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Experimental evidence for a pure collaboration effect

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What makes us willing to sacrifice our own self-interest for another person? Humans can forgo short-term individual gain to achieve long-term benefits[1–4]—but long-run self-interest cannot fully explain unselfish behaviour[5]. Collaboration in our evolutionary past may have played a role in shaping an innate human sense of distributive justice[6], influencing who we consider deserving of our aid or generosity. Previous research has not been able to isolate this response to collaboration as an independent effect, distinct from other motivations to share[7,8]. Here we present evidence of a pure collaboration effect, distinct from motivations of future reciprocity, in-group favouritism or concern for accountability. We demonstrate this effect among adult subjects in an economic setting, showing that the effect constitutes a psychological phenomenon with relevance for real-world social and political behaviour. This collaboration effect is substantial: it motivates sharing among people otherwise inclined to share nothing and increases the proportion of participants willing to give up half of their allotted money. We find evidence supporting our hypothesis that the collaboration effect operates by creating a sense of debt owed to one's collaborator.

In economics[9,10], political science[11], psychology[12] and sociobiology[13,14], the study of what conditions produce a willingness to sacrifice for others has largely resolved its focus to principles of accountability[9] or strong reciprocity[13,14]. According to these principles, others who arrive at a disadvantage through no fault of their own are considered deserving of our aid; not so those who are responsible for their losses due to laziness or poor judgement[10,15]. At a cost to ourselves, we will reward those who adhere to norms of morally upstanding behaviour and punish those who depart from such norms[16].

Discrimination based on collaborator status diverges from the principles of accountability and strong reciprocity. Under a collaborator principle, reward is not dependent on whether the other person is responsible for their position or has adhered to general norms of conduct, but on whether they have engaged in a common enterprise with you. By working with you in this common enterprise, your collaborator is deemed to merit special treatment, above and beyond that merited by someone following all of the rules and working just as hard, but working separately. To the extent that a collaborator principle describes an innate sense of distributive justice—in which equally needy individuals generating equal results at equal effort merit unequal treatment—this innate sense of distributive justice is at odds with proportional equality, an ethical principle of fairness as equity that has ancient lineage[17] and contemporary normative influence[18]. A predisposition to base determinations of desert on collaborator status suggests that we may have an ingrained tendency towards behaviour widely considered unethical: providing preferential treatment contingent on a contribution to your cause.

We hypothesize that collaboration increases willingness to sacrifice, distinct from considerations of accountability, self-interest, in-group favouritism or disparity. In particular, we hypothesize that collaboration induces a willingness to share with a collaborator by creating a sense of debt owed to that collaborator, rather than by creating a general preference for the collaborator to be better off[19]. The idea that collaborative effort should create a sense of debt corresponds with Locke's concept of property rights[20]. If labour bestows ownership, then joint labour should create joint ownership: the collaborator has a 'natural right' to some benefit from the jointly produced product. This indebtedness, focused on a past transaction with no bearing on one's outcomes going forward is distinct from definitions of reciprocity, whether strong[13,14], weak[21], direct[22] or indirect[3,4].

In our first experiment, participants in an online work marketplace are recruited to complete a data-entry task. Participants are assigned either to a treatment condition, in which the participant works in collaboration with a partner, or to a separately working condition, in which the participant and the partner are doing the same work, but working independently. The only difference between these two conditions is whether compensation for the task depends solely on one's own work (separate condition), or if compensation depends on the partner's work as well as one's own (collaborative condition). After completing the work, participants are offered the opportunity to share some of their payment with the partner, who, by chance (through a lottery), has received less than the participant. The amount of money the participant chooses to give to the partner constitutes the primary outcome variable.

To test whether the partner's effort moderates the effect of collaboration on willingness to share, we independently manipulate the level of effort exerted by the partner (to allow investigation of the role of effort, all partners are fictitious, as participants are informed at the end of the study). We implement a design with complete anonymity and no possibility of future interaction to deter subjects from being motivated by considerations of reputation or future reward, and we include an experimental condition emphasizing the impossibility of reputational gain to check for evidence that reputational concerns may still be at play. We present evidence that the treatment does not create a more favourable assessment of your partner, suggesting that the collaborative work does not produce an in-group and that the result is not a product of in-group favouritism. We control for inequality aversion by presenting all participants in both conditions with identical conditions of disparity. Finally, we include questions to investigate our hypothesis that the collaboration effect operates by creating a sense of debt owed to the collaborating partner. We conduct two

