The Cooperative Consequences of Contests

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Abstract:[1]

Although contests are recognized theoretically as a highly effective method of motivation, the competitive nature of contests may generate unintended negative effects on social interactions in more general settings beyond contests. Using a laboratory experiment of real effort tasks with treatments varying by compensation schemes (all-pay auction contest, Tullock contest, proportional prize contest, and piece rate payment scheme), we test the relative effect of contest formats on cooperation in social dilemma games. In comparison to a hypothesized ranking of compensation schemes based on the correspondence between effort exerted and reward received ('Effort Correspondence'), our results provide relatively stronger support for an alternative hypothesis that cooperative behavior after a competition is tied to the potential for obtaining 'fair' payoff outcomes within the contest ('Chance for Fair Division'). Our random re-matching experimental design ensures that our findings do not result from subjects' rivalry towards specific competitors, but rather represents a more fundamental shift in prosocial attitude. The results have managerial consequences for structuring incentives in the workplace when a combination of competition and cooperation is necessary among workers.

Keywords: contests, compensation schemes, pro-social behavior, cooperation
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1. Introduction

Contests have been theoretically proven as a cost-effective incentive mechanism to motivate individuals, and are prevalent in many consequential real-world settings, including academic competition, job promotions and bonuses.[2] Under different institutional settings, the precise contest rules often differ in terms of the relationship between effort exerted and the resulting resource distribution: for example, in some contest formats, a single prize is awarded exclusively to the best performer, while in other contest schemes, the total prize pool is divided among participants based on their relative performances.[3]

Despite their effectiveness in enhancing productivity, contests can also generate some unintended negative effects (for a discussion, see Sheremeta, 2016). Workplace contests have been shown to encourage selfish and less cooperative behavior towards co-workers (Drago and Garvey, 1998). Workers refrain from sharing their knowledge with coworkers (Dechenaux, Kovenock, and Sheremeta, 2015), negatively affecting workers' performance. Contests can even be counterproductive by yielding lower worker effort than piece rate compensation, particularly if sabotage and cheating behavior arises (Carpenter, Matthews and Schirm, 2010; Charness, Masclet, and Villeval, 2014; Rigdon and D'Esterre, 2015).

While these prior studies have documented how contest incentives lead to socially undesirable behavior within the contest itself, a more general question is whether and how being placed into contest settings more fundamentally affects how individuals interact with others, outside of the contest itself. In the above-mentioned studies, while the observed reduction in cooperative tendencies could be driven by underlying shifts in subjects' willingness to cooperate, they could also be affected by payoff concerns within the contest itself. However, it is also possible that the experience of contest participation could alter individuals' basic propensities to cooperate with others. For example, the competitive mindset that helps a person to excel in a contest and the self-interested drive from competition might be difficult to "switch off" in settings which call for cooperation. Contest schemes also often involve a substantially unequal distribution of rewards, potentially resulting in decline in prosocial behavior driven by participants' inequity aversion. The magnitudes of such effects could vary based on the specific contest incentive structures and relative payoff distributions.

In this study, we implement a real-effort laboratory experiment to examine the implications of contests in the domain of cooperation beyond the contest setting itself, aiming to answer two main questions: First, does participation in contests affect individuals' cooperative tendencies in general settings beyond contests where strategic self-interest and social surplus are opposing forces, and in which direction? Second, given that competitive incentive schemes can vary substantially across organizations, what are the comparative impacts of different commonly utilized contest formats on cooperation?

Understanding the underlying consequences contests have on cooperative tendencies is important for settings in which social welfare outcomes are determined by both competition and cooperation. For instance, in many workplace settings, employees need to compete against their colleagues in some domains, while needing to cooperate with the same or other colleagues in other domains. The possible relationship between competition and pro-sociality could adversely affect the willingness of workers to cooperate with others in teamwork settings when common objectives require it. Such effects can be

[2] For a review of contest theory, see Konrad (2009).

[3] For example, in some workplace settings, the revenue from a project is shared among team members based on individual performances, while in others, the single best performer may receive an award.

particularly relevant for societies in which individuals have to overtly compete with others in order to distinguish themselves from others.[4]

To examine the first question, we measure within-person changes in choices in various social dilemma games after subjects experience different competitive payment schemes, allowing a comprehensive assessment of cooperation in social dilemmas while accounting for individual differences in baseline prosocial behavior. Specifically, we assess the within-person effects of contest on choices in the Prisoner's Dilemma (PD), Public Goods Game (PGG), and Trust Game (TG). The sequence of events in the experiment is as follows: In the first stage, to measure subjects' baseline pro-sociality, subjects play each of the three games with a randomly re-matched partner in each game. In the second stage, subjects compete with another randomly matched partner to complete a real-effort task under varying payment schemes. In the third stage, subjects repeat the same social dilemma games, again with different sets of random players. The random re-matching feature was made clearly known to subjects to exclude repeated interaction effects with the same partners (ex. reciprocity, revenge, or reputation concerns). To avoid subjects' dynamic planning considerations, each game in the sequence is introduced one at a time to subjects as the previous game is completed, and is generally implemented without feedback (except for the contest outcome).

We address the second question by comparing subjects' changes in prosocial behavior in four treatment conditions representing common real-world payment schemes. Pairwise comparisons across contest treatments also control for potential confounds, such as fatigue and other time-based effects. Our baseline (control) treatment is a *piece rate payment scheme*. The other three treatments are contests: a *proportional prize contest* in which the prize is shared between the two subjects in proportion to their relative performances, an *all-pay auction contest* in which the subject with the better performance wins the prize (ties broken randomly), and a *Tullock contest* in which the winner is determined probabilistically in proportion to subjects' relative performances. While previous experimental studies have examined individuals' self-selection to contests, as well as effort exerted under different contest formats (Bartling, Fehr, Maréchal and Schunk, 2009; Dohmen and Falk, 2011; Fallucchi, Renner, Sefton, 2013; Cason, Masters, Sheremeta, 2018; Shupp, Sheremeta, Schmidt, Walker, 2018), to the best of our knowledge, this is the first study that examines the effect of different contest formats on cooperation and trust.

When comparing the relative decline of pro-sociality across treatments, we contrast two competing hypotheses that give nearly opposite predictions for ranking of the effect of different contest formats. Motivated by previously documented evidence that effort that goes unrewarded can lead to negative psychological consequences and behavioral responses (Walster, Walster and Berscheid, 1978; Akerlof and Yellen, 1990), our first hypothesis, which we call "Effort Correspondence", suggests that decreases in pro-social behavior after contest participation can be attributed to a lack of correspondence between an individual's effort exerted in the contest and their resulting reward.[5] Under this hypothesis, a payment

[4] For example, education systems in many countries, such as China, tend to promote the emphasis on public ranking of students' scores, bearing close resemblance to a contest, while education systems in other countries may choose to de-emphasize concrete rankings among students.

[5] For example, the fair wage-effort hypothesis suggests that workers will exhibit negative reciprocity and lower their subsequent effort provision if payment is not commensurate with effort (Akerlof and Yellen, 1990) with supporting experimental evidence from field settings (Kube, Maréchal and Puppe, 2013; Cohn, Fehr and Goette, 2015; Ockenfels, Sliwka, and Werner, 2015). In addition, in the framework of loss aversion, effort exerted can be understood to place an individual in the loss domain, while failure to be compensated accordingly keeps them from recovering the utility loss. Studies have shown that being in the loss domain is associated with negative social behavior, such as for example, domestic violence in the case of sports team losses (Card and Dahl, 2011; Munyo and Rossi, 2013).

scheme in which the payoff is less proportional to effort levels leads to a larger decline in pro-sociality. Ranking our four treatments using effort-to-earnings ratios, a decline in pro-sociality among the four treatments is predicted, from largest to smallest: all-pay auction contest, Tullock contest, proportional prize contest, and piece rate payment scheme.

On the other hand, as people interact with their opponents in the contests, their expectations over their opponents' behavior, especially the tendency to jointly produce a fair outcome, might have implications for their subsequent cooperative tendencies. This leads to a competing hypothesis, which we call "Chance for Fair Division", with the reasoning that compensation schemes which have a larger opportunity for fair division (while subjects may fail to achieve it) will diminish pro-social goodwill, through individuals' higher expectations on equal outcomes. The proportional prize contest, as a revenue-sharing incentive scheme, offers the best chance for fair division of surplus among the four treatments, while the all-pay auction contest provides in certain terms, the least chance for fair division due to its deterministic winner-takes-all payoff structure. Hence, in contrast to the Effort Correspondence hypothesis, it predicts the largest decline in pro-sociality in the proportional prize contest, and the smallest decline in the all-pay auction contest.

In line with our overall intuition about the effects of contests on cooperation as well as the prior literature, we find a general decrease in pro-sociality after any of the competitive compensation schemes across all treatments, mostly driven by lower levels of pro-social action in the Prisoner's Dilemma and Trust Game. When testing between the Effort Correspondence and Chance for Fair Division hypotheses, we find a strong support for the 'fair division' hypothesis in the Prisoner's Dilemma and Public Goods Games, where cooperation decreases most in the proportional prize contest, followed by the piece rate payment scheme and Tullock contest, with the lowest drop in cooperation occurring in the all-pay auction contest. In the Trust Game however, the decline in trusting behavior in the piece rate payment scheme is significantly smaller than that in the proportional prize contest and Tullock contest, while also being smaller than the all-pay auction contest, which does lend some degree of support to the effort correspondence hypothesis in the trust domain specifically.

Overall, the favorability of the experimental results towards the 'fair division' hypothesis implies that individuals understandably process their experiences in contests as a social interaction, rather than merely as an individual decision environment as suggested in the 'effort correspondence' hypothesis. In particular, their expectations or hopes about how other participants behave within a contest include social preference considerations such as fairness concerns, in line with a large literature documenting subjects' aversion to unequal outcomes (Fehr and Schmidt, 2003; Charness and Rabin, 2002). When fair division benchmarks are institutionally feasible but not attained, individuals could be more prone to reducing cooperation, in contrast to a decision-based assessment of their experience, in which subjects are mainly averse to the notion that their own efforts are not correspondingly rewarded (i.e. 'effort correspondence'). We observe a highly similar patterns in favor of the 'fair division' hypothesis when assessing subjects' aggregate change in behavior across three social dilemma games.

Finally, we provide suggestive evidence on the motives for changes in pro-social choices, including the comparison of choices of winners and losers of the contests. While contest losers do have significantly lower self-reported emotional states than contest winners following the contest, perhaps counterintuitively, contest winners are largely responsible for the drop in pro-social choices in both the

Public Goods and Trust Games.[6] Subjects' prosocial responses are also not explained by subjects' self-reported mood after the contest, absolute or relative performance, and thus are more suggestive of an "entitlement effect" among contest winners (Major and Testa, 1989; Schurr and Ritov, 2016) for these two games. In addition, examining subjects' self-stated effort and ambition in the contest indicates that personal attitudes towards competition are influential factors on subjects' behavioral response.

Our study belongs to an emerging literature that examines the potential negative consequences of competitive incentive schemes. We contribute to the above-mentioned literature that studies the consequences of contests, by investigating participants' general shift in cooperation tendencies *beyond* the contest itself. Most related to our paper is a small strand of papers that similarly examines changes in participants' prosocial inclinations after exposure to competitive incentives relative to other payment schemes. Herrmann and Orzen (2008) find that subjects are less likely to cooperate in the Prisoner's Dilemma after playing a Tullock contest. Buser and Dreber (2016) compare subjects' contributions in the Public Good Game after participating in a winner-takes-all contest (either with or without feedback), piece-rate, and lottery treatment (with a randomly chosen winner). They find that subjects contribute the least in the Public Good Games after the winner-take all contest and when contest feedback is provided. Harbring (2010) finds that relative to a team-based incentive scheme, subjects display lower levels of trust and expectations for trust and trustworthiness towards their partners in the trust game after a rank-order tournament. Compared to these studies, our study is focused on comparing the effects of *different* types of competitive compensation schemes on pro-sociality. In contrast to many studies in this line of literature, we adopt a real effort task, rather than eliciting subjects' stated-effort choices in the contest, in order to closely simulate real-world contexts that may be more likely to trigger competitive mentalities among participants.

Another strand of studies further shed light on possible channels or amplifiers for socially undesirable behavior after competitive payment schemes. Brandts, Riedl, and van Winden (2009) find that being placed in a rivalrous environment negatively affects subjects' emotion and well-being. Jauernig and Uhl (2019) find that spite and fear of retaliation can drive sabotage behavior after a tournament for both contest winners and losers. Increased social proximity to a competitor can exacerbate the negative effect of the contest, resulting in less altruism in the Dictator Game, relative to their trust exhibited in the trust game in which strategic concerns are present (Dimant and Hyndman, 2019). Grosch, Ibanez and Viceisza (2020) find that participants only lower their cooperation in contests where payoff inequality is high. On the other hand, Fehr, Rau, Trautmann and Xu (2020) further shows that participants lower their trust in the trust game more after experiencing a contest in which pairs of players are given unequal opportunities, while contest losers are more likely to drive the decline in social trust. Our study also examines the potential differential effects of contests on contest winners and losers, providing suggestive evidence that the decline in prosocial inclination is not primarily driven by negative emotional responses and contest results, as might be considered intuitive. On the other hand, subjects' baseline characteristics, such as ambition and effort to win, are significantly correlated with reductions in cooperation. Importantly, contrary to studying the effects of direct rivalry against competitors on pro-social choices, our experiment pins down the more generalized effect of contest participation on cooperative behavior beyond the contest setting itself.

[6] In the piece rate treatment and the proportional prize contest, contest winners are defined as those who have strictly higher payoff outcomes.

More generally, our work is related to a broader body of empirical literature that studies the negative consequences of social comparisons in material outcomes. Prior studies have examined how payment inequality or information on relative pay potentially lowers one's well-being (Brown, Gardner, Oswald and Qian, 2008; Perez-Truglia, 2020), job satisfaction (Card, Mas, Moretti, and Saez, 2012), morale (Breza, Kaur and Shamdasani, 2018), coordination (Camera, Deck and Porter, 2020) as well as effort provision (Cohn, Fehr, Herrmann, and Schneider, 2014). Finally, our study contributes to an extensive literature that investigates how economic incentives as well as social environments influence and help determine social preferences (see Bowles and Polania-Reyes (2012) for a comprehensive review).[7]

The remainder of the paper is structured as follows. Section 2 describes the experimental design. Section 3 discusses our hypothesis for the relative impacts of contest formats. Section 4 presents the detailed experimental results. Section 5 presents further evidence for potential mechanisms. Section 6 discusses and concludes.

2. Experimental Design

The experimental design is summarized in Figure 1. Our experiment consists of three stages with a total of seven games to be played by each participant. Each game is introduced to subjects one at a time in sequence, and subjects do not know what will be coming next in the experiment to prevent dynamic considerations through backward induction. Subjects also do not receive feedback on the outcomes for any of the social dilemma games until the experiment is over, to avoid learning effects.

Subjects are randomly re-matched for each game in each stage, and this is made clear to subjects in the experiment instructions. It is key for our research question that we adopt a random-matching design to eliminate concerns about repeated interaction considerations (ex. reciprocity, revenge, or reputation) that could arise if subjects interact with the same partners. Our experiment is thus appropriate for measuring a general shift in pro-social behavior that is not specific to attitudes towards subjects' direct competitors in the contests.

Figure 1: Experimental Design

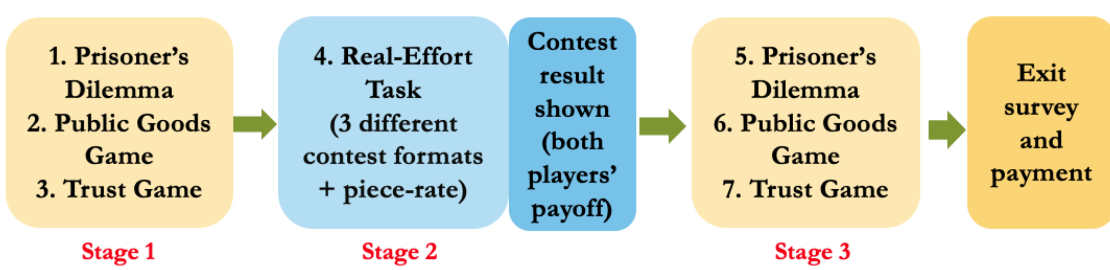

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Table 1: Payoff parameters for the three social dilemma games

Games of Social Behavior	Parameters (in Experiment Currency Units)
Prisoner's Dilemma (PD)	(C,C) payoff = (14,14); (D,D) payoff = (7,7); (C,D) payoff = (3,20); (D,C) payoff = (20,3)
Public Goods Game (PGG)	Endowment = 10; multiplier = 1.6
Trust/Investment Game (TG)	Endowment = 10 (both players); multiplier = 3

In the first stage, subjects play standard social dilemma games in the sequence: Prisoner's Dilemma, Public Goods Game and Trust Game (Berg, Dickhaut and McCabe, 1995). The parameters determining the payoffs in these games are shown in Table 1.

In all social dilemma games, neutral framing is used to avoid expectations on subjects' choices. In the Prisoner's Dilemma, subjects choose between letter "M" (Cooperate) and letter "N" (Defect) with payoff contingent on both players' choices. In the Public Goods Game, subjects are asked to allocate 10 endowment tokens between two boxes, one box serving as a public account and the other as a private account. In the Trust Game, both subjects are endowed with 10 tokens and are randomly assigned to the role of sender or receiver. The sender first decides the amount of tokens X to be sent to the receiver. The amount sent is then tripled ($3X$) when it reaches the receiver and the receiver chooses to return any amount of point Y between 0 and $3X$ to sender.[8] Hence, senders' payoff in Trust Game is $10 - X + Y$, while receivers' payoff is $10 + 3X – Y$.

In the second stage, subjects participate in a contest with another randomly matched partner to complete a real-effort number counting task adapted from Abeler, Falk, Goette and Huffman (2011), which requires no prior knowledge and allows for accurate performance measurement (Abeler et al., 2011; Charness, Gneezy, and Henderson, 2018). In the task, subjects are asked to report the number of ones appearing in a series of 7 by 7 matrices with 49 randomly generated zeros and ones. Subjects' goal is to correctly complete as many matrices as possible in 6 minutes, where the payment scheme differs by treatments. Immediately after the contest, subjects are informed of the contest results, including their correct count, their partner's correct count, and the corresponding tokens earned by each player.

[8] Throughout, we use direct response rather than a strategy method. Therefore, in the Trust Game, the receiver knows the amount originally sent by the sender. This is the only piece of feedback that subjects receive in the first stage. Note that under the random partner re-matching scheme in each game, this feedback may be only of limited use in inferring future partners' behavior.

Table 2: Payoff structure in each treatment

Contest type (Treatments)	Player 1's payoff (wlog) in ECU*
Piece-rate payment scheme (with social comparison, "control")	$\pi_1 = x_1 * 2$
Proportional prize contest	$\pi_1 = (x_1/(x_1 + x_2)) * 150$
All-pay auction (deterministic winning) contest	$\pi_1 = 150\ if\ x_1 > x2,\ 0\ if\ x_1 < x_2$; $\pi_1 = 150\ if\ x_1 = x_2$ with $Prob = 0.5$
Tullock (probabilistic winning) contest	$\pi_1 = 150$ with $Prob = x_1/(x_1 + x_2)$; $\pi_1 = 0$ with $Prob = x_2/(x_1 + x_2)$

Note: Player 2's payoff is defined identically, since the payoff functions in all treatments are symmetric.

We implement four commonly utilized payment schemes in the second stage, summarized in Table 2. Each payment scheme is described to subjects in the instructions of the real-effort task and subjects are unaware of the payment schemes in other treatments. Our baseline (control) treatment is a piece rate scheme, in which subjects earn two tokens for each correctly counted matrix. In the proportional prize contest treatment (Cason, Masters, and Sheremeta, 2010), a total of 150 tokens are shared between the two subjects in proportion to their comparative correct counts. In the all-pay auction contest treatment (Baye, Kovenock, and de-Vries, 1996), only the subject who has more correct counts wins a total of 150 tokens (ties broken randomly). Finally, in the Tullock contest treatment (Tullock, 1980), a total of 150 tokens are awarded to a probabilistically determined winner, where the winning probability is in proportion to the comparative correct counts. Note that although the piece rate payment scheme is not a contest in payoff terms, to remain consistent with the feedback on the subject's own performance and that of their partner in the other contest treatments, we reveal the identical information about the contest result in this 'control' treatment. Finally, to ensure that the contest game is of significant consequence to subjects among the sequence of games played, the expected payoff of the contest stage is set substantially higher than those of the social dilemma games.[9]

In the third stage, subjects repeat the same social dilemma games as in the first stage, in the same sequence, again with randomly assigned partners.[10] This enables us to measure how much pro-social behavior changed from pre-contest to post-contest across the different contest payment schemes, which effectively controls for subjects' differences in baseline pro-social behavior and/or time trends in choices.

