

Chimpanzees are vengeful but not spiteful

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People are willing to punish others at a personal cost, and this apparently antisocial tendency can stabilize cooperation. What motivates humans to punish noncooperators is likely a combination of aversion to both unfair outcomes and unfair intentions. Here we report a pair of studies in which captive chimpanzees (*Pan troglodytes*) did not inflict costs on conspecifics by knocking food away if the outcome alone was personally disadvantageous but did retaliate against conspecifics who actually stole the food from them. Like humans, chimpanzees retaliate against personally harmful actions, but unlike humans, they are indifferent to simply personally disadvantageous outcomes and are therefore not spiteful.

cooperation | fairness | other-regard | punishment | reciprocity

People will willingly suffer a cost to punish others. Although this does not sound like a formula for cooperation, something that humans are exceedingly good at, theoretical models and experimental evidence show that in the absence of punishment, cooperation does not survive the degrading influence of free-riders (1). Punishment, in the biological sense, is a strategy that decreases the occurrence of a behavior, and it is typically selfish in that it provides a future benefit for the individual such as the reduction of harmful behavior received from others (2)[†]. Punishment can make an act of spite, incurring a cost to impose a cost on another individual, beneficial in the long run and is therefore a means to an end. Spite, on the other hand, is the decreasing of the welfare of another individual as an end in itself, just as proximate-level altruism has increasing the welfare of another as the ultimate end (3). Negative reciprocity makes spite selfish just as positive reciprocity does for altruism (4). We use the term “spiteful” for proximate-level spite to distinguish it from ultimate-level spite[‡].

A special form of punishment has been revealed in economic experiments such as the ultimatum and public goods games. This “altruistic punishment” (7) provides benefits in the form of increased cooperation to others, whereas the punisher alone bears the costs. It could be argued that on a short time-scale, such unselfish punishment is spitefully motivated, and altruistic outcomes are an unintended byproduct; to our knowledge, the underlying motivations behind altruistic punishment remain to be shown. What might motivate punitive and possibly spiteful behaviors is that, instead of acting solely selfishly and counting only one’s own gains and losses, people appear to compare their outcomes with those of others and appraise the motives behind the actions of others. The punishment of others based on unfair outcomes (8, 9) or intentions (10–13) has been argued to be a central and possibly unique feature of human cooperation.

There is currently controversy about whether nonhuman primates also have a sense of fairness (in the sense of personally disadvantageous outcomes). Capuchin monkeys (*Cebus apella*) and chimpanzees (*Pan troglodytes*) reject food offered by experimenters when conspecifics receive better food, perhaps because they perceive the situation as unfair (14, 15). However, other studies suggest alternative explanations other than a sense of unfairness (16–19). For instance, great apes beg more for food when there is an expectation that an experimenter will give them better food when she gives it to a partner (19). These studies call into question whether non-human primates are averse to per-

sonally disadvantageous outcomes. Two further studies have even challenged whether chimpanzees are other-regarding when they can control the outcomes themselves. When chimpanzees had the opportunity to deliver cost-free benefits to conspecifics, they failed to show other-regarding preferences (20, 21). One of these studies also gave the chimpanzees the opportunity to control personally disadvantageous outcomes by acting spitefully, and their disinclination to do so led to the conclusion that our closest living relatives are not other-regarding (21). Nonhuman animals do retaliate against others, and this can serve, among other things, to maintain cooperative behavior (2, 22–24). However, it is not known whether animals other than humans react to harmful actions directed toward them by retaliating against the perpetrator, and whether they react to disproportionate outcomes by behaving spitefully toward the fortunes of others.

Results and Discussion

Here we report two studies in which chimpanzees had the opportunity to respond to different personally disadvantageous situations by inflicting costs on conspecifics. In a first study, chimpanzees were given the opportunity to prevent a conspecific from eating at no benefit to themselves, that is, spitefully. This is similar in spirit to a “money-burning” game in which human adults could pay to reduce the amount of money held by another individual either out of envy or a sense of fairness (25). Two separate groups of chimpanzees (A group, $n = 9$; B group, $n = 4$) were tested in dyads within their groups. There were four conditions, with order counterbalanced across subjects. In the partner-feeding test condition, an actor and a partner were in adjacent cages and faced each other across an inaccessible space in which a food table stood. The partner could reach the food through a mesh panel; the actor could not reach the food, but she could pull a rope, causing the table to collapse and the food to fall beyond the reach of both of them. We compared this condition to three others. In the baseline condition (two versions), there were pieces of plastic and inedible bamboo stems on the table and no partner, to measure the general tendency of chimpanzees to pull the table over. In the self-feeding control condition, the actor could eat the food on the table, to measure the ability to inhibit pulling when it was not sensible to do so. In the nobody-feeding control condition, food was on the table, but there was no partner present, to measure general frustration at being unable to access out-of-reach food.

All chimpanzees collapsed the table and therefore had experience with the consequences of pulling the rope. Furthermore, in the self-feeding control condition, chimpanzees collapsed the table they were eating from in only 3% of trials, showing they

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[†]We use synonyms for punishment, such as retribution, retaliation, and vengeance, to avoid confusion with the various uses of punishment in evolutionary biology, social psychology, and experimental psychology.

[‡]True spite, in which there are no direct future fitness benefits to the actor, can theoretically evolve but only in very limited circumstances (5, 6).

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Table 1. Change in behavior across 10 sessions

Condition	Standardized β	Standard error	t ratio	P value	95% bounds	
					Upper	Lower
Response, baseline	0	0.868	0	1.0	2.001	-2.001
Response, loss	-0.656	1.099	-2.459	0.039	-0.168	-5.236
Response, outcome disparity	-0.234	1.218	-0.679	0.516	1.981	-3.635
Response, theft	-0.656	1.378	-2.460	0.039	-0.212	-6.568
Theft	0.556	1.136	1.893	0.095	4.771	-0.469

Results are based on a linear regression after first testing for significance with a Fisher's omnibus test ($\chi^2_{10} = 19.01, P = 0.04$).

did not react to personally disadvantageous outcomes when that same individual was given the food by a human experimenter.

We examined four variables that might have affected the results: kinship, dominance, reciprocity, and time. First, pairs of individuals who were closely related to one another behaved no differently toward one another than unrelated individuals. Second, there was no correlation between dominance rank (based on a test of cofeeding intolerance) and being robbed in the theft condition (Mantel's matrix correlation $r_M = -0.094, n = 11, P = 0.551$), but across all trials, subjects were less likely to collapse the table when food was stolen by a more dominant individual ($r_M = 0.409, n = 11, P = 0.006$). Third, whether a chimpanzee stole from another in the theft condition was in no way related to whether he or she had previously been robbed by that individual ($r_M = -0.077, n = 11, P = 0.508$), and across all trials, there was no reciprocity in the sense that individuals did not collapse the table more against individuals who had previously collapsed the table against them. Finally, responses to loss and theft declined across the 10 sessions, whereas there was no change in responses to the baseline and outcome disparity conditions (Table 1); furthermore, there was a trend toward an increase in theft, suggesting that retribution did not have an effect on noncooperative behavior.

If chimpanzees were motivated toward vengeance against others out of anger [moral outrage (30)], as humans are with second-party punishment in the ultimatum game (31), we predicted that theft would arouse them [measured as intensity of displays and tantrums (32, 33)] more than would outcome disparity and loss. Chimpanzees were indeed aroused differently in the four conditions ($\chi^2_3 = 13.67, P = 0.002$; Fig. 4), and they were more aroused by theft than by loss ($T^+ = 59.00, n = 11, P = 0.018$). However, they were not significantly more aroused by theft than outcome disparity ($T^+ = 49.00, n = 11, P = 0.175$) nor

