

Centralized sanctioning and legitimate authority promote cooperation in humans

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Social sanctioning is widely considered a successful strategy to promote cooperation among humans. In situations in which individual and collective interests are at odds, incentives to free-ride induce individuals to refrain from contributing to public goods provision. Experimental evidence from public goods games shows that when endowed with sanctioning powers, conditional cooperators can discipline defectors, thus leading to greater levels of cooperation. However, extant evidence is based on peer punishment institutions, whereas in complex societies, systems of control are often centralized: for instance, we do not sanction our neighbors for driving too fast, the police do. Here we show the effect of centralized sanctioning and legitimate authority on cooperation. We designed an adaptation of the public goods game in which sanctioning power is given to a single monitor, and we experimentally manipulated the process by which the monitor is chosen. To increase the external validity of the study, we conducted lab-in-the-field experiments involving 1,543 Ugandan farmers from 50 producer cooperatives. This research provides evidence of the effectiveness of centralized sanctioning and demonstrates the causal effect of legitimacy on cooperation: participants are more responsive to the authority of an elected monitor than a randomly chosen monitor. Our essay contributes to the literature on the evolution of cooperation by introducing the idea of role differentiation. In complex societies, cooperative behavior is not only sustained by mechanisms of selection and reciprocity among peers, but also by the legitimacy that certain actors derive from their position in the social hierarchy.

In collective action problems, individuals have to decide whether to contribute to the provision of nonexcludable public goods when incentives to free-ride are pervasive (1). Social sanctioning is widely considered a viable solution to this type of social dilemma (2–5). Experimental evidence shows that, in public goods games (PGGs) (6), participants initially contribute, on average, between 40% and 60% of their endowment.* However, in repeated games, conditional cooperators who wish to avoid being exploited by free-riders gradually refrain from cooperation, thus leading to a drop in contributions in subsequent rounds (7, 8). By contrast, when endowed with sanctioning powers, conditional cooperators can discipline defectors, thus leading to greater overall levels of contribution (2, 9, 10). Peer punishment, as well as reward, provides a possibility of targeted interaction, thus fostering cooperation through mechanisms of direct and indirect reciprocity (11, 12).

Most empirical work on the role sanctioning plays in inducing cooperation has focused on testing evolutionary models of diffused and decentralized punishment (9, 13), and explored the relative efficiency of different peer-sanctioning institutions (14–16). However, scholars have recently begun questioning the ability of spontaneous, uncoordinated, and decentralized peer punishment actions to sustain cooperation in complex societies (17, 18), concluding that “the step from peer punishment to the establishment of sanctioning institutions deserve closer future investigations” (ref. 3, pp. 598–599). Peer sanctioning is only effective under restrictive conditions (3, 19): either individuals in a population are given the option of nonparticipation (20, 21) or the group is sufficiently small (17). In small-size groups, even self-interested contributors may choose to punish defectors at a per-

sonal cost, if interactions are frequent and there are reputation considerations (17). When groups become large and interactions between members infrequent, bilateral punishment is unlikely to sustain cooperation because future gains from punishment cannot be internalized (22).

To overcome this problem, groups tend to develop forms of self-regulation, in which the power to sanction defectors is transferred to a centralized authority (23–25): for instance, villagers in traditional societies turn to their chiefs to adjudicate disputes (26), organized workers developed centralized disciplining institutions to deter defectors (27), and merchants in Medieval Europe created guilds (22).

From an evolutionary perspective, centralized institutions are likely to be more efficient than peer punishment (28) because they are better positioned to overcome coordination failures and free-riding problems (18). To incorporate this phenomenon into theories of public goods provision, we study how group members behave in a context in which a centralized monitor is given a monopoly over sanctioning decisions. Will groups reach high levels of contribution even in a sanctioning regime in which group members do not have the power to decide who should be sanctioned?