Finally, subjects complete a brief post-experiment questionnaire to answer questions about basic demographics and their decisions related to the games, preferences towards competition, cooperation, and emotional status. After submitting the questionnaire, subjects are informed of their payoffs in both rounds of social dilemma games and receive their payments before leaving the experiment.

We implement three different social dilemma games to provide a comprehensive assessment of pro-sociality, in case of differential effects across different social dilemma games given variations in their

[9] In addition, the contest payoff structures are designed to have equivalent expected payoff consequences across treatments conditional on effort exerted. Ex-post, the piece rate payment scheme treatment has significantly lower realized payoffs in the contest stage than the other three treatments.

[10] In order to measure changes in choices within-subject, subjects' role in the post-contest Trust Game is assigned to be the same as in the pre-contest version. However, given the sequentially presented instructions, subjects do not know to anticipate this or other features of the post-contest social dilemma games.

features. Prisoner's Dilemma and Public Goods Game are in the same class of games intended to measure cooperative decisions made simultaneously against individual incentives since social surplus in these two games will be maximized only if both subjects choose to cooperate simultaneously. However, Prisoner's Dilemma has a binary action choice, whereas the Public Goods Game allows observation of the extent of cooperation via participant's contribution out of their endowment, which may lead to differences in decisions. In comparison, the Trust Game is sequential in nature and is better suited for individuals to indicate their trust and trustworthiness to the other player, since senders in the Trust Game can enhance the social surplus by sending more tokens to the receiver, and can personally benefit if the receiver returns at least a share of the multiplied surplus to the senders.[11]

All four treatments in the experiment represent widely used incentive schemes in real-world settings. Piece rate payment schemes are commonly used in labor contracts, especially in developing countries where worker's pay is directly tied to their productivity (Guiteras and Jack, 2018). Proportional prize contests represent a revenue-sharing scheme prevalent in situations with two teams collaborating on a project (Weitzman and Kruse, 1990). The all-pay auction contest and Tullock contest are winner-take-all payoff schemes that are pervasive in settings ranging from academic contests to job promotions where the best performer is awarded or promoted. Compared to the deterministic all-pay auction contest, the probabilistic feature of Tullock contest mimics a noisy performance to reward mapping, representing situations in which higher effort workers are more likely to win the prize, but not guaranteed to do so. Unlike winner-take-all contests, payoff differences are smaller in magnitude and directly tied to the amount of the performance gap between competitors in piece rate payment schemes and proportional prize contests. Notably, although subjects' monetary payoff in the piece rate payment scheme only depends on his/her performance, the disclosure of performance feedback for both participants may induce an implicit social comparison among subjects.

The experiment was implemented on December 17th, 2017 at Tsinghua SEM ESPEL Lab.[12] Subjects were recruited from the student body at Tsinghua University, and in total 104 subjects participated in the experiment. Each subject participated in only one treatment: piece rate payment scheme (N=30), proportional prize contest (N=26), all-pay auction contest (N=24) and Tullock contest (N=24). The experiment was conducted using software z-Tree (Fischbacher, 2007). A show-up fee of 15 RMB was paid to all subjects. On average, subjects earned 43.98 RMB (~6.64 USD) in the piece rate treatment; 52.89 RMB (~7.99 USD) in the proportional prize contest treatment; 52.27 RMB (~ 7.90 USD) in the all-pay auction contest treatment and 51.84 RMB (~7.83 USD) in the Tullock contest treatment.[13] The minimum payment across all treatments was 28.3 RMB (~ 4.27 USD) and the maximum payment was 78.05 RMB (~ 11.79 USD).[14] The conversion ratio between experimental currency units (ECU) and RMB was 4:1.

[11] In fact, as we discuss in detail later in the paper, the results across the three social dilemma games do differ to an extent, which reinforces our intention to seek more robust results by measuring the effects in a variety of social dilemma games.

[12] http://www.thuespel.org/index.htm

[13] Note that although on average, subjects in the piece rate payment scheme have lower payoffs than subjects in the other three treatments, it is unlikely that this will discourage subject's prosocial behavior due to negative sentiments towards the experimenter, since subjects are unaware of the existence of the other three treatments.

[14] The RMB to USD exchange rate at time of experiment was 6.62:1. The range of payment is within the standard expected payment for participation in an experiment locally.

3. Hypotheses

General Effect of Contests: There are several possible behavioral reasons to hypothesize increased Nash equilibrium behavior in the social dilemma games following the contest compensation schemes.

For one, the competitive mentality and self-interested drive that incentivize participants to exert more effort in the contest may not be easily "switched off" in other domains after the contest, and mere exposure to competitive environment could have a negative impact on subjects' emotional states (Brandts et al., 2009).

In addition, the negative psychological consequences after receiving the contest feedback could also affect one's subsequent prosocial behavior by increasing their self-regard (Grusec, Davidov, Lundell, 2002). For example, feeling envy due to contests' unequal distribution could reduce helping behavior and even generate socially undesirable behavior (Wobker, 2015; Fehr, Rau, Trautmann, and Xu, 2020). Subjects may be less willing to contribute to social goods after the contest if they feel disappointed about earning less than they expected or earning less than their competitors (Fehr and Schmidt, 2003, Camera et al., 2020). Subjects could also increase selfish behavior after contests out of a strategic concern to secure their income and reduce income uncertainty. A comparison of before and after pro-sociality between any of the three contest treatments and our piece rate payment scheme 'control' treatment, can serve as a test of this hypothesis.

Hypothesis 1 (The General Effect of Contests): The decrease in socially cooperative behavior from Stage 1 to Stage 3 is greater in the Proportional prize, All-pay auction, and Tullock contest treatments, compared to that in the Piece rate payment scheme.

Relative Effect of Contest Formats: We propose two competing hypotheses to evaluate the relative treatment effects. Building on the idea that unrewarded effort may make subjects feel wronged and react negatively (Walster et al., 1978), the 'Effort Correspondence' hypothesis suggests that contests for which compensation is less directly proportional to effort in the contest will lead to larger drop in pro-sociality. For example, Goodman (1975) shows that in a role-playing scenario in which subjects acting as managers receive different salary evaluation results, subjects in a 'higher performance and low pay' condition also allocate less salary to their subordinates. Similarly, the fair wage-effort hypothesis suggests that workers will reciprocate negatively and withdraw effort level if they think they are not fairly compensated, with some supporting evidence in field experiment settings (Kube et al., 2013; Cohn et al., 2015; Ockenfels et al., 2015).

Ranking the four treatments from least effort proportional to most, based on effort to earnings ratios, the four treatments are ordered as: All-pay auction contest ~ Tullock contest, followed by Proportional prize contest and Piece rate payment scheme.

The all-pay auction contest and the Tullock contest have the least correspondence between subjects' equilibrium effort and the subsequent expected payoff, among the four treatments. Among the contest schemes, equilibrium effort is the highest in the all-pay auction contest (see review in Dechenaux et al., 2015). However, despite the highest equilibrium effort generated in the all-pay auction contest, the outcome for participants is all-or-nothing (i.e. either win 150 points or 0), so participants bear the risk of earning nothing from the contest.

Table 3: Summary of the Effort Correspondence Hypothesis

Treatment	Ranking: Earning Proportional to Effort (Highest to Lowest)	Predicted Decline in Prosocial Behavior (Highest to Lowest)	Intuition of Ranking
Piece rate payment scheme	High	Low	Earnings directly tied to absolute performance
Proportional prize contest	Middle	Middle	Earnings directly proportional to relative performance
All-pay auction contest	Low	High	Highest equilibrium effort, but with risk of earning zero
Tullock contest	Low	High	High equilibrium effort, with risk of earning zero (even under better performance)

The same risk of obtaining a zero payoff also exists in the Tullock contest due to the winner-takes-all structure. However, equilibrium effort in the Tullock contest is lower than the effort in the all-pay auction contest (Dechenaux et al., 2015) as subjects in the Tullock contest are less motivated when there is noise in performance measurement. Yet, on the other hand, the probabilistic winning feature of the Tullock contest comparatively increases the risk of earning 0 for the better performer since it is still possible for them to lose the contest. Thus, arguments can be made for either the all-pay auction contest or the Tullock contest having the lowest effort correspondence among the treatments considered.

By contrast, subjects' payoffs are more directly proportional to their absolute performance in the proportional prize contest and in the piece rate payment scheme, leading to far less extreme payoff distributions. The expected payoff function and hence the equilibrium effort in the proportional prize contest are the same for risk-neutral participants as in the Tullock contest, however, the proportional prize contest has lower payoff uncertainty and guarantees positive payoff proportional to one's own positive effort, conditioning on the opponent's effort level, a feature more favorable to subjects (Cason et al., 2018).

For the piece rate payment scheme, the payoff is linearly tied to subject's own effort level, resulting in the closest mapping between effort exerted and payoff earned. Hence, the effort correspondence hypothesis predicts the smallest drop in pro-sociality in the piece rate payment scheme. The Effort Correspondence Hypothesis and predictions are provided in Table 3 and can be summarized as follows in Hypothesis 2 which further ranks the contest formats.

Hypothesis 2A (Effort Correspondence Ranking Hypothesis): In terms of correspondence between effort and payoff earned, the ranking among the four treatments are from low to high, All-pay auction ~ Tullock contest < Proportional prize contest < Piece rate payment scheme. Thus, the predicted decrease in pro-sociality after the contest stage from low to high, is given by Piece rate payment scheme < Proportional prize contest < Tullock contest ~ All-pay auction contest.

While the Effort Correspondence hypothesis emphasizes contest as a "decision-based" environment, subjects could also have social preference concerns on their opponents' behavior during the contest, such as fairness and payoff equality (Fehr and Schmidt, 2003). Bartling, Fehr, Maréchal and

Schunk (2009) find that individuals with an egalitarian preference are less likely to opt into contests, mainly driven by an advantage aversion. Thus, when involuntarily participating in a given contest format, such as in our setting, such individuals may have a greater expectation for equal outcomes when the contest format itself is not inherently unequal in the reward structure, and hence a greater reluctance to accept various realized outcomes which are in actuality, typically not precisely equal. In other words, individuals may be more psychologically accepting of payoff differences when the rules of the contest reward assignment are inherently unequal. This leads to an alternative "Chance for Fair Division" hypothesis, which proposes that competition which contains a greater opportunity for a fair division of payoffs (while subjects may fail to achieve it) generates greater negative reactions from participants, leading to larger drops in pro-sociality in external contests.[15] According to such an argument, we can re-rank the four treatments based on their chance for fair division, summarized in Table 4.

Table 4: Summary of the Chance for Fair Division Hypothesis

Treatment	Ranking: Chance for Fair Division	Predicted decline in prosocial behavior (Highest to lowest)	Intuition of Ranking
Piece rate payment scheme	Middle	Middle	Subjects can perform and get paid about equally
Proportional prize contest	High	High	Subjects can get a big prize with little effort if coordinate
All-pay auction contest	Low(est)	Low(est)	Subjects make effort, but for sure one person will get nothing
Tullock contest	Low	Low	Subjects make effort and have a fair probability to get paid for it

The proportional prize contest, which is a revenue-sharing scheme, offers the most salient cue for an equal division of a fixed surplus among the four treatments, since both participants can split the pie of 150 tokens evenly with little effort made in the counting task if they can coordinate on low effort, resulting in a large net surplus for each player. The piece rate payment scheme is ranked second by this measure, since subjects can obtain similar payoffs as long as they perform similarly. However, the piece rate has a relatively less salient psychological cue for fair division compared to the proportional prize contest given the lack of large surplus to be divided, and the linear mapping between effort and payment.

The Tullock and all-pay auction contests, which we rank third and fourth by this measure respectively, offer the least chance for fair division as only one player takes the entire prize in both of these contests. However, compared to the Tullock contest, the all-pay auction contest can be viewed as having the least opportunity for fair division, since the higher performing participant wins the entire prize with certainty (except in the case of ties). Meanwhile, the Tullock contest, with the same expected payoff function as the proportional prize contest, can be viewed as a "sharing" contest, albeit in the probabilistic domain.

Hypothesis 2B (Chance For Fair Division Hypothesis): In terms of the chance for equal division, the ranking among the four treatments are from low to high, All-pay auction < Tullock contest < Piece rate

[15] We are grateful to Daniel Kovenock for the insight of this hypothesis.

payment scheme < Proportional prize contest. Thus, the predicted decrease in pro-sociality after the contest stage from low to high, is given by All-pay auction contest < Tullock contest < Piece rate payment scheme < Proportional prize contest.

4. Results

We examine both the aggregate and relative effects of contest on prosocial behavior to test Hypotheses 1 and 2. We begin our analysis in Section 4.1 by briefly comparing the performance in the real-effort task across treatments. In Section 4.2, we first examine the aggregate effect of contest on behavior in each of social dilemma game. We then proceed to examine the relative treatment effect for prosocial behavior in each game, by performing pairwise comparisons of the changes in choices in each social dilemma game for any two treatments. Finally, we further test the two competing hypotheses under a formal regression specification and test whether this effect holds conditional on subjects' performance and payment.[16]

We find in fact, that the experimental data provide a mixed degree of support for our Hypothesis 1 regarding the general effect of contests compared to the piece rate, and from a more specific standpoint, a more favorable support on 'Chance for Fair Division' over 'Effort Correspondence'. The key driver for the two results is that subjects' participation in the all-pay auction contest did not have a significant negative effect on their pro-sociality even compared to the piece-rate, while subjects' participation in the proportional prize contest yielded the worst drop in surplus enhancing choices.

To examine whether subjects' behavior follows a general consistent pattern across the social dilemma games, in Section 4.3, we construct a pro-sociality index that measures subjects' contributions to social efficiency across all three social games, and compare the relative change in pro-sociality index across treatments. Again, we find that the relative treatment effect on the pro-sociality index is more closely explained by the 'Chance for Fair Division' hypothesis.

4.1 Performance in the Real-Effort Task

Figure 2 presents subjects' mean performances in the four treatments. On average, subjects correctly counted 21.81 (std. dev. = 5.73) matrices across all treatments. The treatment ranking of mean performances (from high to low) is Tullock contest, all-pay auction contest, piece rate payment scheme and proportional prize contest. Based on theoretical predictions in the literature, all-pay auction contests are predicted to yield the highest equilibrium effort, followed by the Tullock and proportional prize contests (which are equivalent for risk-neutral individuals). In Table 5 where pairwise comparison tests in mean performances between treatments are conducted, we find average performance in the proportional prize contest is marginally significantly lower than in the all-pay auction contest (one-tailed t-test, $p = 0.0915$) and the Tullock contest (one-tailed t-test, $p = 0.094$). We do not find a significant difference in performance between the all-pay auction contests and the Tullock contest. Meanwhile, the performance in the piece rate is significantly lower than in the Tullock contest (one-tailed t-test, $p = 0.0754$). The result is largely consistent with the established theory findings, although some of the differences between treatments are not statistically different in the effort domain. Overall, the fact that the effort differences between treatments are not large in magnitude (and when statistically significant are in the predicted

[16] Since both performance and payment are affected by the compensation schemes, the treatment dummy coefficients should be interpreted as the direct effects of contest formats on prosocial behavior change (net of the indirect effect via the realized performance or payment).

directions), suffices as reasonable evidence that there are no abnormalities in the contest implementation in each treatment.

Figure 2: Subjects' performance (correct counts) in the real-effort task

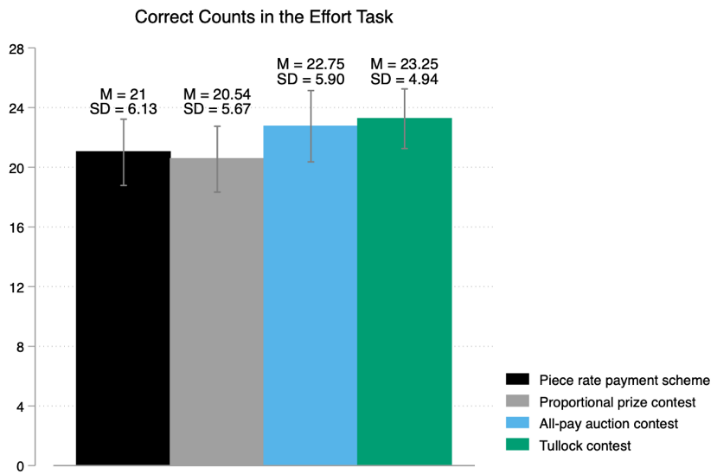


Table 5: Pairwise comparisons on mean performance using one-tailed T-test

	Proportional prize contest	All-pay auction contest	Tullock contest
Piece rate payment scheme	M = 21 > 20.53 t = .2908 (0.3862)	M = 21< 22.75 t = -1.0598 (0.1471)	M = 21< 23.25 t = -1.4583* (0.0754)
Proportional prize contest		M = 20.54< 22.75 t = -1.3511* (0.0915)	M = 20.54< 23.25 t = -1.7963** (0.0394)
All-pay auction contest			M = 22.75 < 23.25 t = -0.3184 (0.3758)

Note: M = X<(>)Y denotes matrices completed in the row category are less than (greater than) matrices completed in the column category; p-values in parentheses: *** p<0.01, ** p<0.05, * p<0.1

4.2 Social Dilemma Games Before and After

Aggregate results: We find that subjects on average decrease their pro-sociality across games after the competitive payment schemes, in spite of substantial heterogeneity in choices among subjects.

Across the social dilemma games, we find the largest and most robust decline in pro-sociality in the Prisoner's Dilemma. Across the four treatments, cooperation in the Prisoner's Dilemma declines significantly from 42.3% to 28.8% (one-tailed t-test, p = 0.0019). [17]

[17] We use a one-tailed test since we hypothesize a decrease in prosocial behavior after the contest.

Contributions in the Public Goods Game decline from an average of 4.55 to 3.93 (one-tailed t-test, p = 0.0256), which is a 13.63% decrease compared to the baseline.

The amount sent to the other player in the Trust Game declines 19.76% after the real-effort task, from an average of 5.06 to 4.06 (one-tailed t-test, p = 0.0064). The average proportion of tokens returned to the sender in the Trust Game declines slightly from 37.3% to 35.1%. 44% of receivers receive zero from the senders at least once in either round of the Trust Games, making it difficult to assess the within-person change for receivers' reciprocal behavior.[18] Thus, we mainly focus on senders when examining choices in the Trust Game in the subsequent analysis.

Relative treatment effects: We begin our treatment-based analyses by comparing subjects' before-contest prosocial behavior. We find that subjects' choices in the social dilemma games before the contests were statistically indistinguishable across treatments with one exception: in the Prisoner's Dilemma, subjects in the proportional prize contest treatment were more cooperative than subjects in the all-pay auction contest treatment (Two-tailed Wilcoxon rank sum test, p = 0.0216). In later analyses, we examine the within-person changes by game to account for any potential differences in individual baseline (before contest) pro-sociality.

Table 6: Within-person differences (before and after) by treatments (one-tailed T-test)

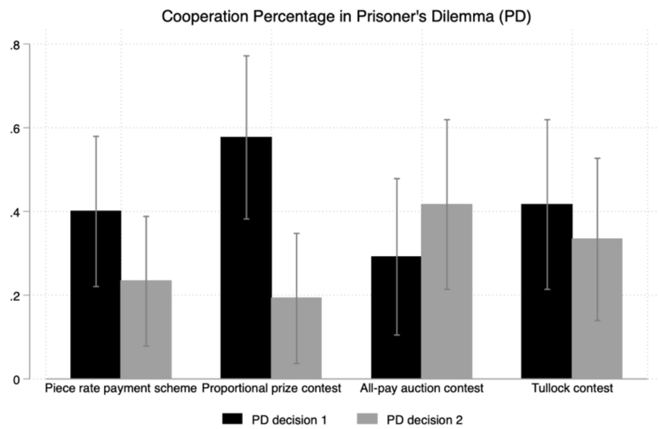
	Piece rate payment scheme	Proportional prize contest	All-pay auction contest	Tullock contest
PD difference	M = -0.167 t = -1.7202** (p=0.0480)	M = -0.385 t = -3.9528*** (0.0003)	M = 0.125 t = 1.8127** (0.0415)	M = -0.084 t = -1.4460* (0.0808)
PGG difference	M = -0.467 t = -0.8176 (0.2101)	M = -1.34 t = -2.1208** (0.0220)	M = -0.042 t = -0.0656 (0.4741)	M = -0.583 t = -0.8636 (0.1984)
Trust Sent difference	M = 0.067 t = 0.1002 (0.5392)	M = -1.923 t = -2.2213** (0.0232)	M = -0.833 t = -1.3320 (0.1049)	M = -1.5 t = -1.6818* (0.0604)

p-val in parentheses: *** p<0.01, ** p<0.05, * p<0.1. All within-person differences are calculated as the decision in the 2nd round of social game minus the decision in the 1st round of social game.

Table 6 summarizes the breakdown of average within-person before-and-after by treatment. A significant drop in cooperation in the Prisoner's Dilemma occurs in all treatments except the all-pay auction contest, which experiences a significant increase in cooperation. In the Public Goods Game, only the proportional prize contest treatment exhibits a significant decline in contributions. In the Trust game, a significant drop in amount sent to the receiver occurs in both the proportional prize contest and the Tullock contest, with a marginally significant drop in the all-pay auction contest.

