

1 **Preschool children and chimpanzees incur costs to watch punishment of antisocial**
2 **others**

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34 children

35 **Abstract**

36 When misfortune befalls another, humans may feel distress, leading to a motivation to escape.
37 When such misfortune is perceived as justified however it may be experienced as rewarding
38 and lead to a motivation to witness such misfortune. We explored when in human ontogeny
39 such a motivation emerges and if such a motivation is shared by chimpanzees. Chimpanzees
40 and 4-6 year old children learned through direct interaction that an agent was either prosocial or
41 antisocial and later saw each agent's punishment with the option to invest physical effort
42 (chimpanzees) or monetary units (children) to continue watching. Chimpanzees and 6-year olds
43 showed a preference for watching punishment of the antisocial agent. An additional control
44 experiment in chimpanzees suggests that these results cannot be attributed to more generic
45 factors such as scene coherence or informational value seeking. This indicates that both 6-year-
46 olds and chimpanzees have a motivation to watch deserved punishment enacted.

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68 How cooperation in societies can emerge and be maintained remains an evolutionary puzzle¹⁻⁵.
69 Punishment of antisocial group members is arguably one key mechanism capable of ensuring
70 that levels of cooperation remain high in human⁶ as well as other species^{7,8}. It has been shown
71 that the experience of emotions is a likely proximate cause that sustains cooperation and
72 motivates costly punishment of antisocial others in humans^{4,9-11}. Seeing others suffer can induce
73 emotional states such as empathic distress¹² or concern¹³, of which the latter is a powerful
74 motivator for altruistic helping^{10,12,14}. Along with humans, several other animal species have
75 been tested for reactions to witnessing pain in conspecifics¹⁵⁻²⁴, providing some evidence for at
76 least some forms of empathic responding. It has been shown in humans that empathic reactions
77 can be radically undermined and change to feelings of pleasure, when the suffering victim was
78 previously antisocial or perceived as an outgroup member^{10,11}. Such signals of reward have
79 been shown to be critical predictors of a subsequent absence of helping and desire for revenge
80 and punishment^{10,11}. Thus, young human infants display an early preference for prosocial
81 compared to antisocial agents^{25,26} and prefer those who are antisocial to previously antisocial
82 others²⁷. Further, preschoolers have been shown to endorse the misfortune of competitors^{28,29},
83 to think antisocial others as deserving of punishment³⁰ and to punish transgressions of outgroup
84 members more than those of ingroup members³¹. Much less is known about how such
85 mechanisms might operate in one of our closest living relatives, the chimpanzee (but see³²⁻³⁵).
86 While it is known that chimpanzees appear to develop attitudes towards others based on
87 previous pro- and antisocial behaviors³⁶⁻³⁸, nothing is known about the phylogenetic origins of
88 the motivation to watch the enactment of revenge.

89
90 We used a cross-species forced-choice behavioral paradigm to study whether chimpanzees and
91 children aged 4-6 years differentially incur costs to continue watching the punishment of agents
92 depending on whether these had been pro- or antisocial in a directly experienced previous
93 interaction with them (Studies 1 and 2). The pro- or antisocial nature of the agents was
94 operationalized by means of them offering valuable goods to children (i.e. their favorite toys)
95 and chimpanzees (i.e. food). Whereas the prosocial agent would both offer and give the goods
96 to the participant, the antisocial agent would offer the goods first but then withdraw the goods.
97 The punishment procedure for all the studies entailed a punisher applying physical punishment
98 in the form of hitting each of the two agents (i.e. either prosocial or antisocial; Figure 1A and
99 1B). Crucially, after a brief period of witnessing the punishment, this was rendered invisible to
100 subjects (i.e. occurred in another part of the room for chimpanzees / was occluded by a curtain
101 of a puppet theatre for children). Therefore to continue watching the punishment subjects had to

102 incur costs, which for chimpanzees entailed physical effort by operating a heavy sliding door to
103 get to the invisible part of the room (Figure 1A) and for children entailed paying tokens or
104 monetary units (henceforth MUs) for the curtain of the puppet theatre to be raised again (Figure
105 1B). As indicators of a motivation to witness punishment we used the amount of cost incurred to
106 continue watching the punishment. We operationalized cost incurred as the expenditure of
107 valuable monetary units (MUs) for children and physical energy and time for chimpanzees. We
108 predicted that both chimpanzees (Study 1) and children (Study 2) would be more motivated to
109 watch the punishment of the antisocial compared to the prosocial agent. We also predicted
110 signs of greater positive emotions during the initial punishment of the two antisocial agent
111 compared to the prosocial agent for the children. To measure emotional correlates, we scored
112 facial expressions (e.g., smiles, frowns) during the punishment of the two agents. In
113 chimpanzees no predictions for specific positive emotions were made given that happy/positive
114 emotions in chimpanzees are very rarely observed, except in playful activities in which the ape
115 being physically touched (tickled/chased) performs play panting vocalizations (laughter-like)³⁹.

116

117 We were also interested in whether, in line with previous work in humans¹¹, there were signs of
118 empathic distress when witnessing prosocial agents being punished. In children, there is
119 already a wealth of evidence for such basic empathic tendencies when watching others harm
120 themselves^{40,41}, as expressed by verbalizations and facial expressions such as frowns⁴². Thus,
121 for children we predicted that they would show greater signs of empathic distress (increased
122 frowns) in response to the punishment of the prosocial compared to the antisocial agent.
123 Whether chimpanzees display empathic tendencies in such situations is much less known. One
124 key behavioral indicator of empathic distress is whether individuals have a motivation to escape
125 the distressing situation¹⁴. Chimpanzees approach victims of aggression and direct agonistic
126 behavior towards aggressors and/or affiliative behavior towards victims²⁰. We were therefore
127 interested in whether the punishment of the prosocial agent would elicit escape behavior (by
128 operating the heavy sliding door and moving into another part of the room without visual access
129 to the punishment of the agent) or approach behavior (i.e. by remaining in the room during the
130 punishment). For chimpanzees, we also used their vocalizations (here defined as a compound
131 of distress and display vocalizations, See Material and Methods section for more details) during
132 the initial punishment as indicators of emotional arousal. The vocalizations were categorized
133 according to their acoustic and temporal properties⁴³ and grouped according to the call
134 categories suggested by Goodall⁴⁴.

