Supporting Information

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SI Text

Manipulation Check Results. Here, we analyze the results from our manipulation check. The goal of our manipulation check was to confirm that our group membership induction successfully created in-group preferences. We wanted to ensure that subjects cared about which group they were in, and thus that our minimal groups had the potential to influence punishment behavior. Our results suggested that this was the case. In the manipulation check phase, subjects selected the in-group member on 54.5% of all trials, although there was heterogeneity across trial types (in-group member selected on 47.7% of behavior attribution trials, 61.5% of sticker allocation trials, and 56.8% of explicit preference trials). A one-sample t test found that overall proportion of 54.5% was significantly above the chance value of 0.5, $t(63) = 2.25$, $P = 0.028$. Thus, our induction successfully created a weak bias in favor of in-group members.

Furthermore, our induction created in-group bias uniformly across age and sex groups. To test for age and sex effects, we conducted a logistic regression predicting a subject's decision on a single trial (1 = in-group member, 0 = out-group member) as a function of age and sex. As in our primary analyses, we clustered SEs on subject to account for the nonindependence of decisions from the same subject. We found no significant effects of age ($\beta = -0.19$, $P = 0.235$, odds ratio = 0.83) or sex ($\beta = -0.19$, $P = 0.236$, odds ratio = 0.83). We also found no significant interaction between age and sex ($\beta = 0.43$, $P = 0.169$, odds ratio = 1.54). Thus, all age and sex groups showed a comparable in-group bias.

Discussion of Costly Punishment Method. Here, we discuss our costly punishment method in more detail. When designing our costly punishment method, our goal was to ensure that paying the cost to punish felt like a sacrifice, but that we would nonetheless observe some punishment. In previous research using the same paradigm, we made the cost of punishment one Skittle for every trial that subjects chose to reject.* We found that this cost was salient enough to deter rejection relative to a cost-free control condition, but that subjects in the costly condition nonetheless punished sometimes. Thus, in the present research we again made the cost one Skittle per trial. This design feature was highly salient to subjects: Every time they rejected, they moved a Skittle from the green box (to keep) to the red box (to be thrown out).

In the present research, we also decided to make the starting endowment 33 Skittles. We wanted to ensure that subjects would have a sufficiently large endowment available in later trials that they would continue to punish at least sometimes. Thus, we chose 33 Skittles so that individuals who rejected all 16 selfish trials would get to keep over half of their candy. However, this design feature was less salient to subjects: When the endowment was introduced, the Skittles were poured from a clear bag into an opaque container, where they remained occluded for the duration of the experiment. Subjects were never told how many Skittles they received or how many trials there would be. Thus, we do not think that the exact endowment size had much effect on our results.

Discussion of the Use of Repeated Trials. In our study, we presented subjects with four identical selfish trials per condition. With any study of children, we expect noise because of factors like confusion or lack of attention, and in our study we anecdotally observed that children explored the apparatus by pulling the handle in both directions on the first few trials. Thus, we used repeated trials to reduce the effects of noise and increase the reliability of our data, as is typical in resource allocation tasks with children (1–3) and nonhuman primates (4). In our selfish trials, we always used the maximally strong test of six skittles for the actor and zero for the recipient. Our goals were to ensure that the allocations were perceived as selfish, and that punishment of selfish allocations imposed a cost on the actor but not the recipient (who did not stand to gain anything from the maximally selfish allocation).

In addition to effects of noise, we also expected variation across identical trials because punishment was costly, perhaps explaining why subjects only punished on 36% of selfish trials [which is significantly less than chance, $t(63) = -3.72$, $P < 0.001$]. Thus, we expected subjects to have limited willingness to continue paying the cost to punish across repeated trials. As a result, using repeated trials allowed us to get more signal out of our binary dependent variable by analyzing the proportion of trials on which subjects were willing to pay this cost.

Across our four conditions, each subject received four sets of four identical (selfish) trials. Within each set, subjects could make the same decision (to accept or reject) two, three, or four times. For each subject, we calculated the mean number of times they made the same decision. We found that on average, subjects made the same decision 3.19 times of 4. This result is significantly more consistent than the chance value of 2.75 that we would expect from random responding, $t(63) = 5.06$, $P < 0.001$. However, subjects were significantly less than perfectly consistent, $t(63) = -9.40$, $P < 0.001$, likely reflecting factors such as noise and limited willingness to pay to punish.

