597 95% CIs (functions 'MAP' and 'link'; R package 'rethinking'). Circles and vertical lines represent  
598 proportions and 95% CIs of the raw data (function 'binom.confint', R package 'binom'; for exact  
599 proportions see Supplementary Table 2). Triangles represent mean DG offers in a prior study by Henrich  
600 and colleagues<sup>4</sup>. **2b:** Results of Model 2, estimating the probability that adults judged the GENEROUS  
601 norm prime to be "most correct". Horizontal lines and shaded regions represent regression estimates  
602 and 95% CIs (functions 'MAP' and 'link'; R package 'rethinking'; for exact proportions see Supplementary  
603 Table 2). Circles and vertical lines represent proportions and 95% CIs of the raw data (function  
604 'binom.confint', R package 'binom'). **2c:** Results of Model 3, estimating how adults' 1/1 choices are  
605 predicted by whether they judged GENEROUS to be "most correct", and by the estimated probability  
606 that someone in their society would judge GENEROUS to be "most correct". The black line reflects the  
607 weak prior distribution, red the posterior distribution for the Estimated Prob. of Society Judgment  
608 parameter (Supplementary Table 4), blue the posterior distribution for the Subject's Own Judgment  
609 parameter (Supplementary Table 4).

610 **Figure 3: Results of Models 4b, 5, 7 and 8. 3a:** Results of Model 4b. Lines represent regression estimates  
611 of the probability that children will choose 1/1 in each of the eight societies, as a function of subject age  
612 (functions 'MAP' and 'link'; R package 'rethinking'). Circles and vertical bars represent proportions and  
613 95% CIs of adults' choices of 1/1 (function 'binom.confint', R package 'binom'). For model coefficients,  
614 see Supplementary Table 5. **3b:** Results of Model 5. The solid line plots the magnitude (and 95% CI) of

615 the estimated relationship between children's 1/1 choices and the 1/1 choices of adults, as a function of  
616 child age (model constructed in Rstan, link: Bernoulli\_logit). This captures the emerging positive  
617 relationship between older children's DG choices and the DG choices of adults' from their society. The  
618 negative values of the effect size for the youngest children is due to young children in Berlin and La Plata  
619 being the least likely to choose 1/1 despite adults from those societies being the most likely to choose  
620 1/1. For model coefficients, see Supplementary Table 6. **3c**: Results of Model 7. The solid line plots the  
621 magnitude (and 95% CI) of the estimated relationship between children's 1/1 choices and the 1/1  
622 choices of adults, as a function of child age (model constructed in Rstan, link: Bernoulli\_logit). This  
623 captures the emerging positive relationship between older children's DG choices and the DG choices of  
624 adults from their society. **3d**: Results of Model 8. The solid line plots the magnitude (and 95% CI) of the  
625 estimated relationship between children's 1/1 choices and adults' judgments as to whether or not the  
626 GENEROUS norm prime is 'most correct', as a function of child age (model constructed in Rstan, link:  
627 Bernoulli\_logit). This captures the emerging positive relationship between older children's DG choices  
628 and judgments about norms by adults from their society.

629 **Figure 4: Results of Models 6c and 6d. 4a**: Lines and shaded regions represent regression estimates and  
630 95% CIs for the probability that children will choose 1/1 in the GENEROUS, BOTH OK, and SELFISH norm  
631 prime conditions, combining samples from the six different societies (functions 'MAP' and 'link'; R  
632 package 'rethinking'). **4b-4g**. Lines and shaded regions represent regression estimates and 95% CIs for  
633 the probability that children will choose 1/1 in the GENEROUS, BOTH OK, and SELFISH norm prime  
634 conditions, for each of the six different societies (functions 'MAP' and 'link'; R package 'rethinking').

635 **Tables**

636

637 **Table 1: Populations sampled.** For more details see Supplementary Table 1.