135

136 We performed an additional study with chimpanzees (Study 3) to control for the possibility that
137 incurring a cost to watch an antisocial agent being punished merely indicates that this is seen as
138 more socially informative or more consistent with the flow of the preceding events. The
139 execution of Study 3 was identical to that of Study 1, with the single difference that in Study 3
140 chimpanzees did not directly experience but merely witnessed, how the prosocial and the
141 antisocial agents interacted with another chimpanzee (stooge). If chimpanzees preferentially
142 watch the punishment of antisocial agents as a function of these more superficial aspects rather
143 than their motivational substrate (anger- and revenge-based vs. norm-based punishment), the
144 pattern of results should be the same in both studies. Based on previous studies showing that
145 chimpanzees do not punish others who stole food from third parties^{38,45} but they preferentially
146 beg for food from those who were prosocial to others^{37,46} we predicted that chimpanzees in
147 Study 3, unlike Study 1, would not care to watch or vocalize differentially when others
148 (regardless of whether they were prosocial or antisocial) were being punished. Note that Study
149 3 differed from Study 1 only in terms of the extent to which the chimpanzee subjects were
150 directly affected by the agents' behavior, while keeping all other aspects of the experimental set-
151 up constant.

152
153 It is important to note that our dependent behavioral variable of opening the heavy sliding door
154 for the chimpanzees is always the same throughout all conditions. However, we interpret it
155 differently depending on the condition (i.e., to continue witnessing the punishment when it is
156 invisible or to escape into another room when it is visible; see Discussion section for more
157 details). While we tested three age groups of children, we were agnostic to any age-related
158 changes in our variables of interest. Given our a-priori predictions one-tailed statistics were
159 applied for the factor prosociality. All other comparisons were two-tailed. Thus, for the
160 chimpanzees (Studies 1 and 3) this resulted in a 2x2 factorial design with factor prosociality
161 (prosocial/antisocial) and visibility (visible/invisible) and one trial for each condition. For children
162 (Study 2) this resulted in a design with one factor of prosociality (prosocial/antisocial) and with 4
163 trials for each condition.

164
165 **Results**
166 *Study 1: Chimpanzees, Watching punishment following directly experienced pro- and antisocial*
167 *behavior*

168 Chimpanzees differentially operated the heavy sliding door depending on whether punishment
169 was visible or not and whether the agent had been previously prosocial towards them or not

170 (Cochran's $Q = 8.59$, $df = 3$, $P = 0.043$, $N = 16$). We conducted pair-wise follow-up comparisons
171 between the two invisible conditions to test our hypothesis of an increased motivation to witness
172 the punishment of an agent who had been previously antisocial towards the subject. Subjects
173 were significantly more likely to incur the physical costs to open the heavy metal door in the
174 antisocial invisible condition (50% of the subjects) compared to the prosocial invisible condition
175 (18.75% of the subjects) (Sign test: $P = 0.032$, $N = 16$, one-tailed; Figure 2A). We conducted
176 another pair-wise follow-up comparison between the two visible conditions to test for the
177 behavioral effects of empathic distress (i.e. increased opening of the door to move to another
178 room when the punishment of the prosocial agent is visible to the subject). Here we found no
179 significant difference in the number of subjects who opened the door during the prosocial visible
180 condition compared to the antisocial visible condition (Sign test: $P = 0.313$, $N = 16$, one-tailed;
181 Figure 2A).

182
183 To assess the presence of vocalizations associated with emotional arousal during the
184 punishment of either of the agents, the testing event was divided into three periods; an initial
185 baseline where just the agent was present; a pre-hit period where the punisher appeared but
186 had not started to punish the agent, and a first-hit period during which the punishment actually
187 took place. We looked at these periods separately for each of the two agents. There was a
188 significant difference between the three periods in the duration of the vocalizations in the
189 presence of the prosocial agent (Friedman exact test: $F = 9.82$, $P = 0.004$, $N = 16$; Figure 2C)
190 but we found no such difference in the presence of the antisocial agent ($F = 4.67$, $P = 0.107$, N
191 $= 16$; Figure 2C). Comparing the vocalizations in response to the presence and punishment of
192 the prosocial and the antisocial agents, showed that chimpanzees produced longer
193 vocalizations in the baseline period when facing the antisocial agent compared to the prosocial
194 one (Wilcoxon exact test: $T^+ = 21$, $P = 0.031$, $N_{total} = 16$; corrected for the duration of each
195 period in the Punishment phase, i.e., baseline, pre-hit, hit periods) and longer vocalizations
196 when the prosocial agent was being punished compared to when the antisocial agent was being
197 punished in the hit period (Wilcoxon exact test: $T^+ = 21$, $P = 0.031$, $N_{total} = 16$; Figure 2C).

198
199 To assess whether the prosocial/antisocial exposure procedure had been effective, we
200 assessed the subjects' preference for the prosocial and antisocial agent upon completion of the
201 tasks (see Materials and Methods section). This was tested by allowing the chimpanzees to beg
202 for food from the two agents to assess whether they showed a preference for one of them.
203 Chimpanzees showed no preference for requesting food from the prosocial over the antisocial

204 agent (Wilcoxon signed rank test: $T^+ = 89$, $N = 17$, $P = 0.579$). This could have been the result
205 of the close physical proximity of both agents, which might not have allowed for a clear
206 dissociation of the subject's behavior.

207

208 Finally, we also assessed relationships between the chimpanzees' vocalizations and their
209 behavior. We found that chimpanzees who produced vocalizations during the punishment of the
210 prosocial agent were more likely to open the door to continue witnessing punishment of the
211 antisocial agent than those who did not produce any vocalizations (57% vs 12.5%; Chi-Square
212 test: $\chi^2 = 5.402$, $P = 0.041$). This suggests, that those chimpanzees who signal distress in
213 response to a prosocial agent's punishment are also more motivated to observe deserve
214 punishment being enacted.

