# CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Political Studies

Department of Political Science


# Bachelor's Thesis


**2023** **Mees de Rijk**

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# The collective-risk social dilemma in two stages; an experimental analysis of the effects of discounting contributions and in-group differences in risk.

Bachelor's Thesis


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**Study programme:** Politics, Philosophy and Economics

**Supervisor:** Mgr. Jakub Tesař, Ph.D.


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## Declaration

1. I hereby declare that I have compiled this thesis using the listed literature and resources only.
2. I hereby declare that my thesis has not been used to gain any other academic title.
3. I fully agree to my work being used for study and scientific purposes.

In Prague on
30-7-2023

Mees de Rijk

## REFERENCE

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**Abstract**
A particular application of game theory, called the collective-risk social dilemma, intends to model long-term cooperation efforts aimed at avoiding losses. Climate change is among the foremost examples of such threats. To emulate such threats in an experiment, participants have to work together over multiple rounds to achieve a collective target if they wish to secure their private endowments. This thesis concerns two modifications; the first is the introduction of inequality in impacts faced among participants, the second is the introduction of discounted contributions. Both of these modifications are introduced only after five rounds of the game, to emulate information drag involved in our scientific understanding of environmental science. This thesis concludes that inequality does not impact the actions of participants as much as discounting does. The purpose of collecting such data is to improve our understanding of the factors that influence decision making in climate change related issues, and to improve our methods of tackling such issues.

## Keywords
Game Theory, Climate Change, Uncertainty, Discounting, Inequality, Collective-risk Social Dilemma, Cooperation, Public good, Threshold, Communication, Experimental Economics.

## Title
The collective-risk social dilemma in two stages; an experimental analysis of the effects of discounting contributions and in-group differences in risk.

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**Table of Contents**

# 1. Introduction

This thesis joins Tavoni et al. (2011) and Barrett and Dannenberg (2012; 2014) in experimenting with changes to the collective-risk social dilemma, first formulated by Milinski et al. (2008). The collective-risk social dilemma emulates situations in which people face a trade-off between investing in a common pool to prevent a disaster, or pursuing their self-interest to avoid individual losses. A dilemma arises, because the success of avoiding the catastrophe depends on the cooperation of all participants. This also creates a tension between short-term individual gains and long-term collective benefits, making it a challenging problem to address. Effective solutions require us to understand the factors influencing cooperation and to design mechanisms that encourage collective action.

In this thesis, the collective-risk social dilemma is modelled into an experiment in similar fashion as done by Milinski et al. (2008), Tavoni et al. (2011) and Barrett and Dannenberg (2012; 2014). Some changes have been made to make it a suitable experiment for a Bachelor's thesis. Changes have also been made to test the effect of discounting contributions and to test the effect of impact inequality. Moreover, to model climate change more accurately, some factor of uncertainty is introduced in these treatments.

Tavoni et al. (2011) introduce two changes to Milinski et al.'s (2008) setup; they introduce inequality and the option to communicate. The option to communicate is uniformly applied to all treatments in the current experiment. Inequality is introduced for one treatment, but has a different character than the inequality that Tavoni et al. (2011) introduce. Their paper introduces inequality in endowments (*wealth inequality*), whereas this paper introduces *impact inequality*. This type of inequality relates to the risks of not reaching the target for the common pool. Moreover, some uncertainty is paired with this inequality. The participants are not immediately informed about the risks they face; the exact information regarding the risks faced by each participant is revealed only in the second half of the game.

The alterations that Barrett and Dannenberg (2012; 2014) introduce concern two types of uncertainty. The first concerns uncertainty about the threshold at which such a catastrophe would occur (*threshold uncertainty*), and the second concerns uncertainty about the consequences of crossing such thresholds (*impact uncertainty*). The current experiment attempts to introduce what one such consequence may be, which is discounting. Given that current contributions to climate mitigation may be more effective than future contributions, discounting of contributions may give us an insight into how participants behave when they are made aware of this aspect of climate change.

This thesis aims to answer the following research questions: (Q1) "*how do participants in the collective-risk social dilemma act when they face uncertainty regarding the usefulness of future contributions?*" and (Q2) "*how do participants' actions in the collective-risk-social dilemma change when information regarding different risks faced by different individuals is revealed?*". For the first question, the hypothesis is: (H1) "*When faced with uncertainty regarding the usefulness of future contributions, participants contribute more early on, to ensure that their contributions do not lose some effectiveness*" and for the second question, the hypothesis is: (H2) "*participants facing different risks of losing their endowment will act differently*".

In order to answer these research questions, this thesis will proceed as follows. First, the literature review is intended to survey the existing state of research into the collective-risk social dilemma. Second, the "method" section concerns the theoretical underpinnings of game theoretic experiments in the form of the collective-risk social dilemma, and points out why the alterations made in this experiment are relevant to the field. Third, the "experiment" section contains three parts; the first serves as an explanation of the experiment that is performed here; the second part states the research questions and hypotheses. The third part provides information about how the experiment was performed practically. Fourth, the "justification" section investigates real-life situations and scientific literature on the environment that relate to the specific setup of this experiment as laid out in the 'experiment' section. Fifth, the "results and discussion" section provides the results of the experiment and an analysis of the results. Lastly, the conclusion summarises the main aspects of this thesis and lists our main findings. It also provides some possibilities for future research based on the current research. The appendices contain some important supporting information. Appendix no. 1 provides the complete instructions given to each group. Appendix no. 2 provides the examples that followed the instructions. In appendix no. 3, the debrief responses of all the participants are compiled. Appendix no. 4 contains screenshots of all the communication that was gathered during the games. In appendix no. 5, some screenshots are provided of the software used to participate in the games, from the participants' perspective.

## 2. Literature review

There is a large amount of research into the application of game theoretic models to environmental issues. Most recently, such models have been used to research compliance with climate goals agreed upon in International Environmental Agreements (IEAs). Other applications of game theoretic models include research into the creation of IEAs (Barrett 1990; Magli and Manfredi 2022; DeCanio and Fremstad 2013; Finus 2008; Madani 2013; Mercure et al. 2021) and research into adaptation to water scarcity (Albiac, Dinar and Sánchez-Soriano 2008; Madani 2010; Ristić and Madani 2019).

Game theory has been applied to a range of aspects regarding collective decision making in the environmental field. According to Takashima (2018, p. 38), "a game represents any situation where countries negotiate and decide on their pollution abatement levels. The stage game model depicts an IEA's formation in a one-shot game and typically focuses on participation… A repeated game model typically assumes that each participating country in the agreement has an incentive to free ride on the abatement of others and focuses on compliance. That is, the repeated game model is used to analyse the conditions under which participants cooperate in accordance with their commitments". Takashima (2018) considers this to be applicable to all one-shot and repeated games within the field of climate-related game theory. Barrett (1994) gives a different interpretation of the usage of repeated game models; Barrett (1994) notes that infinitely repeated games can be used to "calculate the maximum number of countries that could support the full cooperative outcome" (p. 879) of a self-enforcing IEA that is renegotiation-proof (see for example Hasson et al. (2010) and Hasson et al. (2012))

Several characteristics set the collective-risk social dilemma apart from other game theoretic experiments. First, as pointed out by Milinski et al. (2008), participants' motivation to cooperate is "not to realize a gain but to avoid a loss" (p. 2291), and in this sense is a test in aversion to risk. Furthermore, Milinski et al. (2008) point out that the ten-round setup introduces short and long-term tradeoffs faced by the participants. This is in keeping with the nature of the social dynamic related to global warming; as it is not only a conflict between individual and group interest, but also a temporal conflict. The collective-risk social dilemma is not concerned with the creation of IEAs, or with the number of countries that can support cooperation within IEAs, but with compliance of participants to cooperate to reach the targets set in such games.

Game theory experiments in the form of a ‘collective-risk social dilemma’ performed with active participants seem to have started with Milinski et al. (2008); after which several others have followed (Barrett and Dannenberg 2012; 2014; Heitzig et al. 2011; Takashima 2017; 2018; Tavoni et al. 2011, among others). The collective-risk social dilemmas that these experiments attempt to model have a few characteristics: “(i) people have to make decisions repeatedly before the outcome is evident, (ii) investments are lost (i.e., no refunds), (iii) the effective value of the public good (in this case, the prevention of dangerous climate change) is unknown, and (iv) the remaining private good is at stake with a certain probability if the target sum is not collected” (Milinski et al. 2008, p. 2291).

To model these conditions into an experiment, Milinski et al. (2008) test whether participants in groups of 6, each endowed with 40 Euros, would individually contribute to a common fund with a set target sum. Reaching this target sum would ensure each participant that they can keep whatever is left of their private endowment, but the experiment requires that all members of the group co-operate and sacrifice their own potential payout; for the security that is gained by investing in the public pool. The target sum is set at 120 Euros, which requires that, on average, each participant ought to allocate half of their initial endowment to avert the risk of losing their private balance. Milinski et al’s (2008) experiment is performed with three different treatments. In the first, the risk that the private balance of each participant will be lost in case the target isn’t reached is 10%; and in the two other treatments these risks are 50% and 90%.

In the experiment, all players know other players’ contributions and players’ contributions are known to be known: “all subjects could see how much money other subjects contributed after each round. Decisions from the same person could be recognized as such: Altruists, fair sharers, and free riders would become recognizable during the experiment, as well as subjects that change their strategy” (Milinski et al. 2008, p. 2292). However, the identity of each player was not shared, and the game was to this extent anonymous. Within single games, players could build up a reputation as a free-rider, fair-sharer, or an altruist, but this reputation does not remain from one game to another. Milinski et al. (2008) took note of the fact that this is not in keeping with climate or G8 summits (and more relevantly, with real-life emissions reductions and abatement), as in these cases countries interact with one another without anonymity.

The setup of Milinski et al. (2008) has been changed by Tavoni et al. (2011) to modify the assumption that each player has an equal endowment. Tavoni et al. (2011) also change Milinski et al's assumption that the participants have no way to coordinate their contributions. These two additions are justified firstly because "Players are best off when synchronizing contributions in the face of multiple equilibria... The game therefore calls for communication" (Tavoni et al. 2011, p. 11825), and secondly because "Equity concerns over the distribution of emission cuts and associated costs are at the heart of the sustainability of international climate change action" (Tavoni et al. 2011, p. 11825). Tavoni et al. (2011) mention that the climate agreements negotiated in Cancun and Copenhagen include a pledge and review system to smooth communication about climate change mitigation between countries. The Paris climate agreement also has a similar system. Effective communication channels and options are incorporated into many institutions within the climate change regime, as its importance is widely accepted. Moreover, the combination of alterations made by Tavoni et al. (2011) is an interesting addition to the larger field of game theory, as "Inequality has been studied extensively in the context of collective action problems. The presence of inequality is often found to complicate cooperation, although communication between users tends to improve the likelihood of cooperation" (p. 11825). Subsequent experiments (specifically Barrett and Dannenberg 2012; 2014) have implemented communication throughout their experiments.

Barrett and Dannenberg (2012; 2014) alter the setup of Milinski et al. (2008) in order to model two kinds of uncertainty; *threshold uncertainty* and *impact uncertainty*. Barrett (2016) lays out the differences between these two types of uncertainty, and considers how the uncertain probability of sudden catastrophes impacts coordination. Such uncertainty relates to possible climatic changes such as the melting of the polar ice caps. The uncertainty related to what conditions prevail after such a catastrophic event are what Barrett (2013; 2016) classifies as *impact uncertainty*. In this particular case; "Whether melting of the Greenland ice sheet turns out to be truly 'catastrophic', for example, depends on the extent of sea level rise attributable to this event" (Barrett 2016, p. 46), something which may be unknown. Another uncertainty of similar kind is the extent to which the melting of the ice caps contributes to heating of the planet due to the loss of reflective capabilities of the ice sheets and their replacement with the ground beneath (called the Albedo effect). This uncertainty is distinctly different from *threshold uncertainty*. Barrett identifies one threshold uncertainty related to the ice caps: “What is not known is the precise change in mean global temperature that would cause the Greenland ice sheet to melt” (Barrett 2016, p. 46); uncertainties about where the thresholds of the earth's climate system are precisely is thus a distinctly different question. The supporting information of Barrett and Dannenberg (2012; Table S3) lists numerous climate change experiments that also experiment with uncertainty of one or the other kind (namely Hasson, Löfgren, and Visser 2010; 2012; Milinski et al. 2008; Tavoni et al. 2011).  Uncertainty is an important aspect of the climate change mitigation game, and is partly lacking in the setup of Milinski (2008).

Alterations to the original game, such as described here, offer a good way to test the effects of variables that are said to impact climate cooperation, and to test how or whether the negative impacts of such factors can potentially be offset. They also provide valuable insights when attempting to design mechanisms that encourage collective action.

A review of the instructions given for several experiments (especially Milinski and Marotzke 2022; Barrett and Dannenberg 2012) shows that, though the methodology remains largely similar, differences do exist in the way the students are informed about the game and what it attempts to test. To perform the experiment of the collective-risk social dilemma, a lot of decisions regarding information sharing ought to be made, and the information given to participants may have significant impacts on their decision making. In the game instructions, Milinski and Marotzke (2022) inform the participants that the game the participants will play is meant to model climate change mitigation. Barrett and Dannenberg (2012) make no mention of climate change to avoid any potential bias. Instead, Barrett and Dannenberg (2012) “assumed a neutral frame for the context and language of the experiment” (p. 1 of supporting information). The experiment by Milinski et al. (2006) (discussed below) investigates effects of information-sharing with participants more directly.

Milinski et al. (2006) play a public goods game (different from the collective-risk social dilemma game) to test the effects of information. Milinski et al. (2006) test differences between groups that are “well-informed" and groups that are “little-informed”. The well-informed group is given additional information about the state of the global climate, and the little-informed group is not. They also test whether anonymity has effects on participants’ decisions (during some games, the players are completely anonymous, and in other games the players are nonanonymous (meaning that the participants' pseudonyms are shown)). Milinski et al. (2006) find that the extra information shared with the well-informed group had a positive impact on cooperation, and find that cooperation increases when players are aware of one another's contribution through the use of nicknames. They attribute the positive effects of non-anonymity to the idea that players create a social reputation.

The experiments performed by (Milinski et al. 2008; Barrett and Dannenberg 2012; 2014; Tavoni et al. 2011) reveal that alterations to the classical setup can have a significant impact on the success rate of the participants. Firstly, the experiment by Milinski et al. (2008) tests three different loss probabilities, and find that "the percentage of groups not reaching the target is significantly different from all groups reaching the target in each treatment" (p. 2292), substantiating the claim made in the *Experiment* section that parameter values significantly impact participants' behaviour. Second, Barrett and Dannenberg's (2012; 2014) conclusions point out that threshold uncertainties cause significantly lower group contributions, whereas impact uncertainty does not have a significant impact on collective action (2012, p. 17374). In their experiment, the *Certainty* and *Impact Uncertainty* treatment groups managed to avoid catastrophe (i.e., these groups reached the goal), whereas the *Threshold Uncertainty* and *Impact-and-Threshold Uncertainty* treatment groups did not manage to avoid catastrophe. Barrett and Dannenberg's (2014) experiment concerns different ranges of threshold uncertainty, and points out that "collective action fails when threshold uncertainty is large", but that "reductions in this uncertainty may bring about the behavioural change needed to avert a climate 'catastrophe" (p. 36). Finally, Tavoni et al. (2011) conclude that communication drastically increases the levels of cooperation, and that inequality decreases it. However, they also conclude that "inequality is a less serious threat once a better coordination mechanism is introduced" (p. 11827).

The commentary by Dreber and Nowak (2008) discusses what impact the experiment by Milinski et al. (2008) might have. They focus on Milinski et al.'s (2008) conclusion "that people must be well informed about the risk of climate change" (Dreber and Nowak 2008, p. 2261) if they are to cooperate on solving it. Dreber and Nowak claim that solutions can be divided into two; environmental solutions and social solutions, and they regard social solutions as the more decisive solution. Dreber and Nowak also argue that conducting such experiments should be a major role of scientists, as it aids to educate people about what the collective-risk social dilemma is, where and when it occurs, and what strategies exist to solve it. In light of this, the current research aims to contribute to our understanding of factors influencing cooperation. One aspect of the current experiment which has not been researched before is the impact of delayed introduction of pieces of information. Moreover, *impact inequality* is introduced to research whether this has the same effect as does *wealth inequality*, as studied by Tavoni et al. (2011). Lastly, discounting contributions in the second half of the game is meant to further our understanding of short-term versus long-term tradeoffs (Milinski et al. 2008). In keeping with the conclusion of Dreber and Nowak's (2008) commentary, continued experimentation into causes of cooperation ought to aid our effort of organising collective action. Moreover, by using experimental methods to test theoretical models of decision-making and behaviour, researchers can gain insights into how individuals and groups make decisions in strategic situations, and how institutions and policies can be designed to promote cooperation and achieve collective goals. Such efforts are supported by continuous research into factors that influence decision making.