<b>Population [Location]; Description</b>	<b>N Adult (female )</b>	<b>N Child (female )</b>	<b>Child age range (in years)</b>	<b>Children received which norm priming conditions?</b>
German [Berlin, DEU]; Urban	32 (17)	111 (56)	4.07 - 13.36	BOTH OK, GENEROUS, SELFISH
Argentinian [La Plata, ARG]; Urban	29 (13)	133 (65)	4.95 - 13.86	BOTH OK, GENEROUS, SELFISH
Wichí [Misión Chaqueña, ARG]; Rural, sedentized hunter- gatherers	30 (19)	87 (47)	6.47 - 13.61	BOTH OK, GENEROUS, SELFISH
American [Phoenix, USA]; Urban	37 (19)	176 (92)	4.02 - 12.63	BOTH OK, GENEROUS, SELFISH
Indian [Pune, IND]; Urban	30 (16)	155 (75)	4.11 - 13.92	BOTH OK, GENEROUS, SELFISH
Shuar [Amazonia, ECU]; Rural, small-scale horticulture, hunting	20 (8)	58 (27)	6.59 - 15.32	BOTH OK, GENEROUS, SELFISH
Tanna [Tafea province, VUT]; Rural, small-scale horticulture, hunting	52 (27)	81 (43)	5.74 - 13.53	BOTH OK only
Hadza [Great Rift Valley, TZA]; Rural, foraging, hunting	25 (12)	32 (10)	7.00 - 17.00	BOTH OK only

638



639 **Table 2: Model comparisons for Models 1a-1c.** Using WAIC and AIC weight.

Model #	Model Parameters	WAIC (SE)	dWAIC (dSE)	AIC weight
1a	Intercept only	355.00 (1.37)	26.00 (10.22)	0.00
<b>1b</b>	<b>Society D[8]</b>	<b>329.10</b> <b>(10.27)</b>	<b>0.00 (NA)</b>	<b>0.95</b>
1c	Society D[8], Age, Age X Society D[8], Gender, Gender X Society D[8]	334.80 (11.07)	5.70 (3.71)	0.05

“D” indicates a dummy parameter, “Society D[X]” indicates that multiple dummy parameters were used for X number of societies. The model with the lowest WAIC provides the best fit, dWAIC indicates the difference in WAIC between the focal model and the best-fit model, and dSE indicates the standard error for the difference in WAIC. Where AIC weight is substantially larger for the best-fit model, this implies that it provides a substantially better fit to the data. Where dWAIC is larger than dSE, this also implies that the best-fit model provides a substantially better fit to the data. All comparisons were conducted using the ‘compare’ function in the R package ‘rethinking’, with n=40000 samples from the posterior for computing WAIC. **Bold** indicates the models that provide the best fit to the data.

641 **Table 3: Model comparisons for Models 4a-4d.** Using WAIC and AIC weight.

Model #	Model Parameters	WAIC (SE)	dWAIC (dSE)	AIC weight
4a	Society D[8]	411.00 (16.46)	7.90 (7.97)	0.02
<b>4b</b>	<b>Society D[8], Age, Age X Society D[8]</b>	<b>403.10 (17.62)</b>	<b>0.00 (NA)</b>	<b>0.80</b>
4c	Society D[8], Age, Age X Society D[8], Age <sup>2</sup> , Age <sup>2</sup> X Society D[8]	407.40 (17.88)	4.40 (3.55)	0.09
4d	Society D[8], Age, Age X Society D[8], Gender, Gender X Society D[8]	407.20 (18.02)	4.20 (4.12)	0.10

“D” indicates a dummy parameter, “Society D[X]” indicates that multiple dummy parameters were used for X number of societies. All comparisons were conducted using the ‘compare’ function in the R package ‘rethinking’, with n=40000 samples from the posterior for computing WAIC. **Bold** indicates the models that provide the best fit to the data.

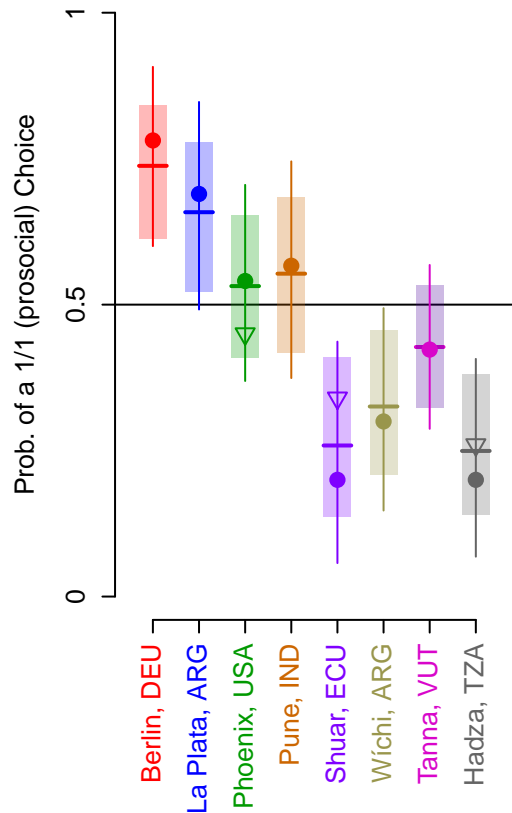
643 **Table 4: Model comparisons for Models 6a-6d; using WAIC and AIC weight.**