[18] An alternative design which could allow for assessment of receivers' behavior in the Trust Game is to employ the strategy method. However, we avoided a strategy method, mainly to gauge subjects' natural tendencies after the contest environments.

Figure 3: Prisoner's Dilemma cooperation before (PD1) and after contest (PD2)



Note: Error bars represent 95% confidence intervals for the mean of the dummy "decision" (1 = Cooperate, 0 = Defect)

Distribution of the subjects' prosocial action before vs. after treatment by games are shown in Figure 3 through Figure 5. Figure 3 shows that while the tendency to cooperate is greatest in the proportional prize contest in the first round of Prisoner's Dilemma, subjects reduce their cooperation most in the proportional prize contest (from 58% to 19%, one-tailed t-test, p = 0.0003). By contrast, after the all-pay auction contest, cooperation in the Prisoner's Dilemma increases from 29% to 42% (one-tailed t-test, p = 0.0415).[19]

Figure 4 presents the distributions of PGG contributions before and after the contest by treatment. After the contest, more subjects are shifting to lower PGG contributions, and in particular, visibly shifting their choice to zero contributions. In the proportional prize contest, where the only significance of the within-person difference in PGG contribution is detected, we also observe a significant drop in the number of subjects that contribute all their endowments. Figure A.2 in the Appendix shows a substantial number of subjects do not alter their contribution, potentially explaining the lack of statistical significance in other treatments.

Figure 5 shows that in the Trust Game, there are substantially more subjects sending zero tokens to the other player after the contest compared to beforehand, especially in the proportional prize contest and Tullock contest. Figure A.3 in the Appendix further suggests there are still around half of the subjects (52%) maintain the same amount sent after the contest stage; however, for those who do exhibit a difference in choices, they tend to lower their trust rather than increase it.

Table 7 presents pairwise comparisons of the changes in each social dilemma game across any two treatments, allowing us to evaluate the relative ranking against both hypotheses. Panel A shows that the drop in PD cooperation is significantly larger in the proportional prize contest than in all other treatments. The decline is not significantly different between the piece rate payment scheme and Tullock contest, but

[19] In terms of the distributional Wilcoxon rank sum test, the within-person differences in the Prisoner's Dilemma are significant between piece rate payment scheme and all-pay auction contest (p = 0.0234); between proportional prize and all-pay auction contest (p = 0.0003); proportional prize and Tullock contest (p = 0.0136); and finally, between all-pay auction and Tullock contest (p = 0.0266). However, we do not find any statistically significant differences in the distribution of choices before and after each treatment for the Public Goods Game and Trust Game.

the drop in PD cooperation in these two treatments are both significantly larger than that in the all-pay auction contest.

Figure 4: PGG contribution before (PGG 1) and after contest (PGG2)

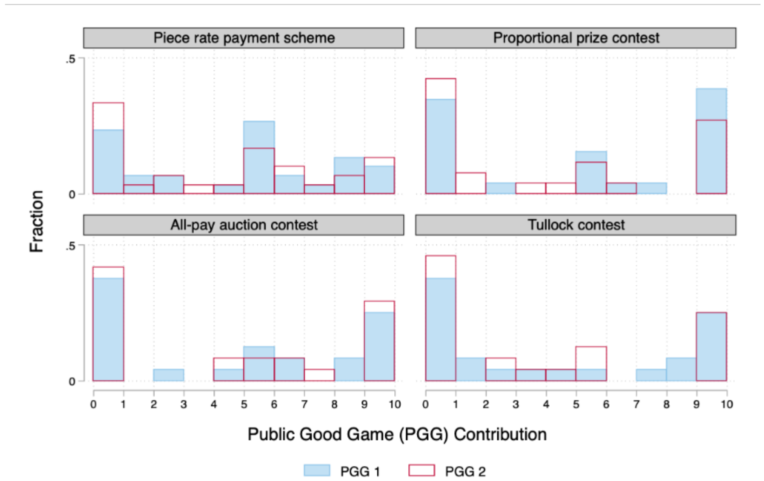


Figure 5: TG amount sent before (TG1) and after contest (TG2)

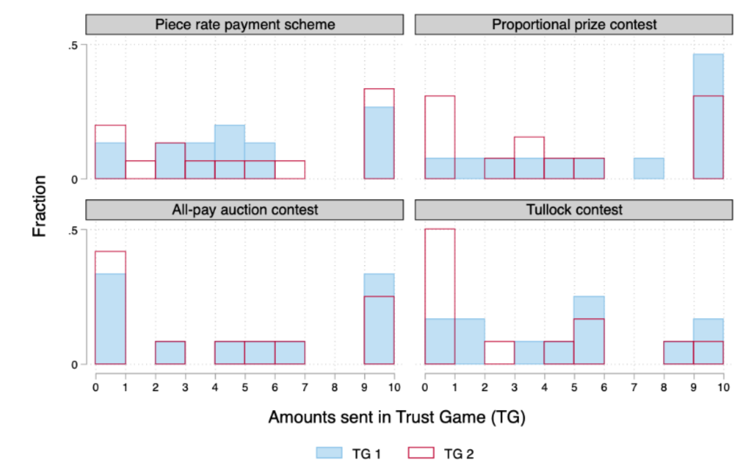


Table 7: Pairwise comparisons, change in prosocial behavior using one-tailed T-test

Panel A: Pairwise comparison in change in Prisoner's Dilemma cooperation

	Proportional prize contest	All pay auction contest	Tullock contest
Piece rate payment scheme	M = -0.167 > -0.385 t = 1.5873* (-0.0592)	M = -0.167 < 0.125 t = -2.4526*** (-0.0089	M = -0.167 < -0.084 t = -0.7392 (-0.2318
Proportional prize contest		M = -0.385 < 0.125 t = -4.2732*** (-0.0001)	M = -0.385 < -0.084 t = -2.6642*** (-0.0055)
All pay auction contest			M = 0.125 > -0.084 t = 2.3182** (-0.0125)

Panel B: Pairwise comparison in change in PGG contribution			
	Proportional prize contest	All pay auction contest	Tullock contest
Piece rate payment scheme	M = -0.467 > -1.34 t = 1.0303 (-0.1538)	M = -0.467 < -0.042 t = -0.4975 (-0.3105)	M = -0.467 > -0.583 t = 0.1319 (-0.4478)
Proportional prize contest		M = -1.34 < -0.042 t = -1.4523* (-0.0765)	M = -1.34 < -0.583 t = -0.823 (-0.2073)
All pay auction contest			M = -0.042 > -0.583 t = 0.5841 (-0.281)

Panel C: Pairwise comparison in change in TG amount sent			
	Proportional prize contest	All pay auction contest	Tullock contest
Piece rate payment scheme	M = 0.067 > -1.923 t = 1.8224** (-0.0406)	M = 0.067 > -0.833 t = 0.9855 (-0.1669)	M = 0.067 > -1.5 t = 1.4080* (-0.0867)
Proportional prize contest		M = -1.923 < -0.833 t = -1.0202 (-0.1595)	M = -1.923 < -1.5 t = -0.3404 (-0.3683)
All pay auction contest			M = -0.833 > -1.5 t = 0.6119 (-0.2738)

Note: M = X<(>)Y denotes matrices completed in the row category are less than (greater than) matrices completed in the column category; p-val in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

The pairwise comparisons of changes in PGG contribution, shown in Panel B, reveals that the only statistically significant difference in reductions is for the proportional prize contest compared to the all-pay auction contest, while other pairwise comparisons show insignificant differences. Regardless, the treatment rankings of the contest effects in Prisoner's Dilemma and Public Goods Games are consistent with one another in terms of the overall ranking, with the largest reduction in cooperation occurring in the proportional prize contest, followed by the Tullock contest / piece rate payment scheme, and finally the lowest drop in the all-pay auction contest.

However, the relative ranking of treatments in the Trust Game does not fully match the rankings in the Prisoner's Dilemma and Public Goods Game. Panel C of Table 6 shows that subjects in the proportional prize and Tullock contests significantly lower their trust to greater degree than subjects do in the piece rate payment scheme. The drop in trusting behavior in the all-pay auction contest is also slightly more severe than in the piece rate payment scheme, while slightly smaller than the proportional prize contest, however both differences are not significant at 10% level (one-tailed t-test, p = 0.1595 and p = 0.1669 respectively). In summary, the ranking of treatments for decline in trusting, from largest to smallest, are: proportional prize contest ~ Tullock contest, all-pay auction contest and finally, piece rate.

We further employ a OLS regression approach to control for additional factors that could potentially explain the change in choices before and after the contest stage in Table 8, where change in each of the social dilemma games behavior is regressed against three contest treatment dummies (i.e. the piece rate payment scheme as comparison group), controlling for performance (or payoff obtained) in the real effort task.[20] Compared to the piece rate payment scheme, the drop in PD cooperation likelihood is 0.212 larger, marginally significantly greater in the proportional prize contest (p = 0.116) and 0.269 to 0.290 points smaller in the all-pay auction contest, controlling for performance or payoffs in real effort task. Again, in line with Table 7, the equality of coefficient test reports a significant difference in PD cooperation drop between the proportional and all-pay auction contests. In the Public Goods Game, although the coefficient estimates are not measured very precisely for all contest dummies, the largest differences across treatments are still observed between proportional prize contest and all-pay auction contest (p = 0.113 and p = 0.152, equality of coefficient test). Lastly, relative to the piece rate payment scheme, the decline in amount sent in the TG is 1.975 points larger in the proportional prize contest, 1.669 points larger in the Tullock contest though imprecisely measured (p = 0.136). Overall, Table 8 suggests that the decreasing effect of proportional prize contest on pro-sociality wherever significant in the previous statistical tests, is also robust to performance or income factors.

Table 8: Changes in social games behavior by treatments (OLS regression)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Change in PD decision	Change in PD decision	Change in PGG contribution	Change in PGG contribution	Change in TG amount sent	Change in TG amount sent
Proportional prize contest	-0.212	-0.220	-0.905	-0.651	-1.975*	-2.022*
	(0.134)	(0.140)	(0.859)	(0.871)	(1.120)	(1.097)
All-pay auction contest	0.269**	0.290**	0.520	0.653	-0.945	-0.929
	(0.125)	(0.124)	(0.853)	(0.839)	(0.919)	(0.949)
Tullock contest	0.054	0.081	0.006	0.111	-1.669	-1.573
	(0.115)	(0.115)	(0.885)	(0.819)	(1.123)	(1.133)
Correct counts	0.013		-0.054		0.053	
	(0.008)		(0.053)		(0.092)	
Real effort task payoff		0.000		-0.007		0.001
		(0.001)		(0.006)		(0.007)
Constant	-0.442**	-0.169*	0.674	-0.176	-1.088	0.027
	(0.202)	(0.101)	(1.300)	(0.634)	(2.270)	(0.760)
Observations	104	104	104	104	52	52
R-squared	0.176	0.151	0.031	0.034	0.090	0.079
Coefficient tests of equality:						
Proportional = All-pay: F-stat	16.07***	18.09***	2.551	2.088	0.852	1.037
Proportional = All-pay: p-val	<0.001	<0.001	0.113	0.152	0.361	0.314
Proportional = Tullock: F-stat	5.872**	7.040***	0.968	0.700	0.0530	0.138

[20] We also implement a specification controlling for both absolute and relative performance (i.e. correct count differences), but find the coefficient estimates do not change substantially after adding this control. However, controlling for both absolute and relative payoff (i.e. payoff differences in real-effort task) leads to less significant estimates of coefficients, which suggests that relative payoffs could be a mediator behind the behavior change. As noted in Footnote 15, performance and payment are both treatment outcomes so the coefficients should be interpreted with caution.

Proportional = Tullock: p-val	0.017	0.009	0.328	0.405	0.818	0.712
All-pay = Tullock: F-stat	5.408**	5.327**	0.312	0.348	0.414	0.358
All-pay = Tullock: p-val	0.022	0.023	0.578	0.556	0.523	0.553

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The baseline treatment is piece rate payment scheme. Change in PD decision is calculated as decision (1 = Cooperate, 0 = Defect) in the second round of PD minus the decision in the first round of PD. Change in PGG contribution and Change in TG amount sent are defined similarly as the choice in second round minus the choice in the first round. PGG contribution and TG amount sent range from 0 to 10.

Throughout the above analyses, we find the Chance for Fair Division hypothesis can better explain the empirical rankings in the Prisoner's Dilemma and Public Good Games, where the cooperation drop is largest in the proportional prize contest and smallest in the all-pay auction contest. This suggests that subjects' expectations over competitive procedures involve fairness concerns (Fehr and Schmidt, 2003), and that this concern is most salient when the contest structure provides an attainable "fair division" outcome. Furthermore, the finding that subjects do not significantly decrease pro-sociality after the all-pay auction contest is consistent with prior observations in the literature that participants do not necessarily consider extreme income inequality in winner-take-all contests as unfair, as long as the winner is determined based on merit (Bartling, Cappelen, Ekström, Sorensen and Tungodden, 2018).

On the other hand, the Effort Correspondence hypothesis does relatively better in predicting trusting behavior in the Trust Game over the Chance for Fair Division hypothesis, suggesting that contests might affect cooperative versus trusting tendencies through distinct mechanisms. One potential interpretation is that the effect of contests on subsequent cooperative settings is larger when the contest offers greater potential for coordination and cooperation, since subjects may infer from forgone fair division opportunities that others in the population are generally uncooperative, while a lack of effort correspondence means more uncertainty regarding subjects' contest payoffs. Flory, Leibbrandt and List (2015) find that job applicants dislike uncertainty in competitive payment schemes, and that this uncertainty aversion can negatively affect subjects' trust of others. Similarly, senders in our setting are less willing to take the strategic risk on trusting others after experiencing a contest with low correspondence between effort and payoff.

4.3 Pro-sociality Index

Since our previous analyses have found somewhat differential response to social dilemma games after the contest treatments, it is useful to obtain an assessment of the *overall* direction of pro-social choices aggregated across the games, accounting for the fact that individuals might vary their prosocial choices differently in different games. Motivated by the feature that deviations from playing Nash in PD, PGG and TG (for senders only) all contribute to greater social efficiency, we create a pro-sociality index to measure the effect of the contest treatments on the overall efficiency of choices in the social dilemma games. The pro-sociality index, called "Efficiency Gain", is defined as the sum of the percentage gains in social efficiency under a subject's actual choices relative to social efficiency under Nash Equilibrium behavior across the three games:

$$Efficiency\ Gain_i = \begin{Bmatrix} \sum_{g\in\{PD,PGG,TG\}} \frac{\pi_{g,i}(s_i,s_{-i}^*)-\pi_{g,i}(s_i^*,s_{-i}^*)}{\pi_{g,i}(s_i^*,s_{-i}^*)} \quad if\ Sender_{TG,i}=1 \\ \sum_{g\in\{PD,PGG\}} \frac{\pi_{g,i}(s_i,s_{-i}^*)-\pi_{g,i}(s_i^*,s_{-i}^*)}{\pi_{g,i}(s_i^*,s_{-i}^*)} + 0.5\ if\ Sender_{TG,i}=0 \end{Bmatrix} \qquad (1)$$

where s_i denotes the strategy of subject i, while s_i^* and s_{-i}^* refers to the Nash-equilibrium strategy by subject i and the opponent $-i$ (different in each game), with slight abuse of notation such that s_i represents a strategy in the respective strategy space of each of the three games. $\pi_{g,i}(s_i, s_{-i}^*)$ therefore, represents the payoff in game g given both subjects' chosen strategy, and $\pi_{g,i}(s_i^*, s_{-i}^*)$ refers to the Nash equilibrium payoff in game g. $Sender_{TG,i}$ is a dummy indicating the sender in the Trust Game. Thus, $\frac{\pi_{g,i}(s_i,s_{-i}^*)-\pi_{g,i}(s_i^*,s_{-i}^*)}{\pi_{g,i}(s_i^*,s_{-i}^*)}$ measures the percentage increase in payoff when subject i chooses s_i rather than s_i^*, given the opponent's Nash equilibrium strategy.

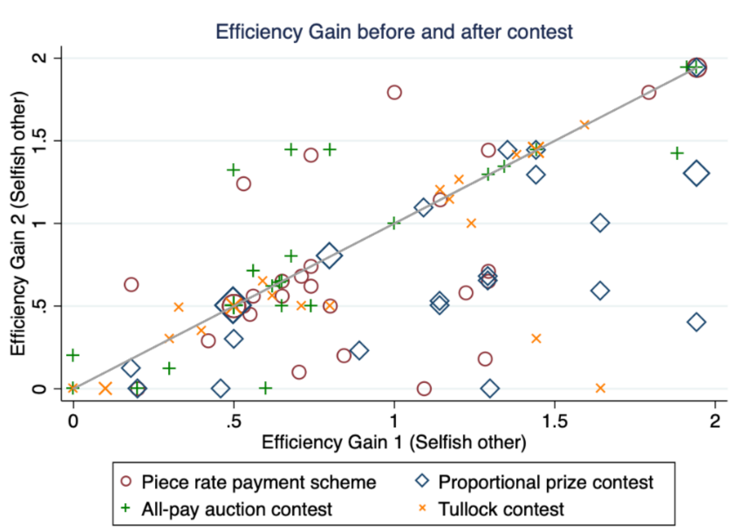
The *Efficiency Gain* is zero if subjects play Nash equilibrium in all games, and is largest when the subject's action across all social games is efficiency-maximizing.[21] Receivers in the Trust Game do not influence the social surplus (but only in part determine the distribution of surplus), so we set receivers' contribution to the percentage gain in efficiency in the Trust Game as 0.5, which is roughly senders' average social contribution in the Trust Game.[22] Since efficiency is determined by both players' actions, we create three different versions of the efficiency gain measure: assuming the other player is playing selfishly (i.e. Nash equilibrium behavior), playing cooperatively, or randomizing uniformly across the possible choices. We mainly present results under the assumption that the other player is playing Nash equilibrium, given this is the most commonly observed behavior across three games. However, the results are qualitatively similar using the other assumptions on the other player's behavior.[23]

Figure 6 illustrates the Efficiency Gain before and after the contest. As seen from the prevalence of observations below the 45-degree line compared to above it, substantially more subjects are shifting towards decreased pro-sociality after the effort task than increased pro-sociality, mainly driven by subjects in the proportional and Tullock contests. Furthermore, in these two treatments, even for subjects who increase pro-social behavior, the magnitude of increase in Efficiency Gain is small while the magnitude of decline in Efficiency Gain from subjects who behave less pro-socially is substantially larger, also shown more clearly in Figure A.4 in the Appendix. Still, 37.5% of subjects do not alter their overall pro-sociality across all treatments.

Figure 7 compares the mean change in Efficiency Gain in each of the four treatments. The relative decline in overall Efficiency Gain among the four treatments is also more consistent with the Chance for Fair Division hypothesis than the Effort Correspondence hypothesis, as the decrease in Efficiency Gain is significantly larger in the proportional prize contest compared to all the other treatments. Decreased pro-sociality in the Tullock contest is also larger than the decline in the all-pay auction contest with marginal statistical significance. Table 9 reports the OLS regression results with change in Efficiency Gain (under different assumptions) as dependent variable and contest treatment dummies as main explanatory variables, controlling for performance or payoff, reinforcing a robust decreasing effect of proportional prize contest on Efficiency Gain index under all three efficiency gain measures, while controlling for subject's performance (or payoff) in the real effort task.

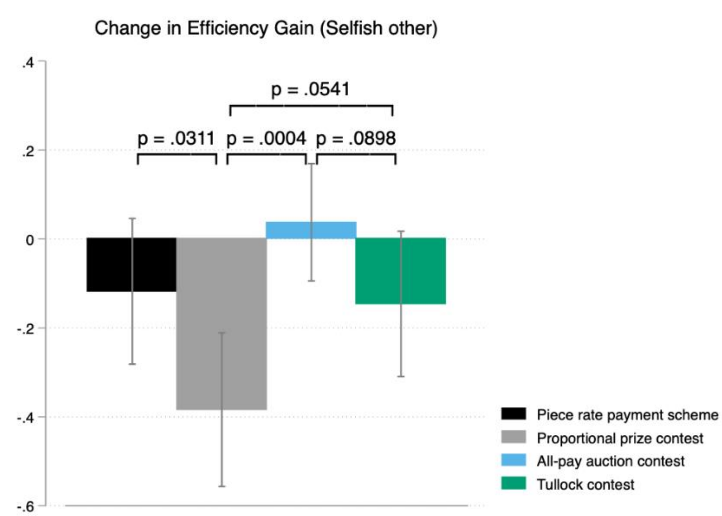
[21] The possible range of efficiency gain (under the assumption that the other player plays Nash) is between 0 and 1.9429.
[22] Note that this specific value is not important in the analysis, since we are mainly interested in change in efficiency gain.
[23] We also compute the actual efficiency gain based on both subjects' actual behavior. Results for the other versions of the efficiency gain indices are presented in the Appendix.

Figure 6: Efficiency Gain (Selfish other) before vs. after contest



Note: Dot size corresponds to the number of observations.