This thesis builds on the work of Milinski et al. (2008), Tavoni et al. (2011), and Barret and Dannenberg (2012; 2014). The work of the latter two is partly motivated on the basis that their corrections to Milinski et al.'s (2008) setup would cause the experiment to better approximate the real-life conditions that affect the collective-risk social dilemma. Regardless, theoretical limitations of the experiment initially pointed out by Milinski et al. (2008) still apply to Tavoni et al. (2011) and Barret and Dannenberg (2012; 2014), and apply to the current experiment also. First, Milinski et al. (2008) point out that climate change requires large scale international cooperation. This cannot be modelled into experiments, and as such the results of the experiment are contestable on the grounds that cooperation of 6 participants does not translate to similar levels of cooperation among national governments. Second, the complexity of the earth's climate system does not allow us to narrow down thresholds of catastrophe to 10, 50, or 90% (as done by Milinski et al. (2008)). Though Barrett and Dannenberg (2012; 2014) attempt to account for this difficulty, the issue is not only one of scientific determination, but also one of agreement on behalf of the participants involved, which is a socio-political issue. The percentages mentioned are part of a larger set of parameter values, none of which can be easily scientifically determined (or accepted broadly). Other limitations to the experiment can also be identified.

The current experiment is thus limited theoretically, but it is also practically limited. The scope of the research is partly limited by the number of participants available to perform the experiment with. Moreover, the resources available to perform and execute the experiment do not match the resources available to Milinski et al. (2008), Tavoni et al. (2011), and Barret and Dannenberg (2012; 2014). For example, in these experiments all participants were endowed with sums of money to perform the experiment with. Instead, the participants in this experiment can earn up to five extra credit points for one of their courses. Moreover, the software through which they organised the experiment is also more sophisticated. Conducting the experiment would have been less hands-on and less prone to problems if it were performed through one software program (for example Z-tree, used by Barrett and Dannenberg (2012)).

Not only climate-related issues satisfy the characteristics of the collective-risk social dilemma. Milinski et al. (2008) list examples of other examples of collective-risk social dilemmas. The need to assemble food reserves, or the need to build collective defense systems (such as a fence against intruders or a levee against floods) fit in the category of collective-risk social dilemmas. They remark that "half a fence or sandbag levee is hardly better than none. When there is no attack or high flood, the investment is lost. If the fence or sandbag levee is not complete and an attack or high flood occurs, all private goods are at stake" (Milinski et al. 2008, p. 2291). Barrett (2013) and Barrett and Dannenberg (2012) provide three other examples. First, they argue that adding more space debris to low earth orbit increases the likelihood of collisions, which in turn can cascade other collisions. They also provide the example of antibiotic resistance; overuse of an antibiotic may be favourable to pathogens with a high evolutionary fitness, thus rendering the use of antibiotics obsolete. Lastly, exploitation of biological resources is also subject to thresholds at which disastrous consequences may follow; specifically, exploitation of a resource could cause the species that is exploited to go extinct.

# 3. Method

### *3.1 Methodology of Game Theory*

The methodological background behind game theory experiments lies in the application of mathematical models to study decision-making and behaviour in strategic situations; where the outcome depends not only on an individual's actions but also on the actions of others, creating interdependencies between the players. The results of these experiments are hard to predict. Though rational-choice theory may provide socially optimal outcomes which may guide expectations, the realisation of such outcomes may be thwarted. Many games are framed in terms of 'cooperating' or 'defecting'; where cooperation means that players cooperate to achieve a common goal and defecting either involves 'giving up' on the common goal, or more commonly, means that a player attempts to benefit from the cooperation of others without contributing themselves. Therefore, defecting may happen because players either use interdependence to their advantage (so-called free-riding), but players may also choose to preemptively defect because they are afraid others will.

The 'collective-risk social dilemma' is a specific type of game used in game theory literature to study the problem of cooperation in situations that satisfy conditions mentioned previously; "(i) people have to make decisions repeatedly before the outcome is evident, (ii) investments are lost (i.e., no refunds), (iii) the effective value of the public good (in this case, the prevention of dangerous climate change) is unknown, and (iv) the remaining private good is at stake with a certain probability if the target sum is not collected" (Milinski et al. 2008, p. 2291). These conditions have a profound effect on two concepts that are important to game theory; the expected payoffs of a game (and the calculation thereof), and the completeness of information that is needed to make such calculations. Especially point (i) (the need to make decisions repeatedly before the outcome is evident) and point (iii) (the effective value of the public good is unknown) impact these two factors.

Information regarding the payoffs players face in the 'collective-risk social dilemma' is more obscure than in many other game theory experiments. Although in theory, it would be possible to work out expected payoffs for participants and their teammates by calculating the average payoff of each course of action (and by taking in mind the probabilities related to the public good), it is unlikely that participants in experiments will go through such lengths.

Moreover, the new variable concerning in-group differences in risk introduced in the unequal treatment will nullify the possibility to calculate expected payoffs and to determine strategy based on these calculations, given that the risk faced by each player will be revealed only after round five. The distribution of these risks is not known prior to the moment this information is revealed, which means that obscurity is created by a particular method of information sharing. In essence, this treatment introduces the play of "Nature", which determines the game the participants are actually playing (for a detailed explanation, see (Mesquita 2023)).

Game theory literature distinguishes between games with complete or incomplete information. The unequal treatment introduces an aspect of incomplete information, as the participants are unaware of the distribution of odds, and therefore are not aware of certain characteristics of both the game and of the other participants. As mentioned in the previous paragraph, this obscurity makes it difficult or impossible for the participants to quickly determine equilibrium points of the game. Once this information is revealed, however, the players theoretically have the ability to re-evaluate their strategy based on the new information. This differentiation will open up analysis of several possible occurrences: the possible occurrence of altruistic or fair sharer behaviour among those whose rational strategy is revealed to be defecting after round five; the occurrence of strategic change among the different groups of participants, or possible changes in the contributions made by participants.

The discount treatment also complicates calculations of expected payoffs. First, because it is difficult to predict what effect the discount factor will have on the players (i.e. whether they will contribute more early on), but also because it will be more difficult to make calculations of expected payoffs for the entire game. However, in this experiment, the discount treatment does allow us to analyse whether between-group differences will arise as a result of this alteration; some groups may take the opportunity in the first five rounds to maximise their total contributions before the discount factor will be introduced, whereas others may be more reluctant to do so.

### *3.2 Theoretical equilibria*

In line with the surveyed experiments, the outcomes are partly assessed in comparison to three pure strategies; the free rider strategy, the fair-sharer strategy, and the altruist strategy.

To simplify the multiple equilibria, it is assumed that all players assume the same strategy throughout the game. For each strategy, the corresponding expected individual payoffs can be found in the table, along with the final climate account values given in parentheses (in other words, the total contributions to the common fund). In case the expected individual payoffs are determined by chance (if the target for the common fund isn't reached), the individual payoffs are determined by multiplying the private account value with the chance that the private account is not lost. The first three treatments (base, discount and unequal) were all performed with 6 players and a goal of 50 tokens. As displayed in the table, the discount-unequal treatment and no-examples treatment were played with 4 and 5 players respectively, and with a 34 and 42 token target respectively.

Free-rider's contribution per round is 0 tokens, the fair-sharer's contribution is 1 token, and the altruists' contribution is 2 tokens. The effects of the discount treatment are not clearly visible because the strategies here are kept constant throughout the game, whereas the purpose of the strategy is to assess whether the participants will display a shift in behaviour in the second half of the game. For the unequal treatments, the effects are visible only in the free rider scenario, as this is the only scenario in which the target is not reached, and the loss probability comes into effect.

| | | free rider | fair sharer | altruist |
|---|---|---|---|---|
| | loss probability | | | |
| Base 1 | 60% | 8 (0) | 10 (60) | 0 (120) |
| discount | 60% | 8 (0) | 10 (54) | 0 (108) |
| unequal | | | | |
| | 40% | 12 (0) | 10 (60) | 0 (120) |
| | 60% | 8 (0) | 10 (60) | 0 (120) |
| | 80% | 4 (0) | 10 (60) | 0 (120) |
| discount-unequal (4 players, 34 goal) | | | | |
| | 40% | 12 (0) | 10 (36) | 0 (72) |
| | 60% | 8 (0) | 10 (36) | 0 (72) |
| | 80% | 4 (0) | 10 (36) | 0 (72) |
| no-examples (5 players, 42 goal) | 60% | 8 (0) | 10 (50) | 0 (100) |

# 4. Experiment

### *4.1 Theoretical background*

The setup of this experiment will be relatively synonymous with the detailed explanation of the experiment by Milinski et al. (2008) given previously. However, this experiment will be modified to incorporate aspects of climate change that are not included in the original experiment. First, the experiment will also allow communication, much like Tavoni et al.'s (2011) alteration. Following the model of Tavoni et al.'s (2011) experiment, inequality will be introduced; however, whereas Tavoni et al. (2011) focus on inequality in endowments, this experiment focuses on inequality in impacts. The experiment will also include a modification where contributions made later on in the game are discounted.

The setup of our game is as follows. The students will be put into groups of 6, and each student is provided with 20 tokens. The game they will play together lasts ten rounds, during which they can decide to contribute 0, 1 or 2 tokens into a common fund each round. The tokens they invest in the common fund will be lost. However, the 'point' of the game is for the group to reach the target of the common fund, which is 50 tokens. If this target is not reached at the end of the game, each student faces the possibility of losing the remainder of the tokens left in their private accounts. Contrary to the surveyed literature, where the participants are given an endowment of money (usually 40 Euros), our experiment is performed with an endowment of tokens. At the end of the game, the tokens left in the participants' personal accounts can be redeemed for extra points for their course evaluation. More information on this will follow in the *Application and execution* section.

These rules or parameters make up the "base" treatment. The alterations which will be modelled into the base treatment concern the introduction of uncertainties much like the ones discussed by (Barrett 2016; Barrett and Dannenberg 2012; 2014) and the introduction of inequalities much like those described by Tavoni et al. (2011). The first modification to the game concerns discounting of contributions made after round five. The second modification concerns the delayed revelation of the unequal risks faced by individual members of the group. These two alterations will form the "discount" and "unequal" treatment. The fourth treatment, the "discount-unequal" treatment, will combine both alterations in a single game.

A total of 27 participants were available to perform the experiment with; which meant that, though all treatments could be performed once, it was not possible to perform all four treatments of the experiment again. Therefore, it was decided that during the fifth game, the base treatment would be played once more with a different alteration. This alteration was decided upon on the basis of the debriefs that were gathered after the first game. One participant indicated that the instructions provided to him influenced his decision-making and his strategy. Therefore, this fifth game is identical to the base treatment, but the instructions given to this group were different. This fifth treatment is called “no examples”. Altogether, the five experiments can be visualised as follows:

| | |
|---|---|
| Base treatment | Discount treatment |
| Unequal treatment | Discount-unequal treatment |
| No examples treatment | |

Milinski et al. (2008, p. 2291) point out that “many public goods games focus on a conflict between individual and group interests, but a major component of the climate problem is also a conflict between short- and long-term interests”. To highlight the conflict between short- and long- term interests, contributions made in the second stage in the game will be discounted by a factor of 0.8, meaning that, if a token has been paid to the common fund, the common fund will go up by 0.8 points instead of 1. At the start of the game, participants will have to consider that it is in their long-term interest to contribute more early on, to offset the discount later applied, though it is always in their short-term interest to hold on to as many tokens as possible.

Similarly to Barrett and Dannenberg (2012), the modification of the discount treatment intends to model uncertainty; not just about the actions of other players, but uncertainty regarding climate change more specifically. In addition to the initial uncertainty inherent in collective action, this game introduces uncertainty about 1) how our actions precisely relate to increases in the global mean temperature, 2) the working of complex climate change phenomena, or 3) uncertainty about the effects of crossing certain (unknown) climate thresholds. This treatment does not seek to emulate one of these specific situations; rather, the point of the discount treatment is to test whether an awareness of the idea that 'the clock is ticking' for effective climate mitigation causes significant changes in behaviour of the participants (see especially Ripple et al. (2023) for literature on why climate feedback loops amplify the need for climate action). The *Justification* section deals with these issues further.

Just like in Tavoni's experiment, the second modification introduces an inequality into the game. The inequality is not in endowments, but in circumstances faced by the participants. Moreover, the circumstances faced by each participant will be revealed only after five rounds, so there is the possibility to analyse whether participants in these treatments have more drastic changes of behaviour due to the new information they can take into account. Of course, in these treatments it is also interesting to observe and measure changes in behaviour between actors in one game, assess whether similarities exist between participants facing the same odds, and assess changes between these groups.

The second of these 'uncertainty resolutions' pertains to the increasing certainty concerning the risks related to climate change, both as time passes and the effects become more obvious, but also as our scientific knowledge about the earth's climate system becomes more advanced and accurate. This increased understanding about the dangers of climate change will also reveal differences in vulnerabilities between actors. The resolution of this factor of uncertainty will be modelled by revealing the probabilities of losing their personal endowment only after round 5, and having differential treatments for each actor; that is to say, some participants face a 40% chance of losing the rest of their personal endowment of tokens in case the target amount of tokens isn't reached, others will face a 60% chance, and a third group may face an 80% chance. The *Justification* section contains more information regarding the purposes of the current experiment, and regarding aspects that the alterations are meant to model.

The personal endowment, loss probability, number of rounds, and the common fund target make up the parameter values of the game. Other variables, such as the discount factor, are also values that may be considered as parameter values in such games. Needless to say, the parameter values of a game are variables that affect the decisions made by the participants. Moreover, any change in these values causes changes in the purely rational courses of action. Milinski et al. (2008) clearly portrays the impact of different parameter values. Their experiment concerns three treatments with different loss probabilities (10%, 50% and 90%). They lay out the different expected responses based on pure strategies related to these variables, and, as mentioned in the literature review, the actions of the group generally tend to follow these expected responses, in the sense that cooperation was highest in the 90% treatment than it was in the 50% treatment, and the 50% treatment in turn saw more cooperation than the 10% treatment.

### *4.2 Research questions and Hypotheses*

The first research question is as follows:

**(Q1) How do participants in the collective-risk social dilemma act when they face uncertainty regarding the usefulness of future contributions?**

The second question adds to the first question as follows:

**(Q2) How do participants' actions in the collective-risk-social dilemma change when information regarding different risks faced by different individuals is revealed?**

For the first question, the hypothesis is:

**(H1) When faced with uncertainty regarding the usefulness of future contributions, participants contribute more early on, to ensure that their contributions do not lose some effectiveness.**

For the second question, the hypothesis is:

**(H2) Participants facing different risks of losing their endowment will act differently.**

Analysis of the research questions will partly be based on a cross-comparison of the results. Moreover, the *Method* section examines how participants may be able to rationalise their strategy based on calculations of the expected utility, and how these calculations differ across treatments. The examples that were provided to the participants (which can be found in appendix 2) provided examples of such calculations to the participants, but a more thorough analysis can be found under the part *Theoretical Equilibria* in the *Method* section. As is discussed in the *Method* section, the participants in the unequal treatment could only start rationalising their strategy after round 5, for this is when they receive the missing piece of crucial information about the chance of loss they themselves face. In the *results and discussion* section, the impact and resolution of this effect will be discussed. This section will also provide some of the crucial insights of the debrief.

### *4.3 Application and execution*

The experiment was performed with a group of 27 Bachelor's students from the courses "Applied Game Theory", "Theories of International Relations", and "Political Psychology in International Relations". The experiment was held online. In order to perform the experiment so that the game is properly executed, several software platforms were used. Their use will be explained here.

First, all students from the aforementioned classes were invited through Google Forms. They were then put into groups depending on their selected availability. On the day of the experiment, they were sent a Google Meet link and instructions on how to set up their Zoom account. Once all participants were gathered in the Google Meet, they were sent the game instructions through email.

Zoom was used during the game itself to host the two communication stages. Because Zoom allows more control for the host, this platform was more suitable than Google Meet. The participants were informed that communication through this channel was only allowed when they were told to communicate. Moreover, the participants were only allowed to enter the Zoom meeting if their name was changed to the nickname they had been assigned, to ensure that anonymity was maintained.

Contributing to the game and monitoring the game was done through Google Forms and Google Spreadsheets. Each participant had to fill in a Google Form once for each round (so ten times per player, and sixty times in total). The answers were sent to a Google Spreadsheet. This information was then configured into tables. These tables served as the information interface, where the participants could monitor one another's contributions. They could also monitor the aggregate contributions and some other information about how the game progressed. (To ensure that the participants did not have access to any of the information being sent into the spreadsheet in real time, the spreadsheets shared with participants were copies of these tables. The originals were exported to different spreadsheets using the IMPORTRANGE function, and these were shared with the participants.)

The participants were supposed to experience the experiment as follows. First, they were informed about the experiment by their teacher and could sign up for the experiment through the registration form. The participants were then invited to the experiment through email. This email was sent the day before the sessions, part of which can be found on the next page. On the day of the experiment the participants received another email as a reminder and, once all participants had joined the google meet, they were sent the game instructions (found in appendix 1). In the instructions, they could find links to the game software and the Zoom setup instructions. All in all, three separate google tabs were open, along with the Zoom meeting. In the first stage of the game, they used the Zoom meeting to communicate about their strategies (using their nicknames). In stage two, they determined their contributions for the first five rounds. In stage three, the participants may have received the missing information, if they participated in the discount or unequal treatment, or in the combination treatment. They then got another chance to communicate through Zoom, as in round one. In the final stage of the game, they determined their contributions for the last five rounds. Appendix 5 includes screenshots of the Google Form and Google Spreadsheet. These intend to provide an indication of how the game was experienced by the participants.