Model #	Model Parameters	WAIC (SE)	dWAIC (dSE)	AIC weight
6a	Society D[6], Age, Age X Society D[6]	883.20 (21.77)	136.60 (22.40)	0.00
<b>6b</b>	<b>Society D[6], Age, Age X Society D[6], GENEROUS D, SELFISH D</b>	<b>747.00 (27.90)</b>	<b>0.30 (4.05)</b>	<b>0.45</b>
<b>6c</b>	<b>Society D[6], Age, Age X Society D[6], GENEROUS D, SELFISH D, Age X GENEROUS, Age X SELFISH</b>	<b>746.60 (28.16)</b>	<b>0.00 (NA)</b>	<b>0.53</b>
6d	Society D[6], Age, Age X Society D[6], GENEROUS D, SELFISH D, Age X GENEROUS, Age X SELFISH, Age X GENEROUS X Society D[6], Age X SELFISH X Society D[6]	754.00 (28.69)	7.40 (6.91)	0.01

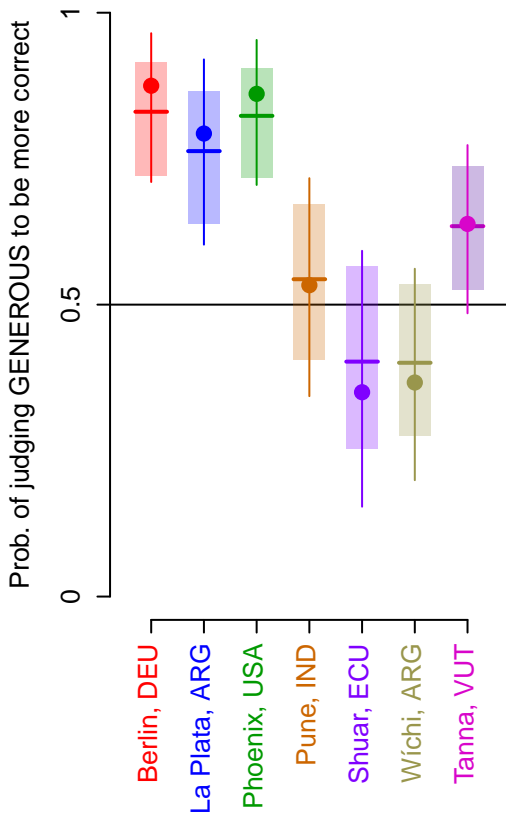
“D” indicates a dummy parameter, “Society D[X]” indicates that multiple dummy parameters were used for X number of societies. All comparisons were conducted using the ‘compare’ function in the R package ‘rethinking’, with n=40000 samples from the posterior for computing WAIC. **Bold** indicates the models that provide the best fit to the data.



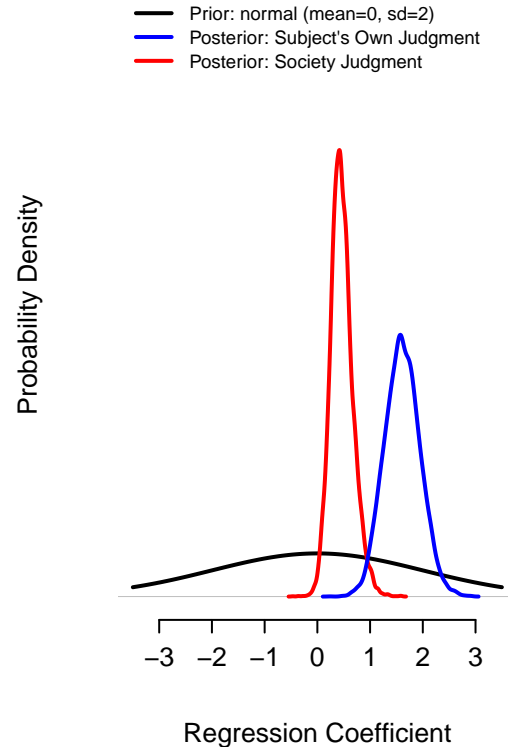
(2a) Model 1b Results:  
Adults' DG choices  
vary across societies