Analyses of Incredulous Subjects. Here, we analyze responses to the two questions we asked to assess whether or not subjects believed that the absent actors and recipients were real children and would really collect their candy rewards. As we report in the main text, the majority of children (90.6%) indicated belief on at least one of the questions, and about half (53.1%) indicated belief on both. Here, we demonstrate that our key results held when excluding incredulous subjects from our analyses.

First, we repeated our analyses when excluding the 9.4% of subjects who did not indicate belief on either our two questions. We found that all of our results held and remained statistically significant. After excluding these subjects, subjects were still more likely to punish selfish than fair allocations ($\beta = 2.14$, $P < 0.001$, odds ratio = 8.51) (Table S1, column 3), and there was still a significant interaction between selfishness and age ($\beta = 1.91$, $P = 0.032$, odds ratio = 6.78) (Table S1, column 4), indicating that 8-y-olds were more sensitive to selfishness than 6-y-olds. Additionally, the effect of selfishness was still significant both within 6-y-olds ($\beta = 1.31$, $P = 0.003$, odds ratio = 3.72) (Table S2, column 3) and 8-y-olds ($\beta = 3.24$, $P < 0.001$, odds ratio = 25.49) (Table S2, column 4).

Additionally, subjects were still more likely to punish selfishness when the actor was an out-group member ($\beta = -0.28$, $P = 0.027$, odds ratio = 0.75) (Table S3, column 4), and there was still no significant interaction between age and actor group ($\beta = 0.02$, $P = 0.938$, odds ratio = 1.02) (Table S3, column 5). Furthermore, there was still no overall effect of recipient group on punishment of selfishness ($\beta = 0.12$, $P = 0.239$, odds ratio = 1.13) (Table S3,

*McAuliffe K, Jordan JJ, Warneken F, Biennial Meeting of the Society for Research in Child Development, April 18–20, 2013, Seattle, WA.

column 4), whereas there was still a significant interaction between age and recipient group ($\beta = -0.56$, $P = 0.008$, odds ratio = 0.57) (Table S3, column 6). Six-year-olds were still more likely to punish selfishness when the recipient was an in-group member ($\beta = 0.43$, $P = 0.025$, odds ratio = 1.54) (Table S4, column 3), whereas 8-y-olds were not ($\beta = -0.13$, $P = 0.154$, odds ratio = 0.88) (Table S4, column 4).

Next, we repeat our analyses when excluding the 46.9% of subjects who did not indicate belief on both our two questions. This exclusion substantially decreases our statistical power, and thus the statistical significance of our results. However, it does not substantially decrease our effect sizes. Table S5 reports the β-values for all significant effects reported in the main text, including all subjects (Table S5, column 1), subjects who indicated belief on at least one question (Table S5, column 2), and subjects who indicated belief on both questions (Table S5, column 3). These results demonstrate that our effects are not driven by incredulous subjects.

These analyses suggest that subjects who explicitly reported believing that the other children were real behaved similarly to subjects who did not report this belief. This result is consistent with experiments of both adults and children demonstrating that it is possible to implicitly activate the psychological processes involved in real social interactions, even when subjects suspect or understand that no actual interaction is taking place (5–8).

Analyses of Sex Interactions. In the main text, we collapsed across sex in all analyses, because sex did not interact significantly ($P < 0.05$) with any of our effects. Here, we report the analysis demonstrating that there were no sex interactions.

First, there were no sex interactions when comparing punishment of selfish and fair allocations. In a regression predicting punishment as a function of allocation type, sex, and their interaction, we found no significant interaction between allocation type and sex ($\beta = -0.06$, $P = 0.933$, odds ratio = 0.94) (Table S6, column 1). Additionally, when including terms for age and all two- and three-way interactions between allocation type, sex, and age, we found no significant three-way interaction between allocation type, sex, and age ($\beta = -0.08$, $P = 0.962$, odds ratio = 0.92) (Table S6, column 2). Thus, sex did not influence sensitivity to selfishness, regardless of age.