Planning and executing each experiment session required planning and adaptability. During the last two games, for example, participants who were invited and had previously confirmed their participation did not show up for the experiment. In order to make sure the experiment could still be executed properly, the game and the target were modified to counter this problem. For the Discount-Unequal session, 4 participants played the game, and the target was changed to 34 tokens. For the no-examples treatment, 5 participants played the game, and the target was changed to 42 tokens. Coordinating the Zoom meeting was another bottleneck, as some participants would join the Google Meeting with their nicknames, rather than the Zoom meeting. Lastly, to ensure that each rounds' contributions would be shared simultaneously, the incoming contributions for each round had to be monitored until a round was complete, after which the information was shared. (This information was controlled through the use of IFS-functions in the Spreadsheets.)

### *4.4 Instructions and alterations*

The day before the experiment, participants were given the following information about the game:

- *The experiment you're participating in tomorrow is a particular version of a public goods game, which consists of six players working together for ten rounds to achieve a target. For this game, it is important that the other players do not know which **nickname** you have (your nickname will be provided tomorrow morning).*
- *In order to perform the experiment online, we will use multiple software programs: Zoom, Google Forms and Google Spreadsheets. Zoom will only be used at the two 'communication' stages. The Google platforms are used to determine your contributions each round, and to monitor the contributions of your teammates.*

The following three paragraphs on the game instructions, the rules, and the groups' task were given to the participants in the base treatment:

## *GAME INSTRUCTIONS*

*In this experiment, you can earn extra credit points. The amount of points you will earn depends on the gameplay; in other words, the decisions you and your teammates make as a group:*

- *During the game, you will be given 20 tokens, which you will need to play the game. Each token you still have at the end of the game, will be transferred into 0.2 extra credits for the course through which you're participating in the experiment.*
- *Carefully read the following instructions on how to participate in the game correctly using the software, and carefully read the instructions for the game.*
- *Also included are two examples of how the game may play out. (Both of these examples are extreme cases, meant to instruct you about possible courses of events of the game, and about the results connected to these courses of events.)*

## *RULES OF THE GAME*

- *You will play a game with 5 other players.*

- *The game will last 10 rounds.*
- *The point of the game is for you, as a group, to reach the target amount of 50 tokens at the end of the game.*
- *You and your team members will each be given 20 tokens.*
- *In each round, you can decide to contribute one or two tokens, or you can decide not to contribute at all.*
- *Any tokens given to the common fund is lost.*
- *In each round, you and your teammates have to commit to contributions simultaneously, and your contribution will only be made public after everyone has made a decision as to their contribution during the round in question.*
- ***In the case that the end target is not reached, the probability you will lose the remainder of your tokens will be 60%.***
- *If the target sum for the common fund is reached, you get to transfer the tokens left in your private account into extra points with certainty.*
- *Your contributions are public, so at any point of the game, you can see how much everybody has participated in the common fund and how many tokens are in the common fund. In other words, your efforts will be shared with your teammates, just as you can monitor their contributions.*
- *You can communicate shortly with your teammates before the game and after round five of the game. You will be given two minutes to convey your goal, strategy, or to instruct others. What you decide to communicate is up to you.*
- *Communicatication will be non-verbal, and* ***must*** *take place through Zoom Chat.*

## *YOUR TASK*

- *In each round, you can decide to contribute one or two tokens to the common fund, or you can decide not to contribute at all.*
- *Please, read the instructions again carefully and familiarise yourself with the game. Carefully consider what you wish to communicate with your teammates, and how best to convey this.*

These instructions also included ‘setup instructions’, in which the participants were informed about how to use the software to participate in the game. Moreover, there were instructions on how to correctly join the Zoom meeting to safeguard the anonymity of the participants. Both of these instructions can be found in appendix 1. Lastly, the first four groups were given the examples that can be found in appendix 2. In the rules of the game found above, there is one sentence in bold because this information was different for every treatment. As such, this sentence determined the treatment being played. The treatment-specific sentences provided to the discount treatment group are as follows:

- **In the case that the end target is not reached, the probability you will lose the remainder of your tokens will be 60%.**
- **after round 5, a discount factor of 0.8 will be uniformly applied to all of your contributions. In other words, if you contribute two of your tokens in round six, the target sum will increase by 1.6.**

The unequal treatment group received the following treatment-specific information:

- **In the case that the end target is not reached, the probability you will lose the remainder of your tokens will be revealed after round 5.**
- **the probability of you losing your tokens is either 40, 60 or 80 percent. You may face different odds than your teammates. This information will be automatically revealed on the spreadsheet after round 5.**
- **The probabilities faced by your teammates will also be revealed after round 5.**

During the experiment session of the discount-unequal treatment, two students who had previously confirmed their attendance were not present at the time of the experiment. For the students in attendance and for the sake of the experiment, the experiment was performed without the missing students. As mentioned previously, to keep the experiment roughly the same, the target in the instructions was lowered to 34 tokens. The same issue occurred the second time the base treatment was performed, but only one student was missing (both these changes can also be found in appendix 1). Apart from that, the changes in instructions for the discount-unequal treatment were as follows:

- **In the case that the end target is not reached, the probability you will lose the remainder of your tokens will be revealed after round 5.**

- **the probability of you losing your tokens is either 40, 60 or 80 percent. You may face different odds than your teammates. This information will be automatically revealed on the spreadsheet after round 5.**
- **The probabilities faced by your teammates will also be revealed after round 5.**
- **after round 5, a discount factor of 0.8 will be uniformly applied to all of your contributions. In other words, if you contribute two of your tokens in round six, the target sum will increase by 1.6.**

The information given in these comments overlaps in places, because the changes between the treatments should be precise, and everything else held constant. As said, the instructions given to the base treatments were identical; except for the fact that examples of how the game may play out were provided in the first treatment (which can be found in appendix 1). The two base treatments will be differentiated by naming the first treatment with examples the base treatment, and the base treatment without examples the no-examples treatment.

### *4.5 Debrief*

The students were sent a debrief which consisted of two parts. The first was a short explanation on what the experiment was supposed to test for. The second part was a short questionnaire about the experiment.
The explanation of the experiment differed slightly depending on the treatment. All participants received the following explanation:

*You have participated in an experiment that was supposed to model the climate change mitigation effort. You and your teammates had to work together for a number of rounds to reach a collective target, in order to avert the possibility that you'd lose the credit points you were initially given. One main distinction is that, unlike regular public goods games, you were asked to cooperate in order to prevent a common threat.*

For the participants in the base treatments, this was the full explanation. The discount treatment group received the following additional information about the modification:

*You participated in a treatment which was supposed to test whether discounting future contributions would cause the participants to contribute more early on in the game.*

The unequal treatment received this additional information about the modification:

*You participated in a treatment that was supposed to test whether unequal chances would significantly change participants' actions.*

And the discount-unequal received the following combination of these explanations:

*You participated in a treatment that was supposed to test whether discounting future contributions would cause the participants to contribute more early on in the game, and that was simultaneously supposed to test whether unequal chances would significantly change participants' actions.*

The second part of the debrief was a questionnaire; the questions that were sent to all participants regardless of treatment are as follows:

1. *On what basis did you determine what you would contribute?*
2. *Did you ever change your strategy, and if so, why?*
3. *Did the possibility to communicate help your cooperation effort?*
4. *Why do you think you and your group succeeded/failed to reach the target?*
5. *Did you expect the game to play out the way it did? What was different about it?*

The sixth question was customised for the first three groups. These groups were asked:

"*Is there something you think has to be improved for the other groups? Your feedback may help to clarify something important.*"

This was meant to bring to light any issues they may have had. The discount-unequal group was sent a particular question:

"*As said, you participated in the treatment where two alterations were applied (the first one was the discounting of later contributions, the second the unequal chances faced by the participants and the delay in the communication of this knowledge). Do you think the game would have played out differently if your game did not include these caveats? In the standard* *treatment, participants were informed from the beginning that the odds of losing their balance was 60% in case the target was not reached, and no discount factor was introduced*.”.

This question was included to investigate whether the alterations had any impact on the participants in the discount-unequal treatment.

Since there was no way to make it mandatory for the participants to answer these questions, the amount of feedback and responses gathered from each treatment group is different. All the responses collected can be found in Appendix 3.

## 5. Justification

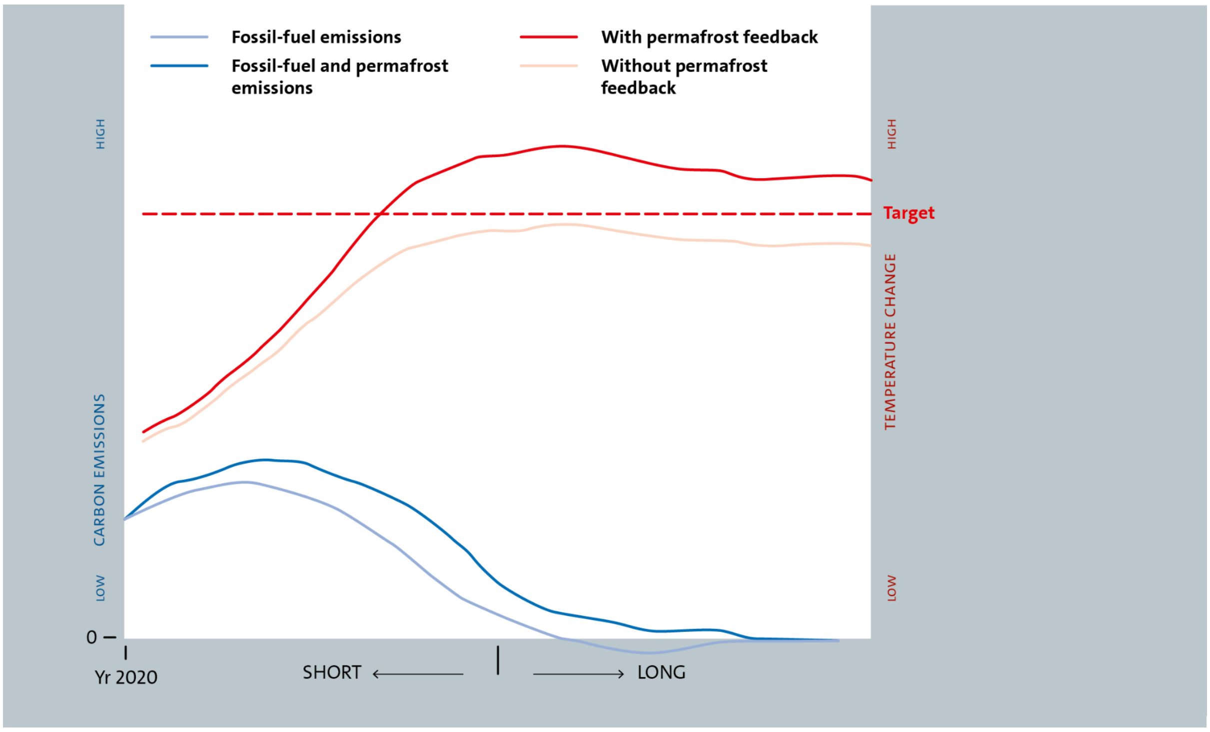
The current experiments' alterations to the original game, as performed by Milinski et al. (2008), would either 1) alter the impact of our mitigation effort, or 2) alter a participant's understanding of the risks they face individually. These modifications were not determined randomly, but have been chosen to model certain dilemma's within the larger field of climate science, and to model ways in which climate change may impact the earth's environment.

### *5.1 Discounting*

As mentioned in the *Experiment* section, the discount treatment does not seek to emulate one specific aspect of climate change; rather, the main point of the discount treatment is to test whether an awareness of the idea that 'the clock is ticking' for effective climate mitigation causes significant changes in behaviour of the participants. However, several examples of such aspects of climate change will be pointed out. Most of these concern so-called 'feedback loops', which are self-reinforcing processes that can amplify the effects of climate change. In turn, amplified climate change effects will make it more challenging to mitigate climate change impacts, represented by a discount factor. The discount factor may also represent some uncertainties or limitations concerning our knowledge of climate change, which will be pointed out last.

Communities impacted by a loss of ecosystem services face a loss of adaptation capacities: "Extremes are surpassing the resilience of some ecological and human systems and challenging the adaptation capacities of others, including impacts with irreversible consequences (high confidence)" (IPCC 2022, pp. 47). This conclusion pertains partly to accrued benefits from early mitigation in relation to delayed mitigation efforts, but can also be said to relate to the loss of ecosystem services. Early mitigation is advantageous because the loss of healthy ecosystems worldwide during the interim period leads to a decline in ecosystem services that combat climate change. Thus, the participants will experience that a latent loss of ecosystem services may decrease the usefulness of future efforts at climate mitigation. Impacts with irreversible consequences decrease the number of ecosystems that slow down the speed of global warming.

The modification concerning discounting laid out in the *Experiment* section may be said to model any number of catalysing factors of climate change. One of the key findings of the CLICCS Hamburg Climate Futures Outlook '23 (Engels, Anita et al. 2023) serves as a great example of one such factor.




"**Conceptual illustration of thawing permafrost effects on the remaining carbon budget**. Left y-axis: global carbon emissions, right y-axis: global temperature change. With increasing temperature in response to fossil-fuel emissions in the climate stabilization scenario (red line), carbon emissions due to thawing permafrost (blue line) lead to an additional increase in temperature reducing the remaining carbon budget for a given temperature target. Permafrost emissions continue on long timescales after fossil-fuel emissions are reduced to zero (on a short timescale), implying either warming exceeding the target temperature or the necessity of negative carbon emissions for climate stabilization." (From (Engels, Anita et al. 2023))

One of the key findings of this report is that three physical processes, namely permafrost thaw, AMOC instability, and Amazon Forest dieback, all have a moderate effect on the global mean temperature. As a result, these factors moderately inhibit the plausibility of attaining the Paris Agreement temperature goals. The report also highlights uncertainties surrounding permafrost carbon behaviour, which prevent the assessment of drastic changes in permafrost thaw within the 21st century. However, it can be excluded that permafrost thaw alone will lead to runaway warming (Engels, Anita et al., 2023). All these processes (permafrost thaw, AMOC instability and Amazon first dieback) are examples of feedback loops, as these processes themselves will cause global warming; but these processes need to be set in motion by rising temperatures. The threat of feedback loops is that the rise in global temperatures will speed up once these feedbacks are set in motion. Other examples of these feedback loops include the albedo effect (discussed in the literature review) or Boreal forest feedback and general forest and vegetation feedback (loss of forests causes the amount of carbon stored in these forests to decrease). In *Many risky feedback loops amplify the need for climate action*, Ripple et al. (2023) identify 41 biogeophysical feedback loops, of which 7 have an uncertain effect. The effects of the other 34 loops are either negative (or balancing, 7 total) or positive (or reinforcing, 21 in total). Of these 41 feedback loops, they identified the feedback strengths of only 17 of these loops. Which means that the strength of the remaining 24 loops is still not known.

Discounting contributions may also reflect a future scenario where better knowledge about the effectiveness of collective efforts in addressing climate change is available, which could lead to adjustments in the perceived usefulness of mitigation. The discount treatment may also relate to uncertainty about how our actions impact the environment. For example, the cumulative nature of our emissions still raises questions about when 'climate thresholds' are reached, and what effect this will have on the usefulness of future contributions to climate mitigation. It is also unsure exactly how much warming can be associated with the emission of any particular amount of greenhouse gas (for example, it is unsure how many degrees the earth warms precisely because of 10, or 100, or 1000 metric tonnes of $CO_2$ (see for example Stips et al. (2016)). Discounting our contributions may be a way of correcting for any deviations of such estimates.

The result of any of the factors mentioned above may be broadly modelled by decreasing the contributions of the participants during the second half of the game. Any of these factors ought to create an awareness that current contributions and efforts are more worthwhile in the long run than delayed contributions. The discount treatment allows for an examination of how people respond to the benefits associated with early mitigation when they are made aware of them.

### *5.2 Inequality*

The purpose and justification of the unequal treatment are similar to the justifications given by Tavoni et al. (2011) for testing the effects of inequality. However, a major difference is that, while Tavoni et al.'s (2011) experiment focuses on inequality in endowments (*wealth inequality*), the current experiment focuses on inequality in risk exposure. Both these factors are pressing issues in the global warming debate.

Inequalities can be observed in risk exposure between countries, but also between larger regions (such as the Sahara, Southern Europe, etc) or on smaller scales (such as river deltas, coastal regions, islands, etc). As the IPCC report (2022) states, climate-sensitive ecosystems will be most at risk, indicating that other ecosystems face smaller odds of disastrous climatic change.  It is commonly agreed that climate change will have disparate consequences across the globe.