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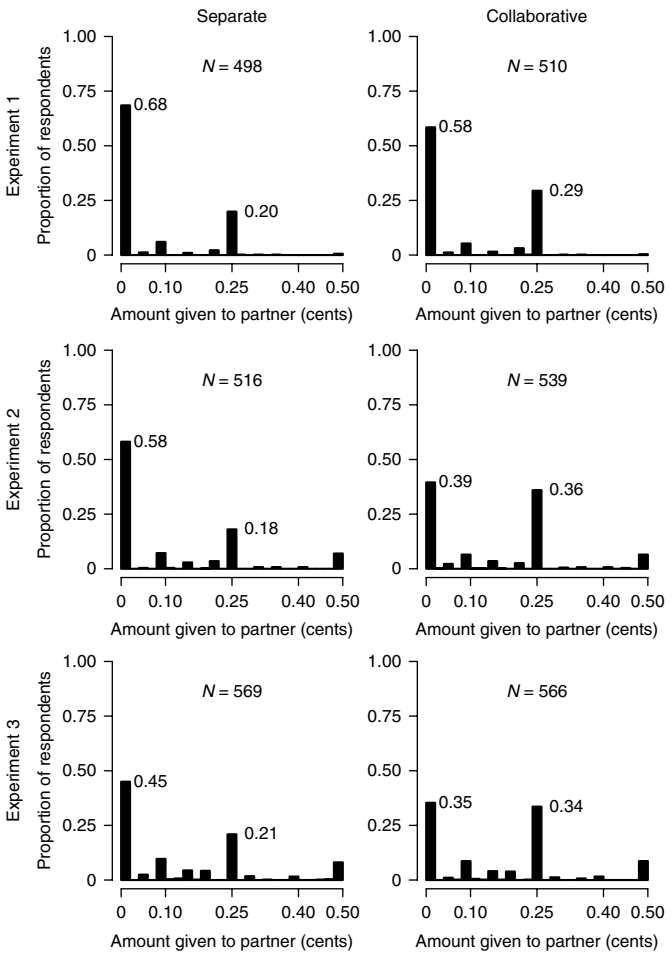

Fig. 1 | Collaboration increases the amount of money given to one's partner. Each histogram shows the proportion of participants giving up the indicated amount of money (shown on the *x* axis) to their partner. Separately working participants are shown in the left column; collaboratively working participants are shown in the right.

replication studies (experiments 2 and 3), confirming our findings in nationally representative samples, as well as a laboratory study (experiment 4) to test whether the effect translates to in-person, side-by-side collaboration.

Fig. 1 provides a complete picture of the outcome data from our original experiment and the two replication studies. Assignment to the collaboratively working condition significantly increases the mean amount shared with the partner. In all three studies, this mean increase results from two notable effects.

(1) Collaboration prompts giving among participants otherwise inclined to give nothing at all. In the initial experiment and both replication studies, a test of proportions (two-tailed) shows that collaboration significantly decreases the proportion of participants who indicate that they wish to give US$0 to their partner. In experiment 1, assignment to the collaboratively working condition caused a 9.4 percentage point increase in the percentage of participants who gave a positive amount to their partner, from 32.3% of participants in the separately working condition to 41.8% of participants in the collaboratively working condition ($z = 3.10$, $P = 0.002$, $h = 0.196$, 95% CI = 0.035–0.154)—a 29% increase in the rate of sharing. In experiment 2, the rate of sharing increased by 18.4 percentage points ($z = 5.98$, $P < 0.001$, $h = 0.371$, 95% CI = 0.125–0.244), and in experiment 3 by 9.7 percentage points ($z = 3.32$, $P = 0.001$, $h = 0.197$, 95% CI = 0.040–0.153).

(2) Collaboration increases the proportion of respondents willing to give up half of their bonus earnings for the partner. Comparing the proportion of participants who split their bonus with the partner (that is, gave US$0.25) relative to those who gave nothing, collaboration increases willingness to give half of the bonus by 10.9 percentage points ($z = 3.58$, $P < 0.001$, $h = 0.242$, 95% CI = 0.050–0.167) in experiment 1, by 23.9 percentage points in experiment 2 ($z = 7.02$, $P < 0.001$, $h = 0.505$, 95% CI = 0.174–0.303) and by 17.0 percentage points in experiment 3 ($z = 4.79$, $P < 0.001$, $h = 0.349$, 95% CI = 0.102–0.239).

To test whether the partner's relative effort moderated the effect of collaboration on willingness to share, we presented each participant with 'effort-level' scores for the participant and the partner. Participants were told that scores were calculated according to each person's speed and accuracy in data entry, but in fact, the scores were randomly assigned. In all three experiments, effort-level scores appeared as a value between 10 and 70, presented to two decimal places. In experiment 1, effort-level scores were assigned categorically: although the values for the participant and for the partner were displayed as if they were calculated as a continuous score, all participants were randomly assigned to one of four sets of scores. In experiments 2 and 3, effort-level scores were selected randomly from the interval (10.00–70.00) and vary continuously.

Figure 2 presents the outcome data from these three experiments, with the amount given to the partner on the *y* axis and the relative effort-level score on the *x* axis. Figure 2 also plots the regression line and 95% confidence bands for collaboratively working participants (red) and separately working participants (purple), pooling the data from all three experiments and including fixed effects for experiment, a quadratic term for relative effort, and robust standard errors. Collaboration has a direct effect on the amount given ($b_c(3,192) = 0.032$, $P < 0.001$, $d = 0.222$, 95% CI = 0.022–0.042), as shown by the distance between the red line and the purple line. Relative effort also has a direct effect on the amount given, as shown by the slope of the regression lines ($b_e(3,192) = 0.006$, $P < 0.001$, $d = 0.044$, 95% CI = 0.004–0.009). Relative effort does not seem to moderate the collaboration effect.