Second, there were no sex interactions when comparing punishment of selfish in-group and out-group actors. In a regression predicting punishment of selfishness as a function of actor group, sex, and their interaction, we found no significant interaction between actor group and sex ($\beta = 0.39$, $P = 0.071$, odds ratio = 1.48) (Table S7, column 1). Additionally, when including terms for age and all two- and three-way interactions between actor group, sex, and age, we found no significant three-way interaction between actor group, sex, and age ($\beta = -0.84$, $P = 0.065$, odds ratio = 0.43) (Table S7, column 2). Thus, sex did not influence sensitivity to actor group, regardless of age. We note that these sex interactions are marginally significant. However, because they are not significant at the $P < 0.05$ level and we had no theoretical predictions about sex effects, we did not pursue them further. In the main text, our model demonstrating that selfish out-group members are punished significantly more than selfish in-group members includes sex as a control variable; however, this effect remains significant ($P = 0.013$) when sex is removed from the model.

Finally, there were no sex interactions when comparing punishment of selfishness toward in-group and out-group recipients. In a regression predicting punishment of selfishness as a function of recipient group, sex, and their interaction, we found no significant interaction between recipient group and sex ($\beta = -0.08$, $P = 0.673$, odds ratio = 0.93) (Table S8, column 1). Additionally, when including terms for age and all two- and three-way interactions between recipient group, sex, and age, we found no significant three-way interaction between recipient group, sex, and age ($\beta = 0.45$, $P = 0.224$, odds ratio = 1.57) (Table S8, column 2). Thus, sex did not influence sensitivity to recipient group, regardless of age.

Analyses of Interactions Between Actor and Recipient Group Membership. In the main text, we separately investigated the effects of actor and recipient group membership because these variables did not interact significantly ($P < 0.05$) when predicting punishment of selfishness. Here, we report the analysis demonstrating that there were no actor-by-recipient interactions.

In a regression, predicting punishment of selfishness as a function of actor group, recipient group, and their interaction, we found no significant interaction between actor and recipient group ($\beta = -0.06$, $P = 0.726$, odds ratio = 0.94) (Table S9, column 1). Additionally, when including terms for age and all two- and three-way interactions between actor group, recipient group, and age, we found no significant three-way interaction between actor group, recipient group, and age ($\beta = -0.19$, $P = 0.601$, odds ratio = 0.83) (Table S9, column 2). Thus, there was no interaction between actor and recipient group, regardless of age.

Reliability Coding Protocol. Here, we report more information on our reliability coding protocol. All sessions were videotaped. For reliability purposes, decisions were coded both live and from video. Our primary dependent variable was (*i*) whether subjects accepted or rejected allocations in the third-party punishment game. We also analyzed: (*ii*) whether subjects selected in-group or out-group members in the manipulation check task; (*iii*) performance on comprehension questions; and (*iv*) whether subjects reported believing that the actors and recipients were real and would really take home their candy. Two independent coders coded each of these variables. A live coder coded variables *i*–*iii* during all experimental sessions. Two video coders watched all video sessions. The primary video coder coded variables *i*–*iv*, and the secondary video coder coded only variable *iv* (to supplement the live coder's coding). Then, for each variable, the two independent coders' judgments were compared. Equipment errors compromised videos from six sessions because of lack of audio (five sessions) or file-writing errors (one session). Disagreements between coders were resolved by rewatching the video. Disagreements were rare: 3% of trials for variable *i*; 1% of trials for variable *ii*; <1% of questions for variable *iii*; and 5% for both questions within variable *iv*.

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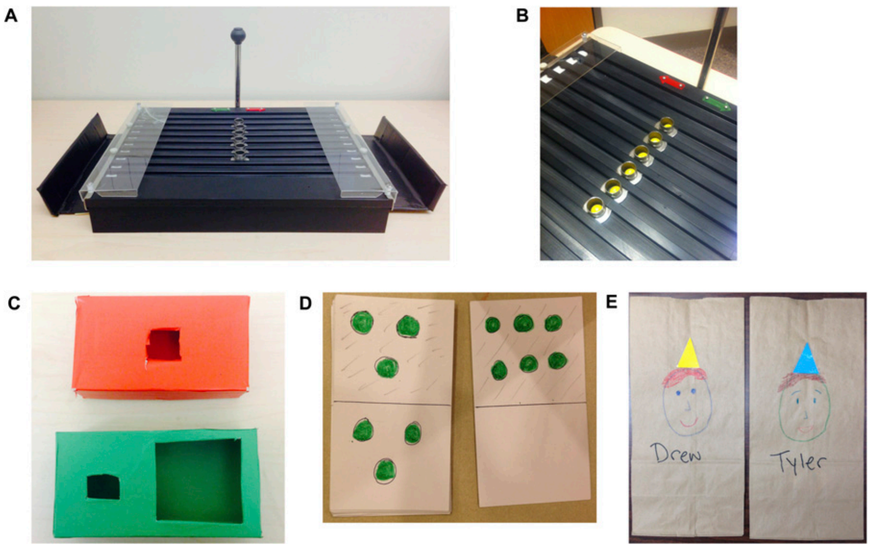