Different types of inequalities are relevant considerations for climate change politics and more specifically to climate change mitigation games. As mentioned previously, Tavoni et al. (2011) focus on inequality in endowments, which models the inequality in wealth among various countries, and thus inequalities in capabilities to address climate change. Wealth inequality is often associated with greenhouse gases emitted in the past, which is a topic in which considerations about historical injustices and causes of wealth inequalities are often brought up. Inequalities in endowments therefore have to be placed in a broader social context, whereas inequalities in impacts are the result of ecological processes outside human control. Though both inequalities play an important role, their distinctness requires both to be researched by itself. Tavoni et al. (2011) points out that "Equity concerns over the distribution of emission cuts and associated costs are at the heart of the sustainability of international climate change action" (p. 11825). Along with wealth inequality, impact inequality plays a considerable role in considerations of equity, especially when less wealthy countries are also disproportionately affected by climate change impacts. Lastly, it is worthwhile considering whether inaction on behalf of some countries may be explained by the relative lack of risk they face due to climate change.

The IPCC report (2022) also takes note of inequalities in risks faced; "Vulnerable people and human systems and climate-sensitive species and ecosystems are most at risk (very high confidence).” (pp. 47) The excerpt concerns different risk exposure of vulnerable people and communities, which directly relates to the second point mentioned at the beginning of this section (it may alter a participants’ understanding of the risks they face).

# 6. Results and discussion

### *6.1 About the tables*

The following tables show the progression and results of each game. The last two tables contain black bars (Tulip, Sunflower, Orange); they represent players who did not end up participating. The first four tables represent games in which the players were given examples of how the game may play out, as per appendix 2. The last table shows the results of a game where participants were not given these examples. During the games, participants were given nicknames (shown on the far left of the tables) in categories of colours, animals, fruit, and flowers. The decimals found in front of the nicknames in tables 3 and 4 are the margins that were revealed to the participants of the unequal treatments after round 5.
As seen in the instructions in appendix 1, the first three games were all played with a target sum of 50 tokens, which they all reached. The fourth group had a target sum of 34 tokens, which they also reached. The target of the last group was 42 tokens, which they missed by one token.

| Player | Round | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total Player |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| blue | | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 2 | 0 | 1 | 8 |
| green | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 9 |
| yellow | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 9 |
| red | | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 8 |
| brown | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 2 | 1 | 10 |
| orange | | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 2 | 1 | 0 | 8 |
| Total contribution round | | 6 | 6 | 6 | 6 | 6 | 4 | 3 | 5 | 6 | 4 | |
| Aggregate contributions | | 6 | 12 | 18 | 24 | 30 | 34 | 37 | 42 | 48 | 52 | **52** |

Table 1. Results of the Base treatment

| Player | Round | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total player |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dolphin | | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| Tiger | | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| Penguin | | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| Fox | | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| Parrot | | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 10 |
| Zebra | | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| Total contribution round | | 12 | 12 | 12 | 12 | 6 | 0 | 0 | 0 | 0 | 0 | |
| Aggregate contributions | | 12 | 24 | 36 | 48 | 54 | 54 | 54 | 54 | 54 | 54 | 54 |

Table 2. Results of Discount treatment

| | Player | Round | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total Player |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0,4 | Peach | | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 9 |
| 0,4 | Apple | | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 0 | 0 | 9 |
| 0,6 | Banana | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 9 |
| 0,6 | Melon | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| 0,8 | Mango | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 8 |
| 0,8 | Strawberry | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 8 |
| | Total contribution round | | 6 | 7 | 6 | 6 | 6 | 7 | 6 | 6 | 2 | 1 | |
| | Aggregate contributions | | 6 | 13 | 19 | 25 | 31 | 38 | 44 | 50 | 52 | 53 | 53 |

Table 3. Results of the Unequal treatment

|  | Player | Round | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total Player |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0,4 | Tulip |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0,4 | Rose |  | 1 | 1 | 2 | 1 | 2 | 1,6 | 0,8 | 0 | 0 | 0 | 9,4 |
| 0,6 | Lilly |  | 1 | 2 | 2 | 2 | 1 | 0,8 | 0,8 | 0 | 0 | 0 | 9,6 |
| 0,6 | Daffodil |  | 1 | 1 | 1 | 1 | 2 | 1,6 | 0 | 0 | 0 | 0 | 7,6 |
| 0,8 | Daisy |  | 2 | 2 | 2 | 1 | 0 | 0,8 | 0 | 0 | 0 | 0 | 7,8 |
| 0,8 | Sunflower |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|  | Total contribution round |  | 5 | 6 | 7 | 5 | 5 | 4,8 | 1,6 | 0 | 0 | 0 |  |
|  | Aggregate contributions |  | 5 | 11 | 18 | 23 | 28 | 32,8 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 |

Table 4. Result of the Discount-Unequal treatment

| Player | Round | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total Player |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| blue |  | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 7 |
| green |  | 1 | 0 | 1 | 2 | 1 | 0 | 1 | 1 | 1 | 0 | 8 |
| yellow |  | 1 | 2 | 1 | 0 | 0 | 2 | 2 | 0 | 0 | 1 | 9 |
| red |  | 1 | 0 | 1 | 2 | 1 | 1 | 2 | 0 | 0 | 1 | 9 |
| brown |  | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 8 |
| orange |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total contribution round |  | 5 | 4 | 4 | 5 | 3 | 4 | 6 | 3 | 3 | 4 |  |
| Aggregate contributions |  | 5 | 9 | 13 | 18 | 21 | 25 | 31 | 34 | 37 | 41 | **41** |

Table 5. Result of the No Examples treatment

The results reveal data that was not previously expected, and, as will be discussed later; the results affirm hypothesis H1 (which states that "*when faced with uncertainty regarding the usefulness of future contributions, participants contribute more early on, to ensure that their contributions do not lose some effectiveness"*). The results reject H2 (which states that *"participants facing different risks of losing their endowment will act differently*"); the differences in how the games concerning Q2 played out are less different from the base treatment than are the results for the discount treatment. The communication screenshots for the discount treatment reveal some interesting insights. Moreover, there are multiple other conclusions to be drawn from the data. The feedback received after distributing the debriefs reveals some information about the factors influencing participants' decisions. The discussion and results section will first focus on questions Q1 and Q2 separately and on the statistical analysis of these results, before some other considerations are discussed.

### *6.2 Regarding Q1*

To the research question "**(Q1) How do participants in the collective-risk social dilemma act when they face uncertainty regarding the usefulness of future contributions?**", the hypothesis "**(H1) When faced with uncertainty regarding the usefulness of future contributions, participants contribute more early on, to ensure that their contributions do not lose some effectiveness**" applies. From the results of figure 2 and figure 4, in contrast with the results of figure 1, it is clear that some preliminary evidence exists to suggest that hypothesis H1 can be affirmed.

Q1 concerns the discount treatment and the discount-unequal treatment, the results of which are found in figure 2 and figure 4, respectively. The gameplay of the discount treatment is strikingly different from the gameplay in the original base treatment. From the communications, it is clear that the initial suggestions made by Tiger and Penguin were approved by all participants, and that very little further consideration of strategy was made. The strategy followed by this group was not instigated by the examples provided to them, as the examples did not include a scenario where all participants would include two tokens each round. The participants that initiated using the strategy they ended up with justified their plan with the discount factor in mind (this was mentioned explicitly by both). The team did not have enough communication time to tackle who would take on the burden of contributing extra in the last round, to reach the 50 token goal or more from the 48 tokens they would have gathered after round 4. This explains why this group reached 54; 4 more tokens than strictly necessary (making the strategy 'irrational' to that extent).

Of the 20 contributions made by the discount-unequal group in the first 5 rounds, 9 were contributions of 2 tokens (that equates to 45% of the first 20 contributions). This was not the case in either the unequal treatment or in the base treatments (none were maximum contributions in the first base treatment, only one in the unequal treatment (so 3%), and four in the no-examples treatment (16%)). Though the communication of the discount-unequal treatment is lost, these results indicate that the participants in the discount-unequal treatment attempted to synchronise their contributions in such a way that their contributions would not be discounted.

### *6.3 Regarding Q2*

To the research question "**(Q2) How do participants' actions in the collective-risk-social dilemma change when information regarding different risks faced by different individuals is revealed?**", the hypothesis "**(H2) Participants facing different risks of losing their endowment will act differently**" applies. From the results of figure 3 and 4, in contrast with the results of figure 1, it seems that hypothesis H2 can be rejected. However, the results concerning Q2 are much less outspoken than the results for Q1.

Q2 concerns the unequal treatment and the discount-unequal treatment, the results of which are found in figure 3 and figure 4, respectively. The gameplay of the unequal treatment is relatively similar to the gameplay of the original base treatment; most participants were determined to stick to the strategy of participating one token each round. Total player contributions in the unequal treatment do not seem to be determined by the chance of losing their leftover endowment; in fact, the participants facing an 80% chance of losing their endowment were among the participants that contributed least both in the unequal as in the discount-unequal sessions. Moreover, there does not seem to be any correlation between the revealed chances and the contributions made by the participants. It is possible that the communication between the participants negated the effects that the inequality that was introduced may have had. Another option is that the inequality simply did not affect the participants' choices or strategy, as it was only revealed after all participants had already contributed significantly to the common fund and the game was almost completed. From the communication during the unequal treatment, it is evident that the chances that were revealed after round 5 were not a major discussion point; they were mentioned only once (by participant *Apple*), who indicated that, though their margin would give them an advantage, they still believed cooperation to be the best strategy.

### *6.4 Statistical testing procedure*

Statistical testing and analysis ought to be performed to determine whether enough evidence exists to confirm the observations regarding hypotheses H1 (*when faced with uncertainty regarding the usefulness of future contributions, participants contribute more early on, to ensure that their contributions do not lose some effectiveness*) and H2 (*participants facing different risks of losing their endowment will act differently*). Statistical testing will first be done for the discount treatment (for H1), and then for the unequal treatment (for H2). Tests with the discount-unequal treatment will also be performed to determine which alteration is more influential. This treatment is not only compared to the base treatment, but also to the discount treatment and the discount-unequal treatment. Lastly, for the no examples treatment, one statistical test is performed. A total of 12 statistical tests were done.

Three different categories of tests will be performed. In the first category, a comparison of 0, 1, and 2 contributions between the base treatment and the experimental treatment is made. This test was done for all four experimental treatments. The second test category is a comparison of the value of contributions between the first and second half of the game. This test was performed for only the discount and discount-unequal treatment. It is intended to test the significance of the difference in contributions between the first and the second half of the games. The third and last test category is an in-group comparison of the contributions of the 40%, 60%, and 80% groups in the treatments that included the inequality alteration. To test for differences between the unequal and discount-unequal treatment, this test will be slightly modified.

### *6.5 Discount treatment (H1) statistical testing*

| | **0** | **1** | **2** | **Sum** |
|---|---|---|---|---|
| **Base** | 11 | 46 | 3 | 60 |
| **Discount** | 31 | 4 | 25 | 60 |

Table 6. Distribution of 0, 1, and 2 contributions between base and discount treatment.

| | Total round 1-5 | Total round 6-10 | **Sum** |
|---|---|---|---|
| **Base** | 30 | 22 | 52 |
| **Discount** | 54 | 0 | 54 |

Table 7. Comparison of contributions made in first and second half of the game in base and discount treatment.

The comparison of the frequency of 0, 1, and 2 contributions between the base and discount treatment is given in table 6. The Chi-squared test performed for this comparison reveals that there is a significant difference in distribution between the observed and expected data for table 6 (the p-value of this test is 3,29E-14). Our first test for the discount treatment thus indicates a strong effect of discounting, in line with hypothesis H1.

The second test prepared for the discount treatment intends to measure the difference between the total amount of the contributions between the first and the second half of the game. The data for this test is found in table 7. The p-value of this Chi-square test is 7,90E-08. However, since one observation is 0, the Chi-square test is not an ideal test. This test assumes a decent number of observations for each entry, so a correction (Yates' correction) is performed to test whether the result is also significant when a more conservative test is performed. The p-value for this Chi-square test with the Yates' correction is 2,90E-07; which indicates that the results are robust.

These tests analyze almost the same thing. If the participants wish to reach the target as soon as possible, they ought to contribute 2 tokens in the first couple rounds. Therefore, the lower the amount of contributions in rounds 6-10, the higher the number of two-token contributions ought to be (provided, as is the case, that the target is reached). Regardless, these statistical tests indicate that H1 should be affirmed.

### *6.6 Unequal treatment (H2) statistical testing*

| | **0** | **1** | **2** | **Sum** |
|---|---|---|---|---|
| **Base** | 11 | 46 | 3 | 60 |
| **Unequal** | 9 | 49 | 2 | 60 |

Table 8. Distribution of 0, 1, and 2 contributions between base and unequal treatment.

| | 0 | 1 | 2 | Sum |
|---|---|---|---|---|
| **40% group** | 4 | 14 | 2 | 20 |
| **60% group** | 1 | 19 | 0 | 20 |
| **80% group** | 4 | 16 | 0 | 20 |

Table 9. Distribution of 0, 1, 2 contributions divided among 40, 60, and 80% treatment in the unequal treatment.

The first test performed for the unequal treatment is a test of the distribution of 0, 1, and 2 contributions between the base and unequal treatment. For the second test, the participants were put in groups according to the chances they faced, and a test was done to see whether there is a significant between-group difference here. To confirm or reject hypothesis H2, a significant result for the test in the difference of in-group contributions of the 40%, 60% and 80% groups is necessary.

The p-value of the Chi-square test performed for the first test (depicted in table 8) is 0,78. Though the Chi-square test does not prove absence of a difference, this result does show that the distribution of contribution size is unaffected by the unequal treatment. This is in line with my hypotheses, as it is not expected that the introduction of inequality would cause all participants, taken together, to alter the value of their contributions.

The result of the Chi-square test of table 9 is 0,15. However, due to the presence of two ‘zero’ values in the dataset, the Yates’ correction has to be performed once more. The Yates’ correction returns the p-value 0,64. Either result 0,15 and 0,64 are not significant enough to establish significance. However, more testing with a larger number of groups may provide more significant results.

### *6.7 Discount-unequal treatment tests*

For the discount-unequal tests, the same tests as for the discount treatment will be performed. The between-group analysis of 40%, 60%, and 80% groups will be altered slightly so that the chi-test can be performed for this data. However, the discount-unequal treatment is not only compared to the base treatment, but also to the discount and the unequal treatment separately. The discount-unequal treatment tests should be compared to the discount treatment and the unequal treatment separately, to disentangle the mutual effect both alterations have together from the effects of the individual treatment. This way, it can be examined whether the observed difference is due to the discount, the inequality, or because of both. Moreover, this allows for an analysis of which of these alterations has had a bigger impact on the decisions of the participants. First, the results of the base and discount-unequal treatment comparison (3 tests) will be analysed, then the results of the discount treatment and discount-unequal treatment comparison (2 tests) are analysed, and finally the unequal treatment and discount-unequal treatment comparison (2 tests) is analysed. The discount-unequal group comprised of 4 rather than 6 students, so some figures are provided to highlight the relative differences between the collected data. Throughout the following analysis of the discount-unequal treatment, it is assumed that contributions of 0,8 and 1,6 are included in the categories 1 and 2, respectively. This goes only for the analysis of the distribution of 0, 1, and 2 contributions of the discount-unequal treatment. In cases where the total contribution value is compared, the p-value is provided both with and without the discount applied.

### *6.8 Base and discount-unequal analysis*

| | **0** | **1** | **2** | **Sum** |
|---|---|---|---|---|
| **Base** | 11 | 46 | 3 | 60 |
| **Disc-unequal** | 15 | 14 | 11 | 40 |

Table 10. Distribution of 0, 1, and 2 contributions between base and discount-unequal treatment.

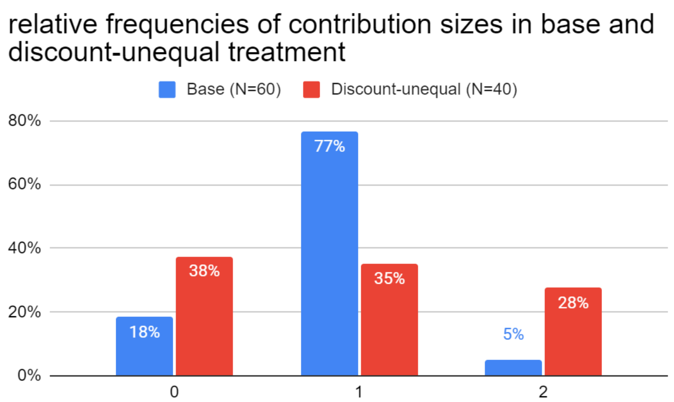



Figure 1. Relative frequencies of data displayed in table 10.

| | Total round 1-5 | Total round 6-10 | **Sum** |
|---|---|---|---|
| **Base** | 30 | 22 | 52 |
| **Discount-unequal** | 28 | 6,4 | 34,4 |

Table 11. Comparison of contributions made in first and second half of the game in base and discount-unequal treatment.

| **OBSERVED** | **0** | **1** | **2** | **Sum** |
|---|---|---|---|---|
| **40% group** | 3 | 4 | 3 | 10 |
| **60% group** | 7 | 8 | 5 | 20 |
| **80% group** | 5 | 2 | 3 | 10 |

Table 12. Distribution of 0, 1, 2 contributions divided among 40, 60, and 80% treatment in discount-unequal treatment.