Participants are informed that they are taking part in a one-shot, anonymous interaction, so considerations of reputation or expectations of future benefit should not motivate the sharing decision. However, this aspect of the interaction may not be in the forefront of participants' minds by the time the primary outcome variable is collected. To check whether reputational concerns could be driving participants' sharing decisions, we include an experimental condition emphasizing the impossibility of reputational gain. Immediately above the space for entering the amount to share, some participants were randomized to see a reminder that not only is the transaction anonymous but also that the partner will not even know that an option to share existed: any amount shared would be presented to the partner as if it had been randomly assigned to them in the bonus lottery. If this condition were to cause the collaboration effect to disappear, that would suggest the effect was driven largely by reputational concerns. The results show no difference in the collaboration effect arising from this condition (see Supplementary Table 1 in the Supplementary Information). This suggests that the collaboration effect is not likely driven by reputational concerns.

To test whether the collaboration treatment increased affinity for the partner, we included an assessment of the subject's general feelings about their partner. All subjects were asked, 'how good do you feel about your partner?' (continuous 0–10 scale), before and after the assigned condition was revealed. Calculating the within subject change from before to after treatment results in a 20-point scale (ranging from a –10-point change to a +10-point change). The overall mean was a 0.21 change with a standard deviation of 1.46 points change. Assignment to the collaboratively working group did not significantly influence how good participants reported feeling

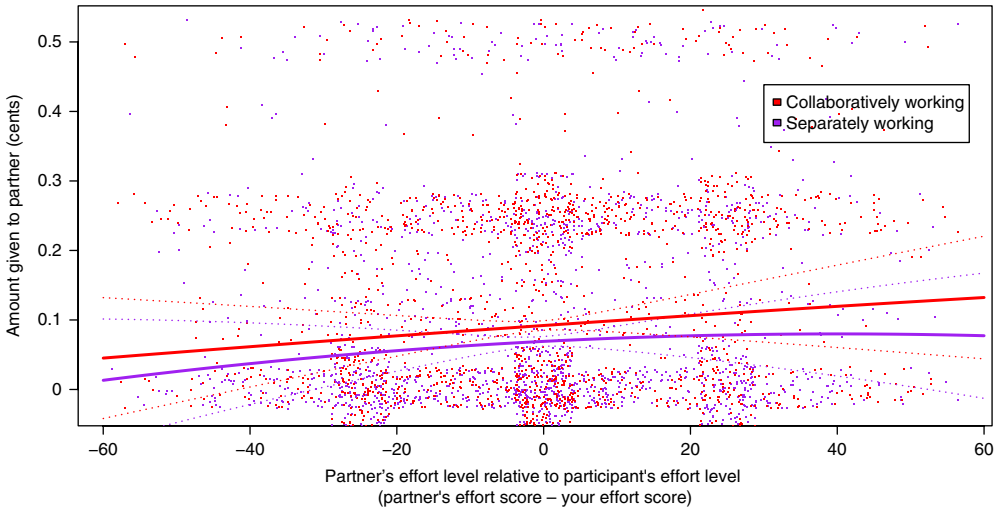

Fig. 2 | The effect of collaboration is independent of the partner's relative effort. The partner's effort margin (calculated as the partner's effort-level score minus the participant's effort-level score) is shown on the *x* axis, with the amount of money given to the partner on the *y* axis. The scatter plot shows data for participants in all three experiments ($N = 3{,}198$), with points jittered for visibility. The predicted values (solid lines) and 95% confidence bands (dotted lines) are shown in red for the collaboratively working group and in purple for the separately working group. Collaboration ($b_c(3{,}192) = 0.032$, $P < 0.001$, $d = 0.222$, 95% CI = 0.022–0.042) and relative effort ($b_e(3{,}192) = 0.006$, $P < 0.001$, $d = 0.044$, 95% CI = 0.004–0.009) each have a direct effect on the amount given. There is no evidence of an interaction between collaboration and relative effort.

about their partner ($t(3{,}196) = 0.714$, $P = 0.475$, $d = 0.025$, 95% CI = −0.064 to 0.138). To rule out the possibility that the lack of a difference might be due to a desire to stay consistent with one's pre-treatment response, we replicated this result in a new sample asking the question only after the assigned condition was revealed. An a priori power analysis indicated that a sample of 550 participants should allow us to detect even a 'small' effect of the treatment on affinity for the partner. The replication again showed no meaningful difference between the conditions, with affinity in the collaborative group slightly lower than in the separately working group ($t(547) = 1.10$, $P = 0.273$, $d = -0.094$, 95% CI: −0.55 to 0.16). The absence of a broader affinity in the collaborative group suggests that the treatment is not creating an in-group and that the mechanism at work is distinct from in-group favouritism[23–27].

We hypothesized that collaboration increased sharing by creating a sense of debt owed to the partner. In experiment 1, we asked participants to indicate the primary reason for their sharing decision out of a list of 14 potential explanations. These 14 explanations included both reasons to share and reasons not to share, along with one neutral explanation—the partner would have made the same decision if their positions had been reversed—that could describe either a reason to share or a reason not to share.

Figure 3 shows the effect of assignment to the collaboratively working group on the probability of selecting each explanation, relative to the neutral option. The debt explanation—I owed it to my partner—stands out as the only explanation for which the probability of selection is significantly increased by assignment to the collaboratively working group ($b_d(100) = 0.421$, $P < 0.001$, $h = 0.417$, 95% CI = 0.235–0.607). Collaboration has a borderline negative effect on the probability of indicating altruism—wanting to do something nice for the partner—as the primary motivation for one's sharing decision.

Finally, we conducted a laboratory experiment (experiment 4) to test whether the collaboration effect also manifests with in-person, side-by-side collaboration. Collaboration in the in-person experiment again increased the mean amount given to the partner, reproducing both elements of the collaboration effect observed in the original experiments. Figure 4 presents the outcome data from experiment 4.