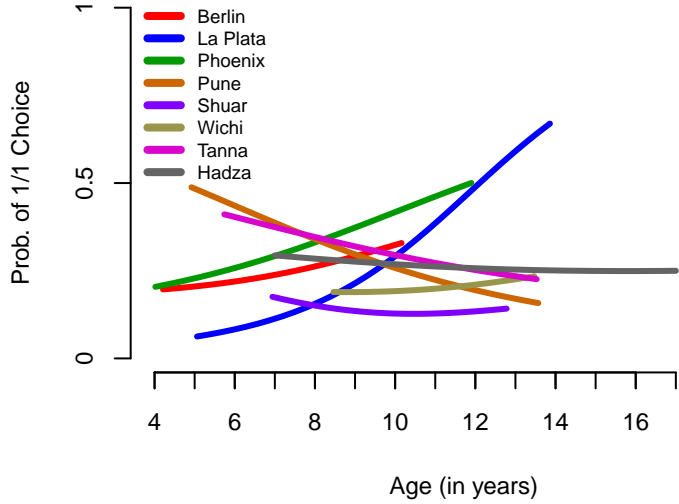
(2b) Model 2 Results:  
Adults' judgments about correct  
norms vary across societies



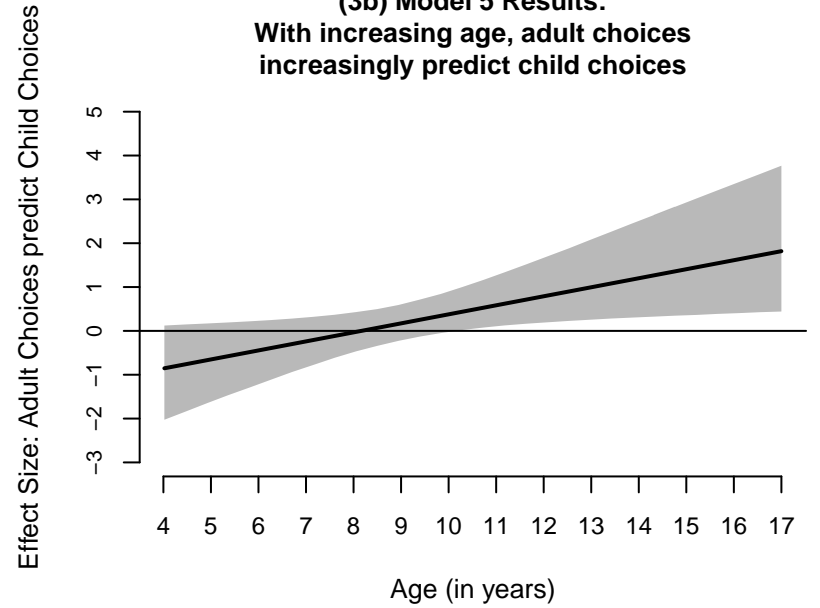
(2c) Model 3 results:  
Adults' DG choices predicted by  
judgements about correct norms



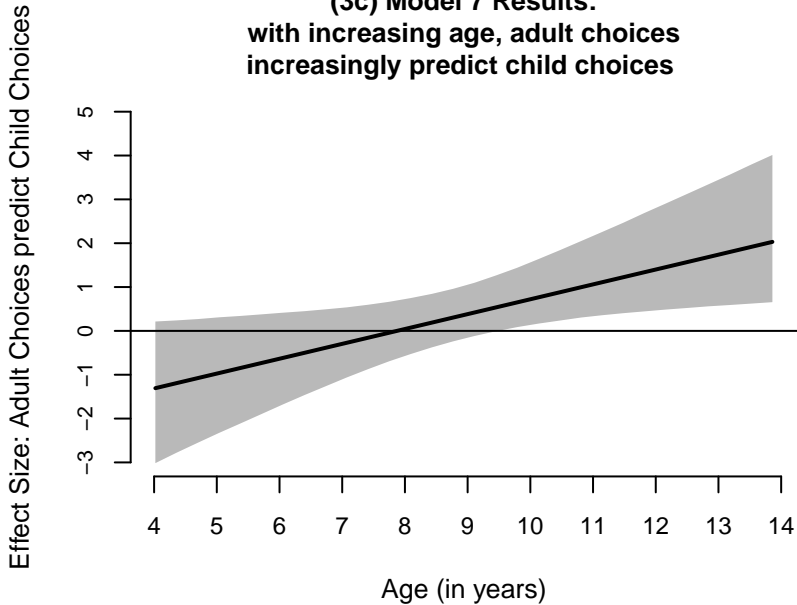
**(3a) Model 4b Results:**  
**Probability of children choosing the 1/1 option, in all 8 populations**