Figure 7: Mean change in Efficiency Gain by treatments



Note: One-sided p-values from t-test of change in Efficiency Gain between any two treatments are reported.

In terms of the cross-game correlation in choices made by subjects, Table A.1. in the Appendix reports strong and significant correlation between subjects' choices in any two of the social dilemma games, with the cross-game correlation is significantly larger in the second round (correlation coefficient > 0.47, $p < 0.0005$). Also, consistent with our previous results, the correlation between the two rounds of pro-social behavior is higher in the PGG and TG (correlation coefficient = 0.6805 and 0.6957 respectively, $p < 0.0001$) than that in the PD (correlation coefficient = 0.5287, $p < 0.0001$). Thus, while cross-game differences exist, the correlation coefficients indicate that subjects' choices are relatively consistent across social games, in line with the results of the Efficiency Gain Index.

Table 9: Changes in Efficiency Gain and correct counts by treatments (OLS regression)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Change in Efficiency Gain (Selfish other)	Change in Efficiency Gain (Selfish other)	Change in Efficiency Gain (Cooperative other)	Change in Efficiency Gain (Cooperative other)	Change in Efficiency Gain (Random other)	Change in Efficiency Gain (Random other)
Proportional prize contest	-0.262**	-0.266**	-0.166**	-0.168**	-0.202**	-0.205**
	(0.120)	(0.121)	(0.079)	(0.077)	(0.093)	(0.092)
All-pay auction contest	0.140	0.155	0.022	0.028	0.067	0.076
	(0.107)	(0.109)	(0.062)	(0.065)	(0.078)	(0.081)
Tullock contest	-0.047	-0.028	-0.070	-0.063	-0.062	-0.050
	(0.118)	(0.122)	(0.077)	(0.081)	(0.092)	(0.096)
Correct counts	0.008		0.003		0.005	
	(0.009)		(0.006)		(0.007)	
Real effort task payoff		-0.000		0.000		0.000
		(0.001)		(0.000)		(0.001)
Constant	-0.296	-0.118	-0.112	-0.044	-0.181	-0.072
	(0.223)	(0.090)	(0.148)	(0.054)	(0.175)	(0.067)
Observations	104	104	104	104	104	104
R-squared	0.131	0.119	0.078	0.074	0.104	0.096
Coefficient tests of equality:						
Proportional = All-pay: F-stat	12.51	14.65	5.807	6.799	9.022	10.61
Proportional = All-pay: p-val	0.001***	0***	0.0180**	0.0110**	0.00300***	0.00200***
Proportional = Tullock: F-stat	2.868	3.897	1.066	1.497	1.823	2.539
Proportional = Tullock: p-val	0.094*	0.0510*	0.304	0.224	0.180	0.114
All-pay = Tullock: F-stat	3.035	2.984	1.590	1.577	2.251	2.219
All-pay = Tullock: p-val	0.0850*	0.0870*	0.210	0.212	0.137	0.139

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The baseline treatment is piece rate payment scheme. Change in PD decision is calculated as decision (1 = Cooperate, 0 = Defect) in the second round of PD minus the decision in the first round of PD. Change in PGG contribution and Change in TG amount sent are defined similarly as the choice in second round minus the choice in the first round. PGG contribution and TG amount sent range from 0 to 10.

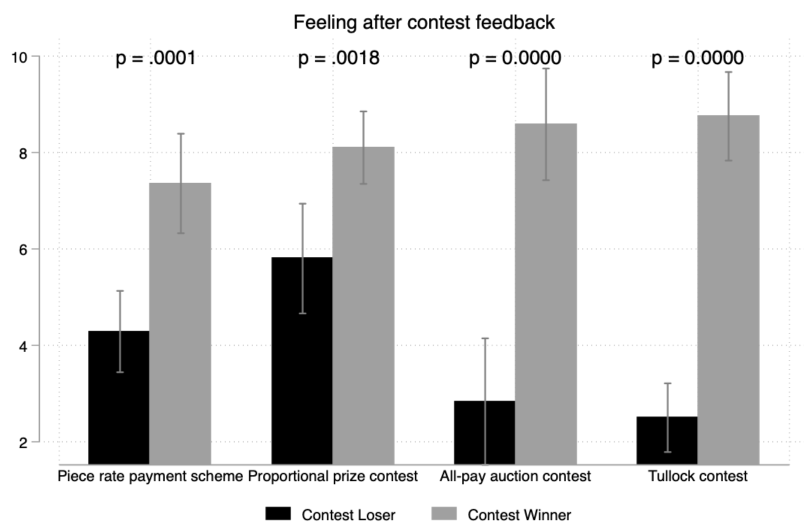
5. Evidence on Potential Mechanisms

We further explore the possible factors behind our finding that pro-social choices drop after competitive compensation schemes, in a ranking largely consistent with the Chance for Fair Division hypothesis. Section 5.1 investigates whether contest winners or losers are contributing to more decline in pro-sociality. As we show, contest losers do not decrease their pro-sociality more than contest winners despite self-reporting a lower emotional state. We also discuss potential explanations of winners' greater drop in pro-sociality. Section 5.2 further explores the relationship between the pro-sociality drop and subjects' attitudes towards competition and performance.

5.1 Decomposition of Effect: Contest Winners vs. Contest Losers

Since contests make the status of winning or losing salient, we examine whether the status of winning or losing drives heterogenous reactions. We define "contest winners" in all treatments as the subject who has strictly higher payoffs and exclude subjects that are tied with their opponents from our analysis.[24] An intuitive hypothesis is that contest losers might experience more negative feelings than winners and respond more negatively, and several prior studies have documented reduced cooperation, effort, and increased anti-social behavior by contest losers. (Buser and Dreber, 2016; McGee and McGee, 2019; Grosch and Rau, 2020).

Figure 8: Self-reported feeling after contest feedback, winners v. losers



Note: One-sided p-values from t-test of feeling between contest winners and losers in each treatment are reported.

Firstly, we do observe that subjects' status as contest winners or losers is highly related to subject's self-reported emotional state in the post-experiment questionnaire.[25] Figure 8 shows that contest losers report significantly lower emotional states upon seeing the contest feedback in all treatments compared to contest winners. The gap in self-reported mood between contest winners and contest losers are much larger in the two winner-take-all contests, while being smallest for the proportional prize contest, a notable pattern in opposite of the reduction patterns in pro-sociality. This suggests that while the reported emotional states of subjects largely adhere to the Effort Correspondence ranking, the reduction patterns in

[24] While piece-rate payment scheme is not a contest, subjects with strictly higher payoff in this treatment is still treated as a "contest winner" for comparison purposes.
[25] The content of the questionnaire is shown in Appendix E.

pro-sociality across treatments do not, so subjects' mood is not necessarily the channel through which the subsequent pro-social choices are determined.

Furthermore, despite the significantly lower moods experienced by contest losers, by decomposing the sources of implied social welfare loss among players, we find that contest losers are not primarily driving the decline in pro-social choices except in the Prisoner's Dilemma. Figure 9 shows the decomposition of the total decline in prosocial choices in each game by players' contest outcomes. For the Prisoner's Dilemma, contest losers (along with the small proportion/influence of ties) account for 64% of the cooperation decline across all treatments, which is mainly driven by contest losers in the proportional prize contest who contribute to 70% of the cooperation decline. Contest losers in the piece rate payment scheme also account for 60% of the cooperation decline. In the all-pay auction contest with *higher* cooperation in the second round of PD, contest winners contribute less to the increase in cooperation. Finally, in the Tullock contest, both contest losers and winners contribute equally to the cooperation decline.

However, this pattern is reversed in the Public Goods Game, in which contest winners contribute to 64% of the decline in contributions, which is in contrast to the 20% contribution by contest losers and 16% contribution by tied subjects. Notably, in the proportional prize contest, contest winners account for 77% of PGG contribution decline, and in the both the all-pay auction and Tullock contests, contest winners account for more than 100% of the contribution decline. By contrast, contest winners in the piece rate treatment increase their second round PGG contribution on average. Altogether, this serves as a strong suggestion that winning in a contest setting seems to lessen the desire or feeling of obligation for contribution in the public goods setting.[26]

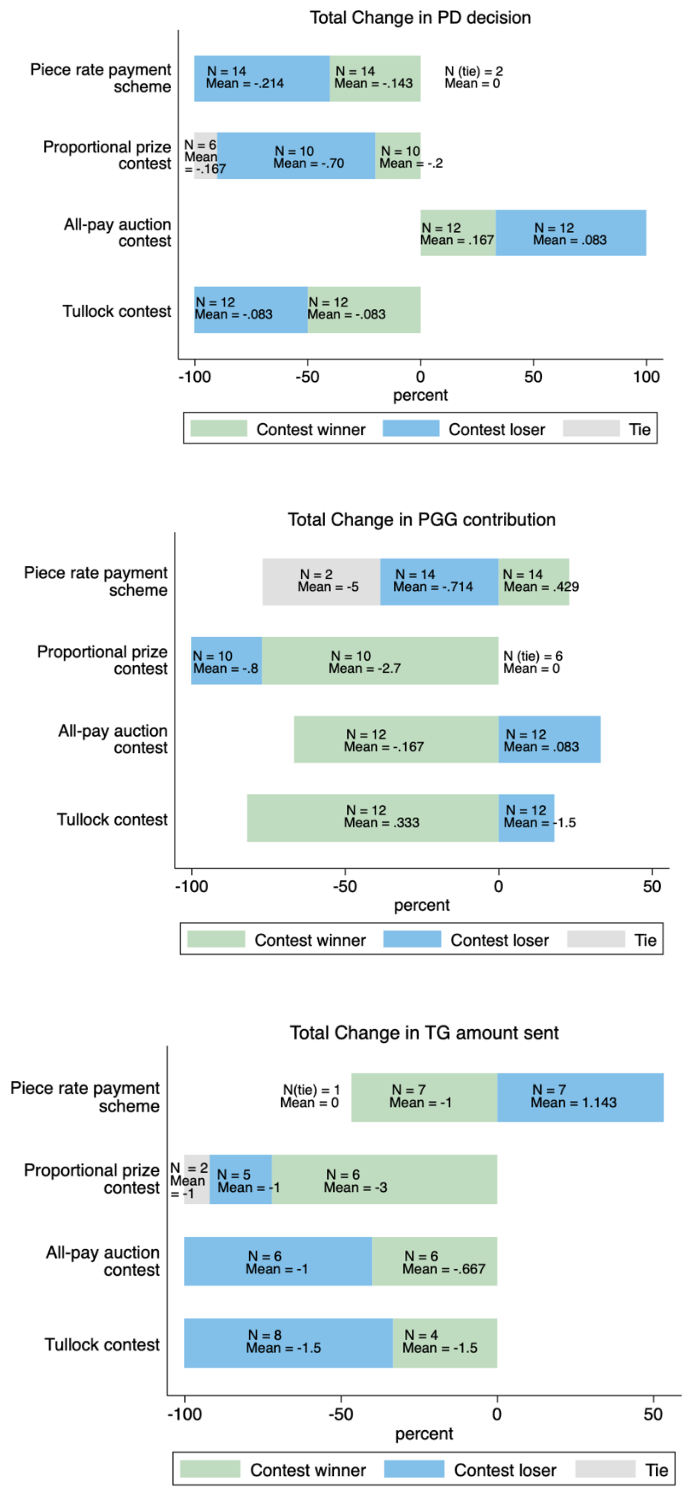
The results are relatively more mixed or balanced for the Trust Game. For senders in the Trust Game, "contest winners" in the piece rate treatment contribute more than 100% of the gross decline in amount sent. Similar to in the Public Goods Game, contest winners in the proportional prize contest contribute 72% of the total decline. One the other hand, contest losers were relatively more responsible for the trust decline in both of the winner-take-all contests.[27, 28]

[26] An interesting observation throughout our study is the difference in results between the Prisoner's Dilemma and Public Goods Game, which are framed in neutral but standardized ways in the experiment. Although the two games are similar in nature, there are several possible channels to account for some of the differences observed, which we discuss further in the Conclusions.

[27] Recall that the Trust Game involves asymmetric roles between the two players, and the distribution of winners and losers in the contest is not balanced across the Trust Game roles under our sample size (observations indicated in Figure 9), so the interpretation of the decomposition can be taken with caution.

[28] Notably, although contest losers have significantly lower self-reported emotional states than contest winners in all treatments, the regression in Table C.2 shows that the lower reported emotional state does not predict a larger decline in prosocial behavior in almost all social games under any treatments (with the one exception being the cooperation change in the PD after proportional prize contest).

Figure 9: Change in social game behavior (in percentage)



Note: The green (blue / grey) bar refers to the percentage of total change in social game choices contributed by contest winners (losers / ties). A negative (positive) percentage means that contest winners contribute to the drop (increase) of prosocial behavior. Mean change in prosocial behavior for each group and the number of subjects in each group are also denoted.

In terms of the aggregate change in efficiency gain across games, since the patterns of relative decline in prosocial choices between contest winners and losers in the PD offset the patterns in the PGG and TG, the change in overall efficiency gain between contest winners and losers is not significantly different in all treatments. The result remains generally unchanged when regressing change in decisions in the social dilemma games on an interaction term between treatments and winners, controlling for absolute and relative performance, as shown in Table C.1 (Appendix).

The relatively higher contribution of winners to pro-sociality declines in the PGG and TG is surprising for a few reasons. First, winners as we have defined them for this analysis, have strictly higher realized payoffs than their contest opponent, which could plausibly correspond to an increased tolerance for strategic uncertainty or generosity based on relative income considerations (ex. as found in Fehr, Rau, Trautmann and Xu, 2020). While this could be an explanation behind the relatively lower contribution of winners towards declines in pro-sociality compared to losers in the PD, where subjects actually have the greatest uncertainty over their own payoffs based on the opponent's choice of action, the opposite in fact occurs in the PGG and TG. Furthermore, Table C.5 in the Appendix indicates no significant interaction effects between payoff and treatment variables, which also suggests that payoff considerations in the contest stage have limited explanatory power in our setting.

A potential explanation for the patterns in PGG and TG, although it cannot be directly tested in our current experiment, is an "entitlement effect", which predicts a higher level of psychological entitlement for winners in the contests (Major and Testa, 1989). Contest winners, feeling themselves more deserving of better outcomes, might be more prone to behaving egoistically, and less generous in their strategic interactions with others. For instance, Schurr and Ritov (2016) find that contest winners determined randomly display more dishonest behavior. In support of this possibility, in our experiment, surprise winners in the Tullock contest (subjects that have fewer correct counts but win the contest through chance) also decrease pro-social choices more than surprise losers, which due to its essentially random assignment of winners/losers, is reasonably explained by an entitlement effect.[29]

5.2 Attitudes Toward Competition

We turn attention to the post-experiment questionnaire, especially subjects' self-reported competitive attitudes to further probe the potential sources of cross-subject differences in behavior changes after the contest, where we survey subjects regarding their personal attitudes and experiences with the contest component of the experiment (see Appendix E for details).

We measure subjects' general attitude towards competition with four questions, including the degree to which subjects 1) enjoy participating in contest regardless of contest outcomes ("contest enjoyment"); 2) have strong ambition to win in contests ("ambition to win"); 3) frequently participate in contests ("participation frequency"); and 4) always exert much effort as possible to win in a contest ("effort to win").[30] These four questions measure how likely subjects will participate in contests, and how strong subjects' eagerness is to win the contests.

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[29] Besides contest winners and contest losers, we also detect significant differences between senders and receivers' behavior in the second round of PD and PGG in some treatments (see Figure C.2). One possible explanation is that senders are at a payoff disadvantage in the Trust Game since they need to risk their endowment for more payoff. Thus, senders may feel it is unfair and turn to greater self-interest and less risk-seeking behavior.

[30] Subjects answer these questions in a 10-point scale from "strongly disagree" to "strongly agree" for questions 1,2,4; and from "none" to "very frequently" from question 3. The translated version of the questionnaire is provided in the Appendix.

Among the four questions, we find a stronger negative effect of the contest on behavior in PGG and TG among subjects with self-reporting high “ambition to win” or high “effort to win” in contests. In Table 10, we estimate a set of OLS regressions where we regress prosocial action change in each game against contest treatment dummies and their interaction with either “ambition to win” or “effort to win” measures. Column 3 shows that, in the all-pay auction contest and the Tullock contest, subjects with a higher ambition towards winning tend to decrease trust more. Similarly, in Column 6, drops in PGG contributions increase with subjects’ willingness to exert high effort to win in all contest treatments relative to the piece rate treatment, suggesting subjects with a higher desire to outperform their opponents may find it harder to ‘switch off’ their competitive mindset than the other subjects. However, no measure of competitiveness in our questionnaire appears to moderate the effect of contests on the subject’s cooperation in Prisoner’s Dilemma.

Table 10: Changes in social behavior and competitiveness by treatments (OLS regression)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Change in PD decision	Change in PGG contribution	Change in TG amount sent	Change in Efficiency Gain (Selfish other)	Change in PD decision	Change in PGG contribution	Change in TG amount sent	Change in Efficiency Gain (Selfish other)
Proportional prize contest	-0.943*	10.575***	6.816	-0.244	-1.134**	0.996	1.455	-0.492
	(0.524)	(3.412)	(8.323)	(0.612)	(0.566)	(2.518)	(4.925)	(0.472)
All-pay auction contest	0.090	9.200***	-1.382	0.244	-0.228	-0.244	3.948	0.097
	(0.458)	(3.382)	(5.356)	(0.561)	(0.519)	(2.999)	(2.350)	(0.445)
Tullock contest	-0.354	7.474**	-10.597*	-0.595	0.141	2.078	11.401**	0.653
	(0.556)	(3.288)	(5.922)	(0.790)	(0.552)	(3.472)	(4.671)	(0.543)
Effort to win	-0.018	0.952***	-0.247	0.001				
	(0.052)	(0.338)	(0.621)	(0.063)				
Proportional prize contest X Effort to win	0.088	-1.399***	-1.002	-0.002				
	(0.065)	(0.420)	(1.031)	(0.074)				
All-pay auction contest X Effort to win	0.022	-1.067***	0.061	-0.012				
	(0.056)	(0.393)	(0.629)	(0.066)				
Tullock contest X Effort to win	0.053	-0.920**	1.137	0.072				
	(0.069)	(0.384)	(0.701)	(0.095)				
Ambition to win					-0.046	0.020	0.391	-0.003
					(0.059)	(0.241)	(0.298)	(0.050)
Proportional prize contest X Ambition to win					0.115	-0.240	-0.434	0.029
					(0.070)	(0.314)	(0.592)	(0.059)
All-pay auction contest X Ambition to win					0.061	0.095	-0.643*	0.006
					(0.063)	(0.332)	(0.336)	(0.053)

Tullock contest X Ambition to win					-0.014	-0.269	-1.650**	-0.091
					(0.070)	(0.471)	(0.649)	(0.072)
Correct counts	0.010	-0.040	0.014	0.007	0.011	-0.051	0.039	0.008
	(0.008)	(0.055)	(0.085)	(0.009)	(0.008)	(0.054)	(0.083)	(0.009)
Constant	-0.243	-7.370**	1.719	-0.285	-0.026	0.446	-3.854	-0.254
	(0.455)	(3.117)	(5.539)	(0.576)	(0.528)	(2.230)	(3.104)	(0.474)
Observations	104	104	52	104	104	104	52	104
R-squared	0.203	0.115	0.294	0.161	0.222	0.042	0.223	0.169

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The baseline treatment is piece rate payment scheme. Change in PD decision is calculated as decision (1 = Cooperate, 0 = Defect) in the second round of PD minus the decision in the first round of PD. Change in PGG contribution and Change in TG amount sent are defined similarly as the choice in second round minus the choice in the first round. PGG contribution and TG amount sent range from 0 to 10.

On the other hand, we do not find subjects' answers to "contest enjoyment" and "participation frequency" significantly moderates the contest effect (see Table C.3 in the Appendix).[31] One possibility is that these two questions lay less emphasis on the contest outcomes and more on selection into contests, and are not closely tied to subjects' competitiveness during the contest.[32] Indeed, Table C.4 (Appendix) shows that despite a high correlation between ambition and effort measures ($p < 0.0001$), we see little correlation between ambition to win and either the contest enjoyment nor the participation frequency, and weak correlation between effort to win and contest enjoyment ($p = 0.098$), or participation frequency ($p = 0.051$), indicating that different aspects of attitudes towards contests are captured by these questions.

Furthermore, although previous studies show that more productive subjects tend to have more cheating behavior (Gill, Prowse and Vlassopoulos, 2013), we do not find any evidence that the contest effect is stronger among subjects with more correct counts or payoffs (see Table C.5 in the Appendix).[33] Similarly, we do not find a larger contest effects driven by subjects with better relative performance or payoffs (see Table C.6 in the Appendix). Altogether, our results suggest that higher competitiveness, rather than actual or relative performance in the contest, may make subjects more subject to a greater effect of contests, potentially because the 'intensity' or 'heat' of the competition drives self-interest more saliently for competitive participants, while not necessarily so for more productive participants.