215

216 *Study 2: Children*

217 To test for the hypothesis that children would show an increased motivation to observe the
218 punishment of a previously antisocial agent, we compared the number of MUs spent on
219 continuing to watch the punishment of the prosocial and the antisocial agents. The data were
220 normally distributed and met assumptions for parametric tests. A Repeated Measures ANOVA
221 with agent as a within-subject and age-group as a between-subject factor, indicated a significant
222 interaction between the factors agent and age-group in how MUs were allocated to watch the
223 punishment ($F_{(2,62)} = 3.417$; $P = 0.039$, Figure 2B). Thus, only 6-year-olds allocated more MUs to
224 watch the punishment of the antisocial compared to the prosocial agent ($F_{(1,20)} = 12.246$; $P =$
225 0.002 ; for 4- and 5-year olds $p > 0.2$; Figure 2B). While there was a linear increase in
226 comprehension of the task with age ($F_{(2,62)} = 5.26$; $P = 0.007$) this did not correlate with MUs
227 allocated either for watching punishment of the prosocial or the antisocial agent (all $r_s < 0.2$; $P >$
228 0.1).

229

230 Coding of facial expressions while watching the initial round of punishment showed significant
231 age-differences in number of smiles co-occurring with frowns depending on which agent was
232 being punished ($F_{(1,62)} = 2.294$; $P = 0.03$, one-tailed; Figure 2D). Thus, only 6-year-olds showed
233 an increased mixture of positive and negative emotions (facial expressions) while watching the
234 punishment of the antisocial compared to the prosocial agent ($F_{(1,20)} = 3.155$; $P = 0.045$, one-
235 tailed; Figure 2D). We assessed the number of frowns during the initial round of punishment as
236 an indication of empathic distress in the children at seeing the punishment of the agents.
237 Whereas children frowned for both the prosocial (one-sample t-test: $t_{(64)} = 2.408$; $P = 0.019$) and

238 the antisocial agent (one-sample t-test: $t_{(64)} = 2.644$; $P = 0.010$), this did not differ between the
239 two agents. Frowning during the punishment did not interact further with age ($P > 0.4$).

240

241 To test the children for a preference for either of the two agents, children were asked explicitly
242 which of the two agents they i) considered nicer, ii) would be more willing to share with and iii)
243 would prefer to play with (see Materials and Methods section and SI). Children of all three age
244 groups displayed a clear preference for the prosocial over the antisocial agent (paired t-test: $t_{(64)}$
245 $= 4.279$; $P < 0.001$) with no age differences in this preference (One-way ANOVA; $P > 0.607$).

246

247 *Study 3: Chimpanzees, Watching punishment following indirectly experienced pro- and*
248 *antisocial behavior*

249 This study was conducted to rule out potential alternative explanations for the outcome of Study
250 1 including an increased social informational value in seeing antisocial others receive
251 punishment or finding it more coherent in terms of the unfolding of events. Unlike Study 1, we
252 found no evidence that chimpanzees differentially opened the heavy sliding door in the four
253 conditions (Cochran's $Q = 3$, $df = 3$, $P = 0.484$, $N = 14$).

254

255 We also analyzed the presence of vocalizations associated with emotional arousal during the
256 punishment of each of the agents during the baseline, pre-hit and first-hit periods. There was no
257 significant difference between the three periods in the duration of the vocalizations in the
258 presence of the prosocial and antisocial agents (Prosocial, Friedman exact test: $F = 0.125$, $P =$
259 1.00 , $N = 14$; Antisocial, $F = 3.26$, $P = 0.218$, $N = 14$).

260

261 Russell and colleagues³⁷ showed that upon witnessing an interaction between a human beggar
262 and either a nice or a nasty agent, chimpanzees showed a preference for the former. We used
263 Russell et al.'s paradigm to test for a potential preference between the prosocial and the
264 antisocial agent³⁷. We found that chimpanzees begged significantly more often from the
265 prosocial than the antisocial agent (frequency of begs corrected for the amount of time spent in
266 front of the correspondent agent, Wilcoxon signed rank test: $T^+ = 82$, $N_{\text{total}} = 14$, $P = 0.008$).

267

268 **Discussion**

269 Our findings demonstrate that chimpanzees and 6-year old but not 4 and 5-year old children
270 appear to possess a motivation to watch the punishment of others who they had previously
271 experienced as antisocial towards themselves as compared to prosocial agents. Thus,

272 chimpanzees endured greater physical efforts and 6-year-old children spent more valuable MUs
273 to continue watching the punishment of an agent who had previously withheld something
274 valuable from the subjects (i.e. food for the chimpanzees and favorite toys for the children) as
275 compared to someone who had been prosocial and shared the valuable items. In contrast,
276 chimpanzees spent the same effort to continue watching the punishment of a human agent
277 regardless of the agents' social behavior towards other chimpanzees.

278

279 We observed concomitant indicators of affective responses in the children. Six-year old children
280 showed a greater mixture of positive and negative emotions in response to watching the
281 punishment of the antisocial agent compared to the prosocial one. The combination of these
282 emotions, rejoicing in the misfortune of a disliked other, is also known as Schadenfreude⁴⁷.
283 These data suggest that in children, pleasure at seeing deserved punishment may be linked to
284 the increased costs incurred to continue watching it. Recent studies have shown that differential
285 punishment of selfish behaviors of in-group and out-group members already occurs from 6
286 years onwards⁴⁸ and that around 6 years, children are capable of experiencing such potentially
287 conflicting emotions⁴⁹. Thus, 6 years of age may be a critical developmental time point at which
288 children are willing to actually sacrifice their resources to see fairness enacted⁵⁰. Importantly,
289 even though there were some age differences in the comprehension of the experimental
290 procedure, comprehension scores did not correlate with our behavioral measure, suggesting
291 that any differences in comprehension cannot account for the age-related effect in the MUs
292 expended. Further, our MUs were made meaningful to children through a subsequent
293 conversion to stickers, which have been shown to be valuable items for the youngest as well as
294 the oldest children of our age groups⁵¹⁻⁵⁴.