Centralized systems of control cannot rely exclusively on the threat of punishment (29). Institutions that are perceived as legitimate only rarely turn to coercion to enforce group norms. In contrast to brute force, the authority of an individual (or organization) depends on the degree of compliance to his commands (30). We expect a leader’s authority to depend on his or her perceived level of legitimacy. Our second question is whether the process by which a central authority acquires sanctioning powers is consequential. We hypothesize that involving subjects in the selection of their monitoring authority will confer him greater legitimacy, thereby leading to greater cooperation.

Lab-in-the-Field Experimental Design

To test our hypotheses, we designed a unique adaptation of the PGG. Unlike peer punishment settings in which players are given the ability to reduce each others’ payoffs, in our centralized sanctioning setting, this power was given to a single monitor. We played three variants of the PGG. In the baseline condition, players participated in six rounds of a PGG without punishment. In the two

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*In PGGs, participants anonymously decide how to split an initial endowment between private and public accounts. What players put in the private account remains theirs, and what is contributed to the public account is doubled and redistributed evenly among all group members, regardless of their level of contribution. The most profitable outcome for the group occurs when all players contribute their entire endowment. Nonetheless, regardless of what other people contribute, the most profitable strategy for the individual is to keep the entire endowment in his private account and benefit from what everyone else contributes to the public account. Designed to induce a social dilemma, PGGs capture how players balance self-interest and the well-being of the group.

treatment conditions, after two preliminary rounds of play, one of the players was selected out of the session to become a monitor endowed with sanctioning power. Monitors received the same endowment as the other players [10 monetary units (MUs)] and could spend 1 MU to take away three MUs from players whose contribution level they disapproved of. The monitor's final payoff did not depend on the group's level of cooperation, but only on her sanctioning decisions. In the random monitor condition (T1), the monitor was selected through a random lottery. In the elected monitor condition (T2), the monitor was elected by group members, using a secret ballot (see *Methods and Materials* and *SI Appendix* sections 4 and 5 for additional information and the game script). Comparing the baseline with the random monitor condition allows for an assessment of the effect of a centralized sanctioning regime, whereas a comparison of the random and elected monitor conditions allows an estimate of the independent effect of the process by which the monitor has obtained her sanctioning power.

Laboratory experiments have greatly contributed to our understanding of cooperative behavior, but they are ill-suited to the study of processes in which group identity and cultural factors are expected to be consequential (23, 31, 32). Behavior is influenced by environmental cues. By stripping context away, laboratory experiments open themselves to the charges of undermining the external validity of the findings (33, 34). In addition, repeated interaction in small groups is generally considered the natural condition in which our ancestors had to operate, thus arguably the proper context for studying the emergence of cooperation (11, 12, 35). Incorporating these aspects in a laboratory setting is difficult (36). To overcome these limitations, we carried out our experiment with the members of natural preexisting groups that face collective action problems on a regular basis: our lab-in-the-field experiment was conducted in 50 different producer organizations (farmer cooperatives) in rural Uganda. A total of 1,543 farmers participated in our experiment.

Results

Fig. 1 summarizes our major findings. First, in the presence of a centralized sanctioning system, players significantly increase their contribution to the public good. In the random monitor condition (T1), subjects contributed 15.0% more on average than in the baseline condition ($P = 0.000$, two-sided Mann–Whitney tests). In the elected monitor condition (T2) subjects gave 25.4%

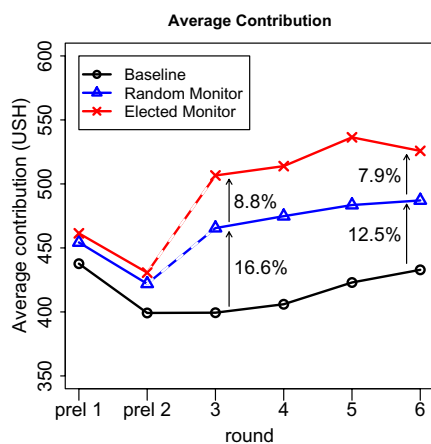


Fig. 1. Average contribution to the public good in the baseline (black), random monitor (blue), and elected monitor (red) conditions. For rounds 3 and 6 we report the percentage increase in contributions comparing the random and baseline conditions, and elected with random [e.g., in round 3, subjects in the random monitor contributed 16.6% more ($P = 0.000$) than in the baseline condition, and subjects in the elected monitor contributed 8.8% more than in the random monitor condition]. $n = 1,446$ (1,543 players – 97 monitors).