5.3 Alternative Explanations

In this subsection, we briefly discuss alternative explanations for the negative pro-social effect of competitive payment schemes in our experiment, and explain why it is unlikely for these explanations to account for our experimental results.

One potential concern is that subjects' prosocial behavior changed after the contest due to learning or repeated game effects independently of the contest treatments. However, since the feedback results of all social dilemma games (including the other player's action and the payoff outcome) are not revealed to subjects until the entire experiment is over, subjects cannot learn from the first round of social games and

[31] One exception is that in the all-pay auction contest, subjects with higher participation frequency tends to decrease trust more.
[32] Additionally, subjects might differ in their perception of frequencies in contest participation, leading to a less accurate measure of participation frequency.
[33] We only find more decline in PGG contribution among more productive subjects in the proportional prize contest only (significant at the 10% level).

cannot update their beliefs.[34] Unlike past experimental literature where subject acts towards Nash equilibrium in the final round of the game, subjects in our experiment are unable to act strategically in a dynamic sense as they do not know ex-ante the full sequence of games in the experiment. The random re-matching design in all social games, made clear in the instructions, further precludes the possibility of repeated interaction effects, and makes earlier experiences of only limited use in inferring future partners' behavior. Lastly, our analysis focuses on cross-treatment effects, while all treatments face identical potential dynamic effects with respect to the social dilemma games. Hence, learning or other dynamic considerations cannot explain the difference in findings across the different compensation treatments.

Our results are also unlikely due to cognitive fatigue resulting from the real-effort task, as our between-treatment comparison of behavior changes should eliminate, if any, the effect of fatigue on pro-social behavior. This is because the level of fatigue across treatments is likely similar given that the differences in the average number of correct counts across treatments is small (not larger than 2), if one presumes that the level of fatigue is positively associated with the performance level. Our results are also robust to controlling for the correct counts (i.e. performance level), which indicates a robustness to fatigue-related effects.

6. Conclusions and Discussion

Contests are used in many real-world settings to extract high levels of effort under limited compensation resources. However, relatively little is known about the short-term and potentially long-term unintended behavioral and welfare consequences of contests. Our study contributes to an understanding of the impact of different competitive compensation formats on participants' generalized willingness to sacrifice or risk one's own benefit for a greater overall social benefit.

We find that on the whole, contest participants generally behave less pro-socially directly after competition, supported by the decline in Efficiency Gain Index (aggregating across games) for the majority of subjects. Our random re-matching design for each game in the sequence helps pin down the generalized nature of the change in pro-sociality such that participants are not simply reacting to, or enacting 'retaliation' upon their competitors. Rather, their change in pro-social behavior represents a potential shift in general attitudes when interacting with others.

Despite a general trend of decreased pro-sociality in all social dilemma games, subjects' behavior in the three games are not equally responsive to the various compensation schemes. The Prisoner's Dilemma was most responsive to contest formats across treatments, while the Public Goods Game was least regularly affected out of the games considered. However, in both the Public Goods Game and the Trust Game, even for subjects who increase prosocial action after the contests, the magnitude of pro-sociality increase is still much smaller than the magnitude of pro-sociality decline for those that become less prosocial after the contests.

The magnitude and direction of behavioral changes in the social dilemma games also varies by compensation formats, but reveals a more nuanced picture of subjects' multi-faceted social behavior than originally hypothesized. While one intuitive hypothesis is that anti-social choices may naturally result

[34] The sole exception to this is the amount sent by one's partner in the Trust Game if a subject is playing the role of receiver. However, when we include role played in the Trust Game as a dummy variable in robustness checks for our regression specifications, the estimated contest treatment effects are highly similar to their original estimated values (see Table A.3 in Appendix).

from the disconnect between effort exerted and payoff received, our experiment results instead provide support for the idea that subjects' cooperative behavior after the contest is related to the potential for fair division in the contest. Specifically, we find that the proportional prize contest, which has the strongest such potential for fair surplus division, primarily drives the drop in cooperative behavior, while subjects in the all-pay auction contest, despite the high payoff inequality and low effort correspondence for contest losers, has the least decrease in prosocial actions overall. Thus, when predicting workers' responses to different competitive compensation schemes, other than considerations about rewards for effort and inequality, it may be at least as important to take into consideration workers' expectations and understanding of their colleagues' likely behavior in the contest.

By contrast, changes in trusting behavior match to some extent better to the Effort Correspondence hypothesis, though the ranking is not a complete validation of the hypothesis. The all-pay auction contest no longer yields the smallest drop in trust, while the piece-rate payment scheme showed the least decline in trust. This might imply distinct mechanisms in the contests' effect on cooperation and trust as represented by these games specifically, despite that they all address concepts of pro-sociality.

Our results also show that the piece rate with performance feedback has a declining effect, indicating a potential social comparison effect even without an explicit monetary contest.[35] This implies that compensation design would also benefit from considering the amount of information disclosure of performance feedback when structuring incentives, since the mere disclosure of feedback without competitive monetary consequences can also induce decline in pro-social attitudes.

Regarding the individual-level explanatory factors behind the pro-sociality declines, especially each individual's contest outcome, we do not find that contest losers are driving the decrease in pro-sociality in all of the social dilemma game, contrasting with the findings in Buser and Dreber (2016) and Fehr et al. (2020). While contest losers do decrease their cooperation in the Prisoner's Dilemma more than contest winners, contest winners are generally responsible to greater degree for the switch towards Nash equilibrium behavior in both the Public Goods Game and in the Trust Game in the second round. Among intuitive explanations, the choice patterns in the Public Goods Game and Trust Game are more suggestive of an entitlement effect.

Through the responses to our post-experiment questionnaire, we further examine the potential relationship between emotions, competition attitudes, and pro-social decline. Although we find that the gap in self-reported emotional state between contest winners and losers largely matches that predicted by the Effort Correspondence hypothesis, emotions are not primarily driving pro-social choices since the pattern of pro-social decline do not generally follow this hypothesis. However, participants with more intense attitudes towards competition seem to be more negatively influenced by the contest experience, as we observe a greater likelihood to decrease pro-sociality in the Public Goods and Trust Games among subjects reporting a general "high ambition to win" or "high effort to win" in contests.

These findings have implications for the behaviorally optimal incentive structure in an organization in which a combination of competition and cooperation is needed. Given potential negative consequences in social interactions outside of contests, the efficiency loss due to reduced cooperation should be an important consideration when implementing competitive incentives, even when individuals compete and cooperate with distinct groups of people. This effect of contests may manifest in multiple settings and result in a substantial decline in overall surplus generated. In terms of labor market

[35] We note that adding an additional control treatment without social information provided, can help concretely distinguish the decline found in the piece rate treatment in our experiment from general effects due to time trends.

performance, our results suggest that persistent worker competition without carefully designed incentives could also hinder workers' ability for teamwork and cooperation in workplace contexts. In addition, while revenue sharing schemes such as the proportional prize contest seem to have positive features such as high effort to reward correspondence, and at least are not winner-take-all, our study shows that the impact on pro-social choices outside of the contest setting is in fact the most severe for this contest format. Beyond compensation design in organizations, our results are also relevant in the long-run for competitive societies that rely on constant and repeated competition among citizens. For instance, the tradition of academic promotion quota in Chinese universities and the required fail rates for students in academic programs may negatively affect students' cooperative social interactions with peers. It also cautions that repeated required competitions in society or over-emphasis therein, could result in a general shift in social preferences and pro-social tendencies in the long run, such as less trust towards strangers and less willingness to contribute to public goods. Notably, our findings are reminiscent of the concept of *neijuan*, a buzzword trending in China since 2020, referring to a vicious cycle of competition for a fixed shared prize.[36] The popularity of word *neijuan* in China reflects the public's aversion to endless intense competition with their peers, especially in situations where the reward is a fixed and unattractive pie and might invoke zero-sum thinking. In response, people choose to give up and reject coordination, which, to an extent, is most consistent with least pro-social and efficiency-enhancing choices observed in the proportional prize contest.[37]

Finally, we discuss some of the limitations of the current study and directions for future work.

In much of our analysis, we detect a significant difference in subjects' responses to the Prisoner's Dilemma compared to the Public Goods Game, despite the two games' inherent similarities. For example, in the aggregate, the PD yields a much larger and obvious drop in pro-social choice compared to the PGG. In addition, the responses of contest winners and losers are opposite between the two games, with losers driving the PD decline, and winners driving the PGG decline. While our current design cannot provide definitive explanations for the differences, there are several possible reasons for the discrepancies observed. For one, the PD is a relatively simpler game, with a smaller and discrete strategy space, and in our setting, a higher degree of own payoff sensitivity to the opponent's range of choices. Also, in our setting, the PGG is framed as an allocation task in which allocation towards one box (the private account) does not carry any strategic uncertainty. Finally, while the PD payoffs are explicitly described, the PGG requires more calculation to determine the hypothetical payoffs. Future work can attempt to pin down the source of difference in results for these two games.

Furthermore, our results show a somewhat complex picture of the heterogeneous responses by subjects' status of winning. While our results suggest that differences in contest winners and losers' choices are not likely to be driven by their emotional state after the contest, future research is needed to

[36] The Chinese word *neijuan* literally means "involution", a term originally used in an American anthropologist Clifford Geertz's book "Agricultural Involution – The Processes of Ecological Change in Indonesia", in which he documented that population growth in Indonesia under the colonial rule did not drive economic growth, as agricultural production became internally more complicated and labor-intensive and failed be more efficient. In the Chinese context, this word is commonly used to describe over-competition in workplace or academic scenarios with an unattractive fixed reward. For detailed description, see https://www.whatsonweibo.com/the-concept-of-involution-neijuan-on-chinese-social-media/

[37] The aversion to "*neijuan*" has led to a social protest movement in China, in which workers pursue a lifestyle of "*Tangping*" (means "lying flat") to reject overwork with little reward. This movement has also been compared to the anti-work movement in the US. For more details, see https://en.wikipedia.org/wiki/Tang_ping; https://www.washingtonpost.com/world/asia_pacific/china-lying-flat-stress/2021/06/04/cef36902-c42f-11eb-89a4-b7ae22aa193e_story.html .

understand the channels of how contest outcomes drive different responses for contest winners and losers, and whether some channels dominate the other in different prosocial domains. Specifically, more direct measures on subjects' tolerance towards strategic uncertainty and psychological entitlement effects after the contests can enhance our understanding of subjects' subsequent behavior in pro-sociality domains.

In addition, while our study fairly solidly refutes the effort correspondence hypothesis, showing that subjects' decisions after the contest are more complicated than merely expressing dissatisfaction with low effort to earnings correspondence, further evidence is needed in testing the proposed alternative Chance for Fair Division hypothesis more directly. A more direct manipulation for chances for fair division in the contest, and measurement on the relationship between chance for fair division and social preference concern could be useful. To further distinguish between the two hypotheses, one could also examine the role of payoff uncertainty on subjects' perceptions on effort correspondence. If a greater uncertainty in mapping effort to outcomes in the contest has a discouraging effect on one's willingness to take risk trusting others, it could explain why the effort correspondence hypothesis better predicts the decline in trust after a contest. With the results of the current study in mind, further experimental designs can pursue a more direct testing approach to the two proposed hypotheses regarding how contest experiences affect individual pro-social attitudes.

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Appendix A: Social Dilemma Games Before and After Contests

In this section, we report more outcomes on changes in prosocial behavior after contest. We present the distribution of both between-person and within-person change in behavior in each social game respectively (Figure A.1-Figure A.4), examine the correlation of subject's behavior in both rounds of games (Table A.1), and finally show that our result on the effect of contest on social games behavior is robust to adding baseline prosocial behavior controls (Table A.2) and controlling for subject's role in the Trust Game (Table A.3).

Figure A.1: Within-person change in the Prisoner's Dilemma decision before vs. after the contest. Subjects that do not alter their decision are further decomposed to two types based on whether they choose 'Defect'(D) or 'Cooperate' (C) before the contest.

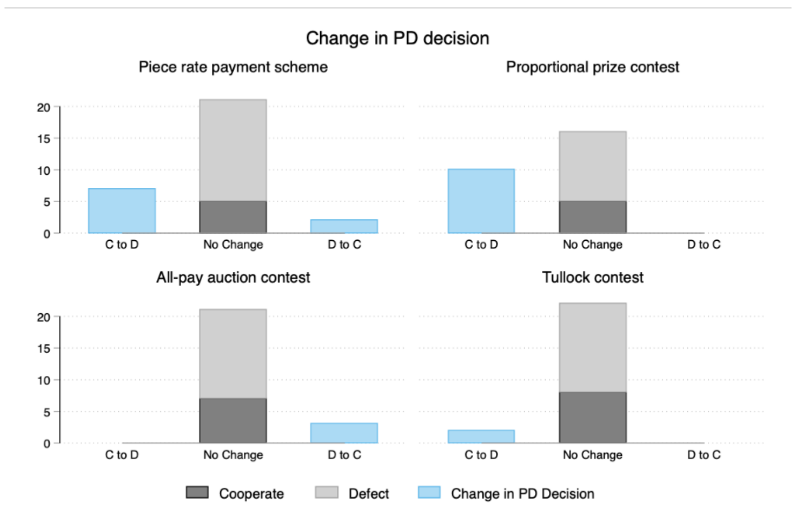


Figure A.2: Within-person change in the Public Goods Game contribution before vs. after the contest. The red lines indicate zero change in PGG contribution. A substantial fraction of subjects does not alter their behavior, contributing to the lack of statistical significances in PGG contribution change.

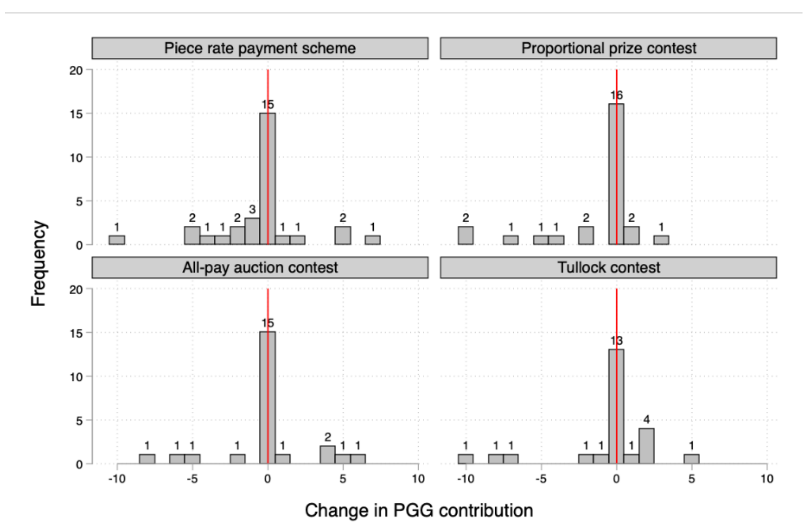


Figure A.3: Within-person change in the Trust Game amount sent (by senders) before vs. after the contest. The red lines indicate zero change in TG amount sent. 52% of subjects do not change the amount sent, and for those who change, they tend to lower their trust rather than increase it.

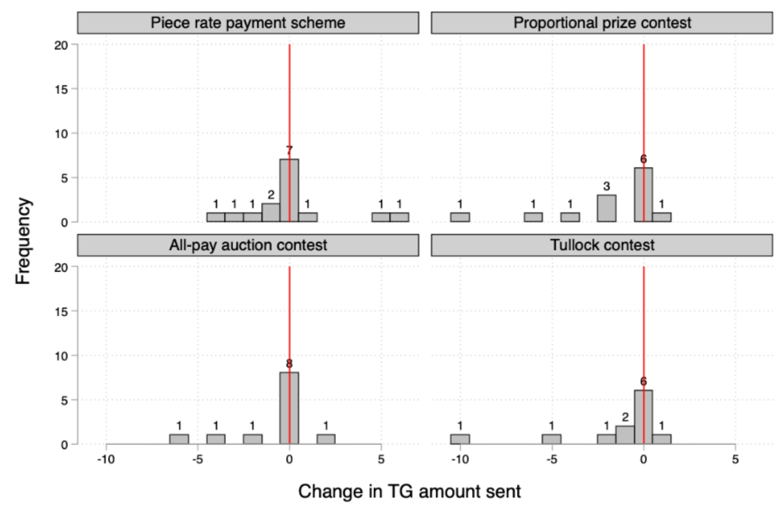


Figure A.4: Within-person change in the Efficiency Gain (assuming the other player is playing selfishly) before vs. after the contest. The red lines indicate zero change in Efficiency Gain. Significantly more subjects are shifting towards lower pro-sociality rather than higher pro-sociality, mainly driven by subjects in the proportional prize contest and Tullock contest.

Table A.1. reports the cross-game correlation in subject's social behavior in both rounds of social dilemma games and shows that subjects' behavior is highly correlated across three different social games.

Table A.1: Spearman correlation for subject's social behavior in two arounds of social games

	Decision1	Decision2	Contribution1	Contribution2	Sent1	Sent2
Decision1	1					
Decision2	0.5287***	1				
	(0.0000)					
Contribution1	0.3205***	0.3049***	1			
	(0.0009)	(0.0016)				
Contribution2	0.3669***	0.5068***	0.6805***	1		
	(0.0001)	(0.0000)	(0.0000)			
Sent1	0.3895***	0.3772***	0.3724***	0.3356**	1	
	(0.0043)	(0.0058)	(0.0066)	(0.015)		
Sent2	0.3395**	0.478***	0.3523**	0.4824***	0.6957***	1
	(0.0138)	(0.0003)	(0.0104)	0.0003	(0.0000)	

Note: pval in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Decision1(2) = Decision in the 1st (2nd) round of Prisoner's Dilemma (0 = Defect; 1 = Cooperate); Contribution1(2) = Contribution in Public Goods Game (range from 0 to 10); Sent1(2) = Amounts sent in Trust Game (range from 0 to 10).

Table A.2. provides additional robustness check for Table 7 by controlling for subject's social behavior in the first round of the social games.

Table A.2: Changes in social games behavior by treatments (control for baseline behavior)

VARIABLES	(1) Change in PD decision	(2) Change in PD decision	(3) Change in PGG contribution	(4) Change in PGG contribution	(5) Change in TG amount sent	(6) Change in TG amount sent
Proportional prize contest	-0.131	-0.123	-0.638	-0.432	-1.618	-1.707*
	(0.104)	(0.110)	(0.777)	(0.794)	(1.057)	(1.005)
All-pay auction contest	0.221**	0.254**	0.509	0.660	-0.983	-0.935
	(0.108)	(0.108)	(0.806)	(0.801)	(0.918)	(0.955)
Tullock contest	0.064	0.104	-0.135	0.002	-1.838*	-1.668
	(0.099)	(0.101)	(0.813)	(0.764)	(1.055)	(1.114)
Correct counts	0.012*		-0.025		0.085	
	(0.007)		(0.049)		(0.092)	
Real effort task payoff		-0.000		-0.006		0.001
		(0.001)		(0.005)		(0.007)
1st round PD decision	-0.459***	-0.467***				
	(0.073)	(0.076)				
1st round PGG investment			-0.307***	-0.308***		
			(0.076)	(0.073)		
1st round TG sent					-0.231**	-0.206*
					(0.111)	(0.103)
Constant	-0.235	0.036	1.394	1.125*	-0.661	1.021
	(0.160)	(0.081)	(1.212)	(0.667)	(2.148)	(0.973)
Observations	104	104	104	104	52	52
R-squared	0.408	0.389	0.175	0.183	0.182	0.156
Coefficient tests of equality:						
Proportional = All-pay: F-stat	12.56	15	1.910	1.702	0.344	0.588
Proportional = All-pay: p-val	0.00100***	0***	0.170	0.195	0.561	0.447
Proportional = Tullock: F-stat	4.363	5.502	0.353	0.278	0.0310	0.00100
Proportional = Tullock: p-val	0.0390**	0.0210**	0.554	0.599	0.862	0.974
All-pay = Tullock: F-stat	2.900	2.726	0.551	0.587	0.692	0.483
All-pay = Tullock: p-val	0.0920*	0.102	0.460	0.445	0.410	0.491

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The baseline treatment is piece rate payment scheme. Change in PD decision is calculated as decision (1 = Cooperate, 0 = Defect) in the second round of PD minus the decision in the first round of PD. Change in PGG contribution and Change in TG amount sent are defined similarly as the choice in second round minus the choice in the first round. PGG contribution and TG amount sent range from 0 to 10.

Table A.3. further controls for subjects' role in the Trust Game by including a dummy indicating the subject played the role of the sender in the Trust Game. Compared to Table 7, the coefficients for all contest treatment dummies barely change, and the results on coefficient of inequality remain basically unchanged.