295

296 Previous studies have shown that chimpanzees engage in punishment of conspecifics who had
297 previously stolen their food by causing the thief's food to disappear^{38,45}. Study 1 demonstrates
298 that also in the absence of food, chimpanzees are motivated to watch antisocial agents being
299 punished after directly experiencing the antisocial behavior themselves. One could argue that
300 the chimpanzees' reaction could be driven by emotional engagement. However, chimpanzees
301 were more aroused when they watched the punishment of the prosocial agent. Following
302 indirectly experienced pro- and antisocial behavior, chimpanzees were equally motivated to
303 watch punishment of the pro- and the antisocial agents. This is consistent with findings showing
304 that chimpanzees do not punish those who stole food from third parties⁴⁵. The results from
305 Study 3, in which chimpanzees merely observed the prosocial and antisocial interaction prior to

306 the agents' punishment, help us to interpret the results from Study 1. In both studies all basic
307 elements were kept constant except for the degree of the chimpanzee's involvement. Thus,
308 alternative explanations such as increased social informational value or a greater coherence in
309 the unfolding of the scene can be ruled out. Instead, the most likely interpretation based on
310 these findings is that chimpanzees have an increased motivation to observe such punishment
311 because it follows a desirable action towards someone who behaved antisocially towards
312 themselves. The literature abounds with examples of animals willing to incur energy costs for
313 something they find rewarding⁵⁵⁻⁵⁷. It is therefore tempting to argue that watching antisocial
314 others getting harmed is rewarding and pleasurable also to chimpanzees. Suggestive of an
315 emotional antecedent to such behavior is also the finding of individual differences in the
316 relationship between vocalizations and opening the door to witness punishment. Thus,
317 chimpanzees who had vocalized distress during the punishment of the prosocial agent were
318 also more likely to incur a cost to continue witnessing the deserved punishment of an antisocial
319 other. Thus, when punishment is deserved, the experience of distress is abolished leading
320 chimpanzees to actively seek out observing such punishment. However, in the absence of direct
321 evidence, we remain cautious with an account positing the presence of actual positive emotions
322 as a driver for the observed behavior.

323

324 In addition to signs of Schadenfreude in children, we found evidence of empathic distress
325 across all three age groups. However, this was not differentially modulated by whether the
326 agent had been previously prosocial or antisocial towards them. Even though children as young
327 as 3-year old have been shown to differentiate their empathic helping between previously
328 prosocial and antisocial others^{58,59} and all age groups showed a decided preference for the
329 prosocial agent, no difference in empathic responding could be found. Chimpanzees produced
330 longer vocalizations indicative of emotional arousal during the punishment of the prosocial agent
331 that had directly interacted with them but no differential vocalizations occurred when they
332 witnessed the agent being punished following the indirectly experienced pro- and antisocial
333 behavior (regardless of her social orientation). Even though in chimpanzees it is difficult to
334 clearly label the valence of such vocalizations as they can reflect conflicting emotions⁴⁴, the
335 specificity of their occurrence (longer vocalizations during the hitting of the prosocial agent
336 compared to the antisocial agent) suggests that they might reflect something akin to empathic
337 distress. However, chimpanzees did not signal distress by attempting to escape witnessing the
338 punishment of the prosocial agent nor tried to approach and console the victim of the
339 aggression as suggested by observational studies²⁰. These conflicting results (distress

340 vocalizations vs. non-escape/non-approach behavior) make it difficult to pinpoint the underlying
341 motivation of the chimpanzees' behaviors upon witnessing the punishment of the prosocial
342 agent.

343

344 There are some limitations to the present set of studies. One is the fact that interactions were
345 observed between individuals that were not of the same species as the subject. However, this
346 concern is reduced given that both chimpanzees and 6-year-olds responded differentially to the
347 two agents. While such cross-species set-ups are common in the study of social behavior of
348 both human and non-human primates⁶⁰⁻⁶² future work will have to assess how far these findings
349 extend onto interactions with one's own species. Further, the different dependent variables for
350 the chimpanzees and the children (i.e. physical energy vs. valuable MUs) makes direct inter-
351 specific comparisons difficult. While using different dependent variables has the advantage of
352 optimizing procedures for each species thus avoiding potential biases favoring one of the
353 species, future work may seek to expand the findings using the same dependent variables for
354 greater comparability of the effects. Finally, we were unable to counterbalance the
355 administration of the direct and indirect exposures to the pro- and antisocial in chimpanzees.
356 Our results, however, were consistent with the existing literature on the occurrence of
357 punishment following directly and indirectly experienced transgressions in chimpanzees, which
358 ameliorates to some extent the concerns derived from our current design.

359

360 We studied the evolutionary and ontogenetic origins of an increased motivation to watch the
361 punishment of antisocial others and their associated emotional states. Chimpanzees and 6-
362 year-old children showed greater motivation by incurring costs to continue watching the
363 punishment of an antisocial over a prosocial agent. Furthermore, children displayed differential
364 responses of mixed positive and negative emotions when they witnessed punishment of
365 antisocial agents, which suggest that they might take some form of pleasure from this. Although
366 such a mechanism is still uncertain in chimpanzees, vocalizations of emotional arousal
367 produced when they witnessed the suffering of a prosocial agent, and their absence when
368 witnessing the suffering of an antisocial agent, might indicate that affective responses such as
369 pleasure may constitute an important motivational contributor to the exaction of revenge, with
370 early evolutionary origins. Crucially, chimpanzees did not vocalize differentially for the two
371 agents when seeing the two agents punished following indirectly experienced pro- and
372 antisocial behavior. Additionally, they did not engage in differential costs to witness the
373 punishment of the antisocial agent as compared to the prosocial agent. These findings provide

374 some evidence for the evolutionary origins of an increased motivation to watch punishment of
375 antisocial behavior with - at least in children- possible links to feelings of pleasure underlying
376 such a motivation. Such a motivation appears to develop at a protracted rate, similar to higher-
377 level cognitive skills⁶³ and might emerge at an age at which children begin to care so much for
378 justice that they are willing to pay for it.