(1) Collaboration prompts giving among participants otherwise inclined to give nothing, increasing the percentage of participants who chose to share some amount with their partner from 77.2% in the separately working group to 98.5% in the collaboratively working group ($\chi^2(1) = 11.51$, $P < 0.001$, $h = 0.747$, 95% CI = 0.317–0.725). (2) Collaboration also increases the proportion of respondents willing to give up half of their bonus earnings for the partner: comparing the proportion who split their bonus relative to those who gave nothing, collaboration increases willingness to give up half of the bonus by 24.2 percentage points, from 74.0% to 98.2% ($\chi^2(1) = 11.72$, $P < 0.001$, $h = 0.804$, 95% CI = 0.322–0.739).

One notable difference between our original design and the in-person study is the high proportion of participants who chose to share under both in-person conditions—a result consistent with evidence that feelings of closeness or distance affect willingness to share with others[28,29]. This underscores an advantage of our original design, which employs a bare-minimum instance of collaboration in a highly controlled setting. Identifying a collaboration effect under such pared-down conditions both allows confidence that the collaborative aspect of the interaction (rather than some confounding factor) causes the treatment effect and illustrates that even a very minimal act of collaboration exerts a substantial and consistent influence on sharing behaviour.

Our results show that a pure collaboration effect appears among adults in a setting with real economic stakes: a minimal act of collaboration increases willingness to sacrifice resources for another person. These effects are substantial: collaboration significantly increases the proportion of participants who give up half of their bonus money and prompts sharing among those who are otherwise inclined to give nothing at all. This collaboration effect seems to be independent of the partner's effort, and the mechanism seems to be distinct from motivations of future reward or in-group favouritism. Rather than being driven by a sense of affinity for a collaborating partner, the effect seems to operate by creating a sense of debt owed to one's collaborator.

This collaborator principle describes a motivation to sacrifice for another that is distinct from principles of accountability, self-interest or altruism, and is not based in aversion to inequality, concern

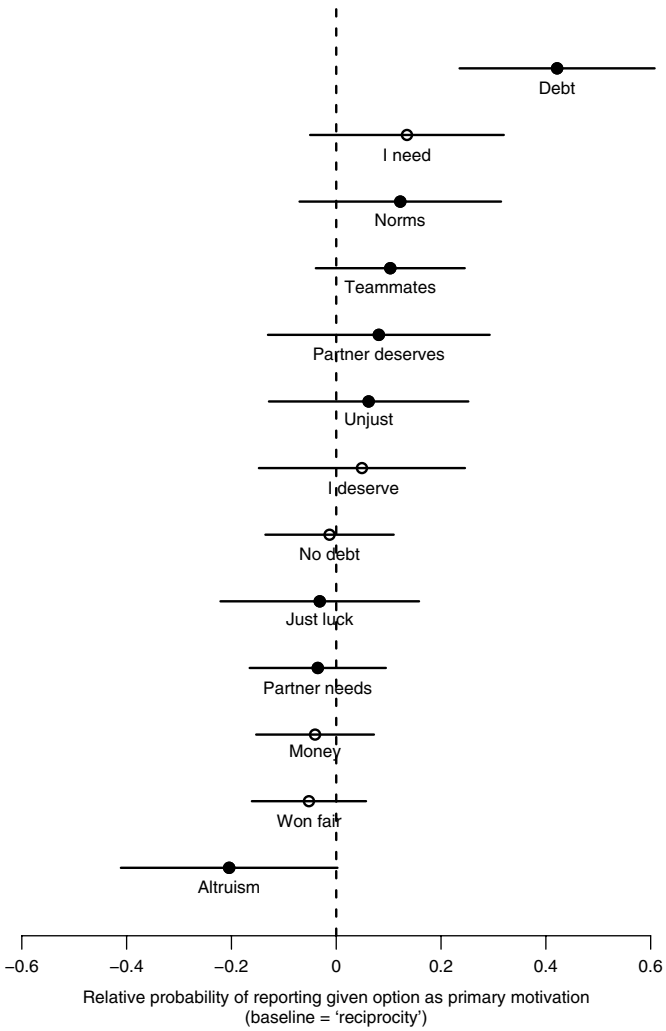

Fig. 3 | Collaboration increases the probability of reporting indebtedness as one's primary motivation. Points indicate the effect of assignment to the collaboratively working group on the probability of selecting each response option as the primary reason for one's sharing decision, relative to the neutral response of reciprocity ('my partner would have done the same if I had gotten US$0') as the baseline, with 95% confidence intervals. Reasons to share are shown as solid points, and reasons not to share are shown as hollow points. Only indebtedness ('I owe it to my partner') is significantly affected by assignment to the collaborative group ($b_d(100) = 0.421$, $P < 0.001$, $h = 0.417$, 95% CI = 0.235–0.607).