Table A.3: Changes in social games behavior by treatments (control for Trust Game sender)

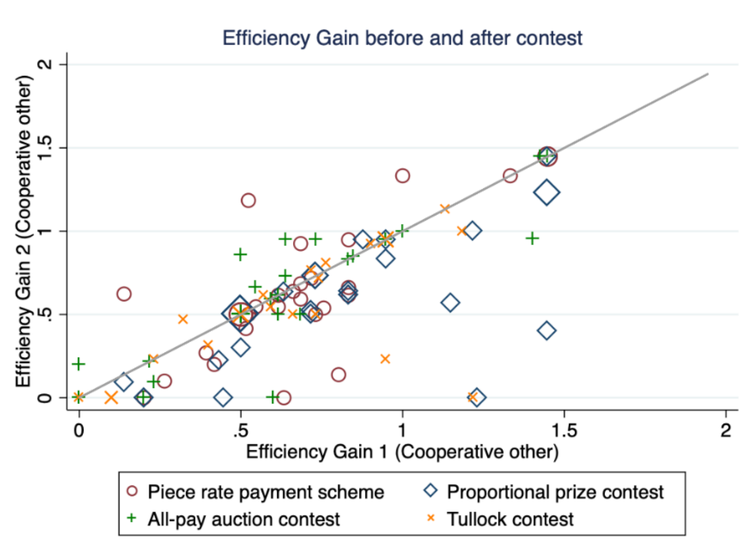
VARIABLES	(1) Change in PD decision	(2) Change in PD decision	(3) Change in PGG contribution	(4) Change in PGG contribution
Proportional prize contest	-0.211	-0.215	-0.901	-0.626
	(0.131)	(0.140)	(0.849)	(0.854)
All-pay auction contest	0.266**	0.295**	0.508	0.679
	(0.122)	(0.120)	(0.842)	(0.842)
Tullock contest	0.050	0.086	-0.010	0.137
	(0.113)	(0.113)	(0.910)	(0.849)
Correct counts	0.015*		-0.047	
	(0.008)		(0.052)	
Real effort task payoff		-0.000		-0.008
		(0.001)		(0.006)
TG sender	-0.207**	-0.193**	-0.876	-0.989
	(0.081)	(0.085)	(0.624)	(0.624)
Constant	-0.373*	-0.066	0.965	0.351
	(0.193)	(0.105)	(1.318)	(0.740)
Observations	104	104	104	104
R-squared	0.226	0.194	0.050	0.059
Coefficient tests of equality:				
Proportional = All-pay: F-stat	17.10***	19.07***	2.727	2.299
Proportional = All-pay: p-val	<0.001	<0.001	0.102	0.133
Proportional = Tullock: F-stat	6.179**	7.250***	0.931	0.714
Proportional = Tullock: p-val	0.0150	0.00800	0.337	0.400
All-pay = Tullock: F-stat	6.008**	6.013**	0.317	0.354
All-pay = Tullock: p-val	0.0160	0.0160	0.575	0.553

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The baseline treatment is piece rate payment scheme. Change in PD decision is calculated as decision (1 = Cooperate, 0 = Defect) in the second round of PD minus the decision in the first round of PD. Change in PGG contribution (ranges from 0 to 10) is defined similarly as the choice in second round minus the choice in the first round.

Appendix B: Alternative Definitions of Pro-sociality Index

The pro-sociality index (measured by "Efficiency Gain") in the main paper assumes that the other player behaves selfishly. In this section, we show that the results are similar under other definitions of pro-sociality index. We report results on the average change and within-person change in pro-sociality index under the assumption that the other contest player plays cooperatively or randomly (Figure B.1-Figure B.6). Results for actual efficiency gain (based on the actual choices) are also reported (Figure B.7-Figure B.9). We also examine the overall efficiency gain for the combination of Prisoner's Dilemma and Public Goods Games alone as both games measure subjects' cooperative behavior. As Figure B.10-Figure B.12 indicates, the same treatment ranking as in the general Efficiency Gain index remains.

Figure B.1: Efficiency Gain before and after contests (assuming the other player is playing cooperatively). Still, few points are above the 45-degree line (i.e. increasing prosocial behavior in the second round of social games).



Note: Dot size corresponds to the number of observations.

Figure B.2: Within-person change in the Efficiency Gain (assuming the other player is playing cooperatively) after the contest. The red lines indicate zero change in Efficiency Gain.

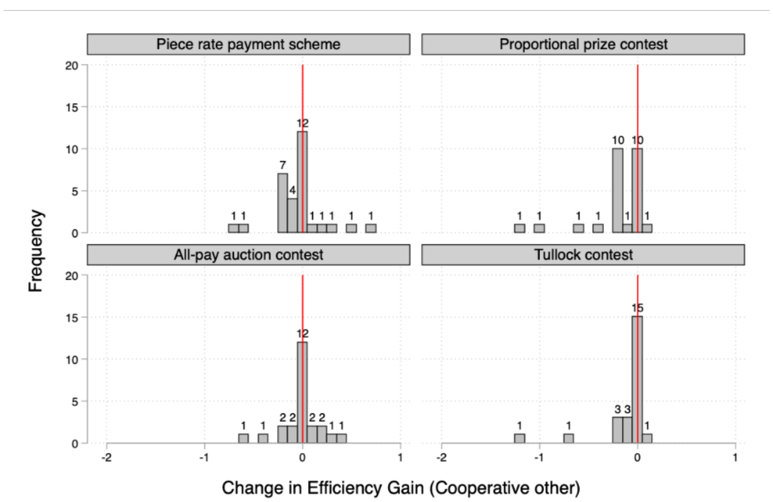


Figure B.3: Mean change in Efficiency Gain by treatments (assuming the other player is playing cooperatively). The pattern is similar to Figure 7, but the treatment differences are smaller and less significant compared to Efficiency Gain (under the assumption of selfish other).

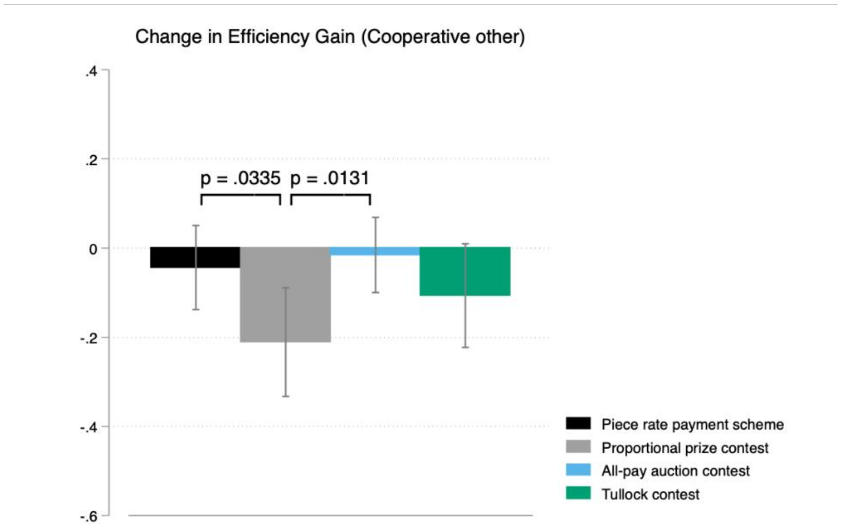


Figure B.4: Efficiency Gain before and after contests (assuming the other player is playing randomly). Still, few points are above the 45-degree line (i.e. increasing prosocial behavior in the second round of social games).

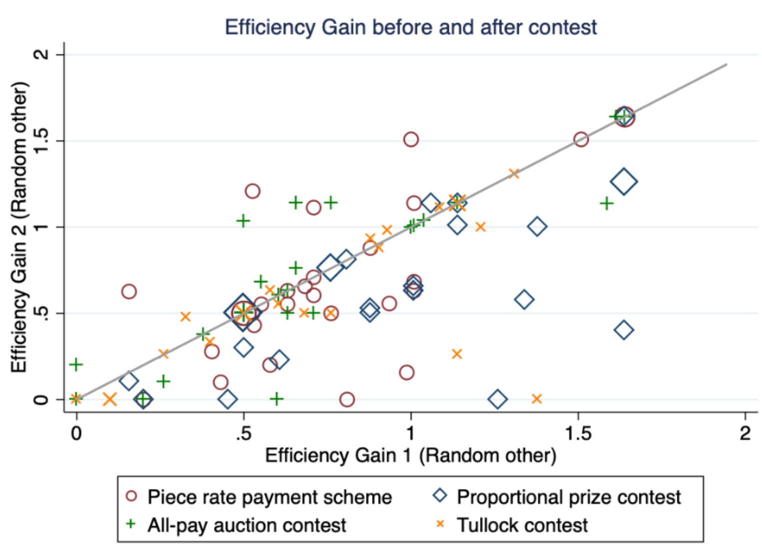


Figure B.5: Within-person change in the Efficiency Gain (assuming the other player is playing randomly). The red lines indicate zero change in Efficiency Gain.

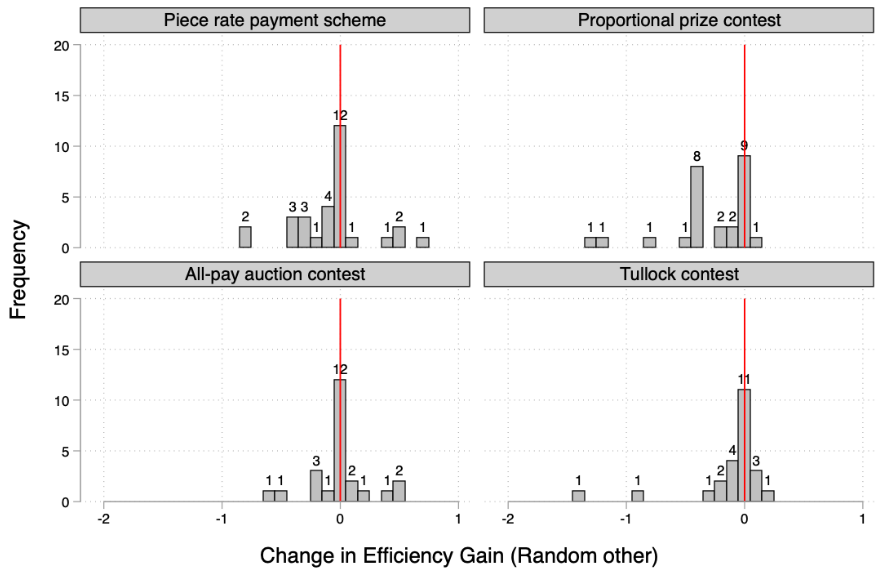


Figure B.6: Mean change in Efficiency Gain by treatments (assuming the other player is playing randomly). The pattern is similar to Figure 7, but the treatment differences are smaller and less significant compared to Efficiency Gain (assuming selfish other).

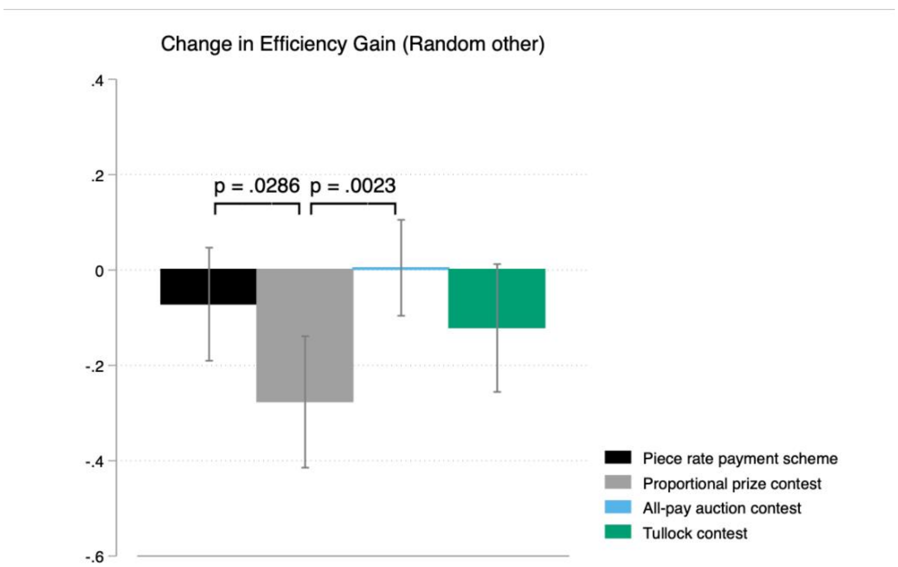


Figure B.7: Efficiency Gain before and after contests (based on both players' actual decision)

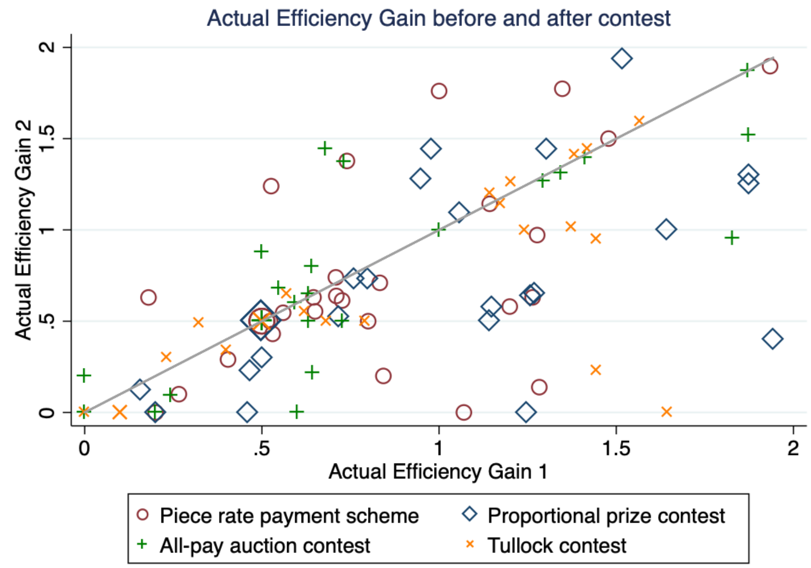


Figure B.8: Within-person change in the Efficiency Gain (based on both players' actual decision). The red lines indicate zero change in actual efficiency gain.

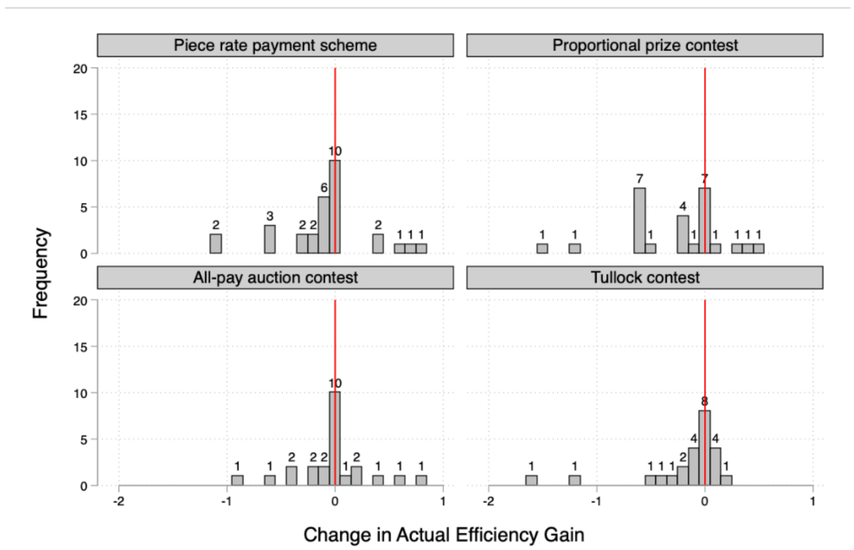


Figure B.9: Mean change in Efficiency Gain by treatments (based on both players' actual decision)

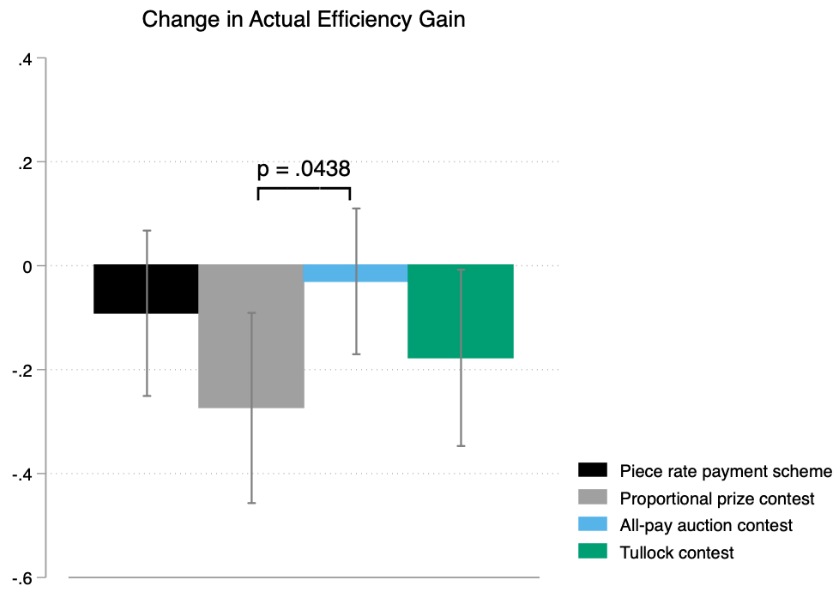


Figure B.10: Mean change in Efficiency Gain (PD+PGG, Selfish other) by treatments

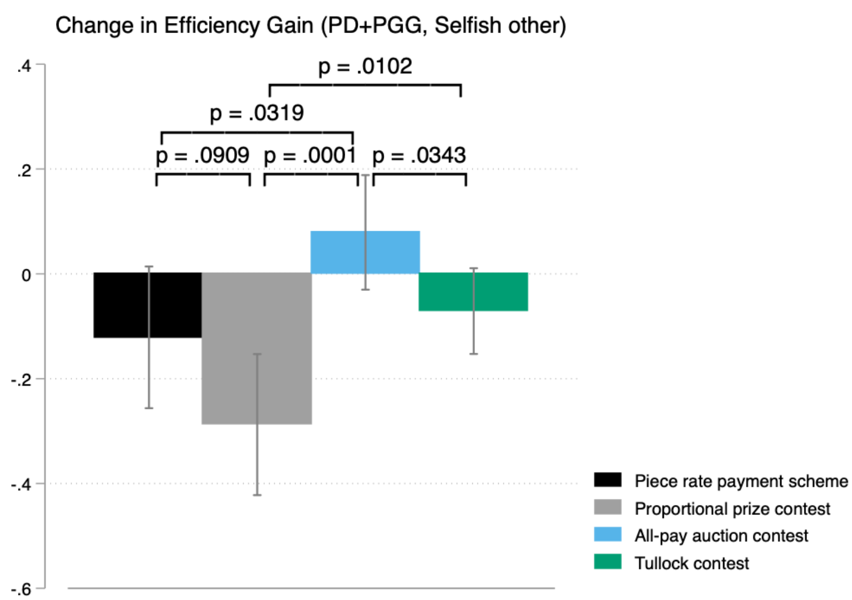


Figure B.11: Mean change in Efficiency Gain (PD+PGG, Cooperative other) by treatments

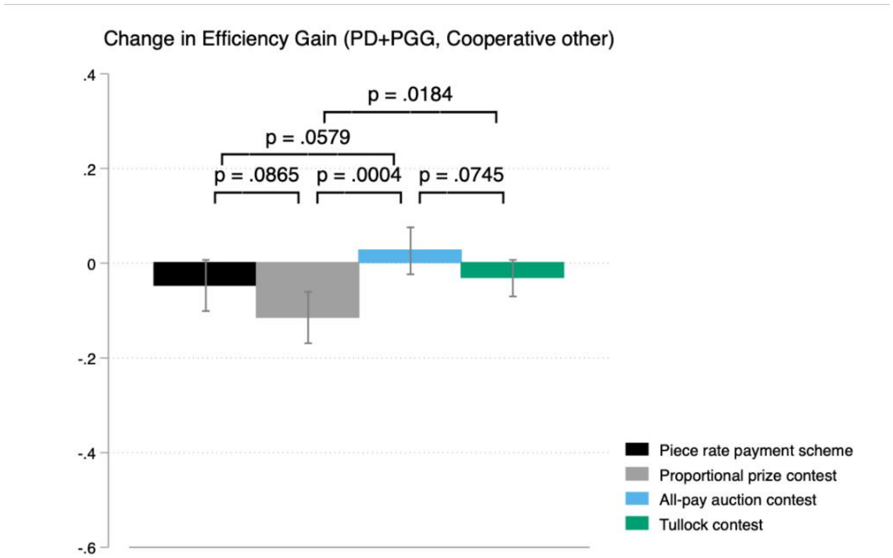
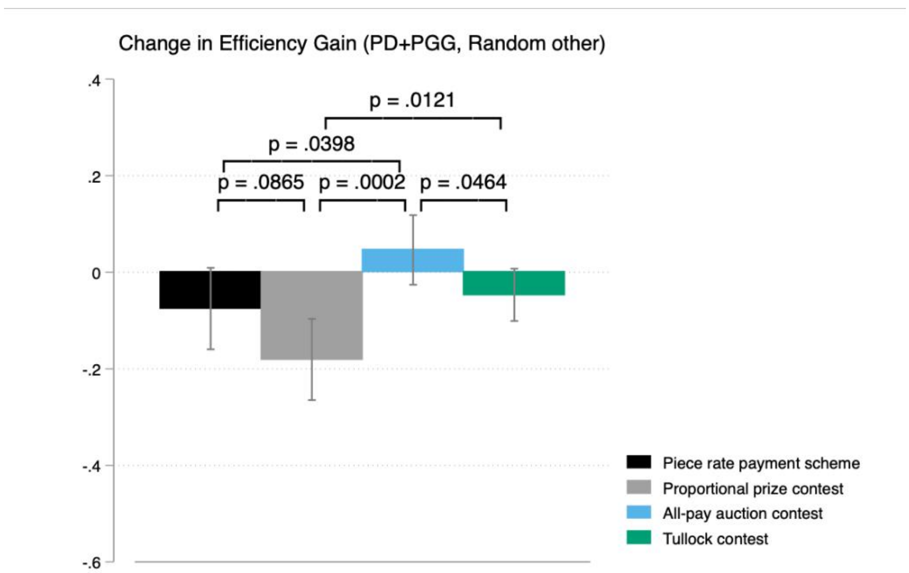