379

380 **Methods and Materials**

381 *Ethics statement*

382 The studies reported in this manuscript were approved by the local ethics committee of the
383 University of Leipzig and complied with all relevant regulations. Thus, the ethics committee of
384 the University of Leipzig approved the study (Ethics Approval Number: 367-11-26092011).
385 Caregivers provided written consent form to use the acquired data. Additionally, the chimpanzee
386 work was approved by the MPI-EVA – Zoo Leipzig ethical committee.

387

388 *Participants*

389 Studies 1 and 3: In Study 1 we tested 17 chimpanzees (*Pan troglodytes*). There were 5 males
390 ranging in age between 8 and 38 years ($M = 16$ years and 8 months) and 12 females ranging in
391 age between 8 and 37 years ($M = 22$ years and 5 months). In Study 3, we tested 14
392 chimpanzees. There were 5 males ranging in age between 8 and 38 years ($M = 15$ years and
393 10 months) and 9 females ranging in age between 12 and 42 years ($M = 27$ years and 3
394 months). All chimpanzees were housed at the Wolfgang Koehler Primate Research Center,
395 Leipzig Zoo, Germany. Eleven of them participated in both studies, whereas the rest could not
396 do so because they were unavailable (see Table S1 for rearing history and detailed participation
397 in each study). All indoor and outdoor enclosures were furnished with vegetation, climbing
398 structures and visual barriers. Subjects were neither food- or water-deprived during the
399 experiment.

400

401 Study 2: We tested 72 children. There were three age groups: 24 4-year-olds ($M = 4.15$, age
402 range = 4.04-4.35), 24 5-year-olds ($M = 5.04$, age range = 4.97-5.4), and 24 6-year-olds ($M =$
403 6.17 , age range= 5.98-6.33). In each group there were equal number of boys and girls. Seven
404 children had to be removed from the analyses due to procedural error or fussiness. All
405 remaining subjects received all conditions. All children were recruited from a subject database
406 at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany.

407

408 *Experimental Procedures*

409 Studies 1 and 3: These two studies consisted of four phases: *Training, Exposure, Preference*
410 *and Punishment* (actual test). Before entering the *Punishment* phase, chimpanzees received a
411 sequence of training stages (see *Training phase* in SI) to ensure that they understood how to
412 open the heavy mesh sliding door that would allow them access to the adjacent room. After the
413 training, all subjects were exposed directly (Study 1) or indirectly (Study 3, by witnessing an
414 interaction between a human agent and a conspecific stooge) to two different human agents,
415 one at a time. The agents either acted prosocially towards the subject/stooge (Study1/Study3),
416 by providing food, or antisocially, by teasing and not allowing the subject/stooge to get access to
417 the food (see *Exposure phase* in SI). Whether the agent was prosocial or antisocial was
418 counterbalanced across subjects. To reduce carry-over effects between studies, different
419 agents participated in Study 3 (except for the punisher), which was conducted a few months
420 after Study 1. To test the efficacy of the *Exposure phase* a *Preference phase* was designed to
421 test for preferential begging from the two agents (see SI for more details). In the *Punishment*
422 *phase* (see SI for more details) either the prosocial or the antisocial agents entered the testing
423 room and sat in front of the Plexiglas window in the subjects' room. After 5 seconds of being
424 seated in front of the Plexiglas window (henceforth referred to as baseline period), a second
425 agent, the punisher, entered the room. The punisher approached the agent from behind with a
426 human facial expression of rage (henceforth referred to as pre-hit period) and started beating
427 her up (henceforth referred to as hit period) with a stick for 4 sec. (i.e., 4 hits with the stick, rate:
428 1 Hz). While being beaten up the agent cried out in pain. After the initial punishment period (i.e.,
429 4 seconds) the agent either: 1) remained in her initial position for the whole time of the
430 punishment visible to the subject (10 more seconds, Figure 1A), so-called *visible* condition, or 2)
431 left her initial position (area A, see Figure 1A) and went into another area of the room invisible to
432 the chimp (area B, see Figure 1A) where the punishment continued for 10 more seconds, so-
433 called *invisible* condition. If subjects wanted to continue watching the punishment in the invisible
434 condition they had to open the heavy sliding door (learned during the Training phase) and move
435 in front of the Plexiglas window in the new room. Similarly, if they wanted to escape from the
436 punishment in the visible condition happening in front of them, they had to operate the door to
437 move to another part of the room where this would then be invisible.

438

439 All sessions were videotaped and the following variables were coded from digital files: 1)
440 opening of the heavy sliding door; 2) duration of the vocalizations associated with emotional
441 arousal, namely: screams, whimpers, and worried hoos considered as distress vocalizations⁴³

442 and (waa) barks and (pant) hoots considered as display vocalizations⁴³. As previously
443 mentioned, vocalizations were categorized according to their acoustic structure and temporal
444 measures and grouped according to the call categories suggested by Goodall⁴⁴. Distress and
445 display vocalizations were lumped together and the combined results used for statistical
446 analysis. The duration of the calls was analyzed with the sound analysis software Avisoft and
447 Praat.

448
449 To assess inter-observer reliability, a second observer coded a random sample of 20% of the
450 trials. Inter-observer reliability was high for opening the sliding door (Study 1: Pearson
451 correlation $r = 1.000$, $P < 0.001$; Study 3: $r = 1.000$, $p < 0.001$), for duration of the vocalizations
452 (Study 1, distress calls: $r = 1.000$, $P < 0.001$; display calls: $r = 0.900$, $P < 0.001$; Study 3,
453 distress calls: $r = 1.000$, $P < 0.001$; display calls: $r = 1.000$, $P < 0.001$), and frequency of begs
454 corrected for the amount of time spent in front of the correspondent human agent (Study 1: $r =$
455 0.999 , $P = 0.028$; Study 3: $r = 0.997$, $p = 0.048$),

456
457 Study 2: Children came into the lab accompanied by at least one parent. Parents had been
458 instructed before on the phone to bring six of their child's favorite toys, without the child noticing.
459 These were then taken by the experimenter and used as in the two exposure phases. Children
460 were given an initial endowment of 4 MUs. It was made clear that at the end of the experiment
461 each of the MUs could be traded for one sticker. The experimental procedure was demonstrated
462 using a miniature-sized puppet theatre.