The p-value of the Chi-square test performed for table 10 is 7,43E-05. This result is significant, and confirms that there is a difference in the distribution of contributions between the discount-unequal treatment and the base treatment. For the same test, performed for comparison of the base and unequal treatment, no significant difference was found. This indicates that the difference between these two treatments (the inclusion of the discount factor) caused a significant difference in results, which is also confirmed by the same test performed between the base and discount treatment.

The p-value of the Chi-square test of the results in table 11 is 0,05 if contributions are counted in full (6,4 would be 8 instead), and the p-value is 0,02 if the discount factor is applied to contributions of round 6-10 (as shown in the table). With a significance level of 0,05 (5%), the results can be considered significant irrespective of method of calculation.

The p-value of the Chi-squared test of table 12 is 0,8181. This low correlation has to be partly ascribed to the low number of data entries. However, it is in line with previous findings in the unequal treatment that the inequality introduced does not have a significant effect on participants' behaviour. Moreover, there is an issue in comparison in table 12. As evident from the table, the sum of the 60% groups' contribution is double the sum of the other two groups. This is due to the fact that only 4 players participated in this treatment, and so the

40% and 80% group both missed one participant, each of which would have made ten contributions total.

### *6.9 Discount and discount-unequal analysis*

| | 0 | 1 | 2 | Sum |
|---|---|---|---|---|
| **Discount** | 31 | 4 | 25 | 60 |
| **Disc-Unequal** | 15 | 14 | 11 | 40 |

Table 13. Distribution of 0, 1, and 2 contributions between discount and discount-unequal treatment.

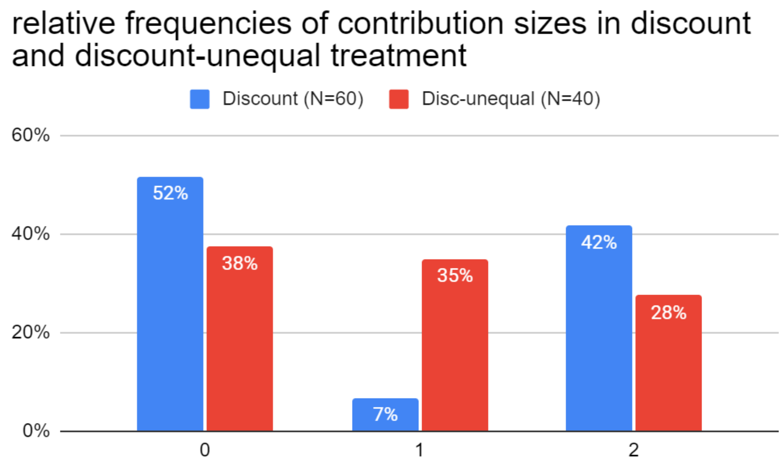



Figure 2. Relative frequencies of data displayed in table 13.

| | Total round 1-5 | Total round 6-10 | **Sum** |
|---|---|---|---|
| **discount** | 54 | 0 | 54 |
| **Disc-uneq** | 28 | 6,4 | 34,4 |

Table 14. Comparison of contributions made in first and second half of the game in discount and discount-unequal treatment.

The P-value for the results displayed in table 13 is 1,44E-03. This is a significant result, but it has to be compared also to the results of the other 0, 1, and 2 distribution tests. The result is less strong than the comparison between the base and discount-unequal treatment, indicating that the results of the discount-unequal treatment are more similar to the discount treatment than to the base treatment.

Table 14 shows the results for the discount-unequal treatment with the discount applied. Without the discount applied, the value 6,4 would be 8. In that case, the p-value for the Chi-square test of table 14 is 2,84E-04. With Yates' correction applied, the p-value for this test is 1,15E-03. With the discount, the p-value for the normal Chi-square test would be 9,98E-04, and with Yates' correction, the p-value is 4,10E-03. Irrespective of how the calculation is made, the result is significant, indicating that the participants of the discount treatment acted differently from the participants of the discount-unequal treatment, and that it is unlikely that this difference is due to group selection. This is not in line with other conclusions that have been made thus far, which confirm that discounting has significant effects and that the inequality has no measurable effect. However, much lower p-values are observed for the tests performed for the discount treatment than the p-values observed in the current comparison of discount and discount-unequal treatments, which indicates that the differences between the base and discount treatment are much bigger than the differences found between the discount and discount-unequal treatment. Moreover, the Chi-square test performed in table 15 below also confirms that the difference between the unequal and discount-unequal treatment is bigger than the difference found between the discount and discount-unequal treatment, strongly indicating that the discount-unequal treatment most resembles the discount treatment, and, as as the p-value for the Chi-square tests of table 8 indicated,  the base treatment most resembles the discount treatment. Lastly, the p-value corresponding to the findings of table 10 confirm that the discount-unequal treatment is less similar to the base treatment than to the discount treatment. Therefore, though significant differences between the discount and discount-unequal treatments can be observed, these treatments are closer related to one another than either treatment is related to any other treatment.

### *6.10 Unequal and discount-unequal analysis*

| | 0 | 1 | 2 | Sum |
|---|---|---|---|---|
| **unequal** | 9 | 49 | 2 | 60 |
| **Disc-Unequal** | 15 | 14 | 11 | 40 |

Table 15. Distribution of 0, 1, and 2 contributions between unequal and discount-unequal treatment.

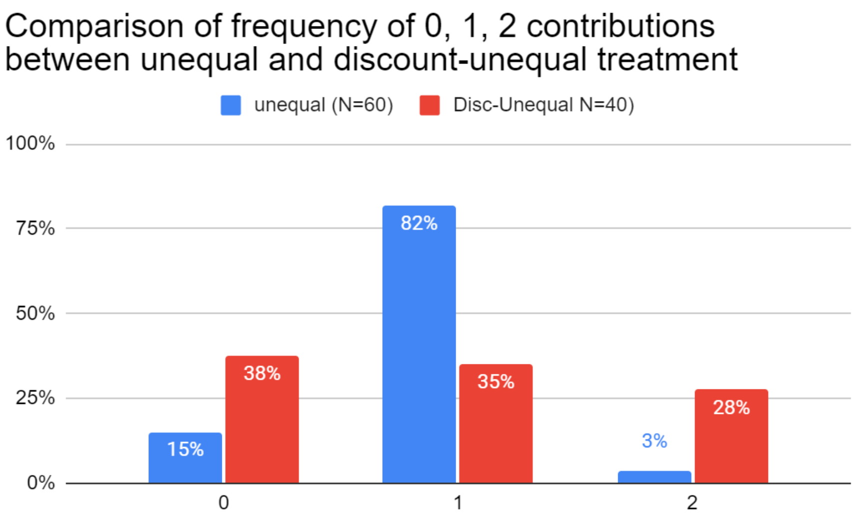



Figure 3. Relative frequencies of data displayed in table 15.

| | 40% | 60% | 80% | Sum |
|---|---|---|---|---|
| **unequal** | 18 | 19 | 16 | 53 |
| **Disc-Unequal** | 9,4 | 17,2 | 7,8 | 34,4 |

Table 16. Comparison of total contributions of 40%, 60%, and 80% groups of unequal and discount-unequal groups.

The p-value of the Chi-square test of the results in table 15 is 5,73E-06, indicating a significant difference of results between the unequal and discount-unequal treatment. This further indicates that discounting played a more significant factor in participants' decision than did the factor of inequality.

The results in table 16 show the contributions with the discount factor applied to the discount-unequal treatment. The p-value of the Chi-square test is 0,42 when the discounted contributions are taken into account. This value is 0,41 when the discount factor is not applied, and contributions after round 5 are counted in full (for this analysis, 9,4 is replaced with 10, 17,2 with 18, and 7,8 is replaced with 8). Both these results do not indicate significance. In fact, all three statistical tests where differences between the 40%, 60%, and 80% groups were tested have not shown any significance. This indicates that the particular unequal treatment applied in this experiment does not have significant effects on participants' actions. More testing would be necessary to examine whether impact inequality does not affect participants' actions in general, or whether it may be the case that the delayed introduction of this information may have stunted these effects.

One purpose of the discount-unequal treatment was to examine which of the two modifications had a bigger impact on the decisions of the participants. As concluded in the analysis of the discount and discount-unequal treatment, the results of the discount and discount-unequal treatment seem to be similar to one another because both groups managed to reach the goal a few rounds before the end of the game. In both games, the participants managed to coordinate their actions in such a way that the first five rounds were used to contribute to the fullest extent, so that discounted contributions would not have to be made. On the other hand, the unequal treatment seems to bear more similarities to the original base treatment, for in both games the participants contributed one token during most rounds. The significance tests corroborate these findings.

### *6.11 Influence of examples provided*

The examples provided were at once meant to instruct the participants about possible courses of action, but they are also helpful in guiding our analysis. The examples provided extreme cases of how the games may play out, and can therefore be contrasted to the actual course of events during the games.

First and foremost, it is evident that the last group is the only group that did not manage to reach the goal. The last group was given the instructions without the examples of how the game may play out. Though these were 'meant to instruct you about possible courses of events of the game, and about the results connected to these courses of events' (taken from instructions), the examples appear to have had a bigger impact than that. In their debrief, *Blue* (base treatment) pointed out that the possible courses of actions laid out in the examples section of the instructions informed their own strategy, and also guided what they would communicate to his group, and their proposal was picked up by the group and followed almost entirely throughout the game. In the last question of the feedback, they suggested that the game may play out differently without the examples, as indeed it did. Participant *Daisy* also indicated that the examples provided possible strategies to communicate to the rest of their team. Therefore, the last opportunity to perform an experiment was used with this feedback in mind.

On the other hand, the results from the discount treatment show that the participants were more cooperative than was proposed in the examples provided to them, indicating that the discount factor was more influential in guiding the actions of the participants in this treatment than were the examples. The same is true for the discount-unequal treatment, although to a lesser extent. For the discount treatment, a very effective communication stage helped to cement this cooperative strategy.

| | **0** | **1** | **2** | **Sum** |
|---|---|---|---|---|
| **Base** | 11 | 46 | 3 | 60 |
| **No Examples** | 17 | 25 | 8 | 50 |

Table 17. Comparison of frequency of 0, 1, 2 contributions between Base and No Examples treatment

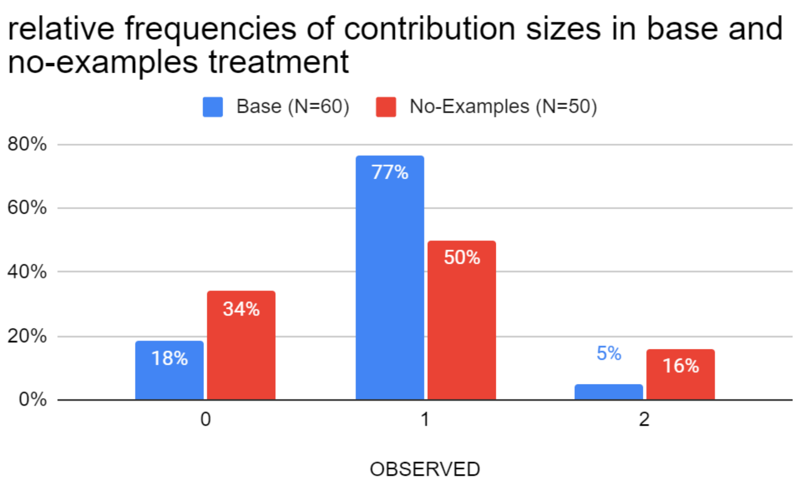



Figure 4. Relative frequencies of data displayed in table 17.

To substantiate the observations concerning the effect of withholding examples, a chi-squared test is performed with the data of table 17. The data in this table is also graphed in figure 4. using relative frequencies, to better portray the observed differences whilst keeping in mind that the number of data entries is not the same due to different group sizes in the Base and No Examples treatment. The p-value of this Chi-squared test is 0,01148, indicating that there is a 1,15% chance that the measured discrepancy is due to group selection. More testing is required to establish stronger results.

### *6.12 Communications*

During the first three sessions, screenshots were of the communications, so as to compile them and be able to make screenshots of the communications of the sessions. From the last two sessions, screenshots of the chats weren't made as the Zoom call ended before they could be made, and the experiment was still being conducted.The transcript of the communications could also not be retrieved after the end of the call, so the communication of these two sessions was lost. The screenshots of the communication of the first three sessions are provided in appendix 4**.**

The ability to communicate as a group was seen by many participants as an essential factor contributing to the groups' success, as is evident from the responses received from *debrief* question three. For some participants or groups, the second communication stage was less useful than the first, as evident from participant *Orange*'s feedback response. On the other hand, participant *Red* (from base treatment) considered the second communication stage to be a 'controlling' stage, without which they feel they would not have contributed as much as they ultimately did. Most other participants agreed that the ability to communicate prior to the game allowed them to get a sense of the other participants' intentions, agree on a strategy together, and propose plans without having to signal their intentions through participation in the game. These observations generally coincide with (Tavoni et al. 2011; Barrett and Dannenberg 2012; 2014)'s experiments and findings.

This influence of communication is particularly evident in the discount treatment, where participants Tiger and Penguin proposed during the first communication stage to contribute two tokens each round. This was not one of the examples provided to the participants, so this had not influenced them. All other participants agreed with this strategy, and they managed to succeed in reaching the goal in the fifth round of the game, with a total of 54 tokens. Of course, the treatment was supposed to test whether higher contributions would be made early on in the game due to the discount factor, but it is also clear from the feedback that the participants in this treatment only decided to follow this strategy after communication and agreement on this point.

The ramifications of the findings concerning H1 are important to highlight. They suggest that participants in collective-risk-social dilemmas will contribute more early on in these social interactions, if there is an awareness that future contributions will not be as useful as current contributions.

## 7. Conclusion

The experiment performed in this thesis is an alteration on the collective-risk social dilemma described by Milinski et al. (2008). A preliminary experiment in discounting is provided, along with more experimentation with inequality, in this case *impact inequality*. Both of these alterations incorporate aspects of uncertainty into the game. The uncertainties that are incorporated are of different kinds. The uncertainty modelled into the discount treatment concerns uncertainty about the consequences of crossing climate thresholds. The uncertainty modelled into the unequal treatment concerns uncertainty about the precise risks related to crossing climate thresholds, and uncertainty about how these risks are allocated among different participants.

Both alterations of discounting and inequality are relevant to the climate change mitigation effort, as discussed in the *Justifications* section. The discount treatment may be considered an alteration meant to encompass numerous aspects of climate change. Discounting contributions may reflect the consequences of crossing the climate thresholds of feedback loops. Uncertainty concerning the precise rise in global temperature related to any particular amount of $CO_2$ emission may also be accounted for by discounting contributions to mitigation efforts. Inequality between the risks faced by participants ought to model the fact that the consequences of climate change will not affect countries or regions in similar fashion. Moreover, Tavoni et al. (2011) correctly point out that inequalities are at the heart of climate change action, and the sustainability thereof.

The results indicate that discounting has a significant effect on participants' actions. The results indicate that impact inequality does not have significant impacts. Tavoni et al's (2011) experiment concerning wealth inequality does indicate that inequality has a significant impact. The difference may be due to the difference between wealth and impact inequality. It may also be a result of the delayed introduction of this information. The discount-unequal treatment shows significant differences from the base treatment. The results of this treatment are most similar to the results of the discount treatment, indicating that the discount applied in this treatment was more influential in determining this groups' contributions than the inequality introduced was. Lastly, the statistical tests performed for the No Examples treatment returned significant results. This indicates that the examples provided to the groups may have had significant results in determining their strategies and courses of action.

### *7.1 Possibilities for future research*

There are numerous possibilities for future research on the basis of the current experiment. First and foremost, it would be interesting to test whether the unequal treatment would provide more significant results if the inequalities between the players were communicated to them at the beginning of the game. The percentages decided upon in this experiment (40, 60, and 80%) may also be changed to test in which scenarios this factor has a significant effect.

Second, it would be interesting to see whether the discount factor may provide different results in the following scenarios. First, it would be interesting to examine whether the effect would be equally strong when introducing uncertainty as to whether or not the uncertainty will come into effect. Second, the experiment may provide different results when the discount is applied sooner. Another interesting option is to test how participants act when the contributions are continuously discounted; that is, a discount factor could also be applied after every single round, making contributions less effective with the passing of each round. Lastly, it is worthwhile to test whether the introduction of a discount factor will prove equally effective in case the discount factor was lower (for example 0,9), and where the cut-off for effectiveness is.

One last alteration that was considered for this paper was a two-tiered coordination game of the collective-risk social dilemma. In this game, six groups of participants would play the game, rather than 6 individual participants. During this game, either 12 or 18 participants would play the game, and each group of two or three players would need to determine their contributions together, before their contributions were made. This way, the game would better reflect the fact that cooperation in the climate game constitutes not just cooperation between countries, but also within countries. Performing this experiment would require far more participants than the 27 students that were available to perform the current experiment.