more on average than in baseline ($P = 0.000$). Moreover, subjects in both T1 and T2 behaved according to the expectation that monitors would discipline defectors: differences between the baseline and the two monitor conditions are already statistically significant in round 3, before the monitors have acted. In round 3, subjects in T1 contributed to the public account 16.6% more ($P = 0.000$), and subjects in T2 26.8% more ($P = 0.000$), than in the baseline.

Second, the process through which leaders obtain their sanctioning power is consequential: players who participated in the selection of their monitor contributed to the public account 9% more, on average, than players whose monitor was selected at random ($P = 0.005$). Similarly, elected monitors generated greater expectations: in round 3, subjects in T2 gave 8.8% more than subjects in T1 ($P = 0.022$). Statistical models with clustered SEs at the session level that control for preliminary contributions confirm the significance of these results (*SI Appendix*, Table S1).

We explain higher levels of cooperation in T2 as a consequence of the greater legitimacy of elected monitors. We conceive of legitimacy as the monitor's capacity to exercise authority and measure it as the extent to which players defer to the leadership (30). Observational studies have often suggested a positive relationship between the legitimacy of an authority and effectiveness in the exercise of power (29, 37, 38). Our experimental design tests the causal nature of this relationship. We expect players to express greater deference to an authority whose legitimacy has been certified through elections.

To test this hypothesis, we consider, first, players' expectations for the monitor, by looking at the change in their contributions from the second preliminary round to round 3 (Fig. 2A). Second, we consider players' reaction to the monitor's sanctioning behavior, by looking at the change in contributions of the sanctioned players (Fig. 2B). Fig. 2 shows the relative increase in contributions for a representative player in T1 and T2. Parameter estimates come from multilevel models in which we control for individual and group-level predictors (*SI Appendix*, Tables S2 and S3). We find that the introduction of a sanctioning system, even before any manifestation of the monitor's behavior, induced a net increase in contribution of 0.37 MUs in T1 and 0.76 MUs in T2. When considering players' reaction to punishment, evidence of the greater deference players have for elected monitors is even stronger. Having been punished at time $t - 1$ increased players' contribution by 0.57 MUs in T1, and by 1 MU in T2. In both cases, the elected monitor has an impact approximately twice as big as that of a randomly chosen monitor.

To strengthen our claim that the legitimacy of the monitor explains the difference in contribution between T1 and T2, we rule out the possibility that the effect we attribute to legitimacy is due to a "leadership selection" effect—namely, to the fact that players may have elected monitors who are well suited to leadership roles. According to this alternative interpretation, higher levels of cooperation in T2 might be due to the intrinsic qualities of the elected monitor. Indeed, subjects selected monitors with a socially dominant profile—elected monitors were mostly male, and, on average, were wealthier, more educated, and more likely to be born in the village, compared with the pool of eligible monitors (*SI Appendix*, Fig. S1). Nonetheless, none of the monitors' sociodemographic characteristics improved our predictions of players' contributions (*SI Appendix*, Table S4). Moreover, as shown in Fig. 2C, monitors with a socially dominant profile (male, born locally, highly educated, and wealthy) have the same sanctioning effect on contributions as monitors with a nondominant profile. These findings, cumulatively, weaken the possibility of a leadership selection effect. It is possible, however, that elected monitors have certain attributes that induce cooperation, which are unobserved to the researcher but visible to the experimental subjects. Although the possibility of unobserved heterogeneity cannot be ruled out completely, it is not likely to have a decisive role in the experiment.

