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RANK-BASED INCENTIVES IN TEAM PRODUCTION: NONLINEAR EFFECTS IN A VOLUNTARY CONTRIBUTION

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Rank-Based Incentives in Team Production: Nonlinear Effects in a Voluntary Contribution Mechanism*

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Abstract

We study a voluntary contribution mechanism (VCM) with intragroup competition, in which individuals' marginal returns depend on their contribution rank within the group. By systematically varying the strength of rank-based incentives, we derive theoretical predictions and test them in a laboratory experiment. We find that intragroup competition significantly increases contributions, but the response is highly nonlinear: contributions increase sharply once incentives become sufficiently strong to support an efficient equilibrium, but further increases in incentive intensity generate only modest additional effects. These findings highlight how incentive design shapes cooperation and provide new insights into the effects of relative performance incentives in public goods environments.

JEL Codes: C92, H41, M52

Keywords: Cooperation; Relative performance incentives; Public goods; Laboratory experiment

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1 Introduction

Production in many economic environments is inherently team-based: individual effort contributes to a joint output, yet is often difficult to observe or verify. This informational friction creates a classic incentive problem, as compensation schemes based on equal sharing of output fail to align individual and collective interests, inducing free-riding. This issue has been central to organizational economics since the seminal analysis of team production by Alchian and Demsetz (1972), who emphasize the difficulty of monitoring individual contributions, and Holmstrom (1982), who shows that free-riding is a structural feature of team production that cannot, in general, be eliminated through simple contract design.

A standard approach to mitigating this problem is to introduce variation in rewards based on individual performance. Relative performance incentives—such as promotions, bonuses, or rank-based compensation—are widely used in practice because they provide strong incentives for effort without requiring precise measurement of individual output. Theoretical work on tournaments (Lazear and Rosen, 1981) shows that rank-based rewards can induce high effort by linking pay to relative performance, even in the presence of noise. Subsequent work (Green and Stokey, 1983; Nalebuff and Stiglitz, 1983) further demonstrates that such mechanisms can outperform standard contracts when output is subject to common shocks, as relative performance evaluation effectively filters out shared uncertainty.

Empirical and experimental evidence broadly supports the effectiveness of such incentives, but also reveals important trade-offs. Field evidence

shows that workers respond strongly to performance-based incentives, while these responses are shaped by social interactions and organizational context (Bandiera et al., 2005; Hamilton et al., 2003). In particular, Bandiera et al. (2005) show that workers internalize the negative externalities imposed on coworkers under relative incentives, reducing effort when performance harms peers, while Hamilton et al. (2003) document that team incentives affect productivity through both effort and sorting. More recent field evidence demonstrates that incentive schemes influence not only effort but also the composition of teams (Bandiera et al., 2013), highlighting that incentive design operates through multiple channels.

A natural laboratory framework for studying these issues is the voluntary contribution mechanism (VCM), which captures a canonical social dilemma. In the standard VCM, individuals choose how much to contribute to a group account that benefits all members. While full-contribution maximizes group welfare, each individual's marginal return is below one, making free-riding the dominant strategy. Despite this prediction, experimental evidence consistently finds substantial initial contributions followed by a gradual decline over time (Isaac et al., 1985; Ledyard, 1995). Fischbacher and Gächter (2010) show that this pattern is driven by conditional cooperation: individuals are willing to contribute if others do so, but reduce contributions when others free-ride.

Although the VCM has primarily been used to study public goods provision, it can also be interpreted as a stylized model of team production. Contributions correspond to individual effort, the group account represents joint output, and the sharing rule determines how output is distributed among

team members. From this perspective, the standard VCM corresponds to a flat sharing rule, mirroring the inefficiencies identified in team production models (Holmstrom, 1982).

A large body of experimental literature has examined how alternative incentive schemes affect behavior in such environments. Early studies comparing individual, team, and relative incentives show that tournaments can increase effort relative to team-based compensation, but may also induce inefficient over-exertion and distort effort allocation (van Dijk et al., 2001; Nalbantian and Schotter, 1997). In particular, van Dijk et al. (2001) demonstrate that while tournaments generate the highest effort, they also lead individuals to concentrate effort on rewarded tasks at the expense of overall efficiency. Other studies investigate hybrid incentive structures that combine team production with relative rewards, finding that such mechanisms can increase contributions, especially at moderate to high incentive levels (Dickinson and Isaac, 1998; Irlenbusch and Ruchala, 2008). However, these findings also highlight a fundamental trade-off: while competition increases effort, it can crowd out cooperation and weaken social cohesion.

Within the public goods literature, a large body of work has explored mechanisms to mitigate free-riding. One prominent approach involves sanctions, such as punishment (Fehr and Gächter, 2000, 2002; Andreoni et al., 2003) and exclusion (Cinyabuguma et al., 2005; Maier-Rigaud et al., 2010; Croson et al., 2015), which are highly effective at sustaining cooperation but may impose efficiency or institutional costs. An alternative approach focuses on sorting and competition, either across groups (Cabrera et al., 2013; Gunnthorsdottir et al., 2010) or through contests for rewards (Sut-

ter, 2006; Struwe et al., 2024). These studies show that competition can increase contributions even without sanctions, although the effectiveness of such mechanisms depends on their design and on how rewards are allocated.

More recently, a growing literature has incorporated intragroup competition directly into the VCM by allowing individuals' marginal returns to depend on their relative performance within the group. Mechanisms of this type introduce competition without altering the underlying social dilemma structure. In particular, Angelovski et al. (2019) and Colasante et al. (2019) show that rank-dependent marginal returns can significantly increase contributions, even when free-riding remains the unique Nash equilibrium. These findings suggest that relative performance incentives can shift behavior by altering best responses rather than by changing equilibrium predictions.

Despite these advances, an important aspect remains underexplored: how the strength of relative performance incentives shapes behavior across different strategic environments. Existing studies typically consider a limited set of incentive parameters and do not systematically examine how behavior changes as the incentive structure varies across environments with different equilibrium properties.

This paper addresses this gap by studying a VCM with intragroup competition in which individuals' marginal returns depend on their contribution rank. We systematically vary the strength of rank-based incentives, allowing us to analyze behavior across environments in which (i) free-riding is the unique Nash equilibrium, (ii) free-riding and full-contribution equilibria coexist, and (iii) full-contribution is the unique Nash equilibrium.

Our results show that while intragroup competition increases contribu-

tions, the response is highly nonlinear. Contributions increase substantially as incentives strengthen, with particularly large changes between the low- and medium-incentive treatments, while further increases in incentives have only limited additional effects. This contrasts with previous findings that emphasize high contributions even when free-riding remains the unique equilibrium (Angelovski et al., 2019; Colasante et al., 2019), and highlights the importance of both incentive strength and the underlying strategic environment in shaping behavioral responses.

2 Model

We consider an n-player voluntary contribution mechanism (VCM) with intragroup competition. Each player $i \in \{1, \ldots, n\}$ is endowed with e and chooses a contribution $c_i \in [0, e]$ to a public account. Let $\mathbf{c_{-i}}$ denote the vector of contributions of the other players.

The payoff of player i is given by:

$$\pi_i(c_i, \mathbf{c_{-i}}) = e - c_i + p_i(c_i, \mathbf{c_{-i}}) \sum_{l \in \{1,\ldots,n\}}^{n} c_l, \tag{1}$$

where $p_i(\cdot)$ denotes the marginal per capita return (MPCR) assigned to player i. As in the standard VCM, we assume

$$1 < \sum_{l=1}^{n} p_l(\cdot) < n, \tag{2}$$

so that the game retains the social dilemma structure.

2.1 Rank-Based Incentives

Let $r_i \in \{1, \ldots, n\}$ denote the rank of player i's contribution within the group, where $r_i = 1$ corresponds to the highest contribution. The MPCR is determined by rank as follows:

$$p_i = p + a - \frac{2(r_i - 1)a}{n - 1}, \tag{3}$$

so that $p_i \in [p - a, p + a]$, where p denotes the average MPCR and $a \geq 0$ captures the magnitude of the incentive gap.

In the case of ties, MPCRs are averaged across the corresponding ranks. Thus, when all players choose identical contributions, each receives p. The parameter a therefore governs the strength of intragroup competition: higher values of a increase the rewards from outperforming others.

2.2 Equilibrium Analysis

We characterize two symmetric equilibria.

Proposition 1. *In the VCM with intragroup competition, the following symmetric Nash equilibria exist:*

1. $c_i = 0 \ \forall i$ *is an equilibrium if* $p + a < 1$.

2. $c_i = e \ \forall i$ *is an equilibrium if* $a > \frac{1-p}{n-1}$.

Proof. First, we show the condition that the equilibrium $c_i = 0 \ \forall i$ exists. Assume $c_j = 0 \ \forall j \neq i$. Player i does not have an incentive to deviate from

the equilibrium and chooses $c_i = c > 0$ if

$$\pi_i(c, \mathbf{0}) - \pi_i(0, \mathbf{0}) = e - c + (p + a)c - e < 0$$

that is, $p + a < 1$.

Next, we show the condition that the equilibrium $c_i = e \; \forall i$ exists. Assume $c_j = e \; \forall j \neq i$. Player i does not have an incentive to deviate from the equilibrium and chooses $c_i = l < e$ if

$$\pi_i(l, \mathbf{e}) - \pi_i(e, \mathbf{e}) = e - l + (p - a)((n - 1)e + l) - pne < 0$$

Because $p - a < 1$, $\pi_i(l, \mathbf{e})$ is maximized with $l = 0$. Thus, the above condition becomes,

$$a > \frac{1 - p}{n - 1}$$

□

When $p + a < 1$, even the highest-ranked contributor faces a marginal return below 1, so contributing is not individually profitable when others do not contribute. Thus, a free-riding equilibrium exists.

In contrast, when a is sufficiently large, the cost of deviating from the full-contribution equilibrium becomes too large as the deviating player loses $a(n - 1)e$, i.e., share a of others' total contribution. As a result, a Pareto-efficient equilibrium can be sustained even in an environment that otherwise exhibits a social dilemma.

Thus, there is a range of a in which both free-riding and full-contribution equilibria coexist. This result highlights that rank-based incentives can ex-

pand the set of equilibrium outcomes by introducing sufficiently strong relative performance incentives.

3 Experimental Design

We test the theoretical predictions using a laboratory experiment with a 3-player VCM with intragroup competition.

3.1 Environment and Payoffs

Each subject is endowed with 10 points in each round and chooses a contribution $c_i \in \{0, \ldots, 10\}$. The payoff is given by:

$$\pi_i = 10 - c_i + p_i(c_i, c_j, c_k) \sum_{l \in \{i,j,k\}}^{3} c_l. \tag{4}$$

We fix the average MPCR at $p = 0.6$, consistent with a standard social dilemma. The MPCR assigned to each subject depends on their rank in contributions. Note that, with $n = 3$ and $p = 0.6$, the full-contribution equilibrium exists if $a > 0.2$, and the free-riding equilibrium disappears if $a > 0.4$.

3.2 Treatments

We therefore consider the following four treatments that vary the incentive parameter a to cover four cases.

- $T0$: $a = 0$ (baseline, no competition, full-contribution equilibrium does

not exist),

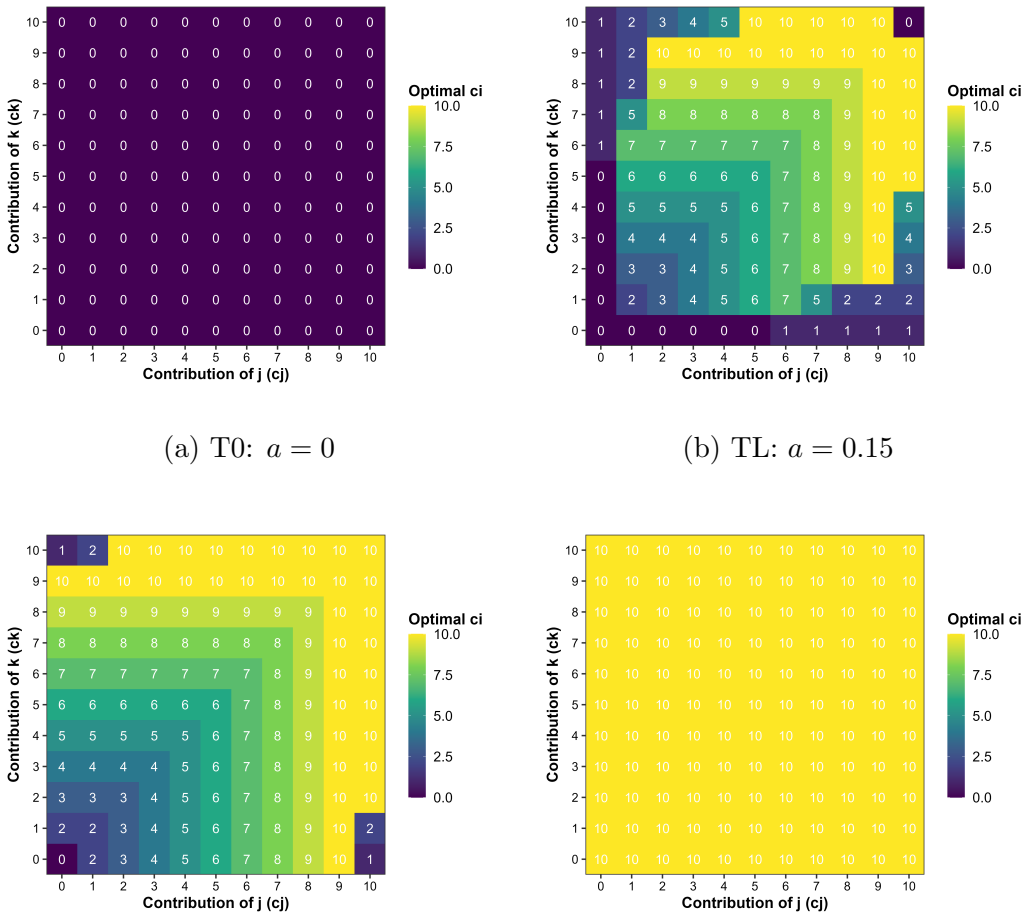
- TL: $a = 0.15$ (low incentive, full-contribution equilibrium does not exist.),
- TM: $a = 0.30$ (medium incentive, full-contribution equilibrium exists.),
- TH: $a = 0.45$ (high incentive, free-riding equilibrium does not exist.).

Figure 1 illustrates best-response functions across treatments. The two axes represent the contributions of the other two players in the group. As a increases, the region in which full-contribution is a best response (shown in yellow) expands. The figure also shows that for $a = 0.15$ and $a = 0.3$, when the other two players both contribute some intermediate amount $0 < l < 10$ (that is, along the 45-degree line), the best response is to contribute $l+1$ and become the unique highest contributor. This implies that contributions may increase in TL relative to $T0$, even though free-riding remains the unique symmetric Nash equilibrium in both treatments.

We therefore state the following hypotheses:[1]

Hypothesis 1. *(a) Average contributions in four treatments are ordered as* $T0 < TL < TM < TH$*. Relatedly,*

[1]In the pre-registration, we also registered another hypothesis regarding the relationship between a participant's degree of advantageous inequality aversion (β) and their tendency to free-ride. Namely, the higher it is, the more likely they are to free-ride. The results of regression analyses are reported in Tables B.2 to B.5. The linear regressions show that β is positively correlated both with the tendency to contribute zero and with the tendency to contribute fully, with both relationships significant at the 10% level. However, in the probit regressions, these relationships are not significant.



(a) T0: $a = 0$

(b) TL: $a = 0.15$

(c) TM: $a = 0.3$

(d) TH: $a = 0.45$

Figure 1: Best response against two other subjects' contributions in four treatments.

(b) the proportions of full contributors ($c_i = 10$) in four treatments are ordered as $T0 < TL < TM < TH$, while

(c) the proportions of free-riders ($c_i = 0$) follow $T0 > TL > TM > TH$.

3.3 Procedure

The experiment was conducted between October 28 and November 10, 2025, and programmed using oTree (Chen et al., 2016). A total of 192 subjects participated in eight sessions, with two sessions per treatment and 24 subjects per session. Subjects were undergraduate and graduate students at the University of Osaka and were recruited from ISER's subject pool managed through ORSEE (Greiner, 2015).

The experiment consisted of two parts. In the first part, we measured participants' degrees of disadvantageous and advantageous inequality aversion following Fehr and Schmidt (1999). See Appendix A for details. The second part was the main experiment.[2]

Subjects first received general instructions about the overall structure of the experiment, together with the instructions for Part 1. The instructions for Part 2 were distributed only after Part 1 had been completed. Subjects were not informed of the outcome of Part 1 until the end of the experiment. In both parts, the written instructions were accompanied by an audio recording. Before each part began, subjects were required to answer a set of comprehension questions correctly. The experiment started only after all subjects had completed the comprehension quiz successfully.

In the main part of the experiment, subjects were randomly assigned to groups of three in each round using a random rematching protocol. Thus, Part 2 consists of repeated one-shot interactions.[3] At the end of each round,

[2]We measure participants' degrees of inequality aversion to explore whether such preferences are correlated with behavior in the VCM, as suggested by Dannenberg et al. (2007).

[3]Note that in Angelovski et al. (2019) and Colasante et al. (2019), groups were created

subjects received feedback on their own contribution, payoff, assigned MPCR, and total group contribution. Each session consisted of 10 rounds, and subjects were paid based on one randomly selected round.

After all subjects had completed the 10 rounds, they were shown a summary screen listing their contributions and payoffs in each round, together with the round randomly selected for payment. Finally, subjects were informed of their earnings in Parts 1 and 2, completed a post-experimental questionnaire, and were then paid in private. See the Online Appendix for an English translation of the instructions and comprehension quiz.

The experiment lasted 62 minutes on average, including the payment. Subjects earned 2755 Japanese Yen (JPY) on average, including a 500 JPY participation fee.

4 Results

Table 1 reports descriptive statistics of subjects' characteristics across treatments. The variable male is a dummy equal to one if the subject is male, and science is a dummy equal to one if the subject's major is in a science field. The variables α and β measure disadvantageous and advantageous inequality aversion, respectively, as elicited in Part 1 of the experiment. The proportion of male subjects differs significantly across treatments, while age and the proportion of science majors do not. We therefore control for these characteristics in the regression analyses below.

randomly at the beginning of the experiment but were fixed throughout the experiment. Thus, their experiments are based on a finitely repeated game.

Table 1: Means and standard deviations of subjects' characteristics in four treatments

Variable	T0	TL	TM	TH	p-value
age	21.958	22.688	23.104	22.083	0.321*
	(1.810)	(5.513)	(2.469)	(2.664)	
male	0.583	0.833	0.562	0.688	0.019**
	(0.498)	(0.377)	(0.501)	(0.468)	
science	0.708	0.771	0.729	0.625	0.454**
	(0.459)	(0.425)	(0.449)	(0.489)	
Disadvantage aversion (α)	-0.037	0.192	-0.002	0.171	0.598*
	(0.108)	(1.447)	(0.077)	(1.454)	
Advantage aversion (β)	0.071	-0.055	0.160	-0.081	0.472*
	(0.788)	(1.041)	(0.255)	(1.057)	
N	48	48	48	48	

Note: $*$: p-values based on ANOVA. $**$: p-values based on Pearson's chi-squared tests.

4.1 Overall results

Figure 2 shows average contributions across treatments. While the difference between TM and TH is not statistically significant (p=1.0), all other pairwise differences are significant at the 1% level.[4] These differences remain robust when controlling for individual characteristics in linear regressions (see Table B.6 in Appendix B). Thus, we find partial support for Hypothesis 1(a).

Observation 1. *The average contributions are ordered* $T0 < TL < TM \approx TH$. *Thus, Hypothesis 1(a) receives partial support.*

Figure 3 shows the average proportion of (a) full-contributors ($c_i = 10$) and (b) free-riders ($c_i = 0$) across treatments. The average proportions of

[4]p-values based on pairwise comparison of estimated coefficients in Regression (1) of Table B.1 in Appendix B.

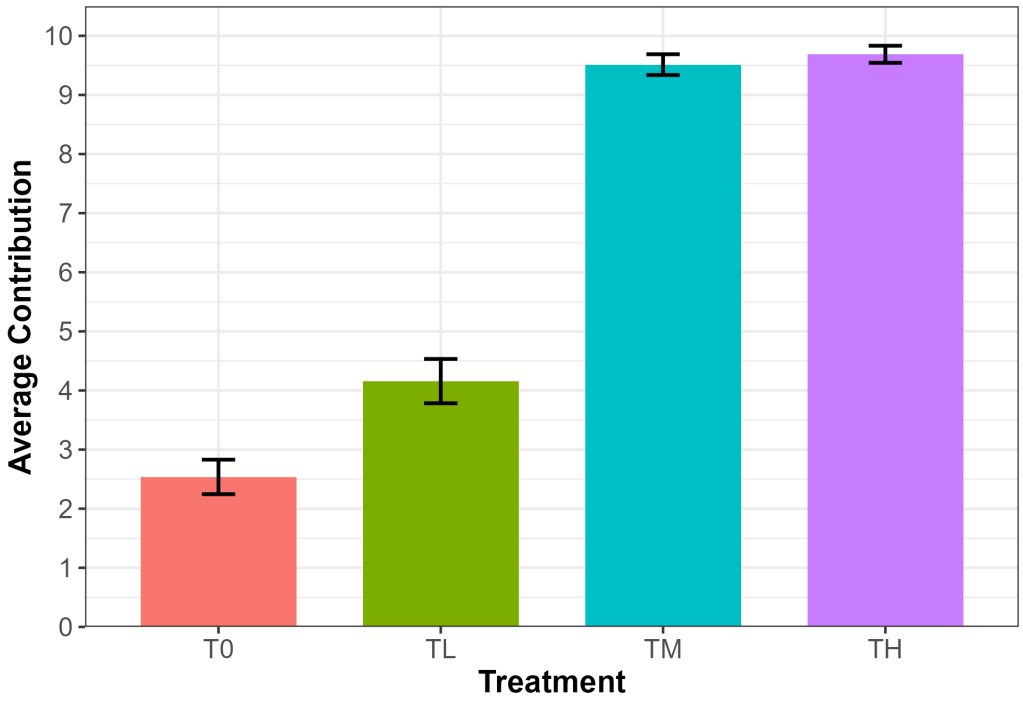


Figure 2: Average Contributions across treatments

Note: The bars represent the average contributions for each treatment. Error bars indicate 95% confidence intervals.

full-contributors are ordered as $T0 < TL < TM < TH$, with all pairwise differences significant at the 1% level, except for the difference between TM and TH, which is significant at the 5% level.

In contrast, the average proportion of free-riders is ordered $TH \approx TM < TL < T0$. All differences are significant at the 1% level, except for the comparison between TH and TM, which is not statistically significant (see Table B.7 in Appendix B).

These findings are robust to both linear and probit specifications controlling for individual characteristics (See Tables B.2-B.5 in Appendix B). Thus, Hypotheses 1(b) and 1(c) are broadly supported.

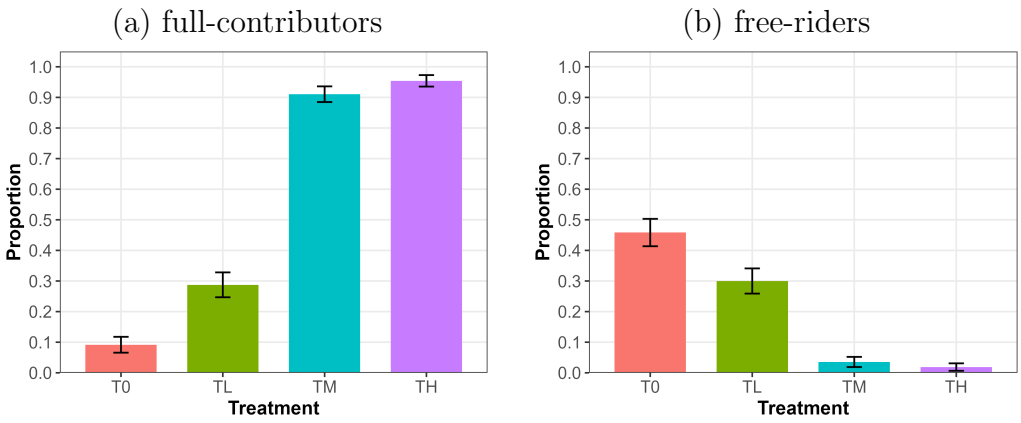


Figure 3: Average proportions of (a) full-contributors and (b) free-riders in four treatments

Note: The bars represent the average proportions of full-contributors (left panel) and free-riders (right panel) for each treatment.

Observation 2. *The average proportion of full contributors is ordered as* $T0 < TL < TM < TH$*, supporting Hypothesis 1(b).*

Observation 3. *The average proportion of free-riders is ordered as* $TH \approx TM < TL < T0$*. Thus, Hypothesis 1(c) is supported except for the comparison between* TM *and* TH*.*

4.2 Dynamics

We next examine the evolution of contributions over the 10 rounds.

Figure 4 shows the average contributions by round across treatments. In $T0$ and TL, average contributions decline over time. In contrast, contributions in TM and TH start at relatively high levels and remain close to full-contribution throughout the experiment.

These patterns are consistent with behavior approaching the equilibrium predictions associated with each treatment. In $T0$ and TL, where free-riding

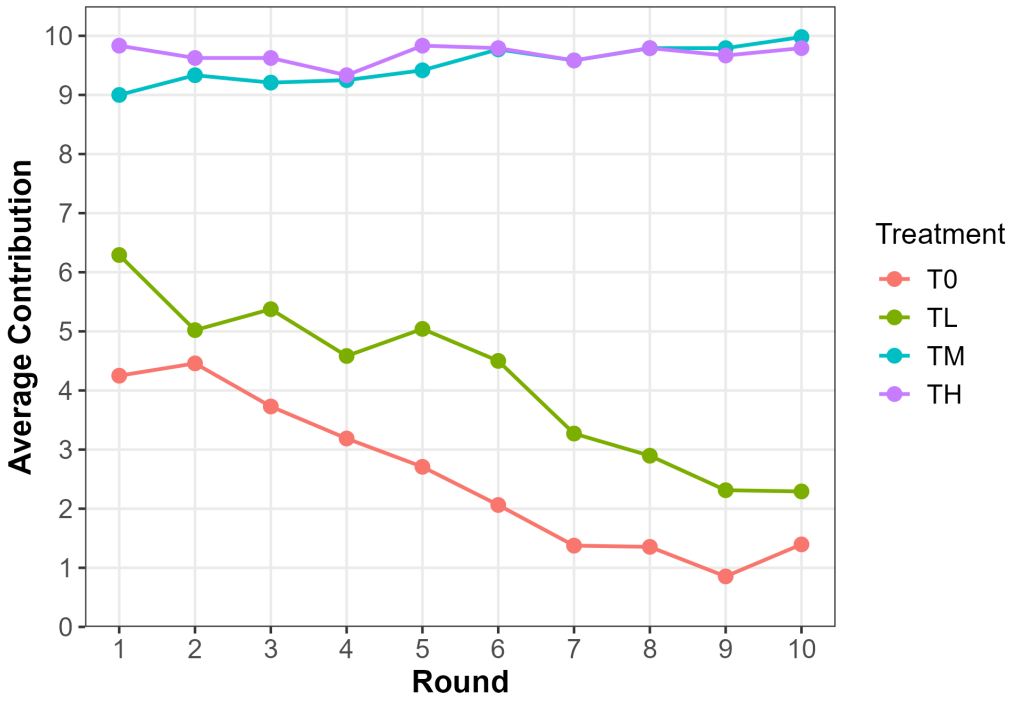
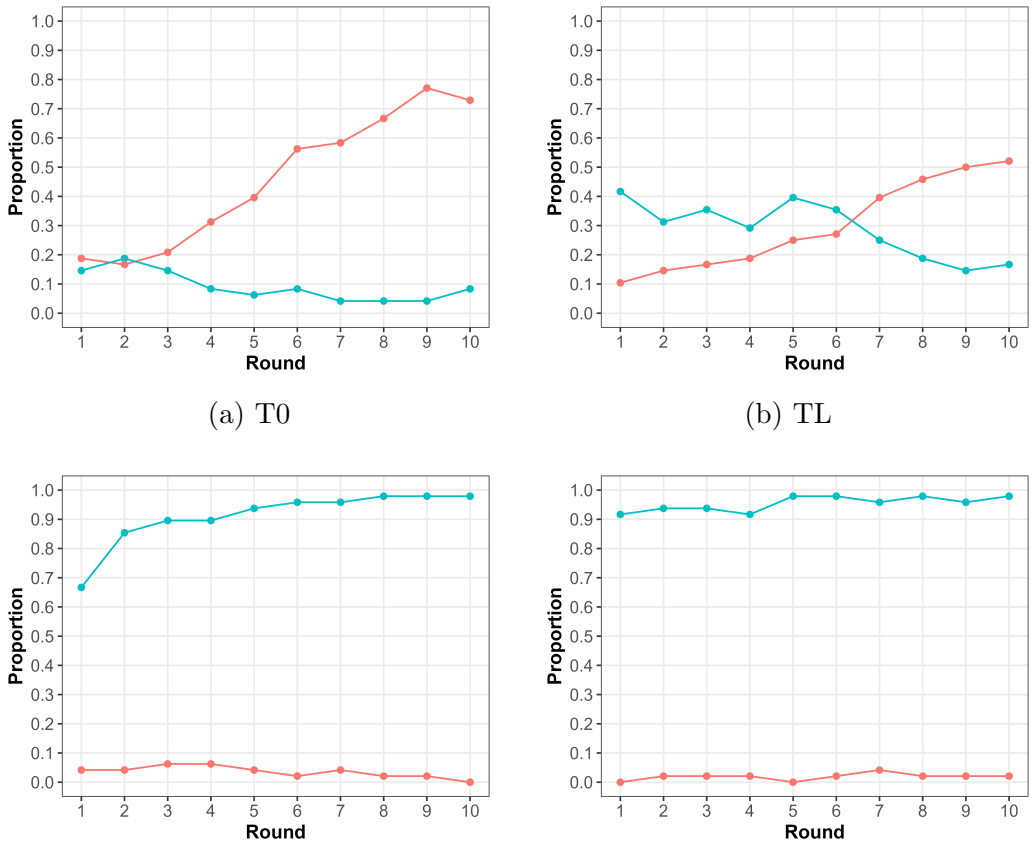


Figure 4: Evolution of the average contributions in four treatments

is the unique symmetric Nash equilibrium, contributions tend to decline over time. In TM, where both free-riding and full-contribution equilibria exist, behavior moves toward full-contribution outcomes. In TH, where free-riding is not an equilibrium, contributions remain close to full contribution.

These findings differ from those in Angelovski et al. (2019) and Colasante et al. (2019), who report sustained high contributions even when free-riding remains the unique Nash equilibrium. A key difference is the matching protocol. While we use a random rematching protocol, resulting in repeated one-shot interactions, their studies use partner matching, which introduces repeated-game incentives.

Figure 5 presents the evolution of the proportions of full contributors (cyan) and free-riders (red). In $T0$ and TL, the proportion of full contributors



(a) T0 (b) TL

(c) TM (d) TH

Figure 5: Trend of Full Contribution and Free Ride across Treatments

declines over time, while the proportion of free-riders increases. In contrast, in TM, the proportion of full contributors increases and the proportion of free-riders decreases. In TH, the proportion of free-riders remains close to zero throughout the experiment.

Taken together, these results indicate that intragroup competition increases contributions, but the effect depends on the strength of incentives. In particular, the transition from TL to TM is associated with a substantial increase in contributions, while further increases in incentive strength from TM to TH have relatively limited additional effects.

5 Conclusion

This paper studies how rank-based incentives affect cooperation in a voluntary contribution mechanism. By introducing intragroup competition, we allow individuals' returns to depend on their relative contribution within the group.

Our theoretical analysis shows that sufficiently strong rank-based incentives can eliminate the standard free-riding equilibrium and support a Pareto-efficient outcome. The experimental results are broadly consistent with these predictions and reveal a nonlinear relationship between contributions and incentive strength: contributions increase substantially as incentives become stronger, with particularly large changes between the low- and medium-incentive treatments and limited additional effects at higher levels.

These findings have direct implications for the design of incentives in team production environments. In many organizations, individual contributions to collective output are difficult to observe or contract upon, giving rise to free-riding concerns as emphasized by Holmstrom (1982). Rank-based incentives—such as promotions, bonuses, or performance rankings—provide a practical way to introduce differentiation in rewards based on relative performance. Our results show that such incentives can effectively promote cooperation, but their impact depends critically on their strength. In particular, modest incentives may not be sufficient to sustain high effort, while stronger incentives can support high-contribution outcomes, albeit with diminishing marginal effects.

More broadly, our findings highlight that incentive design in team settings

is not characterized by smooth responses to stronger incentives. Instead, behavior can change markedly as the structure of incentives changes, even when the underlying environment remains a social dilemma. This suggests that organizations seeking to improve team performance should pay close attention not only to whether performance-based incentives are used, but also to their magnitude and structure.

Finally, our results contribute to the broader literature on competition and cooperation by showing how relative performance incentives can serve as an alternative to sanctions in promoting collective action. Future research could explore how such mechanisms interact with social preferences, information structures, and repeated interactions, which are central features of many real-world team production environments.

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Appendix

A Estimating the parameter of Fehr-Schmidt utility function

A.1 Settings

Before conducting the intragroup competition experiment, we ran a separate elicitation task to estimate the subjects' inequality-aversion parameters of the Fehr-Schmidt utility function.

The Fehr-Schmidt utility function (Fehr and Schmidt, 1999) is given by the following equation:

$$u_i(x) = x_i - \alpha_i \frac{1}{n-1} \sum_{j \neq i} max\{x_j - x_i, 0\} - \beta_i \frac{1}{n-1} \sum_{j \neq i} max\{x_i - x_j, 0\} \quad \text{(A.1)}$$

where x_i denotes the monetary payoff of the individual i, α_i and β_i represent the degree of disadvantage and advantage aversion, respectively.

While Fehr and Schmidt (1999) restricted these parameters to $\alpha_i \geq \beta_i$, $0 \leq \beta_i < 1$, He and Wu (2016) and Yang et al. (2016) observed subjects with $\beta_i < 0$. The method proposed by Drouvelis et al. (2024) allows us to estimate a wider range of parameters than He and Wu (2016).

A.2 Experimental Procedure

The procedure of the experiment is as follows: before the experiment, we conducted a comprehension check about the experimental settings. It continued

until all subjects had correctly answered all the questions. During the process, subjects received feedback after each answer. The experiment started only after we confirmed that all participants had successfully completed the comprehension check.

The experimental task is conducted in pairs. Subjects are randomly paired at the beginning of the experiment. In the experiment, subjects participated in a two-stage decision-making task. At each stage, subjects decide how to allocate payoffs between themselves and their partners. Subjects are given two options: A and B. Both options have 31 questions (see Section 1.2 of Online Appendix). In option A, the allocation to the partner remains constant, while the self-allocation decreases as the question number increases. In contrast, in option B, the payoffs for oneself and the partner are fixed across all questions.

In the first stage, subjects allocate the payoffs in a disadvantageous position to estimate the disadvantageous inequality parameter α.

In the second stage, subjects allocate the payoffs in an advantageous position to estimate the advantageous inequality parameter β.

Subjects are not informed of their pairs. Payments were determined after all the tasks had been completed. Payments were determined randomly from one of the 62 questions for each pair.

B Additional Results

This section reports the results of regression analyses.

Table B.1: Contributions across treatments controlling for individual characteristics

	No Controls			Basic Controls			Full Controls		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TL	1.621***	1.621***	1.719***	1.654***	1.654***	1.752***	1.654***	1.654***	1.753***
	(0.190)	(0.186)	(0.391)	(0.193)	(0.190)	(0.392)	(0.194)	(0.191)	(0.392)
TM	6.975***	6.975***	4.136***	6.963***	6.963***	4.124***	6.972***	6.972***	4.133***
	(0.190)	(0.186)	(0.391)	(0.191)	(0.187)	(0.391)	(0.191)	(0.188)	(0.391)
TH	7.150***	7.150***	4.806***	7.115***	7.115***	4.771***	7.111***	7.111***	4.767***
	(0.190)	(0.186)	(0.391)	(0.190)	(0.187)	(0.391)	(0.191)	(0.188)	(0.391)
Round		−0.186***	−0.417***		−0.186***	−0.417***		−0.186***	−0.417***
		(0.023)	(0.045)		(0.023)	(0.044)		(0.023)	(0.044)
Round × TL			−0.018			−0.018			−0.018
			(0.063)			(0.063)			(0.063)
Round × TM			0.516***			0.516***			0.516***
			(0.063)			(0.063)			(0.063)
Round × TH			0.426***			0.426***			0.426***
			(0.063)			(0.063)			(0.063)
α							−0.033	−0.033	−0.033
							(0.072)	(0.071)	(0.069)
β							−0.062	−0.062	−0.062
							(0.088)	(0.087)	(0.084)
age				0.018	0.018	0.018	0.016	0.016	0.016
				(0.020)	(0.020)	(0.019)	(0.020)	(0.020)	(0.019)
male				−0.065	−0.065	−0.065	−0.061	−0.061	−0.061
				(0.149)	(0.146)	(0.142)	(0.149)	(0.146)	(0.142)
science				−0.474***	−0.474***	−0.474***	−0.484***	−0.484***	−0.484***
				(0.151)	(0.149)	(0.145)	(0.153)	(0.150)	(0.146)

*Note: *p<0.1; **p<0.05; ***p<0.01*

Table B.2: Full contribution across treatments controlling for individual characteristics. Probit regression

	No Controls			Basic Controls			Full Controls		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TL	0.126***	0.126***	0.124***	0.128***	0.128***	0.128***	0.129***	0.130***	0.130***
	(0.014)	(0.014)	(0.029)	(0.014)	(0.014)	(0.029)	(0.014)	(0.014)	(0.029)
TM	0.595***	0.595***	0.338***	0.594***	0.594***	0.335***	0.592***	0.592***	0.332***
	(0.012)	(0.012)	(0.060)	(0.012)	(0.012)	(0.060)	(0.012)	(0.012)	(0.060)
TH	0.630***	0.630***	0.532***	0.630***	0.630***	0.532***	0.631***	0.631***	0.539***
	(0.011)	(0.011)	(0.047)	(0.011)	(0.011)	(0.046)	(0.010)	(0.010)	(0.045)
Round		−0.001	−0.015***		−0.001	−0.015***		−0.001	−0.015***
		(0.003)	(0.005)		(0.003)	(0.005)		(0.003)	(0.005)
Round × TL			0.0003			0.0002			−0.00003
			(0.007)			(0.007)			(0.007)
Round × TM			0.049***			0.049***			0.049***
			(0.008)			(0.008)			(0.008)
Round × TH			0.027***			0.027***			0.027***
			(0.008)			(0.008)			(0.008)
α							−0.008	−0.008	−0.008
							(0.009)	(0.009)	(0.008)
β							0.022**	0.022**	0.020*
							(0.011)	(0.011)	(0.010)
age				0.001	0.001	0.001	0.002	0.002	0.002
				(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
male				−0.016	−0.016	−0.019	−0.016	−0.016	−0.018
				(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
science				−0.011	−0.011	−0.011	−0.005	−0.005	−0.005
				(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
N	1,920	1,920	1,920	1,920	1,920	1,920	1,920	1,920	1,920

*Note: *p<0.1; **p<0.05; ***p<0.01*

Table B.3: No-contribution across treatments controlling for individual characteristics. Probit regression

	No Controls			Basic Controls			Full Controls		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TL	-0.088^{***}	-0.089^{***}	-0.031	-0.102^{***}	-0.103^{***}	-0.044	-0.099^{***}	-0.100^{***}	-0.043
	(0.017)	(0.016)	(0.039)	(0.017)	(0.016)	(0.038)	(0.017)	(0.016)	(0.038)
TM	-0.288^{***}	-0.284^{***}	-0.038	-0.289^{***}	-0.285^{***}	-0.033	-0.290^{***}	-0.286^{***}	-0.034
	(0.014)	(0.013)	(0.048)	(0.014)	(0.013)	(0.048)	(0.014)	(0.013)	(0.047)
TH	-0.302^{***}	-0.302^{***}	-0.170^{***}	-0.299^{***}	-0.299^{***}	-0.166^{***}	-0.296^{***}	-0.295^{***}	-0.159^{***}
	(0.013)	(0.013)	(0.048)	(0.013)	(0.013)	(0.048)	(0.013)	(0.013)	(0.048)
Round		0.028^{***}	0.040^{***}		0.029^{***}	0.041^{***}		0.028^{***}	0.041^{***}
		(0.003)	(0.004)		(0.003)	(0.004)		(0.003)	(0.004)
Round × TL			-0.010^{*}			-0.011^{*}			-0.010^{*}
			(0.006)			(0.006)			(0.006)
Round × TM			-0.053^{***}			-0.055^{***}			-0.055^{***}
			(0.009)			(0.009)			(0.008)
Round × TH			-0.033^{***}			-0.033^{***}			-0.033^{***}
			(0.010)			(0.010)			(0.010)
α							-0.021	-0.023	-0.020
							(0.018)	(0.018)	(0.017)
β							0.018	0.016	0.018
							(0.014)	(0.013)	(0.013)
age				0.001	0.001	0.001	0.002	0.002	0.002
				(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
male				0.035^{*}	0.035^{**}	0.036^{**}	0.036^{**}	0.036^{**}	0.038^{**}
				(0.018)	(0.017)	(0.017)	(0.018)	(0.017)	(0.017)
science				0.073^{***}	0.075^{***}	0.075^{***}	0.077^{***}	0.079^{***}	0.079^{***}
				(0.018)	(0.017)	(0.016)	(0.018)	(0.017)	(0.016)
N	1,920	1,920	1,920	1,920	1,920	1,920	1,920	1,920	1,920

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table B.4: Full-contribution across treatments controlling for individual characteristics. OLS regression

	No Controls			Basic Controls			Full Controls		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TL	0.196***	0.196***	0.269***	0.200***	0.200***	0.274***	0.204***	0.204***	0.277***
	(0.021)	(0.021)	(0.044)	(0.021)	(0.021)	(0.044)	(0.021)	(0.021)	(0.044)
TM	0.819***	0.819***	0.601***	0.816***	0.816***	0.599***	0.813***	0.813***	0.595***
	(0.021)	(0.021)	(0.044)	(0.021)	(0.021)	(0.044)	(0.021)	(0.021)	(0.044)
TH	0.863***	0.863***	0.754***	0.863***	0.863***	0.755***	0.868***	0.868***	0.760***
	(0.021)	(0.021)	(0.044)	(0.021)	(0.021)	(0.044)	(0.021)	(0.021)	(0.044)
Round		−0.002	−0.013***		−0.002	−0.013***		−0.002	−0.013***
		(0.003)	(0.005)		(0.003)	(0.005)		(0.003)	(0.005)
Round × TL			−0.013*			−0.013*			−0.013*
			(0.007)			(0.007)			(0.007)
Round × TM			0.040***			0.040***			0.040***
			(0.007)			(0.007)			(0.007)
Round × TH			0.020***			0.020***			0.020***
			(0.007)			(0.007)			(0.007)
α							−0.008	−0.008	−0.008
							(0.008)	(0.008)	(0.008)
β							0.022**	0.022**	0.022**
							(0.010)	(0.010)	(0.010)
age				0.002	0.002	0.002	0.004*	0.004*	0.004*
				(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
male				−0.021	−0.021	−0.021	−0.021	−0.021	−0.021
				(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
science				−0.017	−0.017	−0.017	−0.011	−0.011	−0.011
				(0.017)	(0.017)	(0.016)	(0.017)	(0.017)	(0.016)
N	1,920	1,920	1,920	1,920	1,920	1,920	1,920	1,920	1,920
Adjusted R^2	0.580	0.580	0.592	0.586	0.586	0.598	0.587	0.586	0.599

*Note: *p<0.1; **p<0.05; ***p<0.01*

Table B.5: No-contribution across treatments controlling for individual characteristics. OLS regression

	No Controls			Basic Controls			Full Controls		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TL	−0.158***	−0.158***	−0.024	−0.174***	−0.174***	−0.039	−0.170***	−0.170***	−0.035
	(0.023)	(0.022)	(0.047)	(0.023)	(0.023)	(0.046)	(0.023)	(0.023)	(0.046)
TM	−0.423***	−0.423***	0.017	−0.425***	−0.425***	0.015	−0.428***	−0.428***	0.011
	(0.023)	(0.022)	(0.047)	(0.023)	(0.022)	(0.046)	(0.023)	(0.022)	(0.046)
TH	−0.440***	−0.440***	−0.036	−0.437***	−0.437***	−0.034	−0.431***	−0.431***	−0.028
	(0.023)	(0.022)	(0.047)	(0.023)	(0.022)	(0.046)	(0.023)	(0.022)	(0.046)
Round		0.031***	0.075***		0.031***	0.075***		0.031***	0.075***
		(0.003)	(0.005)		(0.003)	(0.005)		(0.003)	(0.005)
Round × TL			−0.024***			−0.024***			−0.024***
			(0.007)			(0.007)			(0.007)
Round × TM			−0.080***			−0.080***			−0.080***
			(0.007)			(0.007)			(0.007)
Round × TH			−0.073***			−0.073***			−0.073***
			(0.007)			(0.007)			(0.007)
α							−0.011	−0.011	−0.011
							(0.009)	(0.008)	(0.008)
β							0.022**	0.022**	0.022**
							(0.011)	(0.010)	(0.010)
age				0.001	0.001	0.001	0.002	0.002	0.002
				(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
male				0.038**	0.038**	0.038**	0.039**	0.039**	0.039**
				(0.018)	(0.017)	(0.017)	(0.018)	(0.017)	(0.017)
science				0.080***	0.080***	0.080***	0.086***	0.086***	0.086***
				(0.018)	(0.018)	(0.017)	(0.018)	(0.018)	(0.017)
N	1,920	1,920	1,920	1,920	1,920	1,920	1,920	1,920	1,920
Adjusted R^2	0.210	0.257	0.313	0.214	0.261	0.317	0.216	0.264	0.320

*Note: *p<0.1; **p<0.05; ***p<0.01*

Table B.6: Comparison of Treatment Effect on Contribution

(a) No Controls

	T0	TL	TM	TH
T0				
TL	73.107 (p=0.000)			
TM	1353.851 (p=0.000)	797.749 (p=0.000)		
TH	1422.639 (p=0.000)	850.750 (p=0.000)	0.852 (p=1.000)	

(b) Full Controls

	T0	TL	TM	TH
T0				
TL	72.846 (p=0.000)			
TM	1332.673 (p=0.000)	748.738 (p=0.000)		
TH	1382.994 (p=0.000)	809.957 (p=0.000)	0.522 (p=1.000)	

Note: Values represent F-statistics for pairwise comparisons of the coefficients in column (1) of Table B.1, and column (8) for panel (b). Bonferroni-adjusted p-values are reported in parentheses.

Table B.7: Proportion test for the contribution type across treatments

(a) Full-contribution

	T0	TL	TM	TH
T0				
TL	59.907 (p=0.000)			
TM	643.540 (p=0.000)	387.690 (p=0.000)		
TH	715.653 (p=0.000)	453.131 (p=0.000)	7.277 (p=0.042)	

(b) Non-contribution

	T0	TL	TM	TH
T0				
TL	25.559 (p=0.000)			
TM	230.875 (p=0.000)	120.367 (p=0.000)		
TH	255.319 (p=0.000)	141.701 (p=0.000)	2.530 (p=0.670)	

Note: Values represent Pearson's chi-squared test statistics. Bonferroni-adjusted p-values are reported in parentheses.

Online Appendix for "Rank-Based Incentives in Team Production: Nonlinear Effects in a Voluntary Contribution Mechanism"

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May 27, 2026

1 English translation of the instructions

The instructions have been translated from the original Japanese. Instruction of Part 2 was distributed after completing Part 1.

1.1 Instruction for the Experiment

Thank you for your participation in our experiment today.

This experiment consists of two parts, Experiment 1 and Experiment 2.

Please read the following instructions carefully. These instructions are identical for all participants. The decisions you make during this experiment will directly affect the amount of compensation you receive at the end. Your compensation will be paid to you in cash following the completion of the experiment.

The total payment is determined by a participation fee of ¥500 plus the earnings you gain from the experimental tasks.

Please do not speak to anyone else in the room during the experiment. If you have any questions or concerns, please raise your hand. An experimenter will come to your desk and assist you privately.

The earnings from Experiment 1 will be combined with those from Experiment 2, and the total amount will be announced at the end of the experiment.

In Experiment 2, we use a virtual currency called "points."

The points you earn during Experiment 2 will be converted into Japanese Yen at a rate of 1 point = ¥100 and paid to you in cash.

Please note that the final payment will be calculated by rounding up the ones digit of the amount displayed on your screen.

Now, we will provide the instructions for Experiment 1.

1.2 Experiment 1

In Experiment 1, you will be randomly paired with another participant.

Your earnings will be determined by either your decision or your partner's.

Next, we will provide the instructions about the decisions you will make during the experiment.

In Experiment 1, two tables will be displayed as shown on the following page (see Section 1.2). Each table contains 31 questions. For each of these 31 questions, you are required to choose either Option A or Option B.

The two options in each question represent an allocation of payoffs between yourself and your paired partner. For example, in the first row of the left table, Option A specifies and allocation of ¥600 to yourself and ¥600 to your partner. In contrast, Option B specifies an allocation of ¥400 to

Option A				Option B	
Yours	Other's			Yours	Other's
600	600	○	○	400	1040
580	600	○	○	400	1040
560	600	○	○	400	1040
540	600	○	○	400	1040
520	600	○	○	400	1040
500	600	○	○	400	1040
480	600	○	○	400	1040
460	600	○	○	400	1040
440	600	○	○	400	1040
420	600	○	○	400	1040
400	600	○	○	400	1040
380	600	○	○	400	1040
360	600	○	○	400	1040
340	600	○	○	400	1040
320	600	○	○	400	1040
300	600	○	○	400	1040
280	600	○	○	400	1040
260	600	○	○	400	1040
240	600	○	○	400	1040
220	600	○	○	400	1040
200	600	○	○	400	1040
180	600	○	○	400	1040
160	600	○	○	400	1040
140	600	○	○	400	1040
120	600	○	○	400	1040
100	600	○	○	400	1040
80	600	○	○	400	1040
60	600	○	○	400	1040
40	600	○	○	400	1040
20	600	○	○	400	1040
0	600	○	○	400	1040

(a) 1st

Option A				Option B	
Yours	Other's			Yours	Other's
1407	360	○	○	1267	200
1387	360	○	○	1267	200
1367	360	○	○	1267	200
1347	360	○	○	1267	200
1327	360	○	○	1267	200
1307	360	○	○	1267	200
1287	360	○	○	1267	200
1267	360	○	○	1267	200
1247	360	○	○	1267	200
1227	360	○	○	1267	200
1207	360	○	○	1267	200
1187	360	○	○	1267	200
1167	360	○	○	1267	200
1147	360	○	○	1267	200
1127	360	○	○	1267	200
1107	360	○	○	1267	200
1087	360	○	○	1267	200
1067	360	○	○	1267	200
1047	360	○	○	1267	200
1027	360	○	○	1267	200
1007	360	○	○	1267	200
987	360	○	○	1267	200
967	360	○	○	1267	200
947	360	○	○	1267	200
911	360	○	○	1267	200
868	360	○	○	1267	200
814	360	○	○	1267	200
747	360	○	○	1267	200
659	360	○	○	1267	200
538	360	○	○	1267	200
360	360	○	○	1267	200

(b) 2nd

yourself and ¥1,040 to your partner.

Option B remains the same for all questions. As you move down the table, the amount allocated to yourself in Option A gradually decreases.

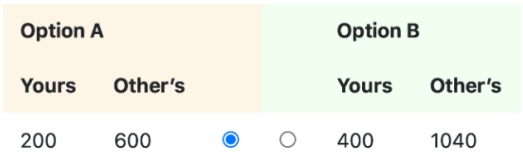
It is common to pick option A for the first few questions and then switch to option B. To simplify the procedure, once you select option B for a given question, all questions in rows above it will automatically be set to option A, and all questions in rows below it will be set to option B.

Finally, we will explain how your earnings for Experiment 1 are determined. The exact amount will be revealed once you have completed all of today's experimental tasks.

After both members of each pair have finalized their decisions, the computer will randomly select one of the 62 questions from the two tables for that pair. It will then randomly decide whether to use your decision or your partner's decision to determine your earnings.

The case your decision is implemented

For example, suppose that you chose option A, as shown in the figure below.



If this question is selected and your decision is implemented, you will receive ¥200 and the other person will receive ¥600.

The case your partner's decision is implemented

For example, suppose your partner chose option B for the same question, as shown in the figure below.

If this problem is selected and your partner's decision is implemented, you will receive ¥1,040 and your partner will receive ¥400.

This concludes the instructions for Experiment 1. To ensure that you have understood the instructions so far, please complete the comprehension quiz.

You are required to continue answering until you have answered all questions correctly. If you provide an incorrect answer, please review the instructions again before re-answering. The experiment will begin once everyone has answered correctly.

After participants completed Experiment 1, they received the instructions for Experiment 2 provided below.
(common across all treatments)

1.3 Experiment 2

(Common part) Experiment 2 consists of 10 rounds of decision-making.

At the beginning of each round, participants are randomly assigned by the computer into groups of three. This means your group will consist of you

and two other members.

On your screen, the members will be displayed as 'You,' 'Player 1,' and 'Player 2.' Since these labels are reassigned randomly in each round, they do not correspond to specific individuals. All decisions are strictly anonymous, and no personal information will be shared with other group members.

At the start of each round, every participant receives an endowment of 10 points. You must decide how to allocate these 10 points between your private account and a group project.

You may invest any integer amount from 0 to 10 points in the project.

Any points not invested will remain in your private account.

For example, if you invest 0 points, all 10 points will stay in your private account.

Once all members have finished their decisions, your payoff for that round will be calculated.

Your total payoff consists of the following two components:

1. Points you have:

   10 – (the number of points you invest in the project)

   These points belong to you.

2. Earnings from the group project:

   The earnings from the project are calculated by multiplying the total points invested by all three group members (you and the other two members) by the return rate. Specifically, the calculation is as follows:

   Project earnings =

Return Rate × (The Point You Invest

+ Sum of Investments by the Other 2 members)

An alert will appear on the screen after 60 seconds have passed. If a decision is still not made after the alert, the experimenter may individually prompt you to finish your decision-making.

The return rate represents the additional earnings you receive from the project for every 1 point increase in your investment.

The return rate is 0.6, which is a common value shared by all members of the group.(only T0)

(The following text was used for TM. In TL and TH, only the numerical values differ.) Your return rate is determined by the relative size of your investment within your group as follows: The member with the highest investment in the group is assigned a return rate of 0.9.The member with the second-highest investment is assigned 0.6.The member with the lowest investment is assigned 0.3.

If two or three members invest the same amount, their return rates will be determined by averaging the values for the corresponding ranks.

The rule of assigning return rate is as follows:

All three members invest the same amount:

Every participant will be assigned a return rate of:

$$\frac{0.3 + 0.6 + 0.9}{3} = 0.6$$

If two members tie for the highest investment in the group:

The two members who tied for the highest investment will each be assigned:

$$\frac{0.6 + 0.9}{2} = 0.75$$

The remaining member with the lowest investment will be assigned 0.3.

If two members tie for the lowest investment in the group:

The two members who tied for the lowest investment will each be assigned:

$$\frac{0.3 + 0.6}{2} = 0.45$$

The remaining member with the highest investment will be assigned 0.9.

Below are some numerical examples.

As in the actual experiment, let us assume there are three players in a group.

1. Suppose that you, Player 1, and Player 2 invest 7, 4, and 2 points in the project, respectively. In this case, the results would be as follows:

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	7	0.9	14.7
Player1	4	0.6	13.8
Player2	2	0.3	11.9

Since you invest most among the three ($7 > 4 > 2$), your return rate is 0.9. Similarly, Player 1 (the second-highest) is assigned 0.6, and Player 2 (the lowest) is assigned 0.3. In this case, your total payoff is calculated as follows:

$$10 - 7 + 0.9 \times (7 + 4 + 2) = 14.7$$

2. Suppose that you, Player 1, and Player 2 invest 0, 0, and 0 points in the project, respectively. In this case, the results would be as follows:

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	0	0.6	10.0
Player1	0	0.6	10.0
Player2	0	0.6	10.0

In this case, since the investment amounts of all three members are the same (0 points), each member is assigned a return rate of:

$$\frac{0.3 + 0.6 + 0.9}{3} = 0.6$$

Therefore, your total payoff in this scenario is calculated as follows:

$$10 - 0 + 0.6 \times (0 + 0 + 0) = 10.0$$

3. Suppose that you, Player 1, and Player 2 invest 8, 8, and 2 points in the project, respectively. In this case, the results would be as follows:

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	8	0.75	15.5
Player1	8	0.75	15.5
Player2	2	0.3	13.4

Since you and Player 1 are tied for the highest investment (8 points) in the group. Thus, the return rate for both you and Player 1 is:

$$\frac{0.6 + 0.9}{2} = 0.75$$

Because Player 2 has the lowest investment (2 points), they are assigned a

return rate of 0.3. Therefore, your total payoff in this scenario is calculated as follows:

$$10 - 8 + 0.75 \times (8 + 8 + 2) = 15.5$$

4. Suppose that you, Player 1, and Player 2 invest 3, 3, and 10 points in the project, respectively. In this case, the results would be as follows:

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	3	0.45	14.2
Player1	3	0.45	14.2
Player2	10	0.9	14.4

Player 2 has the highest investment in the group (10 points), so he is assigned the return rate of 0.9. Since you and Player 1 are tied for the lowest investment (3 points) in the group. Thus, the return rate for both you and Player 1 is:

$$\frac{0.6 + 0.3}{2} = 0.45$$

Therefore, your total payoff in this scenario is calculated as follows:

$$10 - 3 + 0.45 \times (3 + 3 + 10) = 14.2$$

5. Suppose that you, Player 1, and Player 2 invest 10, 10, and 10 points in

the project, respectively. In this case, the results would be as follows:

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	10	0.6	18.0
Player1	10	0.6	18.0
Player2	10	0.6	18.0

In this case, since the investment amounts of all three members are the same (10 points), each member is assigned a return rate of:

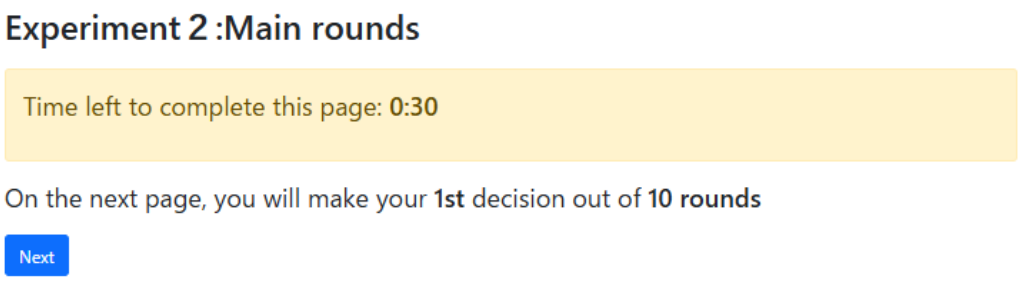
$$\frac{0.3 + 0.6 + 0.9}{3} = 0.6$$

Therefore, your total payoff in this scenario is calculated as follows:

$$10 - 10 + 0.6 \times (10 + 10 + 10) = 18.0$$

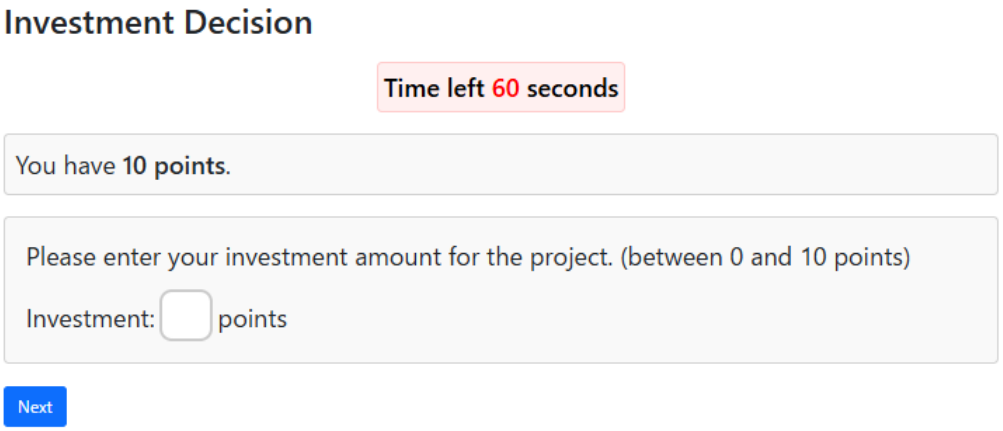
(Common part) Next, we will explain the screens you will encounter during the experiment.

At the beginning of the main task in Experiment 2, the following screen will be displayed first.



This page provides information regarding the current round number of your decision. You can proceed to the next page by clicking the "Next" button.

Please note that the screen will automatically transition to the next page 30 seconds after it appears. On the following page, you will perform the main task, making your investment decision for the project.



On this page, you will decide the amount you wish to invest in the project.

The frame on the screen displays the number of points you have at the start of the round.

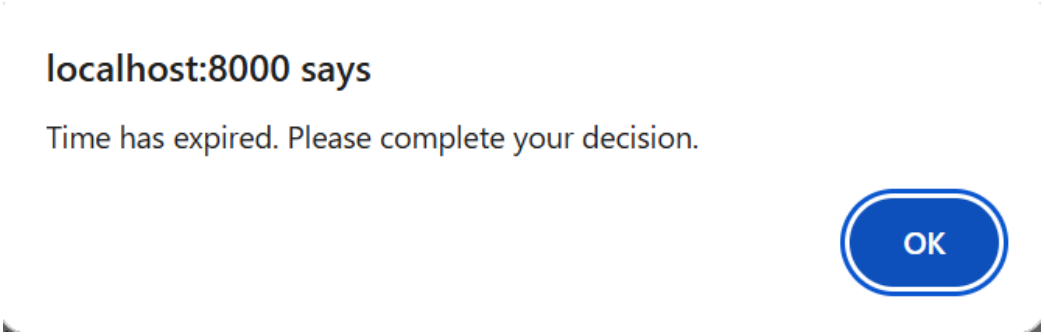
Note that you will receive the endowment of 10 points for each of the 10 decision-making rounds.

You can enter your investment amount by typing the number directly into the input box.

Once you have made your decision, click the "Next" button and wait for the other participants to finish their decisions.

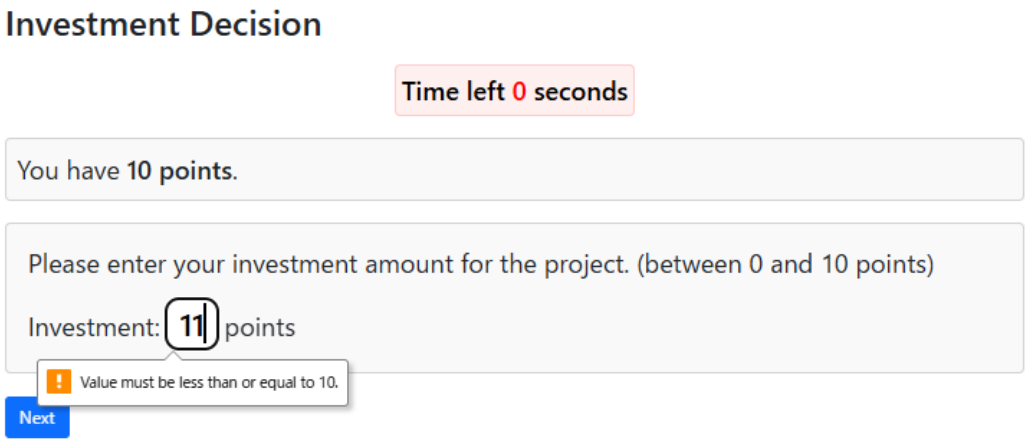
A "Remaining Time" indicator is displayed at the top of the screen, counting down from 60 seconds.

On this page, the screen will not automatically transition even if the timer reaches zero. However, once the remaining time hits 0 seconds, an alert will be displayed as shown in the image below.



If this screen appears, please click the "OK" button, complete your decision promptly, and then click the "Next" button.

Additionally, if you enter an invalid value, such as a number less than 0, greater than 10, or a value including a decimal point, an error message will be displayed as shown below.



In such cases, please re-enter an integer between 0 and 10 and click the "Next" button.

Subsequently, the Results Screen for your decision will be displayed.

The screen above displays the results of the current round.

On this results screen, the following four values are shown in order from top to bottom:

The amount you invested in the project

The return rate assigned to you

The total investment made by all group members

Your final payoff for this round

Additionally, a table at the bottom of the screen provides the following details:

Investment amounts for you and the other two group members

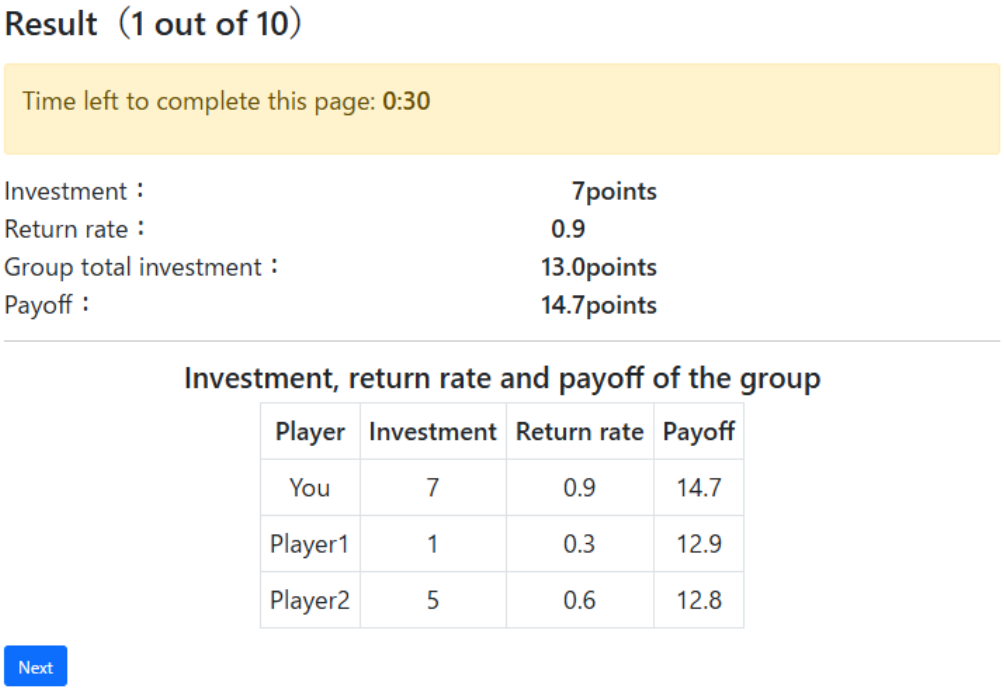
Return rates assigned to you and the other two members individually

Payoffs received by you and the other two members

Once you have finished reviewing the results, click the "Next" button and wait until all participants have completed the screen transition.

This screen will automatically transition after 30 seconds and return to the initial screen of the next round.

After the 10th round is completed and its result screen is displayed, the summary table showing the results of all 10 rounds of your decision-making will be presented.



This table displays your investment amounts and payoffs for each round.

Final Results

All rounds have ended.

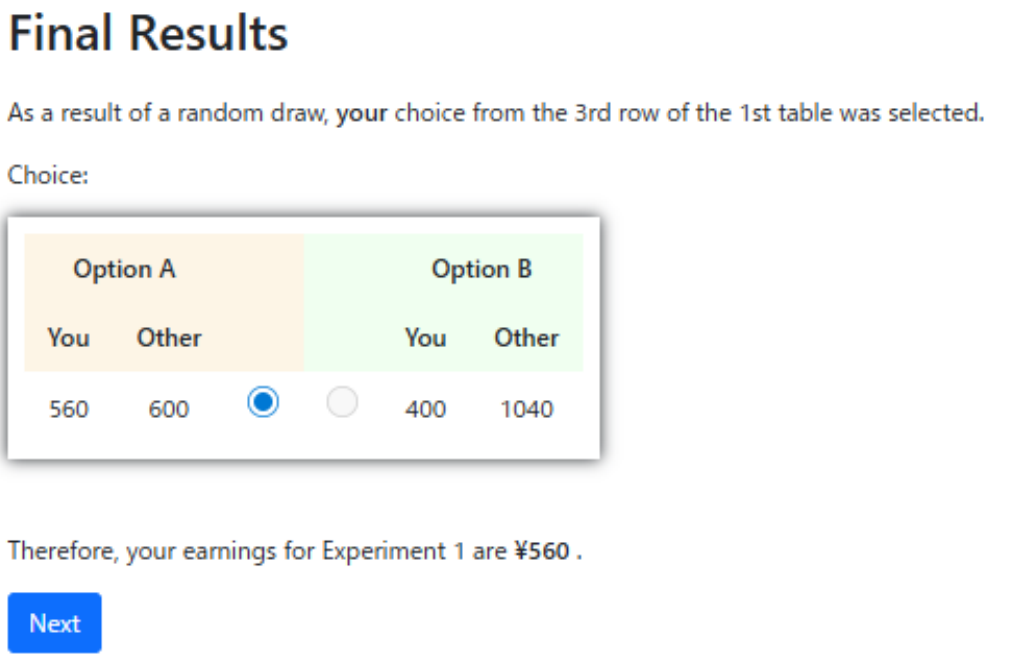
The results of your 10 decisions are as follows.
One of the following 10 rounds will determine your final payment.

Results per Round

Round	Investment	Payoff
1	3	12.1
2	6	11.2
3	8	20.0
4	9	13.6
5	1	11.1
6	6	11.5
7	10	23.4
8	5	12.8
9	9	14.8
10	7	10.2

Next

To determine your final payment for Experiment 2, one of these ten rounds will be randomly selected by the computer.



This screen displays the earnings you have obtained in Experiment 1.

Please note that the specific question used to determine your payment was selected at random by the computer.

The next screen will display the earnings you have acquired in Experiment 2.

This screen shows the round randomly selected for payment, the amount you invested in that round, the payoff you received, and the resulting payment.

Final Results

All rounds have ended.

Round 7 was randomly selected.

Therefore, your payoff is 23.4 points.

Your final payment for Experiment 2 is ¥2340.0 .

Results per Round

Round	Your Investment	Your Payoff
1	3	12.1
2	6	11.2
3	8	20.0
4	9	13.6
5	1	11.1
6	6	11.5
7	10	23.4
8	5	12.8
9	9	14.8
10	7	10.2

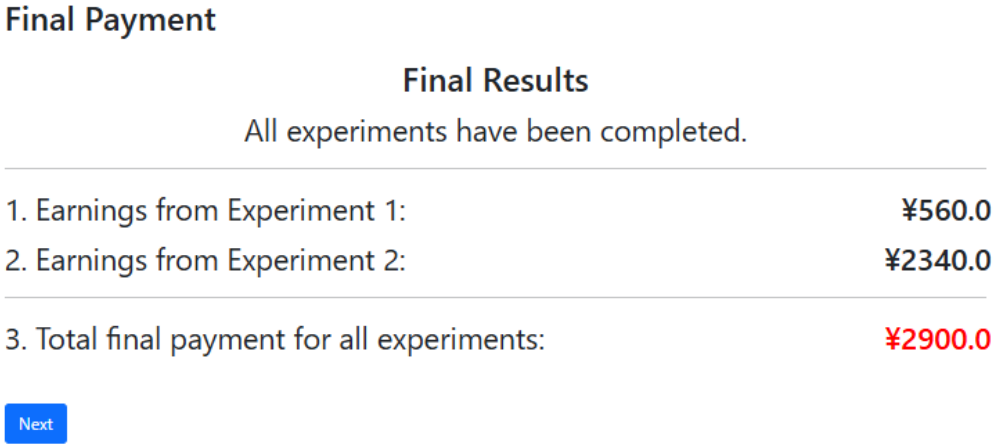
Next

Using this screen as an example, Round 7 has been selected, and the 23.4 points you earned in that round will be converted into your payment. Since the conversion rate for Experiment 2 is 1 point = ¥100, your total payment

in this case would be ¥2,340.

Once you have finished reviewing the information, please click the "Next" button.

The following page will display the final total amount of payment you have obtained for the entire experiment.



Using this screen as an example, you have earned ¥560 in Experiment 1 and ¥2,340 in Experiment 2, resulting in a total of ¥2,900 from the tasks. This amount, plus the ¥500 participation fee, will be paid to you after the completion of the experiment.

Once you have confirmed your payment, a post-experiment questionnaire will be displayed. The experiment will finish after you have answered all the questionnaire.

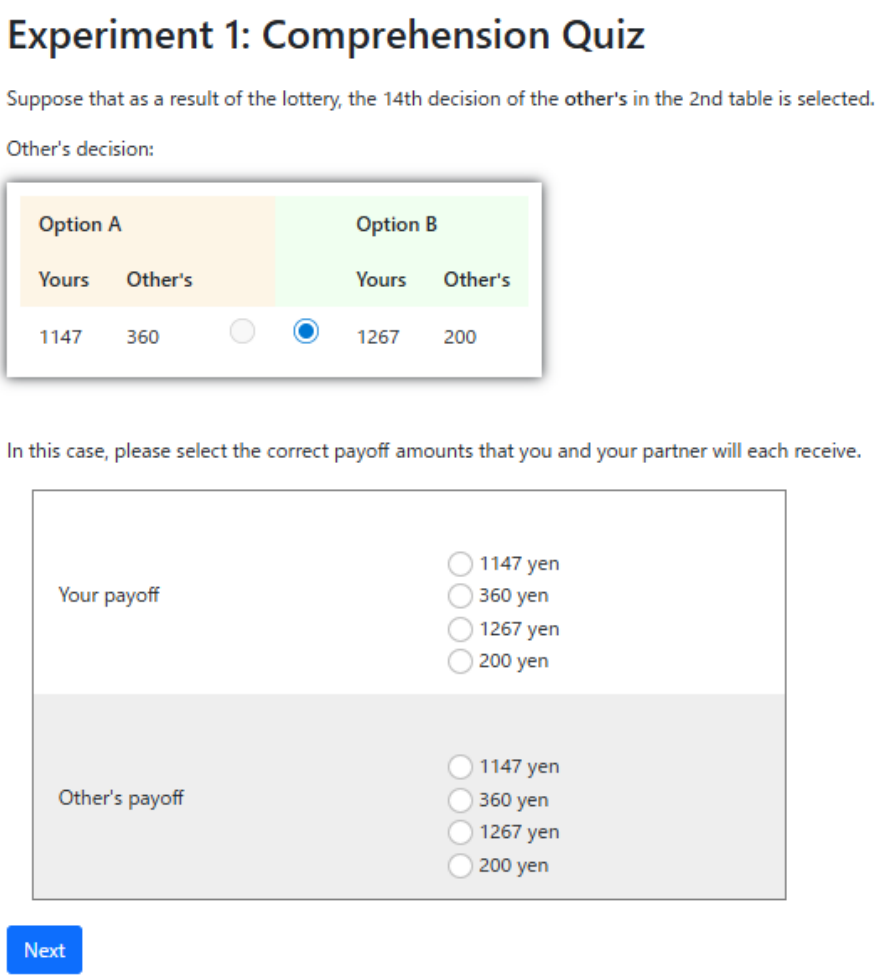
Please remain at your seat until your payment is ready.

This concludes the instructions for Experiment 2. To ensure that you have understood the instructions so far, please complete the comprehen-

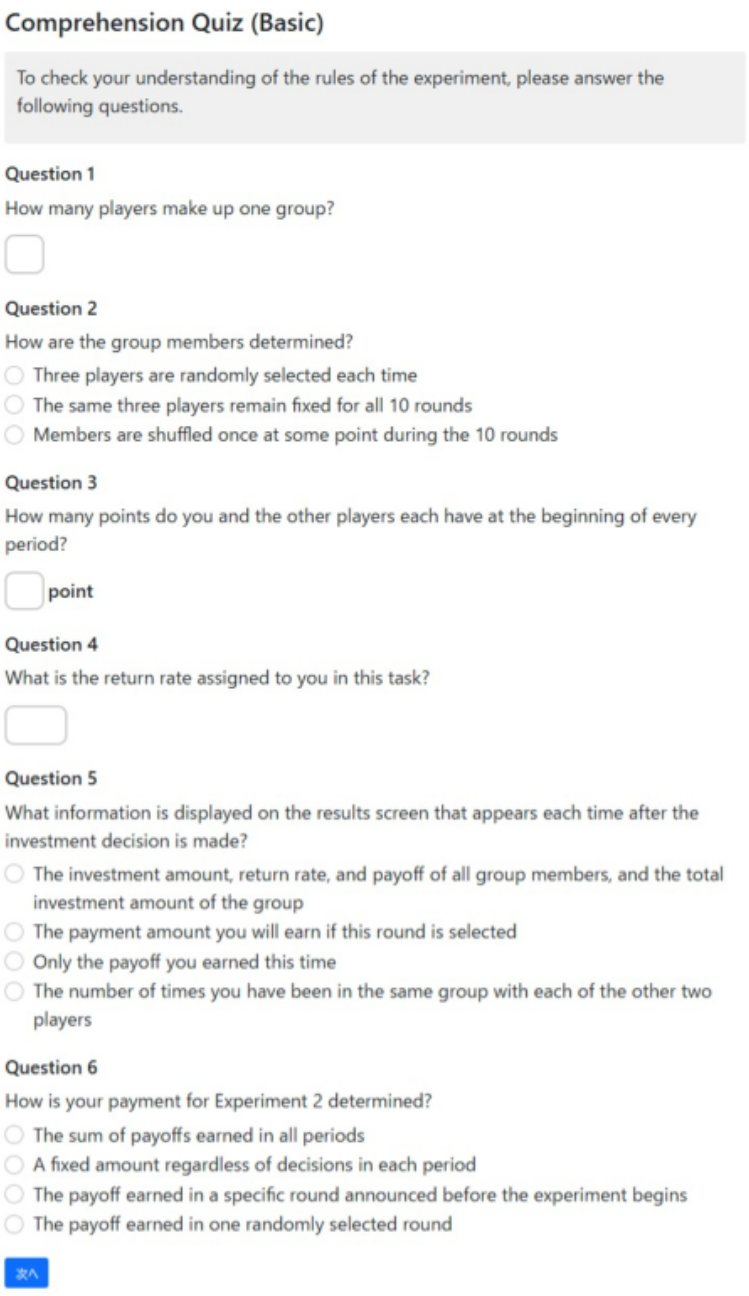
sion quiz.You are required to continue answering until you have answered all questions correctly. If you provide an incorrect answer, please review the instructions again before re-answering. The experiment will begin once everyone has answered correctly.

2 Comprehension Quiz

2.1 Experiment 1



2.2 Experiment 2: T0



Comprehension Quiz (Basic)

To check your understanding of the rules of the experiment, please answer the following questions.

Question 1

How many players make up one group?

Question 2

How are the group members determined?

- Three players are randomly selected each time
- The same three players remain fixed for all 10 rounds
- Members are shuffled once at some point during the 10 rounds

Question 3

How many points do you and the other players each have at the beginning of every period?

point

Question 4

What is the return rate assigned to you in this task?

Question 5

What information is displayed on the results screen that appears each time after the investment decision is made?

- The investment amount, return rate, and payoff of all group members, and the total investment amount of the group
- The payment amount you will earn if this round is selected
- Only the payoff you earned this time
- The number of times you have been in the same group with each of the other two players

Question 6

How is your payment for Experiment 2 determined?

- The sum of payoffs earned in all periods
- A fixed amount regardless of decisions in each period
- The payoff earned in a specific round announced before the experiment begins
- The payoff earned in one randomly selected round

次へ

Comprehension Quiz (Basic) - Correct Answers

The correct answers for the comprehension quiz are as follows:

Question 1: How many players make up one group?

Correct Answer:**3 players**

Question 2: How are the group members determined?

Correct Answer:**Three players are randomly selected each time**

Question 3: How many points do you and the other players each have at the beginning of every period?

Correct Answer:**10 points**

Question 4: What is the return rate assigned to you in this task?

Correct Answer:**0.6**

Question 5: What information is displayed on the results screen that appears each time after the investment decision is made?

Correct Answer:**The investment amount, return rate, and payoff of all group members, and the total investment amount of the group**

Question 6: How is your payment for Experiment 2 determined?

Correct Answer:**The payoff earned in one randomly selected round**

次へ

Comprehension Quiz (Calculation 1)

To check your understanding of the rules of the experiment, please answer the following questions.

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	5	①	②
Player1	7	0.6	16.2
Player2	10	0.6	13.2

Question 1

Please enter the number that goes in ①. (Your return rate)

Question 2

Please enter the number that goes in ②. (Your payoff)

次へ

Comprehension Quiz (Calculation 1) - Correct Answers

The correct answers for the Comprehension Quiz (Calculation 1) are as follows:

Player	Investment	Return rate	Payoff
You	5	0.6	18.2
Player1	7	0.6	16.2
Player2	10	0.6	13.2

Calculation method:

Your return rate is0.6. The total investment amount of the group is 5 + 7 + 10 =22.