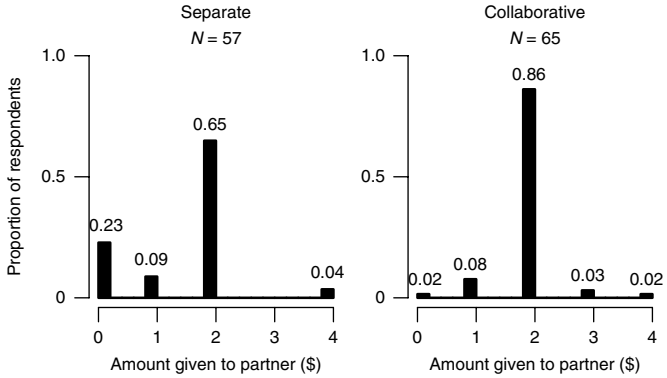

Fig. 4 | In-person collaboration increases the amount of money given to one's partner. Each histogram shows the proportion of participants giving up the indicated number of dollars (shown on the *x* axis) to the partner, out of a US$4 bonus payment. Separately working participants are shown on the left; collaboratively working participants are shown on the right.

for efficiency, in-group favouritism or attention to need. Faced with a decision of whether to sacrifice for someone at a disadvantage, we behave as though our collaborators merit more than others who have worked just as hard, but whose work bears no connection to our own.

Understanding the link between collaboration and resource sharing may shed light on the underpinnings of redistributive preferences more generally. Political rhetoric keying on collaborative effort as an argument for greater taxation and redistribution suggests that political elites consider this connection compelling. For example, during the 2012 US Presidential campaign, Barack Obama gave a speech emphasizing the collaborative nature of the national economy as a reason for the wealthy to pay more in taxes. The response to the speech from Mitt Romney's campaign argued against the fact of collaboration—ads showed small business owners saying they had built their businesses through their own individual work and investment. This focus on disputing the fact of collaboration suggests an implicit acceptance of the logic presented in the speech: if the successes had been built on collaborative effort, that may well have been reason for the successful to 'give something back'. Both parties seemed to find natural the idea that collaborative effort compels sharing the fruits of that labour. The experimental evidence presented here suggests that this intuition of political elites may be correct: we are more likely to share our resources with others when we feel like our lives and work are interdependent with the lives and work of others.

If morality is an evolutionary adaptation resulting from selfless behaviour that enhanced group fitness[15], and if willingness to sacrifice for those who have contributed to your cause represents one form of such selfless behaviour, then a collaborator principle may be woven into the fabric of human morality. But, although an impulse to repay a collaborator may be prosocial in many scenarios, this apparently natural association also suggests a deep-seated bias. A tendency rooted in our evolutionary past to give preferential treatment to those who have contributed to our cause has troubling implications for ethical behaviour. A politician given a generous campaign contribution could feel an innate 'moral' compulsion to satisfy a debt owed to the donor; a doctor receiving a research grant from a pharmaceutical company may feel a similar impulse to 'give something back'. Our work suggests that the same forces potentially responsible for the emergence of human morality may also help to explain a human vulnerability to corruption.

Methods

We complied with all relevant ethical regulations regarding human research participants. Informed consent was obtained from all participants. The protocol was approved by the Human Subjects Committee at Yale University (New Haven, CT, USA).

All statistical tests reported are two-tailed. For experiments 1–3, the data meet the assumptions of the statistical tests used by virtue of sample size. For experiment 4, the data are not normally distributed (distribution shown in Fig. 4), so a non-parametric test is reported.

Experiments 1–3 (original design). *Participants.* Based on a pilot study that generated a Cohen's $d = 0.177$, the sample size for experiments 1–3 was determined by an a priori power analysis, indicating $N = 1{,}004$ (two-tailed, $\alpha = 0.05$, power = 0.8). Participants were assigned to the collaborative or separate condition by simple random assignment through the Qualtrics survey software, and data collection was performed blind to the conditions of the experiment. Data analysis was not blind to the conditions of the experiments. No participants were excluded from the study.

For experiment 1, we recruited participants ($N = 1{,}008$) on Amazon Mechanical Turk in April 2014. The sample was typical of the Mechanical Turk population,

with 36% female, 81% between 18 and 34 years of age, 51% holding a BA or more advanced degree, and disproportionately Democratic (63% Democratic, 14% Independent and 23% Republican). For experiment 2, we recruited respondents (N = 1,055) through Qualtrics Panels in August 2014. Recruitment was targeted to obtain a sample that was nationally representative on age, income, education and sex, with 51% female and 38% between 18 and 34 years of age. The sample was collected to be balanced on race/ethnicity, with approximately one-third of the respondents primarily identifying as black, one-third as white and one-third as Hispanic. Fifty-one per cent of respondents identified with the Democratic party, 23% as Independents and 25% as Republicans. For experiment 3, we recruited participants (N = 1,135) in December 2014 through Survey Sampling International. The sample was again collected to be nationally representative on age, income, education and sex—with 54% female and 32% between 18 and 34 years of age—and balanced on race/ethnicity. Forty-six per cent of respondents identified as Democrats, 27% as Independents and 28% as Republicans. The experimental conditions were balanced on these covariates.

Experimental design. The study was presented to participants as a pilot test of a new system designed to encourage speed and accuracy in online data collection. Each participant was given a list of US towns and asked to look up the name and phone number of the town mayor in a search engine, recording the name and phone number in the space provided. All participants were given the same towns, with the order randomized, although they were not informed that every participant had the same list. The task was designed to be effortful but uncomplicated, and typical of the types of tasks commonly posted to Mechanical Turk. Screenshots in the Supplementary Information show the list of towns as well as instructions as presented to the participants.