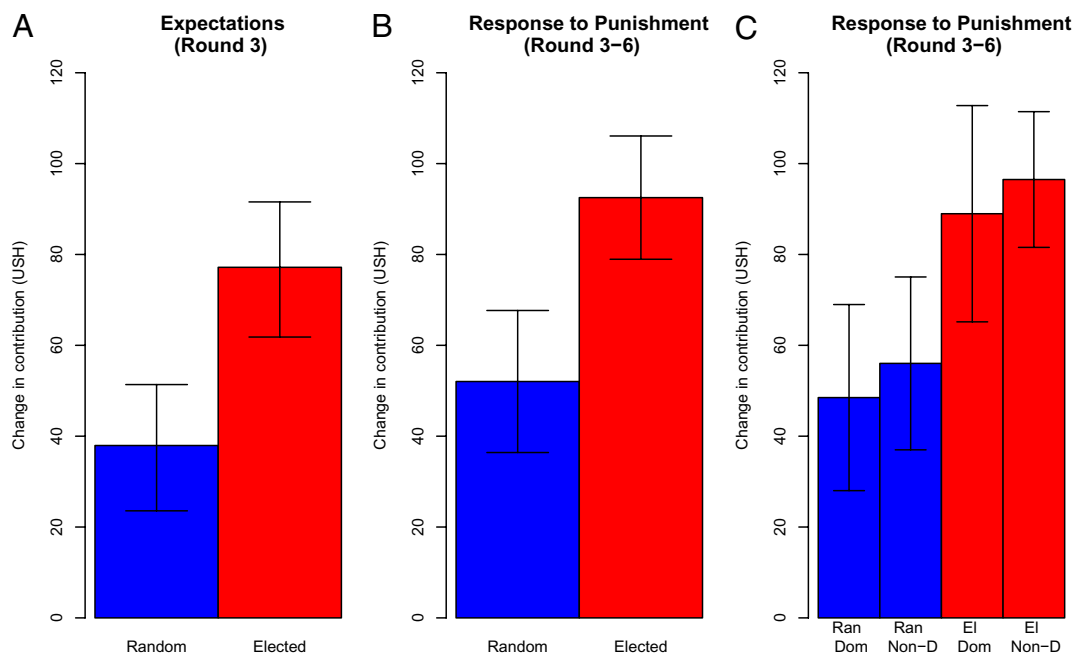


Fig. 2. The marginal effect of an elected monitor on contributions is twice as big as that of the random monitor, both with respect to players' expectations and reaction to punishment. Plot of the estimated change in contributions (A) for all players from second preliminary round to round 3; (B) for sanctioned player in rounds 3–6; and (C) for sanctioned players in rounds 3–6 distinguishing between monitors with a dominant or nondominant profile. Parameter estimates come from multilevel models in which we control for individual and group-level predictors (*SI Appendix, Tables S2 and S3*). All continuous variables are held constant at mean values, and the categorical variables are set to male and born local.

Our experimental design was intended to minimize the leadership selection effect: the subjects were randomly selected from six different villages; thus, subjects did not know more than one or two other subjects in their PGG session. In addition, none of the subjects held leadership positions in the farmer association, and they were not allowed to talk through the entire course of the experiment. These design features further reduce the possibility that participants had private knowledge of how well other subjects would perform as monitors. Finally, if we consider their contributions to the public good in the two preliminary rounds, elected monitors are not more public spirited than random monitors.