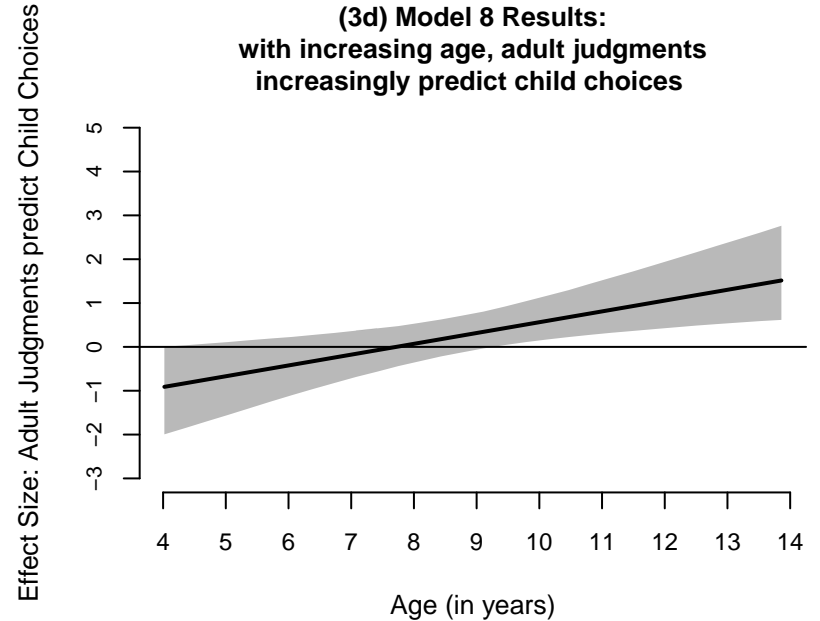
**(3b) Model 5 Results:**  
**With increasing age, adult choices increasingly predict child choices**



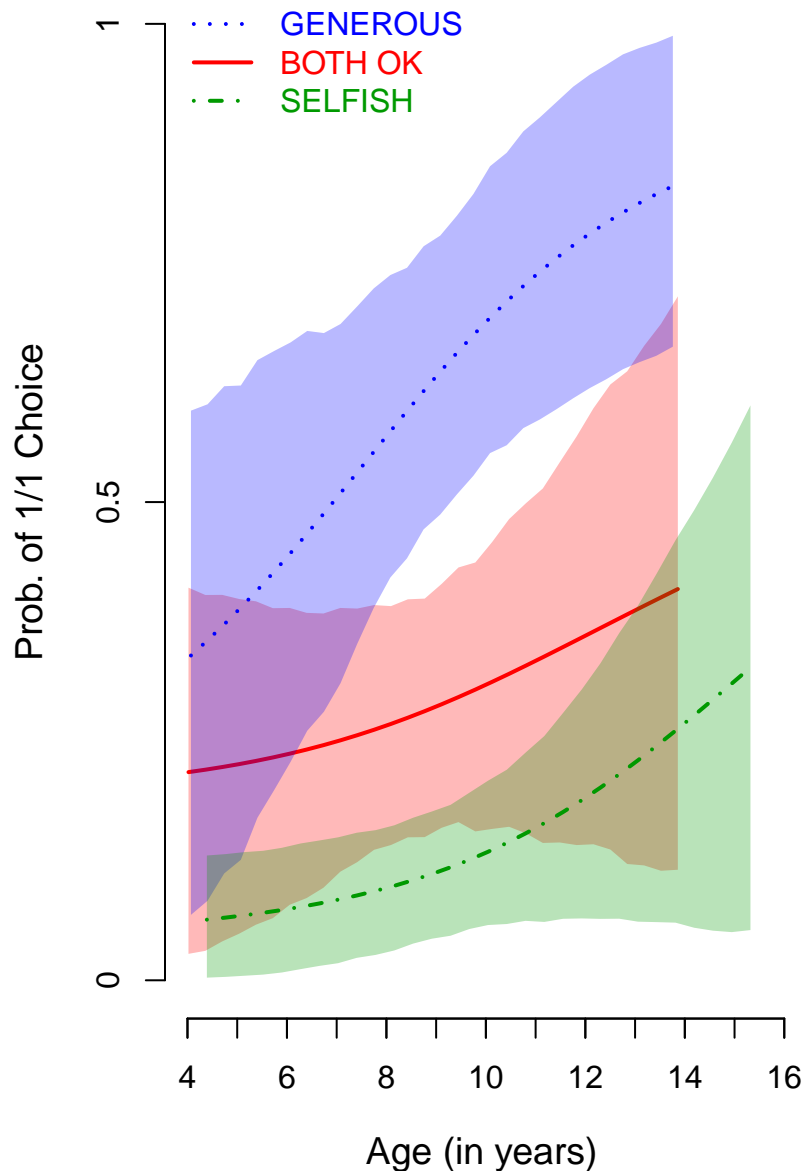
**(3c) Model 7 Results:**  
**with increasing age, adult choices increasingly predict child choices**