Figure B.12: Mean change in Efficiency Gain (PD+PGG, Random other) by treatments

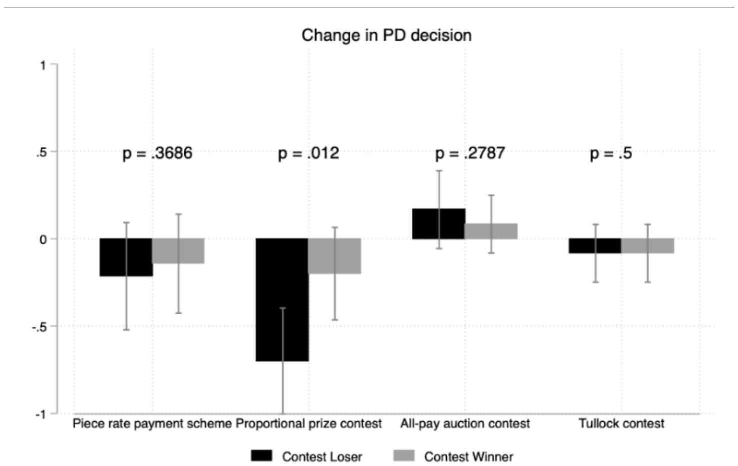


Appendix C: Individual Differences in Reaction to Contests

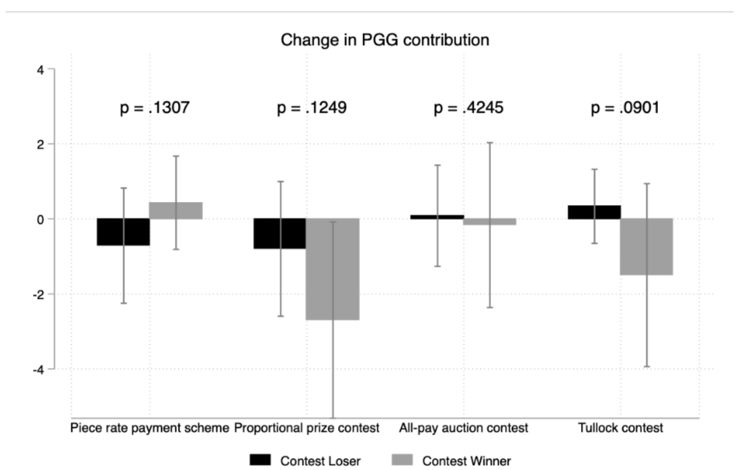
In this section, we explore the potential heterogenous effect of contests by different groups of participants. We first report the average change in behavior in each social game by contest winners vs. losers, by trust game senders and receivers respectively (Figure C.1-Figure C.2). We also show that the effect of contest on prosocial behavior is not significantly mediated by participants' feeling after contest, performance, as well as their performance or payoff gaps (Figure C.3-Figure C.4; Table C.2, C.4 and C.5).

Figure C.1: Mean change in PD decision (A), PGG contribution (B) and TG amounts sent (C) for contest winners versus contest losers in all treatments. The gray bars indicate the 95% confidence intervals for the mean. One-sided p-values from the t-test of behavioral change between contest losers and contest winners are reported. Subjects with the same correct counts with their competitors in the piece rate payment scheme and proportional prize contest are excluded.

Panel A:



Panel B:



Panel C:

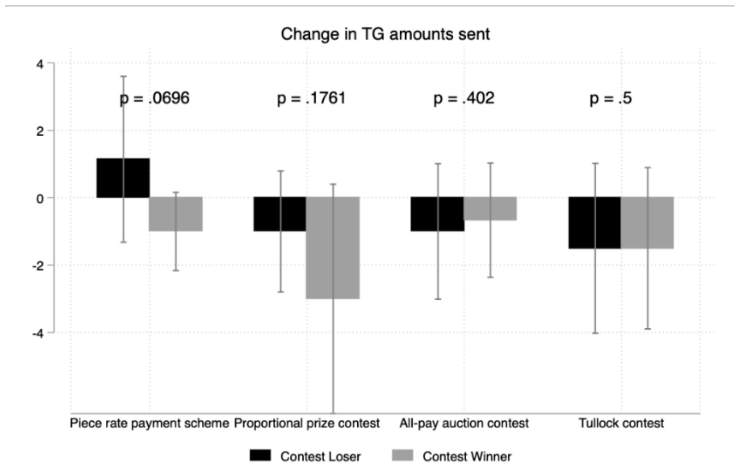
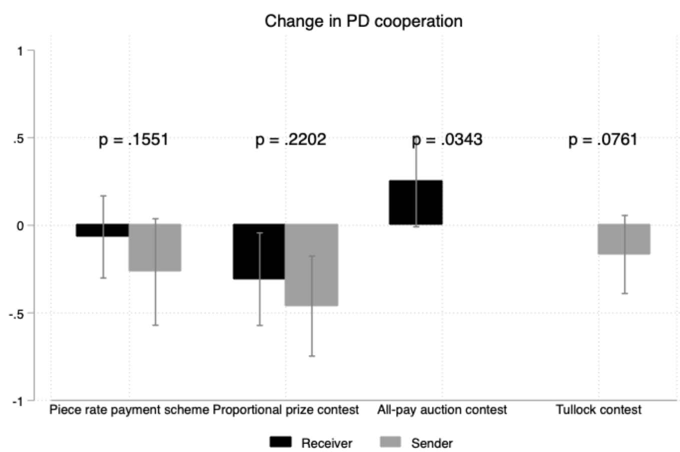


Figure C.2: Mean change in PD decision (A), PGG contribution (B) and TG amounts sent (C) for senders versus receivers in all treatments. The gray bars indicate the 95% confidence intervals for the mean. One-sided p-values from the t-test of behavioral change between senders and receivers are reported. Note that the mean change in PD decision for senders and the mean change in PGG contribution for receivers are zero.



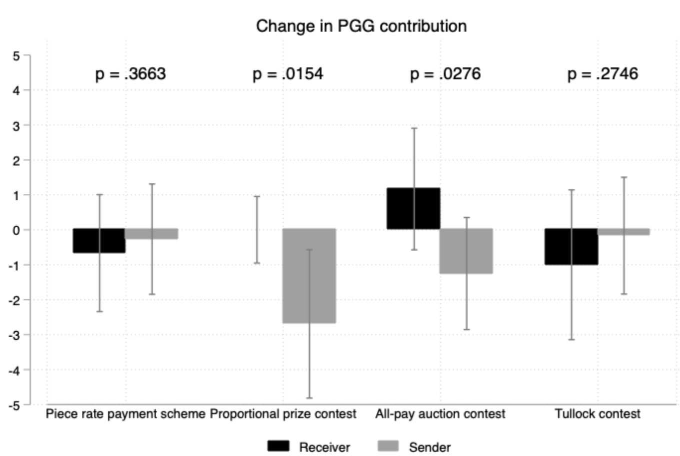


Figure C.3: Change in PD decision (A), PGG contribution (B) and TG amounts sent (C) with respect to the performance (correct counts). The linear fits with 95% confidence interval are displayed.

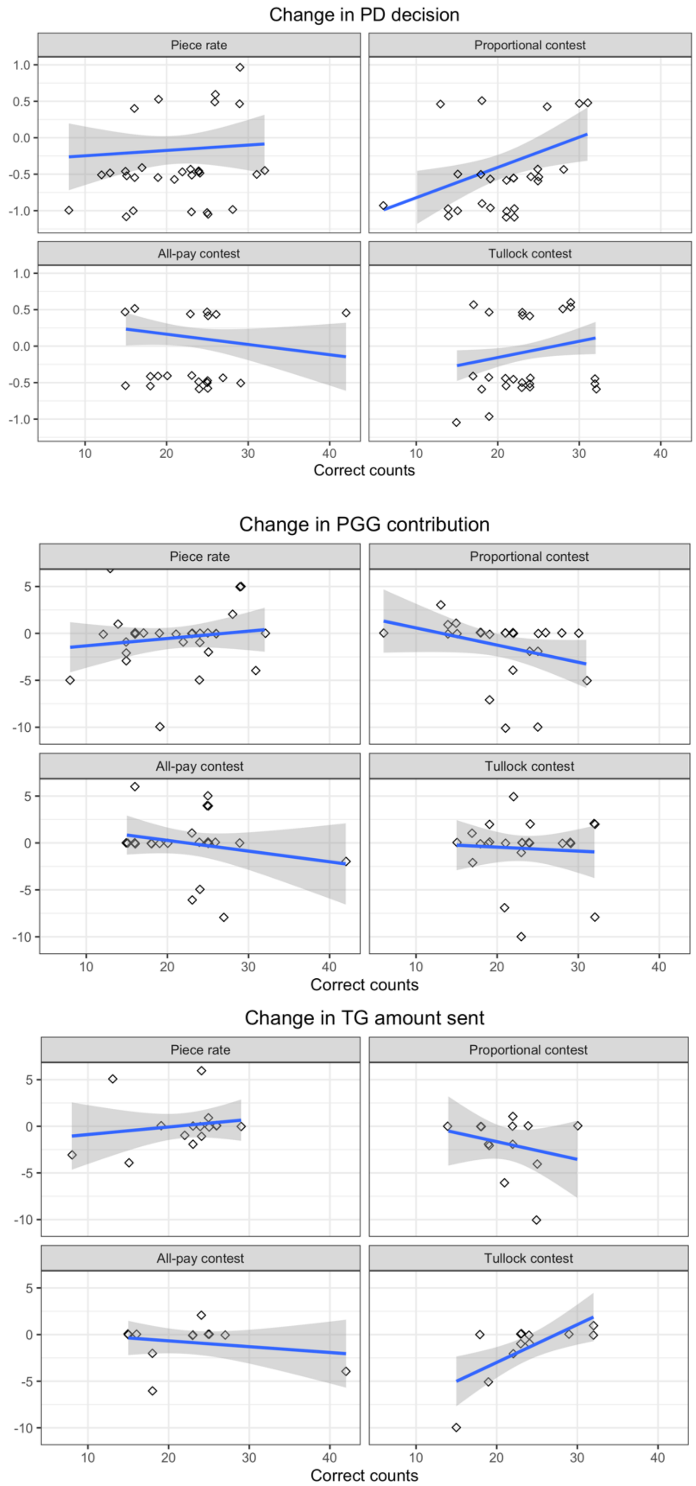


Figure C.4: Change in PD decision (A), PGG contribution (B) and TG amounts sent (C) with respect to the performance difference (Self correct counts – Other player's correct counts). The linear fits with 95% confidence interval are displayed.

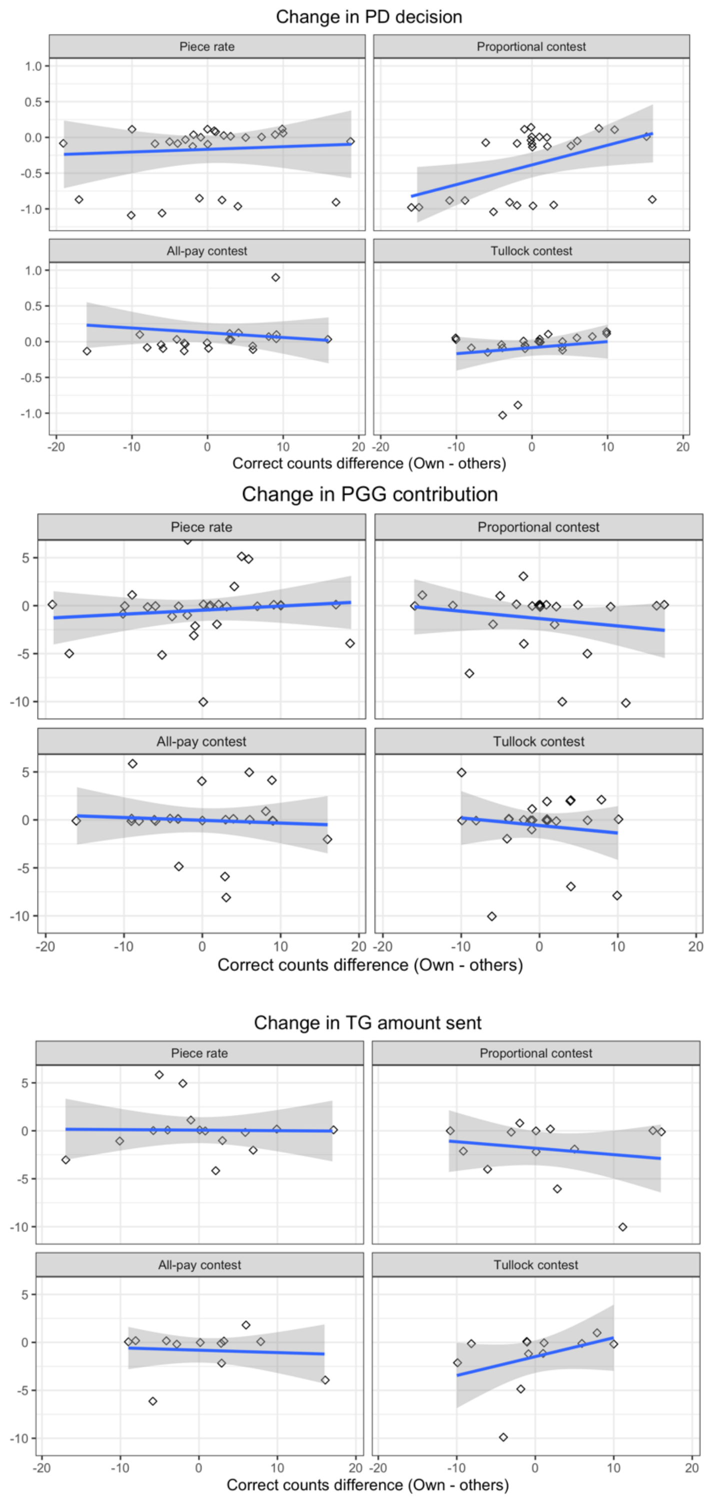


Table C.1. reports the effect of contest formats on behavior in three social games by contest winners and losers, controlling for performance and performance difference. The results show that contest losers are not mainly contributing to the decline of prosocial behavior across games. Instead, in the trust game, contest winners on average decreases their amount sent more than losers after contests.

Table C.1: Changes in social games behavior and the winning status by treatments (OLS regression)

VARIABLES	(1) Change in PD decision	(2) Change in PD decision	(3) Change in PGG contribution	(4) Change in PGG contribution	(5) Change in TG amount sent	(6) Change in TG amount sent
Proportional prize contest	-0.486**	-0.479**	-0.0857	-0.131	-2.143	-2.161
	(0.217)	(0.217)	(1.187)	(1.165)	(1.516)	(1.438)
All-pay auction contest	0.381*	0.360*	0.798	0.935	-2.143	-2.285
	(0.192)	(0.202)	(1.033)	(0.992)	(1.590)	(1.534)
Tullock contest	0.131	0.0740	1.048	1.438	-2.643	-3.505*
	(0.177)	(0.189)	(0.924)	(1.075)	(1.782)	(1.773)
Winner	0.0714	0.00807	1.143	1.598	-2.143	-3.859**
	(0.212)	(0.231)	(1.002)	(1.371)	(1.369)	(1.624)
Winner X Proportional prize contest	0.429	0.427	-3.043	-3.033	0.143	-0.0739
	(0.292)	(0.290)	(1.873)	(1.877)	(2.344)	(2.271)
Winner X All-pay auction contest	-0.155	-0.150	-1.393	-1.428	2.476	2.550
	(0.254)	(0.261)	(1.640)	(1.640)	(1.892)	(1.926)
Winner X Tullock contest	-0.0714	-0.00653	-2.976*	-3.442*	2.143	3.741*
	(0.243)	(0.261)	(1.661)	(2.026)	(2.188)	(2.197)
Correct counts		0.0116		-0.0745		0.0354
		(0.0105)		(0.0666)		(0.123)
Correct counts difference (Self - Other)		-0.00120		0.00411		0.121
		(0.00950)		(0.0776)		(0.0843)
Constant	-0.214	-0.429	-0.714	0.634	1.143	1.215
	(0.156)	(0.277)	(0.778)	(1.964)	(1.238)	(3.088)
Observations	96	96	96	96	49	49
R-squared	0.238	0.252	0.092	0.105	0.151	0.215

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The baseline treatment is piece rate payment scheme. Change in PD decision is calculated as decision (1 = Cooperate, 0 = Defect) in the second round of PD minus the decision in the first round of PD. Change in PGG contribution and Change in TG amount sent are defined similarly as the choice in second round minus the choice in the first round. PGG contribution and TG amount sent range from 0 to 10.

Table C.2 examines whether the effect of contest on prosocial behavior differs by subject's self-reported feeling after contest by regressing change in social games behavior on the interaction terms between contest treatment dummies and feeling after contest. As shown in the table below, lower reported emotional state does not predict a larger decline in prosocial behavior in almost all social games under any treatments (except for the proportional prize contest in the Prisoner's Dilemma).

Table C.2: Changes in social games behavior and feeling by treatments (OLS regression)

VARIABLES	(1) Change in PD decision	(2) Change in PGG contribution	(3) Change in TG amount sent
Proportional prize contest	-1.109***	1.265	2.881
	(0.372)	(3.284)	(3.434)
All-pay auction contest	0.362	0.564	0.00948
	(0.301)	(1.801)	(2.393)
Tullock Contest	0.185	2.159	-0.739
	(0.314)	(1.747)	(2.650)
Feeling after contest feedback	0.0178	0.00965	0.219
	(0.0451)	(0.281)	(0.259)
Proportional prize contest X Feeling	0.126**	-0.311	-0.726
	(0.0564)	(0.517)	(0.540)
All-pay auction contest X Feeling	-0.0116	-0.0239	-0.162
	(0.0481)	(0.330)	(0.343)
Tullock Contest X Feeling	-0.0169	-0.404	-0.132
	(0.0503)	(0.352)	(0.382)
Constant	-0.273	-0.524	-1.177
	(0.282)	(1.518)	(1.776)
Observations	104	104	52
R-squared	0.240	0.071	0.119

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The baseline treatment is piece rate payment scheme. Change in PD decision is calculated as decision (1 = Cooperate, 0 = Defect) in the second round of PD minus the decision in the first round of PD. Change in PGG contribution and Change in TG amount sent are defined similarly as the choice in second round minus the choice in the first round. PGG contribution and TG amount sent range from 0 to 10.

Table C.3 reports OLS regression results with changes in social behavior as dependent variables, and contest treatment dummies interacting with contest enjoyment or participation frequency as explanatory variables. The results suggest that both contest enjoyment and participation frequency play a limited role on the effect of contest on prosocial behavior change.

Table C.3: Changes in social behavior and contest enjoyment/frequency by treatments (OLS regression)

VARIABLES	(1) Change in PD decision	(2) Change in PGG contribution	(3) Change in TG amount sent	(4) Change in efficiency gain (Selfish other)	(5) Change in PD decision	(6) Change in PGG contribution	(7) Change in TG amount sent	(8) Change in Efficiency Gain (Selfish other)
Proportional prize contest	-0.393	-1.454	0.675	-0.339	0.074	1.521	-0.293	0.072
	(0.362)	(2.400)	(2.986)	(0.353)	(0.380)	(1.897)	(2.266)	(0.259)
All-pay auction contest	-0.041	1.877	0.766	0.051	0.394	-1.183	3.246*	0.309
	(0.310)	(2.048)	(2.372)	(0.276)	(0.325)	(2.145)	(1.777)	(0.252)
Tullock contest	-0.212	2.704	-0.201	-0.151	0.361	2.066	-3.218	0.112
	(0.299)	(2.026)	(2.682)	(0.351)	(0.337)	(2.458)	(3.311)	(0.363)
Contest enjoyment	-0.024	0.185	0.408	0.009				
	(0.037)	(0.306)	(0.314)	(0.033)				
Proportional prize X Contest enjoyment	0.028	0.081	-0.420	0.012				
	(0.051)	(0.382)	(0.595)	(0.049)				
All-pay auction X Contest enjoyment	0.051	-0.213	-0.246	0.017				
	(0.049)	(0.353)	(0.369)	(0.042)				
Tullock X Contest enjoyment	0.045	-0.473	-0.132	0.022				
	(0.043)	(0.362)	(0.450)	(0.051)				
Participation frequency					0.069	0.214	0.163	0.058
					(0.049)	(0.252)	(0.204)	(0.035)
Proportional prize X Participation frequency					-0.050	-0.442	-0.298	-0.060
					(0.064)	(0.305)	(0.433)	(0.045)
All-pay auction X Participation frequency					-0.014	0.402	-0.928**	-0.025
					(0.061)	(0.348)	(0.378)	(0.051)
Tullock contest X Participation frequency					-0.054	-0.382	0.360	-0.026
					(0.057)	(0.380)	(0.565)	(0.058)
Correct counts	0.013	-0.060	0.047	0.008	0.013	-0.052	0.059	0.009
	(0.008)	(0.055)	(0.093)	(0.009)	(0.008)	(0.056)	(0.080)	(0.009)
Constant	-0.296	-0.388	-3.546	-0.348	-0.834**	-0.567	-2.153	-0.626**
	(0.309)	(1.602)	(2.484)	(0.273)	(0.321)	(2.139)	(2.441)	(0.281)
Observations	104	104	52	104	104	104	52	104
R-squared	0.190	0.061	0.137	0.151	0.220	0.090	0.192	0.164

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The baseline treatment is piece rate payment scheme. Change in PD decision is calculated as decision (1 = Cooperate, 0 = Defect) in the second round of PD minus the decision in the first round of PD. Change in PGG contribution and Change in TG amount sent are defined similarly as the choice in second round minus the choice in the first round. PGG contribution and TG amount sent range from 0 to 10.