463
464 Before the *Punishment phase*, each child was exposed consecutively to two different puppets, a
465 prosocial and an antisocial puppet (see *Exposure phase* in SI). Exposure entailed one of two
466 puppets to either act prosocially by returning three of the child's favorite toys, or antisocially, by
467 keeping them for itself. The puppets would bring up a toy from behind the theatre and hold it up
468 to the child. After telling the child that it wanted to play with them, the prosocial puppet would
469 hold the toy towards the child and put it into the child's hands, whereas the antisocial puppet
470 would withdraw as soon as the child reached for the toy. Similar procedures has been shown to
471 elicit clear preferences in infants⁶⁴. Which puppet was prosocial or antisocial was
472 counterbalanced across subjects. Exposure and testing was performed for both puppets and
473 fully counter-balanced across all subjects. During the *Punishment phase*, the puppet to which
474 children had just been exposed remained on stage. After 5 seconds, another puppet appeared
475 (different to the two agents) carrying a long stick (punisher). The punisher started beating the

476 other puppet (prosocial/antisocial) up with the stick for 5 seconds (i.e., 5 hits with the stick, rate:
477 1 Hz). After the initial punishment period (i.e., 5 seconds) the theatre curtain closed rendering
478 both the punisher and the punished puppet invisible. The punisher puppet then returned and
479 said to the child that they were going to continue hitting the other puppet and that if the child
480 would like to continue watching then it should put one MU into a box to the right of the stage,
481 whereas if it did not want to continue watching it should put a MU into a box to the left of the
482 stage. Depending on where children placed their MU, the curtains were drawn again or not and
483 children could continue observing the punishment or not. In case they chose not to witness the
484 punishment, the punishment was still executed behind closed curtains. If children decided not to
485 continue watching on the first round then the punisher puppet did not ask again whether the
486 child cared for another round of witnessing punishment. However, if children decided to
487 continue watching, the punisher asked again after 5 seconds of punishment if they would like to
488 continue watching. Given that children had received 4 MUs, the maximum number of paid
489 punishments was 4. Thus, all subjects received exposure to the first round of punishment and
490 the first question of whether they would like to continue watching or not. Depending on whether
491 children paid for punishment, they were asked again until they either decided to stop watching
492 or until they had no more MUs. The final round was the pursuit and punishment behind the
493 curtain, thus the child continued hearing the puppet crying for 10 more sec. but without visual
494 access to the punishment.

495
496 All sessions were videotaped and the following variables were coded from digital files during the
497 exposure phase as well as the punishment phase: 1) behaviors and verbalizations 2) pure
498 smiles, pure frowns and given the potential ambivalence of seeing someone antisocial
499 experience punishment, we also coded for smiles occurring jointly with frowns. Two observers
500 coded all the videos using the Interact software.

501
502 To assess inter-observer reliability, ratings were correlated. Inter-observer reliability was high for
503 answering the questions of the punisher ($r = 0.99$, $p < 0.0001$) as well as for occurrence of
504 smiles, frowns and smiles with frowns during the exposure as well as the punishment phase (all
505 $r > 0.504$, all $p < 0.0001$).

506
507 At the end of the entire Punishment phase the experimenter showed the two agents to the child
508 and asked which puppet the child would rather play with, give a sticker to and thought was
509 nicer. From this a composite score of preference was obtained (see SI).

510

511 All data were analyzed in SPSS 23 (SPSS Statistics Software, IBM). No attempts to replicate
512 the findings reported in this paper have been made.

513

514 **Data availability statement**

515 The data that support the findings of this study are available from the corresponding author on
516 reasonable request.

517

518 **Author Contributions**

519 Conceived and designed the experiments: NM, NS, JC, TS. Performed the experiments: NB,
520 NM, NS. Analyzed the data: NM, NS. Interpretation of data and writing of the paper: NB, NM,
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522

523

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681 **Competing interest statement**

682 The authors declare no competing interests.

683
684

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706
707

708 **Figure Legends**

709

710 Figure 1. Experimental Design for (A) chimpanzees and (B) children. Subjects (S) watch the
711 punishment of a previously either prosocial or antisocial agent (A) by a punisher (P). For the
712 chimpanzees in the visible conditions, the punishment took place outside the cage of the
713 chimpanzee. For the invisible conditions, the punishment moved to a part of the room out of
714 sight from the chimpanzee. For the children the punishment was visible until a curtain fell and
715 children were asked to put their MUs into the box on the right in order to continue watching the
716 punishment.

717

718

719

720 Figure. 2 Behavioral data and emotional indicators for chimpanzees (Study 1; N = 17) and
721 children (Study 2; N = 65). (A) More chimpanzees opened the heavy sliding door to continue
722 watching the punishment in the invisible antisocial (i.e. when punished and human agent left to
723 move to an invisible part of the room) compared to the invisible prosocial condition. Note, that
724 not all the chimpanzees opened the door. (B) All children paid to continue watching some of the
725 punishment, but only 6-year olds paid more to watch the antisocial agent being punished
726 compared to the prosocial agent. (C) Chimpanzees expressed greater distress vocalizations
727 when watching the punishment of the prosocial human agent. (D) Only 6-year old children

728 displayed more frequent smiles coupled with frowns during the punishment of the antisocial
729 compared to the prosocial agent. The error bars show s.e.m.