Fig. S1. Photographs of experimental stimuli. (*A*) The experimental apparatus. (*B*) The "Skittle pods" used to contain the candy rewards in the punishment game, and the metal handle that participants used to make decisions (green direction = accept/enact, red direction = reject/punish). (*C*) The boxes used to hold the subject's candy. To punish, subjects had to transfer a Skittle from the green box to the red box. Punishment was costly because subjects got to take home Skittles from the green box, but not the red box. (*D*) Cards used to depict the actor's proposed fair (*Left*) and selfish (*Right*) Skittle allocations. (*E*) Two of the bags used to represent the absent actors and recipients, and their group membership (blue or yellow).

Table S1. Punishment as a function of allocation type

	All subjects		Nonincredulous subjects	
Variable	(1)	(2)	(3)	(4)
Allocation type (1 = selfish, 0 = fair)	2.306*** (0.358)	1.441*** (0.423)	2.141*** (0.368)	1.317*** (0.440)
Age (1 = 8 y, 0 = 6 y)	0.568* (0.308)	−1.374* (0.806)	0.558* (0.319)	−1.252 (0.813)
Sex (1 = female, 0 = male)	0.245 (0.301)	0.246 (0.304)	0.377 (0.310)	0.380 (0.313)
Allocation type × Age		2.044** (0.890)		1.914** (0.892)
Constant	−3.295*** (0.429)	−2.486*** (0.357)	−3.342*** (0.464)	−2.577*** (0.400)
Observations	1,279	1,279	1,159	1,159
Subjects	64	64	58	58

This table shows the results from logistic regressions predicting punishment as a function of allocation type, both including all subjects and excluding incredulous subjects who did not express belief on either of our belief questions. Columns 1 and 3 show results from our original model, and columns 2 and 4 show results from a model that adds the interaction between allocation type and age. Robust SEs (clustered on subject) shown in parentheses. ***$P < 0.01$, **$P < 0.05$, *$P < 0.1$.

Table S2. Punishment as a function of allocation type by age group

	All subjects		Nonincredulous subjects	
Variable	(1)	(2)	(3)	(4)
Allocation type (1 = selfish, 0 = fair)	1.437*** (0.426)	3.500*** (0.795)	1.314*** (0.444)	3.238*** (0.789)
Sex (1 = female, 0 = male)	0.0160 (0.490)	0.452 (0.373)	0.277 (0.536)	0.466 (0.359)
Constant	−2.364*** (0.410)	−3.980*** (0.809)	−2.513*** (0.497)	−3.879*** (0.806)
Observations	639	640	579	580
Subjects	32	32	29	29

This table shows the results from logistic regressions predicting punishment as a function of allocation type, both including all subjects and excluding incredulous subjects who did not express belief on either of our belief questions. Results are reported separately by age group. Columns 1 and 3 show results among 6-y-olds, and columns 2 and 4 show results among 8-y-olds. Robust SEs (clustered on subject) shown in parentheses. ***$P < 0.01$, **$P < 0.05$, *$P < 0.1$.