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## List of Appendices

### *Appendix no. 1: full instructions*

#### *Appendix 1A; Instructions for both base treatments*

*comment in italics provided only to original base treatment*

**GAME INSTRUCTIONS**

In this experiment, you can earn extra credit points. The amount of points you will earn depends on the gameplay; in other words, the decisions you and your teammates make as a group:

- During the game, you will be given 20 tokens, which you will need to play the game. Each token you still have at the end of the game, will be transferred into 0.2 extra credits for the course through which you're participating in the experiment.
- Carefully read the following instructions on how to participate in the game correctly using the software, and carefully read the instructions for the game.
- *Also included are two examples of how the game may play out. (Both of these examples are extreme cases, meant to instruct you about possible courses of events of the game, and about the results connected to these courses of events.)*

**SETUP INSTRUCTIONS**

To introduce the experiment and communicate any issues and questions, the organiser and all the participants will first join a Google Meet. The game itself will be conducted online through Zoom, Google Forms and Google Spreadsheets. Zoom will only be used at the two 'communication' stages. The Google Forms and Google Spreadsheet platforms are used for you to determine your contributions each round, and to monitor the contributions of your teammates.
You will need to fill in the Google Form for each of the ten rounds. During each round, select your assigned nickname, the round number, and select how much you decide to contribute. **Importantly,** please check whether all the selected information is correct before submitting

your contributions each round. If something accidentally goes wrong, please let the organiser know in the Google Meet call. After each round, if everyone has responded, you can see the contributions of other players in the Google Spreadsheet. This is an overview of how the game is developing.

**RULES OF THE GAME**

- You will play a game with 4 other players.
- The game will last 10 rounds.
- The point of the game is for you, as a group, to reach the target amount of 42 tokens at the end of the game.
- You and your team members will each be given 20 tokens.
- In each round, you can decide to contribute one or two tokens, or you can decide not to contribute at all.
- Any tokens given to the common fund is lost.
- In each round, you and your teammates have to commit to contributions simultaneously, and your contribution will only be made public after everyone has made a decision as to their contribution during the round in question.
- **In the case that the end target is not reached, the probability you will lose the remainder of your tokens will be 60%.**
- If the target sum for the common fund is reached, you get to transfer the tokens left in your private account into extra points with certainty.
- Your contributions are public, so at any point of the game, you can see how much everybody has participated in the common fund and how many tokens are in the common fund. In other words, your efforts will be shared with your teammates, just as you can monitor their contributions.
- You can communicate shortly with your teammates before the game and after round five of the game. You will be given two minutes to convey your goal, strategy, or to instruct others. What you decide to communicate is up to you.
- Communicatication will be non-verbal, and **must** take place through Zoom Chat.

**YOUR TASK**

- In each round, you can decide to contribute one or two tokens to the common fund, or you can decide not to contribute at all.
- Please, read the instructions again carefully and familiarise yourself with the game. Carefully consider what you wish to communicate with your teammates, and how best to convey this.

**JOINING THE ZOOM**

There are a few requirements for the Zoom meeting. In order to match your game nickname to the nickname on Zoom and to preserve your anonymity, it will be necessary for you to **log out** of your Zoom account first, if you are logged in on the device you're participating on. Then open the Zoom desktop app, and join the meeting through manually entering the Meeting-ID and **rename yourself** to the nickname provided to you through email.

Meeting-ID: 521 431 4143
Password: ZC87hP

Use this link to enter the Google Forms:
https://docs.google.com/forms/d/1t2Hb08mMVEHP8xElgOjfpYtdw_X8tLP-KvsHhwk0tk0/edit
Use this link to access the Google Spreadsheet:
https://docs.google.com/spreadsheets/d/1jI2MAsrgThHe-QUD9ddB_Ogc7QI5EmyqfNuOSGWhj6g/edit#gid=0

The Zoom meeting may close during the game. If this happens after round 6, it's not a problem. If it happens before that time, please re-enter the meeting with your nickname.

### *Appendix 1B; Instructions for discount treatment*

**GAME INSTRUCTIONS**

In this experiment, you can earn extra credit points. The amount of points you will earn depends on the gameplay; in other words, the decisions you and your teammates make as a group:

- During the game, you will be given 20 tokens, which you will need to play the game. Each token you still have at the end of the game, will be transferred into 0.2 extra credits for the course through which you're participating in the experiment.
- Carefully read the following instructions on how to participate in the game correctly using the software, and carefully read the instructions for the game.
- Also included are two examples of how the game may play out. (Both of these examples are extreme cases, meant to instruct you about possible courses of events of the game, and about the results connected to these courses of events.)

**SETUP INSTRUCTIONS**

To introduce the experiment and communicate any issues and questions, the organiser and all the participants will first join a Google Meet. The game itself will be conducted online through Zoom, Google Forms and Google Spreadsheets. Zoom will only be used at the two 'communication' stages. The Google Forms and Google Spreadsheet platforms are used for you to determine your contributions each round, and to monitor the contributions of your teammates.

You will need to fill in the Google Form for each of the ten rounds. During each round, select your assigned nickname, the round number, and select how much you decide to contribute. **Importantly,** please check whether all the selected information is correct before submitting your contributions each round. If something accidentally goes wrong, please let the organiser know in the Google Meet call. After each round, if everyone has responded, you can see the contributions of other players in the Google Spreadsheet. This is an overview of how the game is developing.

**RULES OF THE GAME**

- You will play a game with 5 other players.
- The game will last 10 rounds.
- The point of the game is for you, as a group, to reach the target amount of 50 tokens at the end of the game.
- You and your team members will each be given 20 tokens.

- In each round, you can decide to contribute one or two tokens, or you can decide not to contribute at all.
- Any tokens given to the common fund is lost.
- In each round, you and your teammates have to commit to contributions simultaneously, and your contribution will only be made public after everyone has made a decision as to their contribution during the round in question.
- **In the case that the end target is not reached, the probability you will lose the remainder of your tokens will be lost is 60%.**
- If the target sum for the common fund is reached, your tokens left in your private account will be transferred into extra credit points with certainty.
- **after round 5, a discount factor of 0.8 will be uniformly applied to all of your contributions. In other words, if you contribute two of your tokens in round six, the target sum will increase by 1.6.**
- Your contributions are public, so at any point of the game, you can see how much everybody has participated in the common fund and how many tokens are in the common fund. In other words, your efforts will be shared with your teammates, just as you can monitor their contributions.
- You can communicate shortly with your teammates before the game and after round five of the game. You will be given two minutes to convey your goal, strategy, or to instruct others. What you decide to communicate is up to you.
- Communicatication will be non-verbal, and **must** take place through Zoom Chat.

**YOUR TASK**

- In each round, you can decide to contribute one or two tokens to the common fund, or you can decide not to contribute at all.
- Please, read the instructions again carefully and familiarise yourself with the game. Carefully consider what you wish to communicate with your teammates, and how best to convey this.

**JOINING THE ZOOM**

There are a few requirements for the Zoom meeting. In order to match your game nickname to the nickname on Zoom and to preserve your anonymity, it will be necessary for you to **log**

**out** of your Zoom account first, if you are logged in on the device you're participating on. Then open the Zoom desktop app, and join the meeting through manually entering the Meeting-ID and **rename yourself** to the nickname provided to you through email.

Meeting-ID: 521 431 4143
Password: ZC87hP

Use this link to enter the Google Forms:
https://docs.google.com/forms/d/1hewdhkKlVc8Ay2rBIMW3pzy1AktSkogV_VYz8EWaeYM/edit
Use this link to access the Google Spreadsheet:
https://docs.google.com/spreadsheets/d/15WPBGiJol4CA8bQJbvcvhYtCl1sRO0C7OGb-PJ9vX64/edit#gid=0

The Zoom meeting may close during the game. If this happens after round 6, it's not a problem. If it happens before that time, please re-enter the meeting with your nickname.

### *Appendix 1C; Instructions for unequal treatment*

**GAME INSTRUCTIONS**

In this experiment, you can earn extra credit points. The amount of points you will earn depends on the gameplay; in other words, the decisions you and your teammates make as a group:

- During the game, you will be given 20 tokens, which you will need to play the game. Each token you still have at the end of the game, will be transferred into 0.2 extra credits for the course through which you're participating in the experiment.
- Carefully read the following instructions on how to participate in the game correctly using the software, and carefully read the instructions for the game.
- Also included are two examples of how the game may play out. (Both of these examples are extreme cases, meant to instruct you about possible courses of events of the game, and about the results connected to these courses of events.)

**SETUP INSTRUCTIONS**

To introduce the experiment and communicate any issues and questions, the organiser and all the participants will first join a Google Meet. The game itself will be conducted online through Zoom, Google Forms and Google Spreadsheets. Zoom will only be used at the two ‘communication’ stages. The Google Forms and Google Spreadsheet platforms are used for you to determine your contributions each round, and to monitor the contributions of your teammates.

You will need to fill in the Google Form for each of the ten rounds. During each round, select your assigned nickname, the round number, and select how much you decide to contribute. **Importantly,** please check whether all the selected information is correct before submitting your contributions each round. If something accidentally goes wrong, please let the organiser know in the Google Meet call. After each round, if everyone has responded, you can see the contributions of other players in the Google Spreadsheet. This is an overview of how the game is developing.

**RULES OF THE GAME**

- You will play a game with 5 other players.
- The game will last 10 rounds.
- The point of the game is for you, as a group, to reach the target amount of 50 tokens at the end of the game.
- You and your team members will each be given 20 tokens.
- In each round, you can decide to contribute one or two tokens, or you can decide not to contribute at all.
- Any tokens given to the common fund is lost.
- In each round, you and your teammates have to commit to contributions simultaneously, and your contribution will only be made public after everyone has made a decision as to their contribution during the round in question.
- **if the target is not reached, it’s possible that you will lose all of your remaining tokens. the probability that your remaining tokens will be lost, will be revealed after round 5.**

- If the target sum for the common fund is reached, your tokens left in your private account will be transferred into extra credit points with certainty.
- **the probability of you losing your tokens is either 40, 60 or 80 percent. You may face different odds than your teammates. This information will be automatically revealed on the spreadsheet after round 5.**
- **The probabilities faced by your teammates will also be revealed after round 5.**
- Your contributions are public, so at any point of the game, you can see how much everybody has participated in the common fund and how many tokens are in the common fund. In other words, your efforts will be shared with your teammates, just as you can monitor their contributions.
- You can communicate shortly with your teammates before the game and after round five of the game. You will be given two minutes to convey your goal, strategy, or to instruct others. What you decide to communicate is up to you.
- Communicatication will be non-verbal, and **must** take place through Zoom Chat.

**YOUR TASK**

- In each round, you can decide to contribute one or two tokens to the common fund, or you can decide not to contribute at all.
- Please, read the instructions again carefully and familiarise yourself with the game. Carefully consider what you wish to communicate with your teammates, and how best to convey this.

**JOINING THE ZOOM**

There are a few requirements for the Zoom meeting. In order to match your game nickname to the nickname on Zoom and to preserve your anonymity, it will be necessary for you to **log out** of your Zoom account first, if you are logged in on the device you're participating on. Then open the Zoom desktop app, and join the meeting through manually entering the Meeting-ID. **Rename yourself** to the nickname provided to you through email.

Meeting-ID: 521 431 4143
Password: ZC87hP

Use this link to enter the Google Forms:
https://docs.google.com/forms/d/1dIDEAqcgaxk_-fqCrLfgc0rvsU4obCGNqXrY-0mZttM/edit

Use this link to access the Google Spreadsheet:
https://docs.google.com/spreadsheets/d/1QSmdfEdjSHI--WRwMjL_FwZFtcu6pR3QWPjen-v-bLs/edit#gid=0

The Zoom meeting may close during the game. If this happens after round 6, it's not a problem. If it happens before that time, please re-enter the meeting with your nickname.

***Appendix 1D; Instructions for discount-unequal treatment***

**GAME INSTRUCTIONS**

In this experiment, you can earn extra credit points. The amount of points you will earn depends on the gameplay; in other words, the decisions you and your teammates make as a group:

- During the game, you will be given 20 tokens, which you will need to play the game. Each token you still have at the end of the game, will be transferred into 0.2 extra credits for the course through which you're participating in the experiment.
- Carefully read the following instructions on how to participate in the game correctly using the software, and carefully read the instructions for the game.
- Also included are two examples of how the game may play out. (Both of these examples are extreme cases, meant to instruct you about possible courses of events of the game, and about the results connected to these courses of events.)

**SETUP INSTRUCTIONS**

To introduce the experiment and communicate any issues and questions, the organiser and all the participants will first join a Google Meet. The game itself will be conducted online through Zoom, Google Forms and Google Spreadsheets. Zoom will only be used at the two 'communication' stages. The Google Forms and Google Spreadsheet platforms are used for you to determine your contributions each round, and to monitor the contributions of your teammates.

You will need to fill in the Google Form for each of the ten rounds. During each round, select your assigned nickname, the round number, and select how much you decide to contribute. **Importantly,** please check whether all the selected information is correct before submitting your contributions each round. If something accidentally goes wrong, please let the organiser know in the Google Meet call. After each round, if everyone has responded, you can see the contributions of other players in the Google Spreadsheet. This is an overview of how the game is developing.

**RULES OF THE GAME**

- You will play a game with 4 other players.
- The game will last 10 rounds.
- The point of the game is for you, as a group, to reach the target amount of 34 tokens at the end of the game.
- You and your team members will each be given 20 tokens.
- In each round, you can decide to contribute one or two tokens, or you can decide not to contribute at all.
- Any tokens given to the common fund is lost.
- In each round, you and your teammates have to commit to contributions simultaneously, and your contribution will only be made public after everyone has made a decision as to their contribution during the round in question.
- **In the case that the end target is not reached, the probability you will lose the remainder of your tokens will be revealed after round 5.**
- If the target sum for the common fund is reached, your tokens left in your private account will be transferred into extra credit points with certainty.
- **the probability of you losing your tokens is either 40, 60 or 80 percent. You may face different odds than your teammates. This information will be automatically revealed on the spreadsheet after round 5.**
- **The probabilities faced by your teammates will also be revealed after round 5.**
- **after round 5, a discount factor of 0.8 will be uniformly applied to all of your contributions. In other words, if you contribute two of your tokens in round six, the target sum will increase by 1.6.**

- Your contributions are public, so at any point of the game, you can see how much everybody has participated in the common fund and how many tokens are in the common fund. In other words, your efforts will be shared with your teammates, just as you can monitor their contributions.
- You can communicate shortly with your teammates before the game and after round five of the game. You will be given two minutes to convey your goal, strategy, or to instruct others. What you decide to communicate is up to you.
- Communicatication will be non-verbal, and **must** take place through Zoom Chat.

**YOUR TASK**

- In each round, you can decide to contribute one or two tokens to the common fund, or you can decide not to contribute at all.
- Please, read the instructions again carefully and familiarise yourself with the game. Carefully consider what you wish to communicate with your teammates, and how best to convey this.

**JOINING THE ZOOM**

There are a few requirements for the Zoom meeting. In order to match your game nickname to the nickname on Zoom and to preserve your anonymity, it will be necessary for you to **log out** of your Zoom account first, if you are logged in on the device you're participating on. Then open the Zoom desktop app, and join the meeting through manually entering the Meeting-ID. **Rename yourself** to the nickname provided to you through email.

Meeting-ID: 521 431 4143
Password: ZC87hP

Use this link to enter the Google Forms:
https://docs.google.com/forms/d/1dotBq1vau-TjCITRG54j-wC0DwKSnHAUuAtiVDiJuUE/edit#responses
Use this link to access the Google Spreadsheet:
https://docs.google.com/spreadsheets/d/1QFpSEz4DRppFm-cbl8mmuJdT3w9O34SDvEmGqq8eKZg/edit#gid=0

The Zoom meeting may close during the game. If this happens after round 6, it’s not a problem. If it happens before that time, please re-enter the meeting with your nickname.

## *Appendix no. 2: examples*

### *Appendix 2A; Examples given to base treatment*

**EXAMPLE**

Players A through F participate in this game. The information they were given at each stage is presented, along with their successive contributions.

**GAME ONE**

Stage one; before the game. Communication phase 1.

Stage two; contributions phase 1.

**round one**
A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token
total sum: 6 tokens
**round two**
A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token
total sum: 12 tokens
**round three**
A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token
total sum: 18 tokens
**round four**
A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token
total sum: 24 tokens
**round five**
A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token
total sum: 30 tokens

Stage three; communication phase 2.

Stage four; contributions phase 2.

**round six**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 36 tokens

**round seven**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 42 tokens

**round eight**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 48 tokens

**round nine**

A: 1 token, B: 1 token, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 50 tokens

**round ten**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 50 tokens

TARGET REACHED

Payout:

A: 1.1 extra point B: 1.1 extra point C: 1.2 extra point

D: 1.2 extra point E: 1.2 extra point F: 1.2 extra point

**GAME TWO**

Stage one; before the game. Communication phase 1.

Stage two; contributions phase 1.

**round one**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round two**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round three**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round four**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round five**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

Stage three; communication phase 2.

Stage four; contributions phase 2.

**round six**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round seven**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round eight**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round nine**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round ten**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

TARGET NOT REACHED

Payout according to chance

A: 0 extra points B: 2 extra points C: 0 extra points

D: 0 extra points E: 0 extra points F: 2 extra points

## *Appendix 2B; Examples given to discount treatment*

**EXAMPLE**

Players A through F participate in this game. The information they were given at each stage is presented, along with their successive contributions.

**GAME ONE**

Stage one; before the game. Communication phase 1.

Stage two; contributions phase 1.