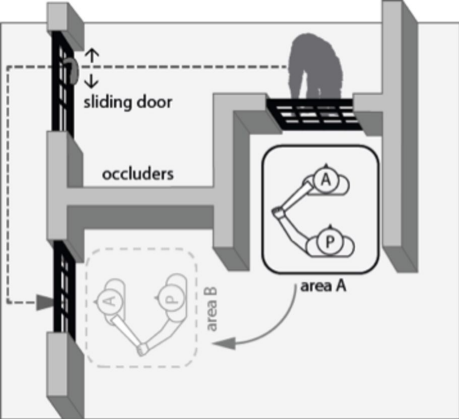
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731

732 Figure. 3 Behavioral data and emotional indicators for chimpanzees in Study 3 (N = 14). (A)

733 There were no differences in the chimpanzees' (A) behavior or (B) vocalizations between any of
734 the conditions. The error bars show s.e.m.

735

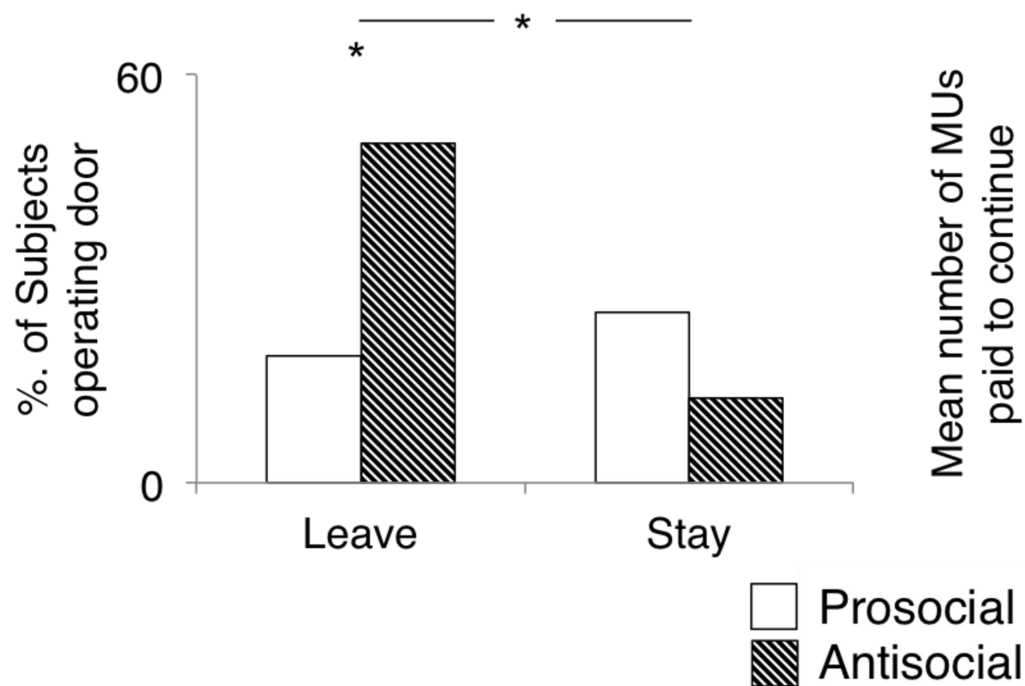


Chimpanzees

Children

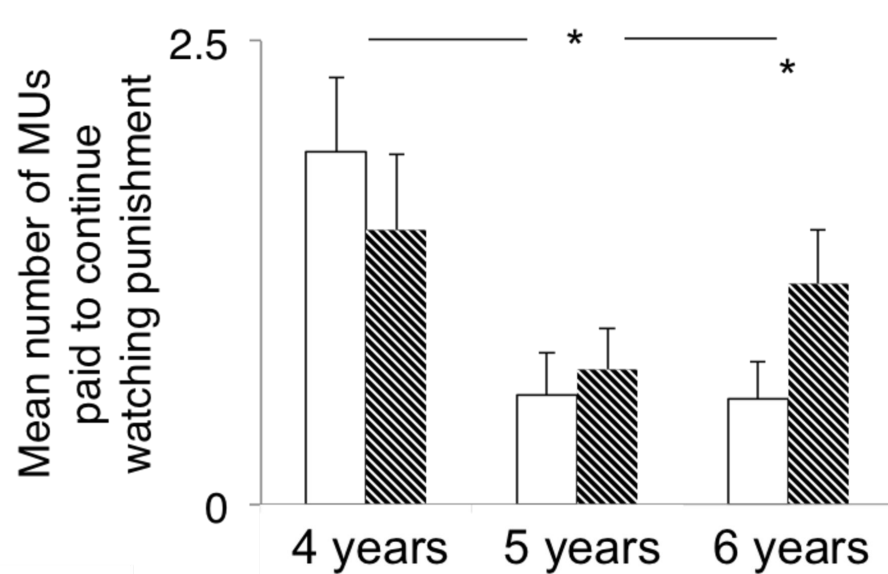
A

Operating the door



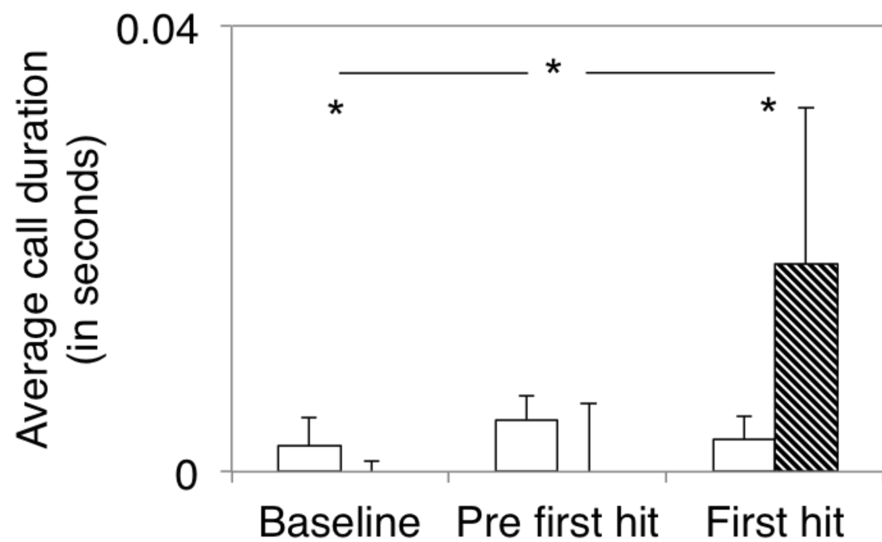
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Paying to watch