Table S3. Punishment of selfish allocations as a function of group membership

	All subjects			Nonincredulous subjects		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Actor group (1 = in-group, 0 = out-group)	−0.280** (0.112)	−0.309 (0.206)	−0.281** (0.113)	−0.282** (0.127)	−0.294 (0.236)	−0.283** (0.128)
Recipient group (1 = in-group, 0 = out-group)	0.123 (0.0918)	0.123 (0.0918)	0.427** (0.168)	0.121 (0.103)	0.121 (0.103)	0.432** (0.191)
Age (1 = 8 y, 0 = 6 y)	0.674** (0.331)	0.648 * (0.343)	0.960*** (0.364)	0.666* (0.343)	0.656* (0.365)	0.956** (0.378)
Sex (1 = female, 0 = male)	0.245 (0.323)	0.245 (0.323)	0.246 (0.324)	0.384 (0.330)	0.384 (0.330)	0.386 (0.331)
Actor group × Age		0.0532 (0.236)			0.0210 (0.271)	
Recipient group X Age			−0.555*** (0.186)			−0.560*** (0.211)
Constant	−0.971*** (0.343)	−0.957 *** (0.351)	−1.132*** (0.369)	−1.188*** (0.367)	−1.182*** (0.385)	−1.354*** (0.394)
Observations	1,024	1,024	1,024	928	928	928
Subjects	64	64	64	58	58	58

This table shows the results from logistic regressions predicting punishment of selfishness as a function of actor and recipient group membership, both including all subjects and excluding incredulous subjects who did not express belief on either of our belief questions. Columns 1 and 4 show results from our original model, columns 2 and 5 show results from a model that adds the interaction between actor group and age, and columns 3 and 6 show results from a model that adds the interaction between recipient group and age. Robust SEs (clustered on subject) shown in parentheses. ****P* < 0.01, ***P* < 0.05, **P* < 0.1.

Table S4. Punishment of selfish allocations as a function of group membership, by age group

	All subjects		Nonincredulous subjects	
Variable	(1)	(2)	(3)	(4)
Actor group (1 = in-group, 0 = out-group)	−0.310 (0.209)	−0.258** (0.116)	−0.295 (0.240)	−0.274** (0.132)
Recipient group (1 = in-group, 0 = out-group)	0.426** (0.170)	−0.129 (0.0800)	0.431** (0.193)	−0.128 (0.0899)
Sex (1 = female, 0 = male)	0.000 (0.546)	0.449 (0.384)	0.289 (0.592)	0.461 (0.369)
Constant	−0.992** (0.440)	−0.287 (0.273)	−1.290** (0.512)	−0.440* (0.244)
Observations	512	512	464	464
Subjects	32	32	29	29

This table shows the results from logistic regressions predicting punishment of selfishness as a function of actor and recipient group membership, both including all subjects and excluding incredulous subjects who did not express belief on either of our belief questions. Results are reported separately by age group. Columns 1 and 3 show results among 6-y-olds, and columns 2 and 4 show results among 8-y-olds. Robust SEs (clustered on subject) shown in parentheses. ****P* < 0.01, ***P* < 0.05, **P* < 0.1.

Table S5. Effect sizes (β values) by belief scores

Effect	(1)	(2)	(3)
Actor group on punishment of selfishness, overall	−0.280	−0.282	−0.240
Recipient group × Age on punishment of selfishness	−0.555	−0.560	−0.674
Recipient group on punishment of selfishness, in 6-y-olds	0.426	0.431	0.517
Selfishness on punishment, overall	2.31	2.14	2.12
Selfishness × Age on punishment	2.04	1.91	2.00
Selfishness on punishment, in 6-y-olds	1.44	1.31	0.955
Selfishness on punishment, in 8-y-olds	3.50	3.24	2.93
Subjects	64	58	34

This table shows the effect sizes (β-values) from all significant results reported in the main text, by belief scores. Only effect sizes are shown; significance levels are not. Column 1 represents the results from all subjects. Column 2 represents the effects from subjects who expressed belief on at least one of our two questions. Column 3 represents the effects from subjects who expressed belief on both of our two questions. We first report the effects of group membership on punishment of selfish allocations, and then report the effects of selfishness on punishment of all allocations.

Table S6. Sex interactions when predicting punishment as a function of allocation type

Variable	(1)	(2)
Allocation type (1 = selfish, 0 = fair)	2.314*** (0.453)	1.532*** (0.558)
Sex (1 = female, 0 = male)	0.296 (0.576)	0.182 (0.600)
Allocation type × Sex	−0.0587 (0.695)	−0.182 (0.836)
Age (1 = 8 y, 0 = 6 y)		−1.692 (1.070)
Sex × Age		0.527 (1.536)
Allocation type × Age		2.134* (1.139)
Allocation type × Sex × Age		−0.0804 (1.694)
Constant	−3.004*** (0.389)	−2.451*** (0.403)
Observations	1,279	1,279
Subjects	64	64

This table shows the results from logistic regressions investigating sex interactions when predicting punishment as a function of allocation type, including all subjects. Column 1 shows results from our original model (which only includes the two-way interaction between allocation type and sex), and column 2 shows results from a model that adds age, plus all two- and three-way interactions between allocation type, sex, and age. Robust SEs (clustered on subject) shown in parentheses. $***P < 0.01$, $**P < 0.05$, $*P < 0.1$.

Table S7. Sex interactions when predicting punishment of selfishness as a function of actor group

Variable	(1)	(2)
Actor group (1 = in-group, 0 = out-group)	−0.477** (0.192)	−0.741** (0.356)
Sex (1 = female, 0 = male)	0.0491 (0.333)	−0.399 (0.554)
Actor group × Sex	0.395* (0.219)	0.856** (0.392)
Age (1 = 8 y, 0 = 6 y)		0.231 (0.491)
Sex × Age		0.840 (0.673)
Actor group × Age		0.476 (0.403)
Actor group × Sex × Age		−0.842* (0.456)
Constant	−0.461* (0.243)	−0.578 (0.410)
Observations	1,024	1,024
Subjects	64	64

This table shows the results from logistic regressions investigating sex interactions when predicting punishment of selfishness as a function of actor group membership, including all subjects. Column 1 shows results from our original model (which only includes the two-way interaction between actor group and sex), and column 2 shows results from a model that adds age, plus all two- and three-way interactions between actor group, sex, and age. Robust SEs (clustered on subject) shown in parentheses. $***P < 0.01$, $**P < 0.05$, $*P < 0.1$.

Table S8. Sex interactions when predicting punishment of selfishness as a function of recipient group

Variable	(1)	(2)
Recipient group (1 = in-group, 0 = out-group)	0.158 (0.142)	0.581** (0.25)
Sex (1 = female, 0 = male)	0.276 (0.347)	0.170 (0.611)
Recipient group × Sex	−0.0759 (0.180)	−0.312 (0.334)
Age (1 = 8 y, 0 = 6 y)		0.848 (0.541)
Sex × Age		0.209 (0.725)
Recipient group × Age		−0.780*** (0.279)
Recipient group × Sex × Age		0.448 (0.369)
Constant	−0.770*** (0.254)	−1.228*** (0.468)
Observations	1,024	1,024
Subjects	64	64

This table shows the results from logistic regressions investigating sex interactions when predicting punishment of selfishness as a function of recipient group membership, including all subjects. Column 1 shows results from our original model (which only includes the two-way interaction between recipient group and sex), and column 2 shows results from a model that adds age, plus all two- and three-way interactions between recipient group, sex, and age. Robust SEs (clustered on subject) shown in parentheses. $***P < 0.01$, $**P < 0.05$, $*P < 0.1$.

Table S9. Interactions between actor and recipient group when predicting punishment of selfishness

Variable	(1)	(2)
Actor group (1 = in-group, 0 = out-group)	−0.242* (0.125)	−0.342 (0.254)
Recipient group (1 = in-group, 0 = out-group)	0.148 (0.121)	0.399* (0.224)
Actor group × Recipient group	−0.0592 (0.169)	0.0579 (0.318)
Age (1 = 8 y, 0 = 6 y)		0.883** (0.370)
Actor group × Age		0.153 (0.286)
Recipient group × Age		−0.462* (0.253)
Actor group × Recipient group × Age		−0.190 (0.363)
Constant	−0.511*** (0.178)	−0.977*** (0.314)
Observations	1,024	1,024
Subjects	64	64

This table shows the results from logistic regressions investigating interactions between actor and recipient group membership when predicting punishment of selfishness, including all subjects. Column 1 shows results from our original model (which only includes the two-way interaction between actor and recipient group), and column 2 shows results from a model that adds age, plus all two- and three-way interactions between actor group, recipient group, and age. Robust SEs (clustered on subject) shown in parentheses. ***$P < 0.01$, **$P < 0.05$, *$P < 0.1$.