Table C.4 reports the correlation among subjects' responses to the four survey questions on contest attitude. Ambition and effort measures are highly correlated (p<0.0001), and so is true between contest enjoyment and participation frequency. However, ambition to win correlate with neither the contest enjoyment nor the participation frequency while the effort to win is only weakly correlated with contest enjoyment (p=0.098) and participation frequency (p=0.051).

Table C.4: Spearman correlation for subjects' responses to survey questions on contest attitude

	Ambition to win	Effort to win	Contest enjoyment	Contest participation frequency
Ambition to win	1			
Effort to win	0.5074***	1		
	(0.0000)			
Contest enjoyment	-0.0526	0.163*	1	
	(-0.596)	(0.0982)		
Contest participation frequency	0.0562	0.191*	0.3342***	1
	-0.571	(0.0517)	0.000500	

Note: pval in parentheses: *** p<0.01, ** p<0.05, * p<0.1. All variables are measured using survey questions with 10-point scale. "Ambition to win" question asks subjects whether they agree they are ambitious at winning the contest; "Effort to win" question asks subjects whether they agree they always exert as much effort as possible to win the contest; "Contest enjoyment" asks subjects whether they agree they enjoy participating in the contest regardless of the contest outcome, and finally, "Contest participation frequency" asks subjects how frequently they consider themselves participating in the contest.

Table C.5 shows that performance (i.e. correct counts in the contest) and real effort-task payoff plays a limited role on the effect of contest on prosocial behavior change. Higher performance only predicts more drop in public goods contribution in the proportional prize contest at the 10% significance level.

Table C.5: Changes in social behavior and performance / contest payoff by treatments

VARIABLES	(1) Change in PD decision	(2) Change in PD decision	(3) Change in PGG contribution	(4) Change in PGG contribution	(5) Change in TG amount sent	(6) Change in TG amount sent
Proportional prize contest	-0.916*	-0.896	4.515	3.404	3.850	2.025
	(0.482)	(0.685)	(2.877)	(3.574)	(5.726)	(5.473)
All-pay auction contest	0.766	0.487	4.656	2.188	2.274	0.697
	(0.504)	(0.416)	(2.842)	(2.493)	(4.270)	(3.861)
Tullock contest	-0.281	0.237	2.496	2.438	-9.406	0.197
	(0.550)	(0.409)	(3.938)	(2.450)	(6.198)	(3.943)
Correct counts	0.00734		0.0780		0.0811	
	(0.0182)		(0.107)		(0.152)	
Proportional prize contest X Correct counts	0.0342		-0.261*		-0.271	
	(0.0211)		(0.136)		(0.275)	
All-pay auction contest X Correct counts	-0.0214		-0.192		-0.144	
	(0.0216)		(0.127)		(0.174)	
Tullock contest X Correct counts	0.0150		-0.120		0.325	
	(0.0231)		(0.177)		(0.242)	
Real effort task payoff		0.00367		0.0390		0.0406
		(0.00912)		(0.0535)		(0.0762)
Proportional prize contest X Real effort task payoff		0.00743		-0.0743		-0.0689
		(0.0120)		(0.0656)		(0.0950)
All-pay auction contest X Real effort task payoff		-0.00423		-0.0407		-0.0384
		(0.00916)		(0.0541)		(0.0767)
Tullock contest X Real effort task payoff		-0.00367		-0.0512		-0.0406
		(0.00915)		(0.0542)		(0.0771)
Constant	-0.321	-0.321	-2.104	-2.104	-1.697	-1.697
	(0.401)	(0.401)	(2.399)	(2.399)	(3.732)	(3.732)
Observations	104	104	104	104	52	52
R-squared	0.236	0.193	0.065	0.056	0.235	0.095

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The baseline treatment is piece rate payment scheme. Change in PD decision is calculated as decision (1 = Cooperate, 0 = Defect) in the second round of PD minus the decision in the first round of PD. Change in PGG contribution and Change in TG amount sent are defined similarly as the choice in second round minus the choice in the first round. PGG contribution and TG amount sent range from 0 to 10.

Table C.6 shows that neither performance difference nor payoff difference significantly moderates the effect of contest on social behavior in any social games.

Table C.6: Changes in social behavior and performance / contest payoff difference by treatments

VARIABLES	(1) Change in PD decision	(2) Change in PD decision	(3) Change in PGG contribution	(4) Change in PGG contribution	(5) Change in TG amount sent	(6) Change in TG amount sent
Proportional prize contest	-0.213	-0.213	-0.909	-0.914	-1.819	-1.804
	(0.132)	(0.133)	(0.864)	(0.864)	(1.093)	(1.075)
All-pay auction contest	0.273**	0.271**	0.537	0.557	-0.903	-0.967
	(0.126)	(0.127)	(0.863)	(0.874)	(0.972)	(0.967)
Tullock contest	0.0597	0.0573	0.0273	0.0531	-1.722	-1.737
	(0.120)	(0.121)	(0.882)	(0.875)	(1.119)	(1.112)
Correct counts difference (Self - other)	-0.00154		0.0743		-0.0377	
	(0.0132)		(0.0605)		(0.0775)	
Proportional prize contest X Performance diff	0.0238		-0.119		-0.0553	
	(0.0175)		(0.104)		(0.140)	
All-pay auction contest X Performance diff	-0.0104		-0.0710		-0.0580	
	(0.0172)		(0.0858)		(0.148)	
Tullock contest X Performance diff	0.00471		-0.121		0.183	
	(0.0142)		(0.172)		(0.123)	
Real effort task payoff difference (Self - other)		-0.00103		0.0400		-0.0171
		(0.00654)		(0.0303)		(0.0386)
Proportional prize contest X Real effort task payoff diff		0.00525		-0.0489		-0.00204
		(0.00697)		(0.0343)		(0.0464)
All-pay auction contest X Real effort task payoff diff		0.000508		-0.0392		0.0164
		(0.00653)		(0.0302)		(0.0384)
Tullock contest X Real effort task payoff diff		0.00104		-0.0462		0.0167
		(0.00657)		(0.0311)		(0.0394)
Correct counts	0.0105	0.0116	-0.0640	-0.0754	0.0852	0.0761
	(0.0103)	(0.00970)	(0.0655)	(0.0608)	(0.121)	(0.111)
Constant	-0.388	-0.409*	0.877	1.118	-1.782	-1.584
	(0.233)	(0.222)	(1.561)	(1.463)	(2.903)	(2.654)
Observations	104	104	104	104	52	52
R-squared	0.219	0.205	0.046	0.065	0.142	0.105

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The baseline treatment is piece rate payment scheme. Change in PD decision is calculated as decision (1 = Cooperate, 0 = Defect) in the second round of PD minus the decision in the first round of PD. Change in PGG contribution and Change in TG amount sent are defined similarly as the choice in second round minus the choice in the first round. PGG contribution and TG amount sent range from 0 to 10.

Appendix D: Experiment Instructions

Translated from Original Chinese version

Stage 1 – Introduction

Welcome to the experiments! You will be playing a series of games and you will be randomly assigned a different partner for each round.
You will receive a certain amount of payment depending on the points you earn in the experiments. The amount of points depends on the mutual decision of you and your partner. The points you earn will be converted into money in a ratio of 4 to 1 (i.e. Four points you earn in the experiment is equivalent to 1 RMB.)
Please click the button to continue.

Okay (Button)

Note: Please keep quiet during the experiment, thank you!
(Waiting Screen) Please wait for the next stage.

Stage 2 – Transition to games

Note:
Next, you will start a series of experiments formally.
(Waiting Screen) Please wait for the next stage.

Stage 3 – Prisoner's Dilemma Instruction

Game 1 Letter Combination game: Instructions

Next, you will participate in a "Letter Combination" game with another player. In this game, you will choose between two options: Letter M and Letter N. How many points you earn depends on you and the other player's mutual decision.
If you and the other player both choose Letter M, then both of you will earn 14 points. If you and the other player both choose Letter N, then both of you will earn 7 points.
If you choose Letter M while the other player chooses Letter N, then you will earn 3 points and the other player will get 20 points.
On the contrary, if you choose Letter N while the other player chooses Letter M, then you will earn 20 points and the other player will get 3 points.
The outcome of this experiment will be reported at the end of all games. Please click the button to continue.

(Waiting Screen) Please wait for the next stage.

Stage 4 – Prisoner's Dilemma Game

You have now formed a group with a randomly paired player to play game 1. Below is the scoring rule for game 1:

If you and the other player both choose Letter M, then both of you will earn 14 points. If you and the other player both choose Letter N, then both of you will earn 7 points.
If you choose Letter M while the other player chooses Letter N, then you will earn 3 points and the other player will get 20 points.
On the contrary, if you choose Letter N while the other player chooses Letter M, then you will earn 20 points and the other player will get 3 points.

Please choose Letter M or Letter N: (Radio buttons)
Submit (Button)

(Waiting Screen) You will enter the next game soon. Please wait until the other player finishes his/her choice.

Stage 5 – Public Goods Game Instruction

Game 2 - Point Allocation Game: Instruction

Next, you will play a "Point Allocation Game" with the other player: You and the other player will both have 10 endowment points. Both of you will decide how to allocate all 10 points between box A or box B.
If you put ***n*** points in box A, the rest of the ***(10-n)*** points will be put in box B. At the end of this game, the number of points you earn from box A at the end of this game will be equal to the average points you and the other player have allocated to box A (i.e. the sum of the points in Box A put by the other subject and you divided by 2), and the points will then be multiplied by 1.6; the number of points you earn from box B is ***(10-n).*** The points you earn from this game will be the sum of the points you earn from box A and box B. For example, if the other player allocates **m** points in box A, then your points will be equal to ***(10-n)+(m+n)/2*1.6***.

The outcome of this experiment will be reported at the end of all games. Please click the button to continue.

OK (Button)
(Waiting Screen) Please wait for the next stage.

Stage 6 - Public Goods Game Investment

Allocating the Points

You have now formed a group with a randomly paired player to play game 2. Below is the scoring rule for game 2:
If you allocate ***n*** points in box A, and the other player allocates ***m*** points in box A, then your points will be equal to ***(10-n)+(m+n)/2*1.6***.

Now, you will choose among the following options to decide how many points will be allocated to box A. The remaining points will be allocated to box B.

Please choose the number of points to be allocated to Box A:
Submit (button)

(Waiting Screen) You will enter the next game soon. Please wait until the other player finishes his/her choice.

Stage 7 – Trust Game Instruction

Game 3 Point Transfer Game: Instructions

Next, you will be playing the Point Transfer game with another player. You and the other player will be randomly assigned to different roles: Player A or Player B.
In the game, you will both have 10 endowment points. In the first stage, player A will have the opportunity to send any integer point between 0 and 10 to player B. The points that player B received are three times the amount sent by player A. In the second stage, player B will decide how many points between zero to the received points to return to player A. For example, if player A sends ***x*** endowment points to player B, then player B will receive ***3x*** points. In the second stage, player B will decide to return any integer point between **0** and ***3x*** to player A.

At the end of the game, player A's final points will be equal to its remaining points (i.e. A's initial endowment points minus the points sent to Player B) plus the points A received from player B in the second stage. Player B's total points are his endowment points, plus the points that player B receives in the first stage (i.e. three times the points sent by Player A) and minus the points he/she return to Player A in the second stage. For example, if player A sends ***x*** endowment points to player B, player B returns ***y*** points in the second stage (***y*** is no larger than ***3x***), then in this game player A's point will be ***10-x+y***, and player B's points will be ***10+3x-y***.

The outcome of this experiment will be reported at the end of all games.
Please click the button to continue.

(Waiting Screen) Next, Player A will enter directly into the next stage, and player B would stay on the current screen and wait until player A makes a choice.

Stage 8 – Trust Game Decision (only displayed to Player A)

You have now formed a group with a randomly paired player to play game 3, and your role is A. Below is the scoring rule for game 3: if player A sends ***x*** endowment points to player B, player B returns ***y*** points in the second stage (***y*** is no larger than ***3x***), then in this game player A's points will be 10-x+y, and player B's points will be 10+3x-y.

Your role is A and your endowment points are 10.
Next, you may decide how many points to be sent to Player B.

Please decide how many points to be sent to player B (Please enter an integer between 0 and 10):

(Error Message) Error in entering a number: The points you sent should be an integer that is between 0 and 10 points. Please enter your number again.

(Waiting Screen) You have submitted your points to be sent. Please wait until player B makes his/her choice.

Stage 9 - Trust Game Decision (only displayed to Player B)

You have now formed a group with a randomly paired player to play game 3 and your role is B. Below is the scoring rule for game 3: if player A sends x endowment points to player B, player B returns y points in the second stage (y is no larger than $3x$), then in this game player A's point will be $10-x+y$, and player B's point will be $10+3x-y$.

Your role is player B.
The points sent by Player A: *<the # of points sent by player A>*
The points you received is: *<the # of the received points>*
Now, you may decide how many points to be returned to Player A. The points you can return are between 0 *and <the # of the received points>*.
Please enter the points to be returned to Player A:
Submit

(If the amount sent by player A is 0, the screen will show:) The amount sent by Player A is 0, thus the amount you can return is 0.

(Error Message) Error in entering a number: The points you transferred should be an integer that is no smaller than 0 and no larger than the points you received. Please enter your number again.
(Waiting Screen) Please wait for the next stage.

Stage 9 – Contest Instruction

Game 4 – Number Counting Task Instruction

In this task, you and the other player will perform a number counting task for 6 minutes. You will count the number of ones in a series of 7 by 7 matrices that include numbers 0 and 1 and enter your result in the box on the screen and click the OK button. After you click the button, a new matrix will be generated. Your goal is to have as many correct counts as possible correctly within 6 minutes.

Messages shown in the Piece rate payment scheme:

Your final points in the number counting task depend on the # of your correct counts. Specifically, you will earn 2 points for each correct counted table. Your final points = the # of your correct counts * 2 points.

Messages shown in the Proportional prize contest:

The bonus points awarded in this task are 150 points. You and the other player will be dividing the total bonus points in proportion to your correct counts. Specifically, the final point you get will be the number of your correct counts / the sum of the correct counts by you and the other player * total bonus points. For example, if your correct counts are ***x***, the other player's correct counts are ***y***, your final points in this task will be equal to ***150*x/(x+y)***. If both of you have zero correct counts, and you will split the total bonus points.

Messages shown in the All-pay auction contest:

The bonus points awarded in this task are 150 points, only the winner of the task could get the bonus points. If your correct counts in the 6 minutes are larger than the correct counts by the other player in the same group, you will win the task. If both of you have the same correct counts, then the winner will be determined randomly with the same probability by the program. If you win the task, you will get 150 points; otherwise, you will not get any points.

Messages shown in the Tullock contest:

The bonus points awarded in this task are 150 points, only the winner of the task could get the bonus points. The correct counts in the task will influence the probability that you win the game, specifically, the probability of you winning the game = the number of your correct counts / the sum of your correct counts and the other subject's correct counts. If both of you have zero correct counts, then the probability for each of you to win the task is 0.5. If you win the task, you would get 150 points; otherwise, you will not get any points.

Note: The result for this task would be announced immediately when the task is over. Please keep quiet while doing the number counting task and do not disturb others completing the task. Thanks!

(Waiting Screen) Please wait for the next stage.

Stage 11 – Performing the task

Now, you will form a group with a randomly paired partner. You have 6 minutes to count as many tables as possible for the number of 1s. The remaining time is shown in the upper-right corner.

*(The 7*7 matrix will be displayed here)*

This is the <X>th table that you are counting.

Please enter the number of ones in the table:

Stage 12 – Contest Result

Result

Your correct count is ---; the other subjects' correct count is ---.

Messages shown in the piece-rate, proportional prize contest, all-pay auction contest (with no tie), and Tullock contest:

Your final point in the number counting task is --- points, the other player's final point in the number counting task is --- points.

Messages shown in the all-pay auction contest (with tie):
[For randomly chosen winner]
You and the other subject have the same correct count. You are randomly chosen to get 150 points, the other player will not get any bonus points.
[For randomly chosen loser]
You and the other player have the same correct count. The other player is randomly chosen to get 150 bonus points, you will not get any bonus points.

Please click the OK button to continue.

(Waiting Screen:) You will be entering into the next game soon. Please wait for the other player to complete confirmation.

Stage 13 – Stage 19 are the same as Stage 3 – 9.

Stage 20 – Results (Social Games)

Game **1/5**- Letter Combination Game: Result
In the letter combination game, the letter you chose is:
The letter that the other player in the same group chose is:
The points you earn are:

Game **2/6** - Point Allocation Game: Result
You and the other subject all have 10 points. The number of points you allocate to box A is …, the number of points you allocate to box B is …
The total points you earned are …

Game **3/7**- Point Transfer Game: Result
(For Player A) In the Point Transfer game, your role is Player A. The points you sent to player B are …, the points Player B returned to you are …
(For Player B) In the Point Transfer game, your role is Player B. The points Player A transferred is …, the points you received are … the points you returned to Player A are …
The total points you earned are …

Stage 21 – Results (Payoff)

Experiment	Score	The Amount of Money (= Score*0.25)
Game 1 – Letter Combination Game		
Game 2 – Point Allocation Game		
Game 3 – Point Transfer Game		
Game 4 – Number Counting Task		
Game 5 – Letter Combination Game		
Game 6 – Point Allocation Game		
Game 7 – Point Transfer Game		
Sum		(plus show-up fee **X** Yuan)

Stage 22 – Exit Survey

Congratulations on completing the experiments! Finally, you will complete a brief survey before receiving your reward displayed on the previous page.

(Button) Confirm

Appendix E Post-Experiment Survey

Section I – Demographic Information
1. Age:
2. Gender: Female __ Male __
3. Year in College:
4. Major:
5. Your Monthly Spending:

Section II – Experiment-related Questions
1. How difficult did you find the number counting task?
   Very low difficulty 1 2 3 4 5 6 7 8 9 10 Very high difficulty
2. How would you characterize the amount of effort you put into the number counting task?
   Very low effort 1 2 3 4 5 6 7 8 9 10 Very high effort
3. When you found out the number counting contest results, how was your mood?
   Very unhappy 1 2 3 4 5 6 7 8 9 10 Very happy

Section III – General Questions
1. Generally speaking, how much do you agree with the statement, "I enjoy participating in contests, independent of the contest outcome"?
   Strongly disagree 1 2 3 4 5 6 7 8 9 10 Strongly agree
2. Generally speaking, do you agree that you have strong ambition to win contests that you participate in?
   Strongly disagree 1 2 3 4 5 6 7 8 9 10 Strongly agree
3. Generally speaking, how frequently do you think that you participate in contests (for example, in academic or sports competition)?
   None 1 2 3 4 5 6 7 8 9 10 Very frequently
4. Generally speaking, how much would you agree with the statement, "I always exert as much effort as possible to win a contest"?
   Strongly disagree 1 2 3 4 5 6 7 8 9 10 Strongly agree
5. Generally speaking, do you think you are 1) someone willing to take risks or 2) someone unwilling to take risks?
   Unwilling to take risks 1 2 3 4 5 6 7 8 9 10 Willing to take risks
6. Generally speaking, would you say that most people can be trusted?
   Strongly disagree 1 2 3 4 5 6 7 8 9 10 Strongly agree
7. Generally speaking, is it likely for you to risk the potential loss of your personal payoff to increase the value of a publicly available good?
   Very unlikely 1 2 3 4 5 6 7 8 9 10 Very likely
8. Generally speaking, if your individually best choice conflicts with the best choice for the group, which choice are you more inclined to choose?
   Group's best choice 1 2 3 4 5 6 7 8 9 10 Individually best choice
9. What motivated your choices in the final three games?

Free Response: