Effects of Intergroup Competition on the Collective Risk Dilemma

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ABSTRACT

This paper explores the effect of intergroup competition on the Collective Risk Dilemma. We conducted an experiment where groups of humans played a Collective Risk dilemma game. The game lasted ten rounds and was played in groups of three. Players started with a budget (private account) and, each round, players could contribute or not to a shared public account. If the value in the public account reached a given target, the group won, and each member was paid according to the remaining value in their private account at the end. Each group played under one of the following conditions: a control condition with no competition, intergroup competition with low reward and intergroup competition with high reward. Participants playing in the intergroup competition conditions were, simultaneously, engaged in a within-group (intragroup) conflict and a between-group (intergroup) competition. Our results suggest that group competition can be a motivational solution to reduce the free-riding phenomenon and increase the total contributions in the Collective Risk dilemma, even with a minimal competition reward. Furthermore, we found that a significant increase in contributions occurred when players observed their team ranking.

KEYWORDS

Game Theory; Collective Risk Dilemma; Behavioral experiments; Intergroup Competition; Cooperation;

1 INTRODUCTION

One key factor for human evolution is the cooperation between individuals, groups and even countries [2]. Cooperation has allowed humans to solve many problems over many years of human development and will continue to be fundamental for the growth of our society. Despite this fundamental aspect of human societies, we, unfortunately, observe many cases where cooperation fails. Human societies are following paths of action where competition for individual resources can lead to the destruction of our planet and, eventually, even of our species.

One crucial example that is constantly present in the media due to its enormous impact on our lives is climate change. In fact, this November, the scheduled conference COP26 in Scotland is constantly on the news, and reports from the potential advances and drawbacks dominate the media. Forecasts show that global warming over this century is projected to be considerably greater than over the last century. The global average temperature since 1900 has risen by about 1.0°C. By 2100, it is projected to rise between 2°C in the best-case scenario or 5°C in the worst-case scenario[14].

Scientists predict that if the rate of growth of the global mean temperature stays the same, severe consequences will happen in our planet. Sea levels are expected to rise between 30 and 121 centimeters or higher by the end of the century. Hurricanes and other storms are likely to become stronger. Floods and droughts will become more common. Less freshwater will be available, since glaciers store about three-quarters of the world's freshwater. Human activities, especially emissions of greenhouse gases, are the dominant cause of the observed warming since the mid-20th century, therefore the magnitude of climate changes beyond the next few decades will depend primarily on the amount of greenhouse gases (especially carbon dioxide) emitted globally [14]. The global atmospheric carbon dioxide (CO_2) concentration has now passed 400 parts per million (ppm), a level that last occurred about 3 million years ago, when both global average temperature and sea level were significantly higher than today [14]. Reducing emissions of carbon dioxide would lessen warming over this century and beyond. Sizable early cuts in emissions would significantly reduce the pace and the overall amount of climate changes. Earlier cuts in emissions would have a greater effect in reducing climate change than comparable reductions made later. In addition, reducing emissions of some shorter-lived heat-trapping gases, such as methane, and some types of particles, such as soot, would begin to reduce warming within weeks to decades. In 2014 and 2015, emission growth rates slowed as economic growth became less carbon-intensive [8].

This critical problem that humankind faces has been studied by many types of disciplines, such as economics, mathematics and even computer scientists and AI. In particular, this type of situation can be captured and modelled as a social dilemma. A social dilemma is a situation where individuals (agents) would be better off cooperating but, unfortunately, many times, fail to do so because of conflicting interests. Social dilemmas can be formalised and captured through game contexts that help to study how people would act in a social dilemma scenario. This allows researchers to study questions such as: Will people implement some sacrifices in their day-to-day life in order to contribute to the community welfare? Will people contribute without actually seeing evidence of that contribution to the outcome?

In order to understand the factors that affect the level of cooperation in social dilemmas, experimental research must be done. Public good games have been a general method to capture these types of social dilemmas. Essentially, a public goods game models a social dilemma in which there is a conflict between contributing to the benefit of the group or acting selfishly and taking advantage of other contributing people. One particular type of public goods game, known as Collective-Risk Social Dilemma (CRD) has been a growing topic of interest and study over the last decade and captures remarkably well the situations we observe with climate change (see for instance [11], [10], [6]).

CRD has some singular characteristics that differs from classic public goods games: a) people will have to make multiple decisions without seeing evidences on the outcome, b) if the target its not reached, all investments are lost, and c) the real value of the public good is uncertain and the remaining private goods are at stake with a high probability if the common goal its not achieved.

2 RELATED WORK

The Collective-Risk Dilemma has initially been presented in [9]. The authors wanted to study decision-making in the context of the prevention of climate changes. The dilemma described in the study captured the world problem associated with the necessity to reduce the global greenhouse gas emissions by 50% (target) by 2050. We know that in order to accomplish that goal, international coordination is required where everyone must contribute. Failing of this target can result in resounding losses for the world. Groups of six students each took part in a public goods game altered to simulate the collective-risk social dilemma via an interactive computer program. It was found that the contributions increase when the risk of losing all the private goods is higher if the target is not achieved. Moreover, it was reported that cooperation improved with small group sizes.

Several studies have been carried out in the field of intergroup competition, namely in the areas of psychology and economics. The generality of them reported that intergroup cooperation could improve intragroup performance, coordination and cooperation ([1], [7], , [12], [13]) . However, intergroup competition is a field of study practically unexplored in the context of public goods games. In fact, we did not find any work on intergroup competition in the context of the Collective Risk dilemma. Interaction between groups is highly competitive—much more so than interaction between individuals under the same structural conditions (Bornstein and Ben-Yossef (1994) and Schopler and Insko (1992)). Players are often able to coordinate by focusing on aspects of the environment that are ignored by economic models. Studies made on the field of Intergroup Competition suggest that good results can be obtained in the Collective-Risk Social Dilemma. In [1] a minimal-effort coordination game [13] is played with/out the intergroup competition structure. The group with the higher minimum won the competition and the members of the winning group were paid an extra flat bonus. It was found that intergroup competition improved collective efficiency as compared with single-group control treatments.

In [7] the intragroup conflict is modeled as an n-person Prisoner's Dilemma game, in which the dominant strategy is to contribute nothing. Each group was embedded in a intergroup in which a commonly known prize were to be shared by members of the winning group. It was found that embedding the intragroup conflict in intergroup competition markedly reduces free riding.

Furthermore, some factors can enhance or diminish the effect of intergroup competition on intragroup cooperation. Giving information to individuals about the relative success of their group lead to significantly higher levels of cooperation and emotional responses to group success (see for instance [3]). In [12], it was investigated the effect of intergroup competition with/out monetary incentives to win on intragroup cooperation. It was found that in one-shot games, competition increases cooperation with/out incentives. In finitely repeated games, cooperation is sustained with incentives. In [5], receive information about their relative individual and group performance after each round with non-incentivized and then incentivized group competition. It was found that incentivized competition, where the relative ranking of the group increases individual payoffs, the reaction to relative performance is more significant with individuals contributing more to the group. Additionally, it was reported that the variance of strategies decreased as individual and group rankings increased.

3 GAME FOR HUMANITY

Game For Humanity is a game where mixed teams of humans and agents play a Collective Risk dilemma. All team members start with a budget in their private account and contribute to a shared public account. If the sum of all contributions exceeds a threshold, players have the chance to gain their private goods at the end. Each player tries to maximize the collective goal by contributing to the public good. At the same time, individuals may opt to free ride on the efforts of others while choosing to maximize the amount on the private account. The game is played in groups of 3 and lasts 10 rounds. Each player starts with 80 virtual units of money in the private account and can contribute to the public account with 0, 4 or 8 units each round. The group target for the public account is 120 virtual units of money.

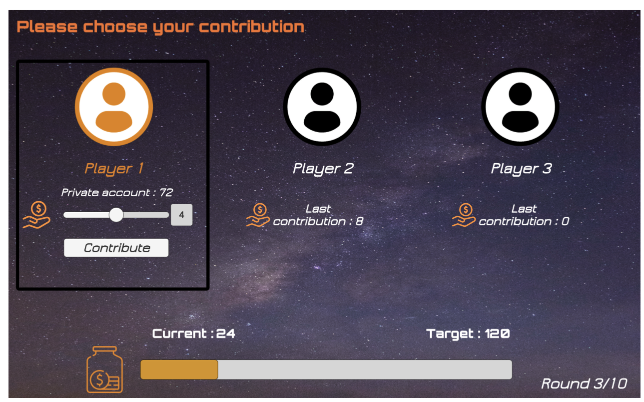

Figure 1: *Game For Humanity* Interface - Contribution Phase

3.1 Game Parametrization

The following parameters can be changed before starting the game.

- **Number of groups** : number of groups that will be playing the game. Each group has 3 players do the number of players will be 3 x the number of groups.
- **Number of rounds** : number of rounds for the game. By default, the game has 10 rounds.
- **Risk** :Players risk of losing all the private goods if the group target is is not achieved. By default, this value is at 1 (inevitable loss).

- **Target** : public account target. By default, the target is 120.
- **Initial Private Account** : initial private account value for each player. By default, this value is 80.
- **Number of virtual agents** : number of virtual agents per group. By default, there are no virtual agents playing.
- **Agents Strategy** : the virtual agents strategy. There are three possible strategies to choose : Free-rider, Fair-Sharer, Altruist.

4 CASE STUDY

We conducted a user study using the previously described *Game For Humanity*. We used the default values in parameters described in Section 3.1.

Groups of 3 humans played the game under three different conditions: a control condition with no competition and two conditions with intergroup competition. We refer to each one of the 3 conditions analyzed in this manuscript in the following manner:

- No competition - **NC**
- Intergroup Competition with low reward - **ICL**
- Intergroup Competition with high reward - **ICH**

A condition was assigned to each group randomly. Plus, participants playing in the intergroup competition conditions were, simultaneously, engaged in a within-group (intragroup) conflict and a between-group (intergroup) competition.

Moreover, the intergroup competition conditions differ only on the competition reward for the winning team. There are some parameters that can enhance or diminish the impact that intergroup competition can have on intragroup prosociality. In this study, besides studying the impact of intergroup competition on the Collective Risk dilemma we decided to investigate also the influence of the competition reward. There are contradictory studies in this topic. Some works reached to the conclusion that it is possible to improve intragroup performance, cooperation and coordination even with minimal rewards, where others report the opposite.

4.1 Hypotheses

The following hypotheses state our expectations towards the differences in people's cooperation, contributions and free-riding between the conditions (NC, ICL and ICH).

H1: Intergroup Competition groups have higher cooperation rate then No Competition groups.
H2: In average, players on Competition groups contributed more than players on No Competition groups.
H3: Free-riders change their strategy due to the group competition.

Our rationale behind these hypotheses is the following. Concerning **H1** and **H2**, we expect that by embedding the Collective Risk dilemma in an intergroup cooperation structure, groups cooperation and contributions can be higher than in the Collective Risk dilemma with No Competition. Moreover, in these hypotheses, we are comparing the Competition conditions (ICL, ICH) with the No Competition condition (NC). Therefore, we expect that Intergroup Competiton, both with high or low rewards, can have an impact on cooperation and contributions. If we find evidence for these hypotheses, we can suggest that embedding the Collective Risk dilemma in an intergroup competition structure can be a viable solution to improve cooperation and contributions, even with low incentives. **H3** is based on the assumption that, if players change their strategy from contributing 0 to 4, 8 that option is directly connected to the intergroup competition.

4.2 Procedure

This experiment was performed 100% remotely using the online participants recruitment platform Prolific. Prolific is a website where users can earn money by participating in scientific or market studies. Usually this studies do not last more than twenty minutes. We had to do some configurations in Prolific. We defined parameters like the amount we wanted to pay to participants, the average study completion time, and the description of what will the participants be doing in the study. After we published our study, Prolific users received a notification that a new study was available. Users could review all the information about the study in the Prolifc website before choosing to accept to participate or not. Users who decided to participate were redirected to a new tab in their browser containing the Collective Risk dilemma WebGL game.

Before starting to player, participants were asked to enter their Prolific id. This id allowed us to match a Prolific user to the corresponding player in the game. Then, players watched a game tutorial. The tutorial contained the explanation of : the game objective and rules, the dilemma of choosing to cooperate or not to the public account, how they could interact with the game interface and how the bonus payments worked (see section 4.4. For conditions, ICL and ICH, the tutorial had extra information about the intergroup competition. It was explained that other teams of humans would be playing at the same time and a competition between teams would be taking place. It was also explained that the competition winner would be the team with the most accumulated amount in the public account at the end. After completing the tutorial, players entered a virtual "waiting room". When two more participants showed up to play, the game started.

The participants played a Collective Risk dilemma game for 10 rounds. Each round players had to choose to contribute 0, 4 or 8 to a public account. At the end of each round, the contributions made by the other players in the previous round were displayed. For conditions, ICL and ICH, players saw a leaderboard after rounds five and ten. The leaderboard displayed the teams ranking in the competition. .

When the game ended, players were asked to answer a questionnaire about the game experience. The questionnaire contained questions about demography, game experience, game strategies, and satisfaction with team members. When the game ended, players were asked to answer a questionnaire Finally, after the questionnaire was answered, we provided a code to the players for them to submit the study as complete on the Prolific website. Through this code, we were able to identify the participants who completed the experience successfully.

4.3 Data Analysis

We analysed a CSV file containing information about all the games and questionnaires that players answered after playing. The file is organized by game with information on condition, player Prolific ids, and 3 arrays containing players contributions during the game.

We computed the cooperation rate per group by counting all the non-zero contributions throughout the game and divide by the total number contributions in the game (see Equation 1). To compute the total contributions per group, we summed all the contributions made by all the players on each round (see Equation 2). To calculate the total contributions in half1 and half2 per group we used the same formula as total contributions per group, however for half1 the summation stops at round 5 and for half2 starts at round 5 and goes until round 10 (see Equations 3 and 4).

$$CooperationRate(g) = \frac{\sum_{n=1}^{10}\sum_{i=1}^{3}\begin{cases}1, & \text{if } c_{n,i} \neq 0\\ 0, & \text{if } c_{n,i} = 0\end{cases}}{30} \quad (1)$$

$$TotalContributions(g) = \sum_{n=1}^{10}\sum_{i=1}^{3} c_{n,i} \quad (2)$$

$$TotalContributionsHalf1(g) = \sum_{n=1}^{5}\sum_{i=1}^{3} c_{n,i} \quad (3)$$

$$TotalContributionsHalf2(g) = \sum_{n=6}^{10}\sum_{i=1}^{3} c_{n,i} \quad (4)$$

4.4 Rewards/Bonus

Table 1: Base and Bonus payments by condition, where NC means No Competition, ICL competition with low reward and ICH competition with high reward.

	Base	CRD Bonus	Competiton Bonus
NC	2.2€	0.3€ x PC	–
ICL	2.2€	0.3€ x PC	0.5 €
ICH	2.2€	0.3€ x PC	2€

All the participants received a **Base** payment if they successfully finished the game and answered the questionnaire. The payment was the same for three conditions. Players that were unable to finish the game, due to other player disconnection, received half of the Base payment (1.1€).

Additionally, participants could receive a bonus payment depending on the result of the game and the condition they were placed on. The earning of the **CRD Bonus** depended on the success or not on reaching the team objective of the Collective-Risk Social Dilemma. If the team reached the value of 120 in the public account, players earned their ending private account amount (**PC**) x 0.3€.

The **Competition Bonus** was only available for the people who, randomly, got placed in the Competition conditions. This bonus was awarded to the players if their team won the competition.

4.5 Sample

For our study, we recruited participants from different countries in the world using the Prolific platform. 200 Prolific users were recruited. In those 200, 52% were male, and 48% were female. 17 were unable to successfully finish the game, having 91.5% of valid data to analyze.

5 RESULTS

We used SPSS (v. 28) program for data analysis. First, we assessed the normality of our data by running a Shapiro-Wilk Test. We found that our data violated normal distribution for the total of our variables with $p < 0{,}05$. Given the violation of the assumption of normality for the total of our variables, we opted to conduct non-parametric tests to assess our hypothesis.

In order to investigate our first hypothesis, we considered the cooperation rate. For the second hypothesis, we analysed the total contributions per group. Finally for the third hypothesis, we considered the number of free-riding plays per group, i.e the number of null contributions per group, and the questionnaire questions : "Have i consider myself a free-rider during the game" and "My strategy was guided mainly by the teams competition". Since the game played is a repeated public goods game with 10 rounds, it is difficult to classify a player as a free-rider. Players can contribute zero in a round and in the next contribute four or eight. In our data, we did not had any player contributing zero all the time during their game. We decided then to analyze the number of free-riding plays per group instead of the number of free-riders per group.

Furthermore, we investigated the dynamics of contributions throughout the 10 rounds of the game. We analysed the total contributions per group in the game´s first half (round 1-5), the total contributions per group in the game´s second half (round 6-10).

5.1 H1 - Intergroup Competition groups have higher cooperation rate then No Competition groups

A Kruskal-Wallis H test showed that there was a statistically significant difference in cooperation rate between the different Conditions (NC, ICL and ICH) resulting in $x^2(2) = 10{,}040$, $p = 0{,}007$.

Moreover, a Dunn´s pairwise test was carried out to see the differences between the the three Conditions. There was a strong evidence of a difference between No Competition and Competition with high reward. This pair had a value of $p = 0{,}05$ adjusted by the Bonferroni correction for multiples tests, having a significance level of 0,05. In the frequency table of Fig. 5, we observe that for NC, 53% of the players had a cooperated rate of 0,9 or higher. For ICH we observe that 83% of the players had a cooperation rate of 0,9 or higher. Moreover, we observe that for NC, 11% of the players had a cooperation rate of 0,6 or less and for ICH, 4% had that same cooperation rate.

5.2 H2 - In average, players on Competition groups contributed more than players on No Competition groups

Given the results for cooperation rate, we expected that there would be a statistically significance in the total contributions per group, at least for NC and ICH. We carried out a Kruskal-Wallis H test that showed that there was a statistically significant difference in total contributions per group between the different Conditions (NC,ICL,ICH) with $x^2(2) = 10{,}825$ and $p = 0{,}003$.

Then we performed a Dunn´s pairwise test to find out where the differences were. We found that there was a statistically significance in the pair NC - ICL and the pair NC - ICH, with these pairs having p = 0,036 and p = 0,003 respectively. The adj.sig (p) was adjusted by the Bonferroni correction for multiples tests, with the test having a significance level of 0,05.

The mean Total Contributions per Group was 140 and 170, 180 for NC, ICL and ICH respectively. The ICH condition had the maximum value with a group having a Total Contributios of 230. We observed also that the value order of the mins and maxs followed the means order between Conditions, i.e the lower is NC, then ICL and the highest ICH.

5.3 H3 - Free-riders changed their strategy due to the group competition

We carried out a Kruskal-Wallis test for the free-riding plays. All the tests had a significance level of $p < 0,05$. The tests showed that there was a significant difference, only in the number of free-riding plays between groups, with $x^2(2) = 9,171$ and $p = 0,010$. A Dunn pairwise test, for the free-riding plays, was carried out with a significance level of up $< 0,05$. We found that for this test, the only pair of conditions with significant difference was the NC - ICH with a value of p = 0,07 adjusted by the Bonferroni correction for multiple tests.

Regarding the questionnaire questions, we also performed Kruskal-Wallis tests for each question but there was not a significant difference between the conditions for both questions.

5.4 Contributions Dynamics throughout the Game

We performed two independent Kruskal-Wallis tests for Total Contributions per Group in Half1 and Total Contributions per Group in Half2. The Kruskal-Wallis results were $p = 0,574$ and $p < 0,001$ for Total Contributions per Group in Half1 and for Total Contributions per Group in Half2, respectively. The last test results showed that there was as strong statistically significant difference in Total Contributions per Group in Half2 but not in Half1. These results showed that the difference in the total contributions between Conditions at the end is a consequence of the difference Total Contributions per Group in Half2.

In Fig 2 we observe that until round 5 the contributions in each round are very similar for the 3 Conditions. After round 5, the difference between the No Competition Condition and the Competition Conditions is very perceptible. In round 6 the average groups contribution for No Competition decreases to around 14 and for the two Competition Conditions increases for values around 22. Then, until the end of the game, in No competition the average groups contributions progressively decreases to around 10. Regarding the competition Conditions, the Competition with high reward looks more capable of remaining stable until the end of the game, with just a small decrease to around 18, when the Competition with low reward decreases to around 14.

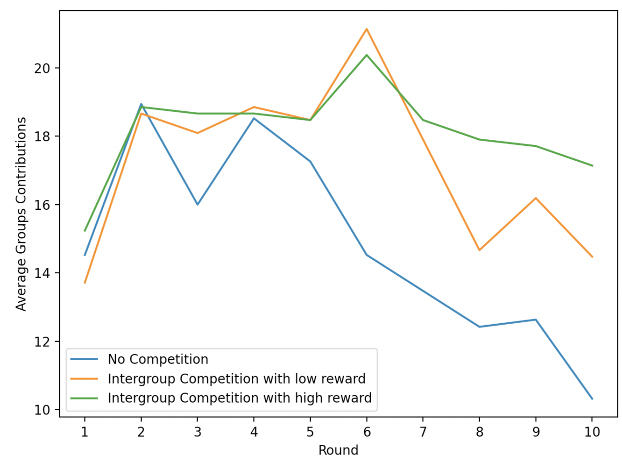

Figure 2: Average Groups Contributions

6 DISCUSSION

We investigated the impact of intergroup competition in the Collective-Risk dilemma. With this study we intended to explore if, the CRD embedded in a intergroup Competition structure can be a viable solution to solve the dilemma or improve the results in relation to the simple dilemma model with no competition. Particularly we studied the impact on cooperation rate (H1) , total contributions (H2) and free-riders (H3). Furthermore, we explored the contributions dynamics between the Conditions, throughout the game.

To validate H1, we required to find evidences to support that intergroup Competition groups had higher cooperation rate then No Competition groups. This means that we needed to find significant differences in cooperation rate between the Intergroup Competition conditions (ICL,ICH) and the control condition (NC). We found significant differences in the pair NC -ICH. In the cooperation rate frequency table (see Fig 5) we observe that in ICH Condition 30% more players had a high cooperation rate (0,9 or higher) then in NC. In addition to this, in ICH 4,9% of the players had a low cooperation. rate (0,6 or lower) when in NC 10,8% of the players had that same cooperation rate. Given that we found a significant difference for Intergroup Competition with high reward but not for low reward we have evidences to partially support H1.

For H2, we required to find evidences that players, in average, contributed more in Intergroup Competitions Conditions in relation to the control condition (No Competition) to validate the hypothesis. We found a significant difference in the average group contributions for Intergroup Competition with low reward and for Intergroup Competition in relation to No Competition. In the boxplot of Fig 8 we can observe where the differences are between the 3 Conditions. The mean Total Contributions per Group in NC is 140 and 170, 180 for ICL, ICH respectively. We can see also that the ICH Condition has the higher value of a group Total Contributions with 230. We observe also that the value order of the mins and maxs follow the means order between Conditions, i.e the lower is NC, then ICL and the highest ICH. With these results we can conclude that, in average, players in intergroup Competition groups contributed more then players in No Competition groups, therefore we have evidences to fully support H2.

Regarding H3, given that both the questionnaire questions we did not find evidence to support that hypothesis.

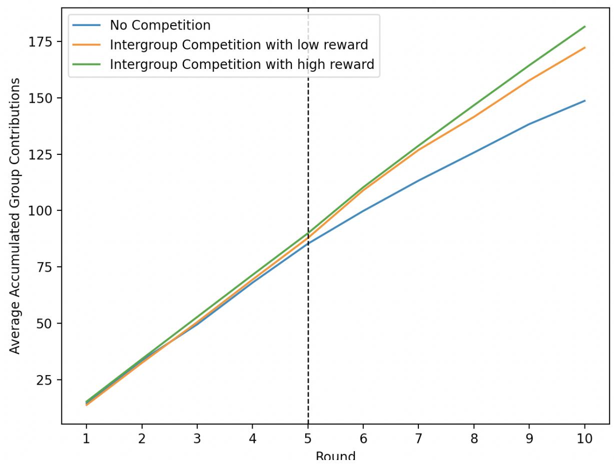

Figure 3: Average Accumulated Groups Contributions

Average accumulated contributions per round and per group of 3 players for each condition. From round 1 to round 5 the groups have almost the same accumulated contributions (around 80) in the three conditions. Starting in round 6, the differences between conditions start to notice with the NC rate of growth decreasing. In round 10, in average, groups in NC, ICL and ICH ended with an accumulated contributions of 140, 175 and 185, respectively.

This substantial difference between No Competition and Competition Conditions starting in round 6 (see Figs. 2, 3) can be explained by the competition Leaderboard provided to the players after round 5. We believe that after the players observed the Leaderboard and perceived that they were almost tied with the other teams, the players competitive motivation came to surface. Players gave priority to the group´s payoff rather then their own payoff. Thede results raises an important question to explore in future works. If the Leaderboard had been shown more times, would the competitive part of the players be present longer and consequently would the contributions have been even greater?

Additionally, in Fig 2 we observe that condition ICL was better than condition NC after round 6, although it cannot keep as stable as condition ICH. This can be explained by the higher competition reward in ICH making players even more motivated to win the competition.

We found that intergroup competition with good incentives significantly increases contributions on the Collective Risk dilemma. Nevertheless, it is necessary to be prudent when choosing the competition reward. If the reward is too high, the dilemma payoff structure can be significantly altered and, with that, the essential dilemma of choosing to desert or cooperate can be changed. For this reason, we studied whether if, even with minimal incentives, competition can be a motivational mechanism to increase prosociality within the group. Our results indicated that intergroup competition increases intragroup prosociality, even with minimal rewards.

7 CONCLUSIONS AND FUTURE WORK

In this paper, we explored the effects of intergroup competition on the Collective Risk Dilemma. Our results suggest that intergroup competition can be a motivational solution to reduce the free-riding phenomenon and increase the total contributions in the Collective Risk dilemma. Additionally, we found that a significant increase in contributions occurred when players observed their team ranking. Given these findings, a question remains. Can cooperation be maintained at even higher levels if the team ranking is shown to players more times throughout the game? This question can be explored in future works.

Additionally, our case study proves that it is possible to conduct a study entirely remotely in which a large group of people play a game and interact with each other. The possibility to conduct entirely remotely experiments is essential because, for example, it allowed to continue scientific research even during the Covid-19 pandemic. Furthermore, these crowd-sourcing websites like Prolific or Amazon Mechanical Turk [4] allow researchers to have scalability, speed and variety when recruiting participants. These features can lead to an increase in the quality and quantity of studies done globally.

8 APPENDIX

Pairwise Comparisons of Condition

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
No competition-Intergroup competition with low reward	-13.708	8.868	-1.546	.122	.366
No competition-Intergroup competition with high reward	-27.857	8.796	-3.167	.002	.005
Intergroup competition with low reward-Intergroup competition with high reward	-14.149	8.679	-1.630	.103	.309

Figure 4: Pairwise cooperation rate significance.

	NC		ICL		ICH	
Cooperation Rate	N	Percent (%)	N	Percent (%)	N	Percent (%)
0,4	2	3,6	1	0,0	0	0,0
0,5	2	3,6	6	1,7	1	1,6
0,6	2	3,6	5	10,2	2	3,3
0,7	4	7,1	3	8,5	3	4,9
0,8	16	28,6	16	5,1	5	8,2
0,9	10	17,9	28	27,1	12	19,7
1,00	20	35,7	59	47,5	38	62,3
Total	56	100,0	100,0	100,0	61	100,0

Figure 5: Frequency Table for Cooperation Rate

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
No competiton-Competion with low reward	-14,096	5,612	-2,512	,012	,036
No competiton-Competion with high reward	-18,620	5,612	-3,318	<,001	,003
Competion with low reward-Competion with high reward	-4,524	5,470	-,827	,408	1,000

Figure 6: Pairwise Total Contributions per Group significance

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of Total Contributions per Group in Half1 is the same across categories of Condition.	Independent-Samples Kruskal-Wallis Test	,574	Retain the null hypothesis.
2	The distribution of Total Contributions per Group in Half2 is the same across categories of Condition.	Independent-Samples Kruskal-Wallis Test	<,001	Reject the null hypothesis.

a. The significance level is ,050.

b. Asymptotic significance is displayed.

Figure 7: Kruskal Wallis results for contributions dynamics throughout the game.

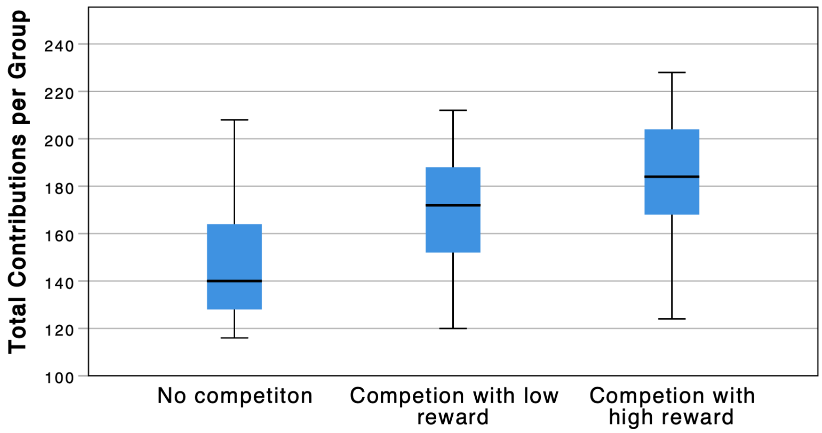

Figure 8: Total Contributions per Group Boxplot.

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