Your payoff is 10 (initial points) - 5 (your investment amount) + 0.6 (your return rate) × 22 (total investment amount of the group) =18.2 .

次へ

Comprehension Quiz (Calculation 2)

To check your understanding of the rules of the experiment, please answer the following questions.

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	5	0.6	②
Player1	5	0.6	17.0
Player2	10	0.6	12.0

Question 1

Please enter the number that goes in ①. (Your payoff)

次へ

Comprehension Quiz (Calculation 2) - Correct Answers

The correct answers for the Comprehension Quiz (Calculation 2) are as follows:

Player	Investment	Return rate	Payoff
You	5	0.6	17.0
Player1	5	0.6	17.0
Player2	10	0.6	12.0

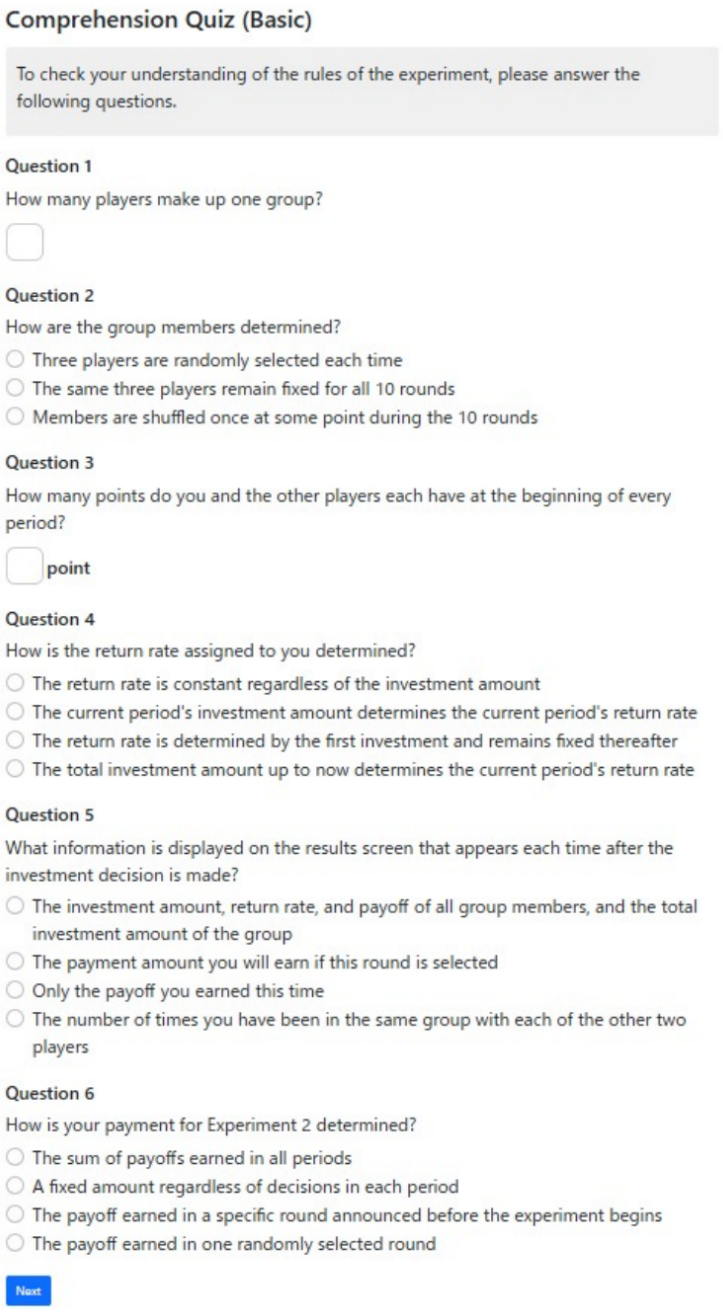
Calculation method:

Your return rate is 0.6. The total investment amount of the group is 5 + 5 + 10 =20.

Your payoff is 10 (initial points) - 5 (your investment amount) + 0.6 (your return rate) × 20 (total investment amount of the group) =17.0 .

次へ

2.3 Experiment 2: TM (TL and TH have the same question, except for the numbers.)



Comprehension Quiz (Basic)

To check your understanding of the rules of the experiment, please answer the following questions.

Question 1

How many players make up one group?

Question 2

How are the group members determined?

- ○ Three players are randomly selected each time
- ○ The same three players remain fixed for all 10 rounds
- ○ Members are shuffled once at some point during the 10 rounds

Question 3

How many points do you and the other players each have at the beginning of every period?

point

Question 4

How is the return rate assigned to you determined?

- ○ The return rate is constant regardless of the investment amount
- ○ The current period's investment amount determines the current period's return rate
- ○ The return rate is determined by the first investment and remains fixed thereafter
- ○ The total investment amount up to now determines the current period's return rate

Question 5

What information is displayed on the results screen that appears each time after the investment decision is made?

- ○ The investment amount, return rate, and payoff of all group members, and the total investment amount of the group
- ○ The payment amount you will earn if this round is selected
- ○ Only the payoff you earned this time
- ○ The number of times you have been in the same group with each of the other two players

Question 6

How is your payment for Experiment 2 determined?

- ○ The sum of payoffs earned in all periods
- ○ A fixed amount regardless of decisions in each period
- ○ The payoff earned in a specific round announced before the experiment begins
- ○ The payoff earned in one randomly selected round

Next

Comprehension Quiz (Basic) - Correct Answers

The correct answers for the comprehension quiz are as follows:

Question 1: How many players make up one group?

Correct Answer: **3 players**

Question 2: How are the group members determined?

Correct Answer: **Three players are randomly selected each time**

Question 3: How many points do you and the other players each have at the beginning of every period?

Correct Answer: **10 points**

Question 4: How is the return rate assigned to you determined?

Correct Answer: **The current period's investment amount determines the current period's return rate**

Question 5: What information is displayed on the results screen that appears each time after the investment decision is made?

Correct Answer: **The investment amount, return rate, and payoff of all group members, and the total investment amount of the group**

Question 6: How is your payment for Experiment 2 determined?

Correct Answer: **The payoff earned in one randomly selected round**

Next

Comprehension Quiz (Calculation 1)

To check your understanding of the rules of the experiment, please answer the following questions.

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	3	0.45	14.2
Player1	3	0.45	14.2
Player2	10	0.9	14.4

Question 1

Please enter the number that goes in ①. (Your return rate)

Question 2

Please enter the number that goes in ②. (Player 1's return rate)

Question 3

Please enter the number that goes in ③. (Player 2's return rate)

Next

Comprehension Quiz (Calculation 1) - Correct Answers

The correct answers for the Comprehension Quiz (Calculation 1) are as follows:

Player	Investment	Return rate	Payoff
Yours	4	**0.3**	12.0
Player1	10	**0.9**	18.0
Player2	6	**0.6**	16.0

Calculation method:

Comparing the investment amounts, it is 10 > 6 > 4. The return rates according to the ranking are 0.9 for 1st place, 0.6 for 2nd place, and 0.3 for 3rd place.

Your investment amount is in 3rd place, so your return rate is**0.3**.

Player 1's investment amount is in 1st place, so their return rate is**0.9**.

Player 2's investment amount is in 2nd place, so their return rate is**0.6**.

Next

Comprehension Quiz (Calculation 2)

To check your understanding of the rules of the experiment, please answer the following questions.

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	10	①	18.0
Player1	10	②	18.0
Player2	10	③	18.0

Question 1

Please enter the number that goes in ①. (Your return rate)

Question 2

Please enter the number that goes in ②. (Player 1's return rate)

Question 3

Please enter the number that goes in ③. (Player 2's return rate)

Next

Comprehension Quiz (Calculation 2) - Correct Answers

The correct answers for the Comprehension Quiz (Calculation 2) are as follows:

Player	Investment	Return rate	Payoff
You	10	0.6	18.0
Player1	10	0.6	18.0
Player2	10	0.6	18.0

Calculation method:

Since the investment amount is the same for all three players (10), everyone's return rate is0.6.

Next

Comprehension Quiz (Calculation 3)

To check your understanding of the rules of the experiment, please answer the following questions.

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	8	①	17.0
Player1	8	②	17.0
Player2	4	③	12.0

Question 1

Please enter the number that goes in ①. (Your return rate)

Question 2

Please enter the number that goes in ②. (Player 1's return rate)

Question 3

Please enter the number that goes in ③. (Player 2's return rate)

Next

Comprehension Quiz (Calculation 3) - Correct Answers

The correct answers for the Comprehension Quiz (Calculation 3) are as follows:

Player	Investment	Return rate	Payoff
You	8	0.75	17.0
Player1	8	0.75	17.0
Player2	4	0.3	12.0

Calculation method:

Comparing the investment amounts, it is 8 = 8 > 4. In this case, since two players are tied for 1st place, the average return rate is assigned.

Your investment amount is tied for 1st place, so your return rate is0.75 (the average of 0.6 and 0.9).

Player 1's investment amount is also tied for 1st place, so their return rate is0.75 (the average of 0.6 and 0.9).

Player 2's investment amount is in 3rd place, so their return rate is0.3.

Next

Comprehension Quiz (Calculation 4)

To check your understanding of the rules of the experiment, please answer the following questions.

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	6	①	13.0
Player1	6	②	13.0
Player2	8	③	20.0

Question 1

Please enter the number that goes in ①. (Your return rate)

Question 2

Please enter the number that goes in ②. (Player 1's return rate)

Question 3

Please enter the number that goes in ③. (Player 2's return rate)

Next

Comprehension Quiz (Calculation 4) - Correct Answers

The correct answers for the Comprehension Quiz (Calculation 4) are as follows:

Player	Investment	Return rate	Payoff
You	6	0.45	13.0
Player1	6	0.45	13.0
Player2	8	0.9	20.0

Calculation method:

Comparing the investment amounts, it is 8 > 6 = 6. In this case, since two players are tied for 2nd place, the average return rate is assigned.

Your investment amount is tied for 2nd place, so your return rate is0.45 (the average of 0.3 and 0.6).

Player 1's investment amount is also tied for 2nd place, so their return rate is0.45 (the average of 0.3 and 0.6).

Player 2's investment amount is in 1st place, so their return rate is0.9.

Next

Comprehension Quiz (Calculation 5)

To check your understanding of the rules of the experiment, please answer the following questions.

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	5	0.3	①
Player1	7	0.6	16.2
Player2	10	0.9	19.8

Question 1

Please enter the number that goes in ①. (Your payoff)

Next

Comprehension Quiz (Calculation 5) - Correct Answers

The correct answers for the Comprehension Quiz (Calculation 5) are as follows:

Player	Investment	Return rate	Payoff
You	5	0.3	11.6
Player1	7	0.6	16.2
Player2	10	0.9	19.8

Calculation method:

Your return rate is0.3. The total investment amount of the group is 5 + 7 + 10 = 22.

Your payoff is 10 (initial points) - 5 (your investment amount) + 0.3 (your return rate) × 22 (total investment amount of the group) =11.6 .

Next

Comprehension Quiz (Calculation 6)

To check your understanding of the rules of the experiment, please answer the following questions.

Investment amounts and return rates within the group

Player	Investment	Return rate	Payoff
You	5	0.45	①
Player1	5	0.45	14.0
Player2	10	0.9	18.0

Question 1

Please enter the number that goes in ①. (Your payoff)

Next

Comprehension Quiz (Calculation 6) - Correct Answers

The correct answers for the Comprehension Quiz (Calculation 6) are as follows:

Player	Investment	Return rate	Payoff
You	5	0.45	14.0
Player1	5	0.45	14.0
Player2	10	0.9	18.0

Calculation method:

Your return rate is0.45. The total investment amount of the group is 5 + 5 + 10 = 20.

Your payoff is 10 (initial points) - 5 (your investment amount) + 0.45 (your return rate) × 20 (total investment amount of the group) =14.0 .

Next