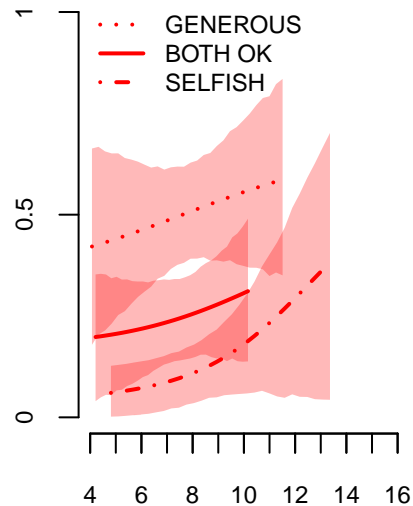
**(3d) Model 8 Results:**  
**with increasing age, adult judgments increasingly predict child choices**



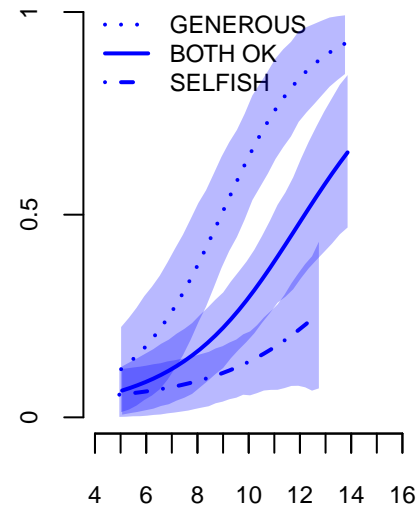
**(4a) All six societies, combined**



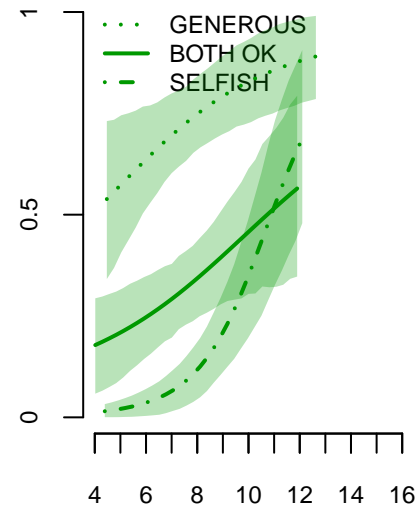
**(4b) Berlin**



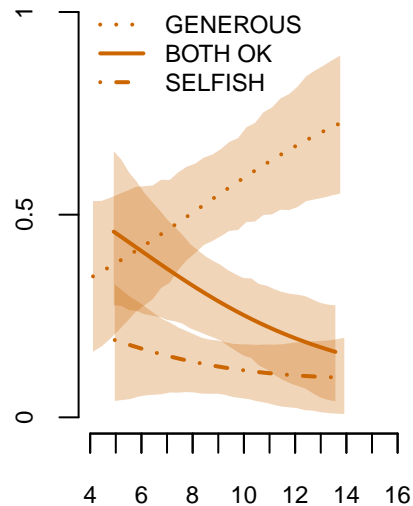
**(4c) La Plata**



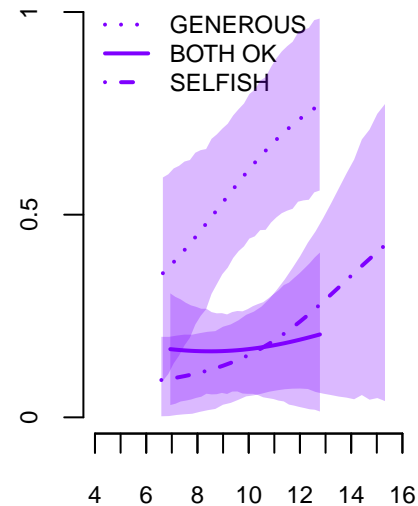
**(4d) Phoenix**



**(4e) Pune**



**(4f) Shuar**



**(4g) Wichí**