It remained to be seen whether monitors' sanctioning behavior is different in T1 and T2. A descriptive analysis suggests that elected and random monitors sanctioned, on average, the same number of players (from an average of 2.5 players sanctioned in round 3, to 1.5 players in round 6), whereas elected monitors sanctioned, on average, higher contribution in later rounds (see *SI Appendix* section 1.4.1 for a detailed descriptive analysis).[†] However, comparing the behavior of monitors in T1 and T2 is complicated by the fact that the distributions of contributions faced by elected monitors were different from those faced by random monitors. To overcome this problem, we used the Kullback–Leibler divergence measure to match the distribution of contributions that an elected monitor faced with the closest distribution that a random monitor faced. Using the matched pairs, we were then able to assess the extent to which elected and random monitors differed in their sanctioning behavior (see *SI Appendix* section 1.4.2 for a complete account of our method) and found that, when facing similar distributions, elected and random monitors tend to punish the same number of players (Fig. 3A) and maximum amount of contribution (Fig. 3B). This finding further weakens the possibility of a leadership selection effect.

[†]In round 6, players in T1 who contributed more than 25% of their initial endowment were not punished, whereas players in T2 were sanctioned for contributing up to 37% of their initial endowment ($P = 0.022$).

Because T1 and T2 monitors both used a similar sanctioning strategy, and since the frequency of punishment was not related to a group's average contribution (*SI Appendix, Fig. S3*), we conclude that monitors do not punish according to a predefined acceptable level of contribution. Rather, they consider players' contribution relative to the contribution of others and follow the heuristic strategy of sanctioning a few contributors at the bottom of the distribution. Moreover, with respect to monitors' impact on players' contribution, the number of players sanctioned and the maximum amount sanctioned do not affect changes in contribution (*SI Appendix, Table S4*). More than their actual sanctioning

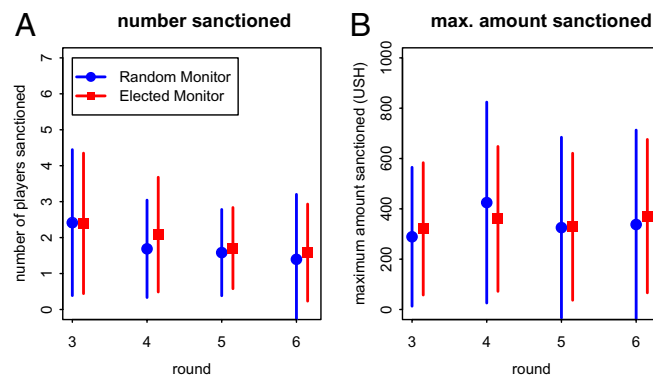


Fig. 3. When facing similar distributions of contributions, elected and random monitors have similar sanctioning behavior. The plots present a comparison of the sanctioning behavior of matched pairs of monitors. We used a Kullback–Leibler divergence measure to match the distribution of contributions that an elected monitor faced with the closest distribution faced by a random monitor. Plot of the (A) number of players sanctioned and (B) maximum contribution sanctioned per round. Vertical bars indicate \pm SD. P values from Wilcoxon matched-pairs signed-rank test are all greater than conventional levels of significance.

strategy, monitors' major impact on cooperation was the anticipation and response to sanctioning that they elicited.

Discussion

In recent years, a large cross-disciplinary literature has studied the role that diffused peer sanctioning plays in inducing cooperation. Although this literature has contributed much to our understanding of the evolution of cooperation, large-scale cooperation in complex human groups is not sustainable on the basis of peer punishment alone (39). Turning our attention to the role of centralized authorities opens up new research questions. Our findings suggest that in the presence of a leader, groups can reach higher levels of cooperation, and that monitors, at least in a situation in which their reputation is at stake, are willing to sacrifice part of their welfare to increase cooperation.[‡] These results are qualitatively similar to those obtained using peer sanctioning institutions, with the advantage that a centralized system of monitoring will be more efficient than a decentralized one, because it avoids the problem of uncoordinated over punishment (18). However, the efficiency of a centralized authority decreases as its distance from the monitored group or community increases. In fact, proximity increases monitoring capabilities, reduces information gaps and enforcement errors (41), and facilitates the adaptation of sanctioning practices to local norms (42). Future studies should investigate the relative efficiency of peer vs. centralized sanctioning regimes, distinguishing between centralized local authorities and larger institutional entities, such as the state.

Centralized authorities cannot rely exclusively on coercive punishment (29). Indeed, institutions that are perceived as legitimate only rarely turn to coercive force or power to enforce group norms. In contrast to brute force, the authority of an individual (or organization) depends on the degree of deference to his commands (30). Our study demonstrates that beyond the mere threat of punishment, cooperation is conditional on the perceived level of legitimacy of the sanctioning authority. The fact that subjects who were allowed to select their monitor increased their contribution in subsequent rounds by more than double the increase of subjects who faced an arbitrary authority is indicative of the role legitimacy plays in sustaining cooperation. This research documents experimentally the role of legitimate authority in fostering collective action.[§] This finding is consistent with empirical evidence suggesting that public goods provision is higher in democratic regimes. More work is also needed to understand the relative effectiveness of different sources of legitimacy, considering, for example, more traditional forms of authority.

Role differentiation and dominance hierarchies are organizing principles of most animal groups (43–45). In complex societies,

centralized systems of control can emerge endogenously by virtue of the legitimacy that certain actors derive from their position in the social hierarchy. The literature on the evolution of cooperation has focused mostly on mechanisms of selection and reciprocity among peers. Here, we advance the hypothesis that, under certain conditions, a legitimate authority might constitute an additional mechanism fostering cooperation and thus the construction of new levels of organization. Sources of authority can vary across species and cultures. Position in the pecking order or in the economic structure, religious or traditional power, and political rituals (i.e., elections) are just a few examples of the factors that might enhance authority and facilitate the establishment of leadership roles in humans.

Materials and Methods

To increase the external validity of our findings, we conducted our research with members of farmer associations created as part of one of Uganda's largest recent rural development interventions: the Agriculture Productivity Enhancement Project (APEP). Our lab-in-the-field experiment was conducted in 50 different groups in nine districts across Uganda. In each location ~30 farmers were randomly sampled from a list of all members of a local farmer association, for a total of 1,543 subjects. We used a stratified, random, multistage cluster design to select our sample (see *SI Appendix* section 3 for further details on the sampling strategy).

We played all three variants of the game in each of the 50 sampled farmer associations. Each participant was randomly assigned to one of the variants. The number of participants per session ranged from 8 to 12. This number is higher than in most PGGs (2–4), but was required to protect our subjects' confidentiality. Game participants were endowed, in each round, with 10 coins of 100 Ugandan shillings which corresponds to half a daily wage in rural Uganda, but paid the payoff of only one round, which was randomly selected at the end of the game. In addition, our subjects received a participation fee, travel reimbursement, and additional gains from other behavioral games played during the day.

The voting procedure in the elected monitor condition guaranteed complete anonymity: each player wrote on a piece of paper the identification number of the player she would like to select as a monitor. Subjects could see each other, but were not allowed to talk and were not given any information about the other participants. Subjects were sampled from six different villages and did not know, on average, more than one or two other PGG session participant (i.e., covillagers). They knew, however, that all subjects shared membership in their farmer cooperative. Finally, none of the participants held leadership positions in the farmer associations.

Data were collected between July 2009 and September 2009 by a group of 60 experienced local interviewers, divided into three language teams. The experimenter script was translated and back-translated from English into each of the native languages (Basoga, Luganda, and Ranyankole), and several pilot tests and debriefing sessions were conducted. Interviewers went through a 2-wk training in class and in the field setting, which included training on human subjects issues as well as survey techniques, and they were supervised by team leaders through the entire data collection.

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[‡]In the experiment, monitors did not gain from higher levels of cooperation, and they had a monetary disincentive to sanction. Nonetheless, their identity was known by the group, and thus we could not measure the extent to which their sanctioning decisions were affected by reputation considerations.

[§]Barr et al. (40) ran a corruption experiment with random and elected monitors, demonstrating that elected monitors were more willing to invest in exposing corruption.

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