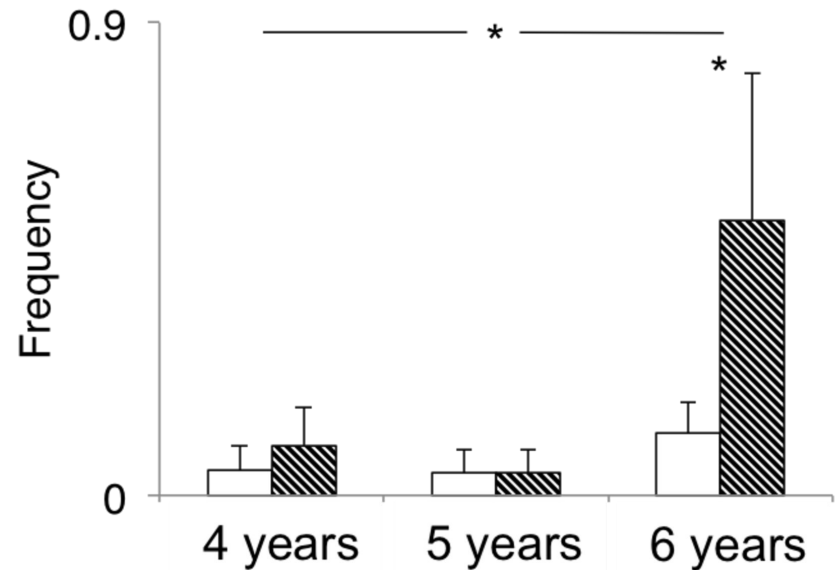
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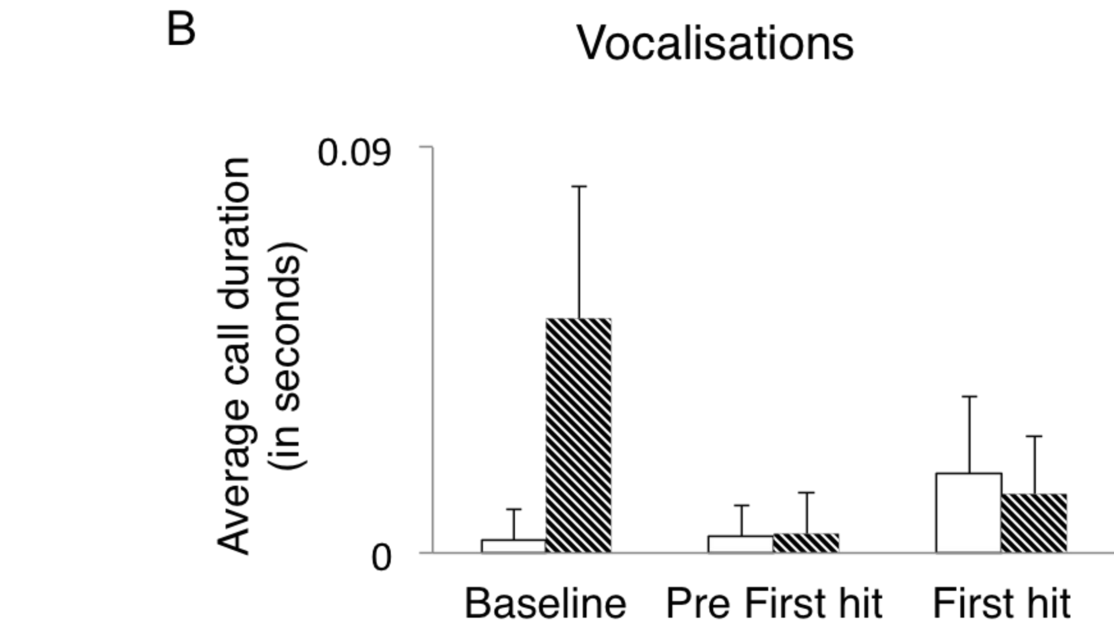
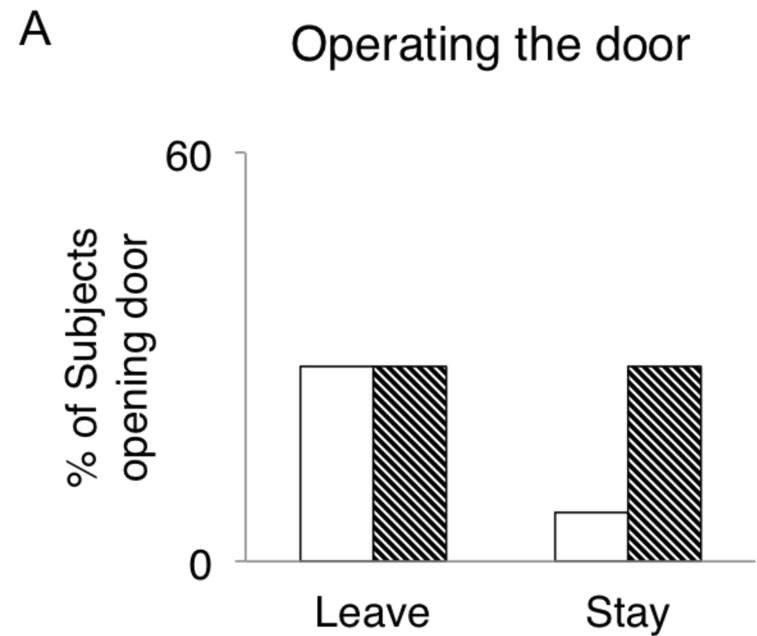
Vocalisations



D

Smiles with Frowns





□ Prosocial
▨ Antisocial