by outcome disparity than by loss ($T^+ = 25.00, n = 11, P = 0.078$). Within each of the conditions analyzed separately, chimpanzees were more likely to collapse the table when aroused (baseline $r_M = 0.547, n = 11, P < 0.001$; loss $r_M = 0.579, n = 11, P < 0.001$; outcome disparity $r_M = 0.558, n = 11, P < 0.001$; theft $r_M = 0.578, n = 11, P < 0.001$). These results suggest that anger mediated the chimpanzees' collapsing of the table, but it is not clear how arousal was influenced by a feeding conspecific in the different experimental conditions. Because acts of aggression are frequently directed at the appropriate target (2), and because displays in this study were frequently directed toward the conspecific partner, it is most probable that the collapsing of the table was not just the unintended byproduct of arousal.

The studies presented here suggest that chimpanzees are vengeful but not spiteful. Chimpanzees are retaliatory, in that they are negatively reciprocal (34), at least on a very short time scale, consistent with retribution as a means of discipline in animal societies (2, 22–24). Retribution did not enforce cooperative behavior through reciprocity in the current experiments likely due in part to the fact that subjects switched roles only once and only after engaging with all others. Furthermore, the benefit of stealing outweighed the costs of suffering retribution in the long run, so perhaps it is not surprising that, in this context, retribution declined with time, and stealing increased. Chimpanzees are not spiteful, in that they did not appear to have the decrease in welfare of conspecifics as an end in itself in either of the two experiments. Spitefulness may thus be a peculiarly human phenomenon. Further studies that attempt to distinguish vindictive motives from spiteful motives in humans and other animals are needed to validate this claim.

Humans who punish noncooperators with no expectation of personal gain may be motivated either to correct personally disadvantageous outcomes (8, 9) or to reciprocate according to perceived intentions (10–13) or both (35). For instance, in studies such as the ultimatum game when unfair proposals are generated randomly (36) or constrain a proposer to unfair options (37, 38), people still reject unfair offers, although at a lower rate, suggesting that both outcomes and intentions influence their perception of unfairness. Chimpanzees recognize negative intentions in others (39), and so it is conceivable they reacted to the harmful intent behind thefts in the current study. That chimpanzees were sensitive to harmful behavior and/or intent, but not to simple disparity over which the partner had no control, is consistent with intention-based models of fairness (10–13) but not with outcome-based models (8, 9). Although altruistic punishment (7) appears to be a key feature supporting sociality on the scale exhibited by humans because it stabilizes cooperation, even in sizable groups in which altruistic rewarding by itself cannot (1), it remains to be shown whether non-human animals will punish noncooperative behavior for no material benefit, and whether such behavior will stabilize cooperation within groups. Although punishment, spitefulness, retribution, revenge, envy, and *Schadenfreude* are often seen as blemishes in human nature, the propensity of people to compare their

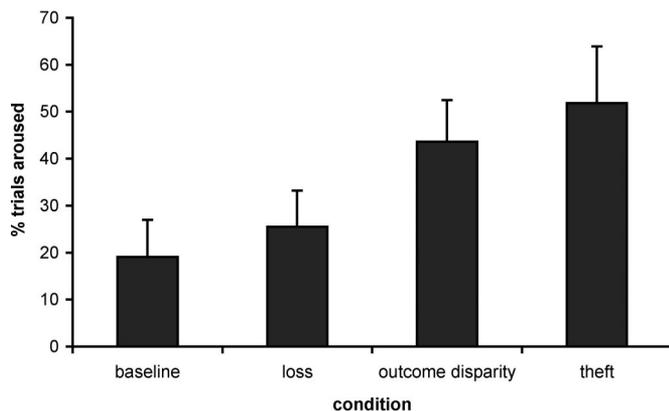


Fig. 4. Mean percentage of trials (\pm SEM) in which arousal (displays and tantrums) was exhibited by actors in Study 2 in response to nonfood items (baseline), losing food (loss), losing food to a conspecific (outcome disparity), and having the food stolen (theft).

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