Participants were instructed that each person would be paired with a partner for the task. To provide a rationale for partnership, participants were told that the entries of the two partners would be compared against each other to check for accuracy. In all cases, the partner was fictitious, as explained in a debrief at the end of the study. Each person would be given 4 min to complete as much of the data collection list as possible. Participants were informed that, before the task, each two-person team would either be assigned to a collaboratively working group or to a separately working group, but would only learn which group their team had been assigned to after completion of the task. That is, participants were told that group assignment would occur before the task began, as soon as they were paired with a partner, but that they would only learn which group their team had been assigned to after the task. This allows all participants to have a full understanding of the two possible payment schedules, and the same expectation across both groups while performing the task that they might be working under either of the two schedules.

A lottery to receive a bonus payment would be held after completion of the task. Participants were told that the rules for lottery eligibility differed for the collaboratively working group and the separately working group. It was explained that, in the collaboratively working group, each person's lottery eligibility was dependent on their partner's work as well as their own: if, and only if, both members of the team completed the required number of entries accurately, then both members of the team would be granted lottery eligibility. In the separately working group, lottery eligibility was dependent only on one's own work: for each person on the team, lottery eligibility was granted if they themselves completed the required number of entries accurately, regardless of their partner's performance.

After the data entry task was completed, all participants responded to the same set of questions that assessed their understanding of the lottery eligibility rules, with feedback correcting or confirming their answers to reinforce comprehension of experimental conditions. These questions reminded participants that, if someone were eligible for the bonus lottery, it meant that person had completed the required number of accurate entries, and that owing to random allocation of bonuses through the lottery, some people who achieved lottery eligibility would not be selected to receive a bonus.

Two opinion questions were included along with the comprehension questions: how effective do you think this system is at encouraging speed and accuracy in data entry? How good do you feel about your partner? These questions appeared again later, immediately after the condition assignment was revealed, to measure individual-level change caused by the treatment.

After receiving the comprehension feedback, participants were informed which group their team had been assigned to. After a brief 'processing' delay, all participants were informed that they had met the lottery eligibility requirements for their assigned condition. Participants were then presented with 'team statistics' conveying information about each member of the two-person team. One row provided information about the participant's performance and outcomes; the next row provided corresponding information about the partner. The information included each team member's 'effort-level' score, each team member's lottery eligibility and whether each member of the team was selected in the lottery to receive a bonus.

The only differences in the 'team statistics' table for the collaboratively working and separately working conditions appeared in the bottom row, which indicated whether the team had been 'working collaboratively' rather than 'working separately,' and indicated whether lottery eligibility had been 'jointly achieved' rather than 'separately achieved.'

All participants and their partners were listed as having achieved lottery eligibility, indicating (in both conditions) that both members of the team had completed the required number of accurate entries. To further control participants' perceptions of their partners' effort, participants were told that each person's effort had been rated based on their response pattern and timing, as calculated by the 'effort-level' algorithm. In fact, effort-level scores were randomly assigned.

In experiment 1, participants were assigned to one of four effort-level conditions representing four different pairings of participant–partner effort scores. In the first condition, the partner was shown to have an effort level of 23.38, whereas the participant scored 48.41 (partner effort level much lower than participant effort level), giving the partner a relative effort level of 25.03 points lower than the participant. In the second condition, the partner was shown to have an effort level of 23.38 and the participant scored 23.41 (partner effort level slightly lower than participant effort level), giving the partner a relative effort level of 0.03 points lower than the participant. The third and fourth conditions reversed the score pairings of the first two conditions, so that the partner had a relative effort level 0.03 points (slightly higher) and 25.03 points (much higher) higher than the participant. In experiments 2 and 3, the effort-level scores of the participant and the partner were independent random draws from the interval (10.00–70.00).

Although both the participant and the partner gained lottery eligibility, as noted above, only the participant was selected in the lottery to receive a bonus. In the 'Message(s)' column of the team statistics table, all participants were told that they would be awarded a US$0.50 bonus (on top of a base payment of US$1.00) as part of their compensation. The row providing information about the partner included a message noting that the partner was not selected to receive a bonus.

This set-up created a situation in which all participants first learned about the two possible compensation schemes, then completed a task, and after the task learned which compensation scheme they were in (collaborative or separate). All participants then learned that they had won a bonus of US$0.50 in the lottery, whereas their partner, who had completed the work required to be eligible for a bonus, had not won anything in the lottery.

As the key design feature in this experiment, treatment and control groups differ only in that, after completing the data-entry task, participants either learned that their team had been assigned to the collaboratively working condition or that their team had been assigned to the separately working condition.

The experimental design controls for other important motivations for sharing. Perceptions of the partner's effort are controlled in three ways. First, participants learn about the two work conditions before completing the task, but are informed that neither they nor the partner will learn which condition they are working in until after the task is completed. Learning the condition afterwards prevents participants in the two conditions from making different assumptions about the amount of effort their partner may be putting in given the treatment assignment, as no one knows their treatment assignment while doing the work. This also prevents participants in the two conditions from putting in different levels of effort themselves. Second, all participants in both conditions learn that their partner met the required threshold for accurate data entry to gain eligibility into the lottery, just as the participant did. That is, in both conditions, participants learn that both they and their partner completed the required work. Finally, we independently manipulate the reported level of effort exerted by the partner, both to avoid any differential assumptions about relative or absolute effort in the collaborative and separate conditions, and to test whether relative effort moderates the effect of collaboration on willingness to share. A manipulation check on the participant's perception of the partner's effort confirmed that there were no differences in perceptions of effort across the two conditions.

The design also controls for inequality aversion, by holding disparity constant across the two conditions. In all cases, the participant wins a US$0.50 bonus in the lottery and the partner wins nothing. Three elements of the design are intended to control for reputational concerns or expectations of future benefit. First, the experiment consists of only one round—there is no possibility of repeated interaction with the partner. Second, participants are reminded that the interaction is entirely anonymous. Third, participants are informed that their partner will not know that the opportunity to share was even offered: any amount shared will be presented to the partner as if it had been won in the lottery.

Two additional elements contribute to the validity of the design. First, Mechanical Turk, from which participants were recruited for experiment 1, presents an ideal platform for this experiment. Mechanical Turk is a real online workplace: participants visit the site for the explicit purpose of doing work to earn money, and the task involved in the experiment was very similar to the types of data-entry tasks frequently posted to Mechanical Turk. Second, the absence of any in-person contact from the collaboration is an important feature of the design. This minimal instance of collaboration isolates the effect of collaboration from any effects of interpersonal interaction that may influence the sharing decision. Limiting treatment to the barest possible form of collaboration prevents contamination of the treatment effect estimate by confounding factors that could arise from a more hands-on instance of collaboration.

Measures. The primary outcome measure records how much of the bonus money was shared with the partner. At the bottom of the 'team statistics' page, participants were given the option to share some of the bonus with their partner. In both

conditions, a message noted that the respondent's partner had not been selected to receive a bonus in the lottery, and continued: 'if you would like to share some portion of the US$0.50 bonus with your partner, please enter the amount you consider fair. If not, please enter 0'.

Although this outcome measure was designed to be visually understated, participants were required to enter an amount between 0 and 0.50 before proceeding to the next page. No default was offered. For example, to give nothing, the participant had to enter US$0. Although the amount of money at stake is small, considerable research has shown that higher stakes tend not to substantively alter behaviour in economic games[30] and that, even with very low stakes, economic game experiments run on Mechanical Turk have been found to be comparable to those run in laboratory settings[31].

We asked several questions to investigate the mechanism at work. Participants were asked to rate their partner's effort, to rate how good they felt about their partner and to characterize the thought process behind their sharing decision. We asked participants to characterize the thought process behind their sharing decision in three ways. First, we asked participants to indicate the extent to which they had deliberated over their sharing decision. A continuous 0–10 scale was presented, with 0 indicating 'thought through all of the reasons' and 10 indicating 'went with my instinctive feelings'. Assignment to the collaboratively working condition significantly increased the extent to which subjects reported going with their instinct (0.53 scale points; 95% CI: 0.13–0.92). This finding corresponds with the experimental evidence suggesting that forcing an intuitive rather than reflective decision increases cooperative behaviour[32]. (Taken together, these findings suggest that intuitive thinking leads to cooperation and that cooperation leads to intuitive decision making.)

The other two items inquiring into the decision process focused on 14 potential explanations for the sharing decision. These 14 explanations included both reasons to share and reasons not to share, along with one neutral explanation that could describe either a reason to share or a reason not to share. Supplementary Table 2 in the Supplementary Information displays the exact wording of these explanations alongside the labels used in Fig. 3. Reasons not to share included the inherent fairness of a lottery outcome (won it fair), a desire to maximize earnings (maximize $), the sentiment that the subject owed nothing to the partner (no debt to P.), the subject's greater desert (I deserve it) and the subject's greater need (I need it). An expectation that the partner would have made the same decision if the positions were reversed (reciprocity) could be used to describe either a decision to share or not to share. Reasons to share included reference to the arbitrary nature of a lottery (won it arbitrarily), feelings of owing the partner (debt to P.), an urge to do something nice for someone else (altruism), the partner's desert (P. deserves it) and need (P. needs it), the fact that the subject and partner were part of a team (we're teammates), a sense of injustice on the partner's behalf (unjust P. got 0) and a desire not to be seen as greedy (not seem greedy).

The first of the two explanation questions asked subjects to select which 1 of the 14 explanations most closely matched the primary reason for their sharing decision. On the subsequent page, the second of the two questions asked subjects to rate the extent to which each of the reasons influenced their sharing decision. Each of the 14 explanations was listed alongside a continuous 0–10 scale, with 0 labelled 'did not influence my decision at all' and 10 labelled 'influenced my decision a lot'. For both questions, the 14 explanations were presented in a randomized order. As with the primary reason question, the largest experimental difference for the influence ratings appeared regarding the debt explanation (1.09 scale points; 95% CI: 0.70–1.49).

Experiment 4 (in-person design). *Participants.* For experiment 4, sample size was determined by the size of an undergraduate student subject pool. Students enrolled in the subject pool in January and February 2018 were recruited to participate in the study, resulting in $N = 122$. The sample was 47% female, 65% white, 98% between the 18 and 22 years of age and disproportionately Democratic (69% Democratic, 24% Independent/other and 7% Republican). The experimental conditions are balanced on these covariates. Participants were assigned to the collaborative or separate condition by simple random assignment conducted by the laboratory manager. Data collection and analysis were not performed blind to the conditions of the experiment. No participants were excluded from the study.

Experimental design. The study was presented to participants as a test of how people's work speed, quality and efficiency vary under different compensation systems. Once both the participant and a confederate were present in a waiting room, the laboratory manager gave a brief description of the experiment and informed them that they would either be assigned to work collaboratively or separately. The laboratory manager then brought the pair into the laboratory room, which contained a large table prepared with two identical, side-by-side work stations. Each work station consisted of two stacks of 25 fliers, one stack of envelopes and a box in which to place stuffed envelopes. The laboratory manager seated both workers (the participant and the confederate), ran a program randomizing the pair to the collaborative group or the separate group, and read a set of instructions depending on the assigned treatment condition. In both conditions, the instructions specified to take one sheet from each stack, fold them together in thirds, place them in an envelope for mailing and set the stuffed envelope into the box provided. Workers were told that they would have 8 min to complete as many envelopes as possible. This task was designed to be effortful but uncomplicated, as with the task in the original design. The Supplementary Information contains the instructions as presented to the participants.

In the collaborative condition, workers were informed that their two-person team had been assigned to the collaboratively working group, which meant that, if both of them met a work quota (based on benchmarks for efficiency and quality), they would both be entered into a bonus-payment lottery. In the separate condition, workers were informed that their two-person team had been assigned to the separately working group, which meant that, if each worker individually met the quota, that worker would be entered into the lottery. After this description of the appropriate condition, workers in both conditions were asked three true-or-false questions regarding the quota requirements to check for understanding.

After describing the work task, the laboratory manager left the laboratory room, and after 8 min had passed, returned to collect the boxes of completed envelopes. The laboratory manager took the boxes out of the laboratory room for 'scoring', then returned (after counting the envelopes) to announce that both workers (in both conditions) met the criteria for entry into the lottery. The laboratory manager then ran a program that performed a 'lottery' for the confederate and announced that that worker had not won anything in the lottery. Then, the laboratory manager ran a program performing the lottery for the participant and announced that the participant had won US$4 in the lottery. 'Participant 1' (the confederate) was asked to step out to the waiting room while 'participant 2' (the participant) completed an exit survey.

Once the confederate left the room, the participant was given a tablet on which to complete a brief 'exit survey', which included an option to indicate some amount of the bonus winnings to share with the partner. Participants were then paid US$1 for participating plus any amount of the US$4 bonus not given to the partner.

Measures. The primary outcome measure records how much of the bonus money was shared with the partner. Participants were required to enter an amount between US$0 and US$4 before submitting the exit survey. No default was offered. Although participants had the option of selecting US$0.25 increments, all participants indicated full dollar amounts or US$0.

Reporting Summary. Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Code availability

The code reproducing the analysis is publicly available in Northwestern University's Arch Research and Data Repository at: https://arch.library.northwestern.edu/collections/mg74qm27m.

Data availability

The data sets generated during and analysed for the current study are publicly available in Northwestern University's Arch Research and Data Repository at: https://arch.library.northwestern.edu/collections/mg74qm27m. These data sets include data for all figures (Figs. 1–4).

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Author contributions

M.C.M. conducted experiment 4. M.C.M. and A.S.G. otherwise contributed equally.

Competing interests

The authors declare no competing interests.

Additional information

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Software and code

Policy information about availability of computer code

Data collection	Qualtrics survey software
Data analysis	R (3.3.2) and Stata (15)

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Behavioural & social sciences study design

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Study description	The study involves four experiments involving a behavioral measure of willingness to share (amount of money given to a partner). Experiments 1-3 were conducted online. Experiment 4 was conducted in a laboratory setting.
Research sample	Experiment 1 involved a convenience sample drawn from Amazon Mechanical Turk workers. Experiments 2 and 3 were samples designed to be nationally representative on age and sex, and balanced on race/ethnicity. Expeirment 4 involved a sample of Northwestern University undergraduates enrolled in the Research Study Subject Pool.
Sampling strategy	Experiments 1 and 4 involved a convenience sample. Experiments 2 and 3 were sampled to be nationally representative on age and sex, and balanced on race/ethnicity, conducted by Qualtrics and Survey Sampling International, respectively. Sample sizes were chosen through a power analysis based on a small pilot study.
Data collection	For Experiments 1-3, subjects participated in the study online using Qualtrics Survey software. For Experiment 4, subjects participated in person. A study manager and one confederate were also present. Data was collected on a laptop computer and a tablet. Study managers were not blind to the conditions during data collection.
Timing	Experiment 1: April 2014, Experiment 2: August 2014, Experiment 3: December 2014, Experiment 4: January-February 2018
Data exclusions	No data were excluded from analysis.
Non-participation	No participants dropped out between administration of the treatment and collection of the outcome data.
Randomization	Participants were allocated into treatment and control groups by simple random assignment through the Qualtrics Survey software

Reporting for specific materials, systems and methods

Materials & experimental systems

n/a	Involved in the study
☒	☐ Unique biological materials
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology
☒	☐ Animals and other organisms
☐	☒ Human research participants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Human research participants

Policy information about studies involving human research participants

Population characteristics	See above.
Recruitment	For Experiments 1-3, participants were recruited online through platforms that allow people to earn rewards for doing tasks, including participating in studies. This feature of the participant pool contributes to (rather than detracts from) the design, as the subjects have chosen to take part in order to do work and earn money, which they are then asked if they are willing to part with. This is more parallel to a real-world setting than an experiment in which subjects receive a laboratory-bestowed windfall they are asked to share.