**round one**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 6 tokens

**round two**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 12 tokens

**round three**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 18 tokens

**round four**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 24 tokens

**round five**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 30 tokens

**Stage three; extra information.**

**From now on, all players' contributions to the target sum will be devalued by 20%.**

Stage four; communication phase 2.

Stage five; contributions phase 2.

**round six**

A: 0.8 token, B: 0.8 token, C: 0.8 token, D: 0.8 token, E: 0.8 token, F: 0.8 token

total sum: 34,8 tokens

**round seven**

A: 0.8 token, B: 0.8 token, C: 0.8 token, D: 0.8 token, E: 0.8 token, F: 0.8 token

total sum: 39,6 tokens

**round eight**

A: 0.8 token, B: 0.8 token, C: 0.8 token, D: 0.8 token, E: 0.8 token, F: 0.8 token

total sum: 44,4 tokens

**round nine**

A: 0.8 token, B: 0.8 token, C: 0.8 token, D: 0.8 token, E: 0.8 token, F: 0.8 token

total sum: 49.2 tokens

**round ten**

A: 0.8 token, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 50 tokens

TARGET REACHED

Payout:

| | | |
|---|---|---|
| A: 1 extra point | B: 1.1 extra point | C: 1.1 extra point |
| D: 1.1 extra point | E: 1.1 extra point | F: 1.1 extra point |

**GAME TWO**

Stage one; before the game. Communication phase 1.

Stage two; contributions phase 1.

**round one**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round two**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round three**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round four**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round five**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**Stage three; extra information.**

**From now on, all players' contributions to the target sum will be devalued by 20%.**

Stage four; communication phase 2.

Stage five; contributions phase 2.

**round six**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round seven**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round eight**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round nine**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round ten**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

TARGET NOT REACHED

Payout according to chance

| | | |
|---|---|---|
| A: 0 extra points | B: 2 extra points | C: 0 extra points |
| D: 0 extra points | E: 0 extra points | F: 2 extra points |

### *Appendix 2C; Examples given to unequal treatment*

**EXAMPLE**

Players A through F participate in this game. The information they were given at each stage is presented, along with their successive contributions.

**GAME ONE**

Stage one; before the game. Communication phase 1.

Stage two; contributions phase 1.

**round one**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 6 tokens

**round two**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 12 tokens

**round three**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 18 tokens

**round four**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 24 tokens

**round five**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 30 tokens

**Stage three; extra information.**

**to player A, it was revealed that they face a 40% chance of losing all of their tokens in case the target sum isn't reached.**

**to player B, it was revealed that they face an 80% chance of losing all of their tokens in case the target sum isn't reached.**

**to player C, it was revealed that they face a 40% chance of losing all of their tokens in case the target sum isn't reached.**

**to player D, it was revealed that they face a 60% chance of losing all of their tokens in case the target sum isn't reached.**

**to player E, it was revealed that they face a 60% chance of losing all of their tokens in case the target sum isn't reached.**

**to player F, it was revealed that they face an 80% chance of losing all of their tokens in case the target sum isn't reached.**

Stage four; communication phase 2.

Stage five; contributions phase 2.

**round six**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 36 tokens

**round seven**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 42 tokens

**round eight**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 48 tokens

**round nine**

A: 1 token, B: 1 token, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 50 tokens

**round ten**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 50 tokens

TARGET REACHED

Payout:

| | | |
|---|---|---|
| A: 1.1 extra point | B: 1.1 extra point | C: 1.2 extra point |
| D: 1.2 extra point | E: 1.2 extra point | F: 1.2 extra point |

**GAME TWO**

Stage one; before the game. Communication phase 1.

Stage two; contributions phase 1.

**round one**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round two**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round three**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round four**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round five**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**Stage three; extra information.**

**to player A, it was revealed that they face a 40% chance of losing all of their tokens in case the target sum isn't reached.**
**to player B, it was revealed that they face an 80% chance of losing all of their tokens in case the target sum isn't reached.**
**to player C, it was revealed that they face a 40% chance of losing all of their tokens in case the target sum isn't reached.**
**to player D, it was revealed that they face a 60% chance of losing all of their tokens in case the target sum isn't reached.**
**to player E, it was revealed that they face a 60% chance of losing all of their tokens in case the target sum isn't reached.**
**to player F, it was revealed that they face an 80% chance of losing all of their tokens in case the target sum isn't reached.**

Stage four; communication phase 2.

Stage five; contributions phase 2.

**round six**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round seven**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round eight**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round nine**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round ten**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

TARGET NOT REACHED

Payout according to chance

| | | |
|---|---|---|
| A: 2 extra points | B: 0 extra points | C: 2 extra points |
| D: 2 extra points | E: 0 extra points | F: 0 extra points |

### *Appendix 2D; Examples given to discount-unequal treatment*

**EXAMPLE**

Players A through F participate in this game. The information they were given at each stage is presented, along with their successive contributions.

**GAME ONE**

Stage one; before the game. Communication phase.

Stage two; contributions phase 1.

**round one**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 6 tokens

**round two**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 12 tokens

**round three**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 18 tokens

**round four**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 24 tokens

**round five**

A: 1 token, B: 1 token, C: 1 token, D: 1 token, E: 1 token, F: 1 token

total sum: 30 tokens

**Stage three; extra information.**

**to player A, it was revealed that they face a 40% chance of losing all of their tokens in case the target sum isn't reached.**
**to player B, it was revealed that they face an 80% chance of losing all of their tokens in case the target sum isn't reached.**
**to player C, it was revealed that they face a 40% chance of losing all of their tokens in case the target sum isn't reached.**
**to player D, it was revealed that they face a 60% chance of losing all of their tokens in case the target sum isn't reached.**
**to player E, it was revealed that they face a 60% chance of losing all of their tokens in case the target sum isn't reached.**
**to player F, it was revealed that they face an 80% chance of losing all of their tokens in case the target sum isn't reached.**

**From now on, all players' contributions to the target sum will be devalued by 20%.**

Stage four; communication phase 2

Stage five; contributions phase 2.

**round six**

A: 0.8 token, B: 0.8 token, C: 0.8 token, D: 0.8 token, E: 0.8 token, F: 0.8 token

total sum: 34,8 tokens

**round seven**

A: 0.8 token, B: 0.8 token, C: 0.8 token, D: 0.8 token, E: 0.8 token, F: 0.8 token

total sum: 39,6 tokens

**round eight**

A: 0.8 token, B: 0.8 token, C: 0.8 token, D: 0.8 token, E: 0.8 token, F: 0.8 token

total sum: 44,4 tokens

**round nine**

A: 0.8 token, B: 0.8 token, C: 0.8 token, D: 0.8 token, E: 0.8 token, F: 0.8 token

total sum: 49.2 tokens

**round ten**

A: 0.8 token, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 50 tokens

TARGET REACHED

Payout:

| | | |
|---|---|---|
| A: 1 extra point | B: 1.1 extra point | C: 1.1 extra point |
| D: 1.1 extra point | E: 1.1 extra point | F: 1.1 extra point |

**GAME TWO**

Stage one; before the game. Communication phase.

Stage two; contributions phase 1.

**round one**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round two**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round three**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round four**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round five**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**Stage three; extra information.**

**to player A, it was revealed that they face a 40% chance of losing all of their tokens in case the target sum isn't reached.**
**to player B, it was revealed that they face an 80% chance of losing all of their tokens in case the target sum isn't reached.**
**to player C, it was revealed that they face a 40% chance of losing all of their tokens in case the target sum isn't reached.**
**to player D, it was revealed that they face a 60% chance of losing all of their tokens in case the target sum isn't reached.**
**to player E, it was revealed that they face a 60% chance of losing all of their tokens in case the target sum isn't reached.**
**to player F, it was revealed that they face an 80% chance of losing all of their tokens in case the target sum isn't reached.**

**From now on, all players' contributions to the target sum will be devalued by 20%.**

Stage four; communication phase 2

Stage five; contributions phase 2.

**round six**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round seven**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round eight**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round nine**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

**round ten**

A: 0 tokens, B: 0 tokens, C: 0 tokens, D: 0 tokens, E: 0 tokens, F: 0 tokens

total sum: 0

TARGET NOT REACHED

Payout according to chance

| | | |
|---|---|---|
| A: 2 extra points | B: 0 extra points | C: 2 extra points |
| D: 2 extra points | E: 0 extra points | F: 0 extra points |

## *Appendix no. 3: compilation of debriefs gathered*

*Debrief responses of the participants of the original base treatment*

The format of the responses sent in by the participants differed slightly each time. To maintain their integrity, they have not been altered. If the questions were repeated before each answer, these were deleted; otherwise, the responses are exact copies.

From *Orange*

1. My teammates and I determined the strategy of contributing 1 token for each round until the 10th round where we all would contribute 0.
2. I did decide to change my strategy to where one round I contributed 0, and the next I contributed 2, because I was curious as to how it would impact the team and if it would be more beneficial for myself.
3. I do think that the first communication did help the team effort because we agreed on a team strategy, however I found that the second communication time was less effective and necessary.
4. I think our group succeeded to reach the target because we agreed on a strategy beforehand, and most of the team stuck to that strategy the entire time.
5. I expected more people to stray from the group strategy, and contribute 0, however that didn't happen and most of the players remained loyal to the original strategy.
6. I think the experiment went smoothly, however the Zoom cut off midway through the experiment so it was confusing, and I think it would be helpful for the organizer to send out a reminder during every round for people to submit responses.

From *Brown*

1) Since we had an opportunity to discuss our strategy before the game, we made a deal that everyone will contribute 1 point each round - that is how I determined my contribution.
2) I changed my strategy once as a response to the defection of two players, when I contributed 0 points, and the second time I did so to surely reach the goal of 50 tokens, when I contributed 2 points.

3) Cooperation certainly helped, for I suppose it would take us more time to come up with a strategy by looking at what others do and thus we may have not reached the goal. As it is said, communication is key :)
4) We succeeded first of all, because we had an opportunity to discuss our strategy, and second of all, because even after some of us defected, others wanted to reach the goal and thus kept contributing regardless of what others were doing.
5) Yes, I expected that we would reach 50 tokens in the end, even though my expectations were not that strong when some of us defected.
6) I honestly have no comments on what should be improved, since everything was fine.

From *Red*

1. At first I was planning to play my "own game" by giving the least amount of points as possible, but when the whole team decided to contribute equally, I followed their strategy of giving each 1 point every round.
2. Yes, when 2 players for the first time changed (or rather betrayed) strategy and decided to give 0 points, then I decided that it is a moment everything broke up and it is a "single-player game", so I contributed 0 points in the next round myself.
3. I would say definitely for the first time, but for the second it was more as a "controlling stage" than communicative. Also, the existence of 2 stages helped, I think, to reach the goal, as without communication (and maybe some control from the team) I would not give any points at all (so, the communication was something like a "watcher" for me).
4. Succeeded, as we had a strategy and people, who were ready to contribute to the result of the whole team more than the others (even if in the outcome they would receive fewer points)
5. I thought it would be more chaotic and there would be more zeroes))
6. Nothing.

From *Blue*

1. A big influencing factor was the document that was sent to us before the experiment itself (the instructions), which outlined one possible strategy - that was the strategy that I ended up suggesting to others before round 1.

2. I changed my strategy after round 5 (when no more communication rounds were left), in order to maximize the potential points I could be left with in the end, while still achieving 50 points overall as a team.

3. It did very much - without it, it would be a free-for-all, and the strategy we ended up sticking with (at least for the first half) would have never been possible.

4. We had the same goal in mind (after the suggestion, as mentioned above, during the first communication round), and we saw that we stuck with it for the first 5 rounds, therefore verifying that everyone else was on board with reaching the threshold as described.

5. It was one of the possibilities (or, probably the likeliest one after the first 5 rounds). Maybe I didn't expect another player to also join my strategy of "sabotaging" the group in round 6.

6. Maybe don't suggest possible strategies in the instructions document - could help the players develop their independent strategies, that could be different, or at least the game itself could play out differently (I get that it was there mainly as an example for the players to understand how the game is going to play out, but that could most likely be described without an explicit example in the document).

*Debrief responses of the participants of the discount treatment*

From *Zebra*

1. My initial thought was to suggest the people in the Zoom meeting to all give one point away, to first assess whether people would be cooperative. During the first conversation phase, it yet seemed that everyone was willing to act in a very cooperative way. We thereby all agreed on giving 2 points away for the first 4 rounds and then 1 point for the last round.

2. No

3. It did! Without communication, I think people (including me) would have tempted to act in much less cooperative way.

4. From the very beginning, we all agreed that the first priority was to reach the 50 point goal. Seeing that everyone continued giving two points away every round enabled to build trust.

5. To be honest, I wasn't sure how the experiment was suppose to model. Somehow I thought that one of the person on Zoom would be assigned the task not to follow what we had agreed on, and thereby test our (in)ability to reach this goal. But as the game continued, I was quite confident that we would succeed as a group.

6. I haven't used the option but I noticed that on Zoom we were able to speak to either "everyone" or individual people (animals). I know we were not allowed to discuss with fellow colleagues but I wonder whether this option could be blocked as well? This would hinder any extra-communication out of the official channel.

From *Penguin*

1. Reading the rules, I saw that with the 6 of us, we could reach the goal before the discount came into place, which I thought would be an effective strategy, since everyone had to contribute equally (until round 5 where only 2 people needed to give 1 point each to reach the goal of 50)
2. No, it wasn't needed. In round 5 I did contribute 1 point even though only 2 people needed to do it, but I did that just in case someone decided to not contribute anything, but we were so close to the goal it probably would have not changed anything.
3. Very much so. If there was no possibility of communication, the game would be much more chaotic, as I would have to gauge everyone's intentions just by looking at the spreadsheets of their contributions as the game progressed. With the communication, I declared my idea immediately and the rest of the participants caught on quickly too.
4. I think this declaration and realization of the strategy at the start helped massively, as well as everyone agreeing to it.
5. No actually. I was not sure if someone there would be trying to save some more points for themselves, but then again 1 token was only 0.2 points, so I think it was more valuable for everyone to cooperate rather than trying to gain something small like 0.8 points and then betraying the whole group.

6. I think you should remind all participants in the chat that communication is only permitted at the start and after round 5, some participants in our group missed that. But other than that I have no other complaints.

From *Dolphin*

I will answer as an essay rather than addressing each point so bear with me.

So the approach towards the game was a mix of both individual and group strategy. In this case it was important to take into consideration others opinion . In our case we could achieve the desired outcome well before time because there was this unspoken leadership when one of the teammates put forward an opinion we all agreed to and any difference was politely addressed and considered than vehemently denying it. There was clear communication about what was to be done and how best to approach the game and it helped that all of us stuck to what was decided hence we accomplished what we set out to. With group activities I have realised that having a strong democratic leadership even though an unspoken one in our case helps.

*Debrief responses of the participants of the unequal treatment*

From *Peach*

1. Based on the strategy we decided on in the beginning.

2. I once accidentally submitted an extra point.

3. Yes. If we didn't communicate prior I would've submitted less points in the beginning.

4. We succeeded because everyone decided to stick to the agreed plan all throughout the game.

5. I expected something to happen later on which would make it more difficult to cooperate (something that wasn't in the instructions)

6. I think the game was executed well overall.

From *Banana*

1. We as a group decided we would cooperate and all put in the same number of points. I saw no problem with that approach so contributed what we all agreed upon.
2. No we didn't even when the odds changed. This is because that really had no bearing on our strategy and we were fine with how our starters was going.
3. Yes it was pretty important to get everyone on the same page.
4. We were successful because we came up with a plan and everyone committed to that and didn't deviate.
5. Yes pretty much. I didn't think there would be many surprises.
6. Just clarity around the 50 point total. And if you are able to go over it without a penalty or not.

*Debrief responses of the participants of the discount-unequal treatment*

From *Lilly*

1. At first i was going with the original technique of contributing one per round but then when is trated realizinz that if we all contributed more we could finish sooner and get more tokens then i gave 2 per round.

2. Yes after the first round when i saw others contributing more i did so as well so we could finish before the last round.

3. It really did help us to finish sooner as we agreed on a startegy.

4. I think we succeeded due to good communication and understanding of where we were heading.

5. I didnt expect us to end before the last round so am happy we did it and cooperated through it.

6. If anything i think these factors where very useful as they put more pressure to make the best decision as a group. So in the end it was worth the effort.

From *Daffodil*

1. My main goal was to reach our common target, while ensuring that all of the teammates will equally participate with the same amount of assets.
2. Yes. Our main goal was to reach the target by round 5, however, when a couple of members did not donate the same of credits as the agreed upon, I resolved to 0 credits.
3. Definitely. It made our strategy clearer.
4. The main reason might be the promised extra credits. We shared a common goal, so we had to save as much as possible.
5. Not really. I thought we will have to answer some questions in order to get the points.
6. Probably some participants would have not shared any of their credit points at all.

From *Daisy*

1. Regarding the given instructions, I was trying to find the correct strategy for all of the members so we would get most of the points guaranteed.

2. After half of the game before the 5th round I was sure that we would never be able to complete our goal so I decided to play on my own and try to make the most of it while being able to gather as many points as possible.

3. I was hoping that by proving our contribution I could have made the group to make the most of it, however some of the players did eventually contribute more than they needed to.

4. I would say that in my opinion, the rules and principles of the game were explained, however not understood by all of the members.

5. The idea was in my honest opinion, that one could have risked all his points not to meet the goal while accepting the chance of 40% of losing them. On the other hand the safe option seemed better in our group and I would say that it is viable to be.

6. In our environment and group we were happy that we finished and did not lose the game so basically nothing would change.

*Debrief responses of the participants of the no examples reatment*

From *Green*

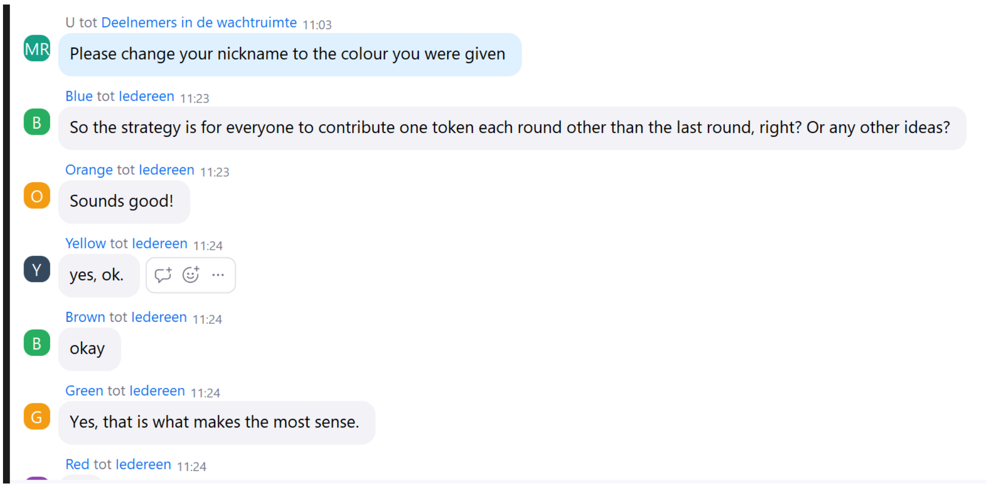
1. I thought for the fairest option is to contribute at least 8 points, but I was conservative at first to see, whether anyone else contributed more. When I reached 8 points, though we were missing a little of points, I did not want to sacrifice my points and hoped other would contribute more.
2. I actually wanted to contribute even less, but since I saw others contribute nothing, I decided to add a bit more
3. Yes, since we said in the beginning that each of us should contribute at least 8, I kept that in mind. But I think the communication should have been longer.
4. I think some were a little bit selfish and did not want to give up more points. Thus we have reached only 41.
5. I did not expect anything, though I was leaning more towards failure, as it seems that everyone was mainly looking out for themselves.

From *Red*

1. My plan was to get as many points as I could because I really needed them, while attaining the goal of 42 tokens as a group.
2. No
3. Yes to be sure that everyone was on the same page
4. We failed because blue decided to put only 7 tokens rather than 8
5.I thought we would reach the final target of 42 tokens and I would get additional credits

# *Appendix no. 4: communication transcripts (screenshots)*

## *Appendix 4A; Screenshots of the base treatment communication*


U tot Deelnemers in de wachtruimte 11:03
MR Please change your nickname to the colour you were given

Blue tot Iedereen 11:23
B So the strategy is for everyone to contribute one token each round other than the last round, right? Or any other ideas?

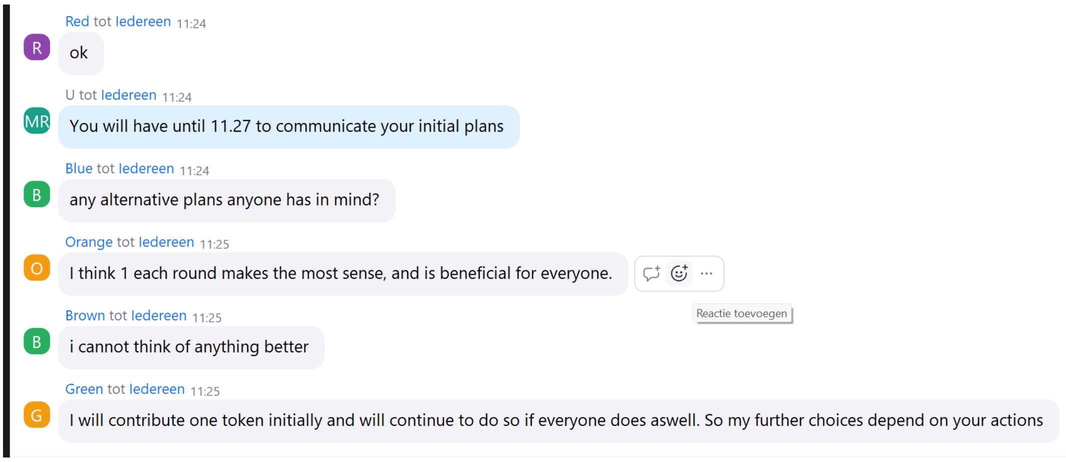
Orange tot Iedereen 11:23
O Sounds good!

Yellow tot Iedereen 11:24
Y yes, ok.

Brown tot Iedereen 11:24
B okay

Green tot Iedereen 11:24
G Yes, that is what makes the most sense.

Red tot Iedereen 11:24


Red tot Iedereen 11:24
R ok

U tot Iedereen 11:24
MR You will have until 11.27 to communicate your initial plans

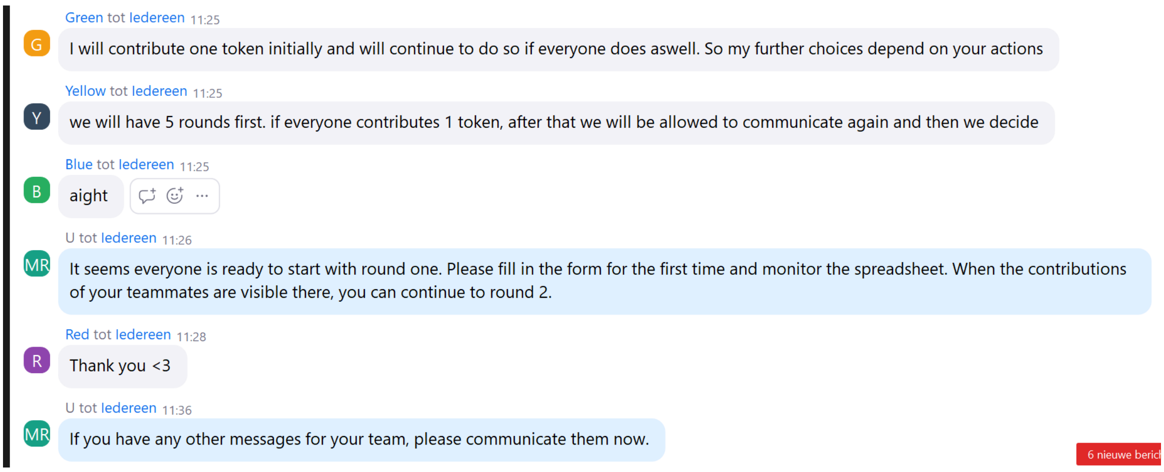
Blue tot Iedereen 11:24
B any alternative plans anyone has in mind?

Orange tot Iedereen 11:25
O I think 1 each round makes the most sense, and is beneficial for everyone.

Reactie toevoegen

Brown tot Iedereen 11:25
B i cannot think of anything better

Green tot Iedereen 11:25
G I will contribute one token initially and will continue to do so if everyone does aswell. So my further choices depend on your actions


Green tot Iedereen 11:25
G I will contribute one token initially and will continue to do so if everyone does aswell. So my further choices depend on your actions

Yellow tot Iedereen 11:25
Y we will have 5 rounds first. if everyone contributes 1 token, after that we will be allowed to communicate again and then we decide

Blue tot Iedereen 11:25
B aight

U tot Iedereen 11:26
MR It seems everyone is ready to start with round one. Please fill in the form for the first time and monitor the spreadsheet. When the contributions of your teammates are visible there, you can continue to round 2.

Red tot Iedereen 11:28
R Thank you <3

U tot Iedereen 11:36
MR If you have any other messages for your team, please communicate them now.

6 nieuwe berich

MR If you have any other messages for your team, please communicate them now.

Orange tot Iedereen 11:37
O I think we should just keep doing this, it seems to be working well.

Blue tot Iedereen 11:37
B well lads, time to continue the strategy, right?

Brown tot Iedereen 11:37
B right

Red tot Iedereen 11:37
R yes

Green tot Iedereen 11:37
G We will reach 48 Points, are there volunteers who are willing to contribute the two remaining Points afterwards? because otherwise we waste Points

Yellow tot Iedereen 11:37
Y we need a strategy because at the end somebody needs to choose 1, others 0

8 nieuwe berich

Yellow tot Iedereen 11:37
Y we need a strategy because at the end somebody needs to choose 1, others 0

Green tot Iedereen 11:37
G we will reach 48 in round 8

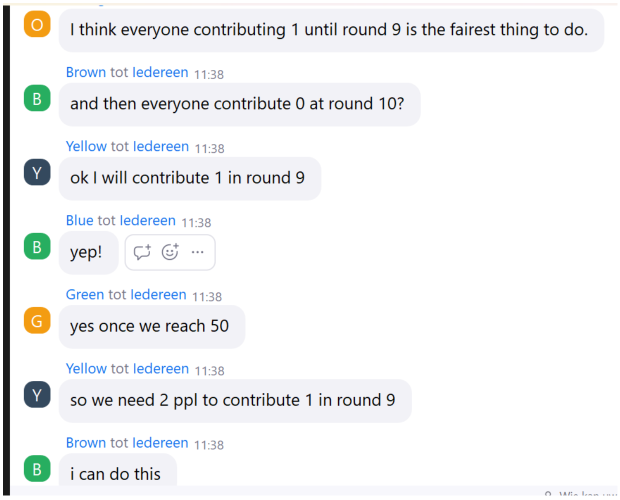
Blue tot Iedereen 11:37
B yeah, everyone might as well just contribute 1 in round 9 too

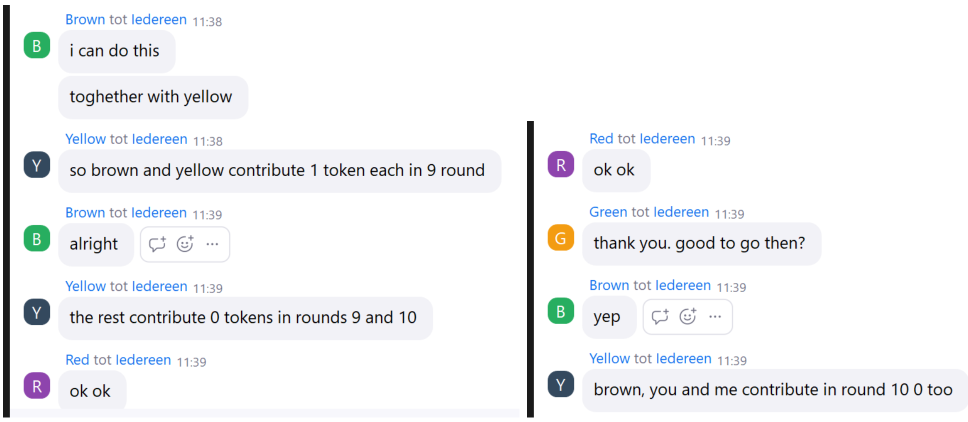
Green tot Iedereen 11:38
G Okay

Blue tot Iedereen 11:38
B there's not really a mechanism to distribute who would sacrifice themselves, right

Orange tot Iedereen 11:38
O I think everyone contributing 1 until round 9 is the fairest thing to do.

Brown tot Iedereen 11:38




## *Appendix 4B; Screenshots of the discount treatment communication*

Tiger tot Iedereen 11:16

Hello!

Parrot tot Iedereen 11:16

Hi!

Zebra tot Iedereen 11:16

Hello everyone!

Dolphin tot Iedereen 11:16

Hello

Tiger tot Iedereen 11:16

I think its better to start with contributing 2 points each at least in the first phase

since then there will be a discount factor

Penguin tot Iedereen 11:17

Hi, I think we can all easily get two extra points for all of our classes, if we all contribute 2 tokens before the discount comes into play

Penguin tot Iedereen 11:17

Hi, I think we can all easily get two extra points for all of our classes, if we all contribute 2 tokens before the discount comes into play

Alles samenvouwen ^ 👍 1

Fox 11:17

yes, i agree

Beantwoorden...

Penguin tot Iedereen 11:17

We can reach the goal before round six even

👍 1

Dolphin tot Iedereen 11:17

Agreed then we can decide as the game progresses

Dolphin tot Iedereen 11:17

Agreed then we can decide as the game progresses

Tiger tot Iedereen 11:17

And considering the nature of human, whenever someone will defect

or contribute 0

I guess everyone will start defecting then

I guess everyone will start defecting then

Penguin tot Iedereen 11:18

P Well I don't see why one would risk that for a 0.something extra points

Zebra tot Iedereen 11:18

Z I would have suggested we each contribute 1 token in the first round. This way, we could have assessed our collective participation and adjust our contributions accordingly but if you all agree on 2, than let's do that

Tiger tot Iedereen 11:18

T I mean lets try and see

T I mean lets try and see

I think its better 2

Fox tot Iedereen 11:19

F yeah, i would also start with 2

Parrot tot Iedereen 11:19

P I vote for 2 as well, just to have some headstart

Penguin tot Iedereen 11:19

P We cant communicate for the remainder of the first 5 rounds tho

Fox tot Iedereen 11:19

F btw. if everyone gives two for the first 4 rounds, we will have 48

Parrot tot Iedereen 11:19

P If someone decides not to contribute, we will still have to make 50 points even without her/him

P If someone decides not to contribute, we will still have to make 50 points even without her/him

Fox tot Iedereen 11:19

F and then for the fifth round everyone just gives 1 and we have 50

Alles samenvouwen

Penguin 11:20

P Yeah, I'd go with this

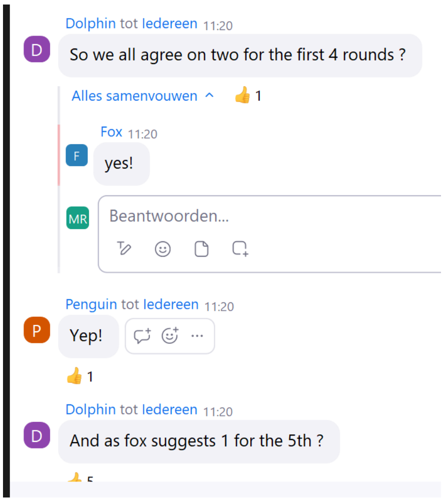
MR Beantwoorden...

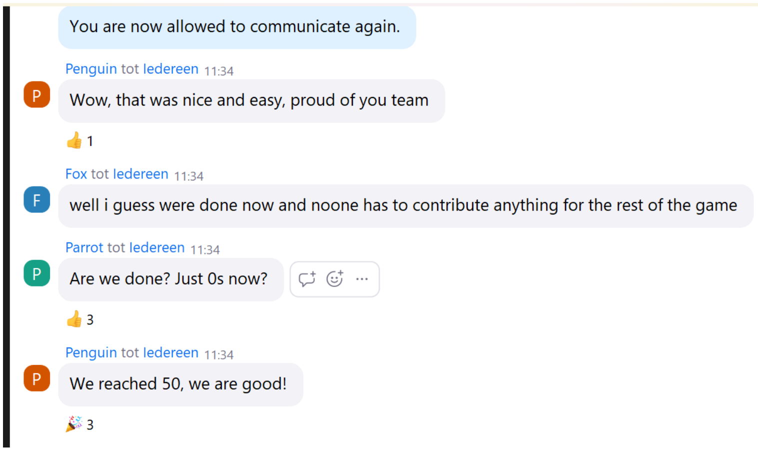
Tiger tot Iedereen 11:20

T yeah

Dolphin tot Iedereen 11:20

D So we all agree on two for the first 4 rounds ?




## *Appendix 4C; Screenshots of the unequal treatment communication*

U tot Deelnemers in de wachtruimte 12:17

MR Hey, please log out of zoom and rejoin the meeting with the nickname you've been sent

U tot Deelnemers in de wachtruimte 12:25

MR Hello

can you see this message?

Mango tot Iedereen 12:27

M Mango

Strawberry tot Iedereen 12:27

S Hello

Melon tot Iedereen 12:27

M melon

U tot Deelnemers in de wachtruimte 12:28

MR Hello

Hello

Apple tot Iedereen 12:28

A Let's collaborate everyone, we can all give 1 token for 8 rounds, (48 points) and in the last 2 rounds only two volunteers can give out a token. So we don't risk losing everything?

Melon tot Iedereen 12:28

M Seems reasonable

Strawberry tot Iedereen 12:28

S I had a similar plan

Apple tot Iedereen 12:28

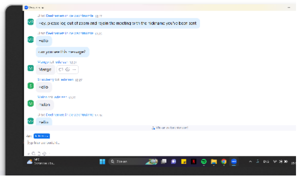
A 8 x 6 = 48, we need 50

U tot Iedereen 12:28

MR You can start communicating now

Apple tot Iedereen 12:28

A I volunteer to give one token at the end



Apple tot Iedereen 12:28

A I volunteer to give one token at the end

Banana tot Iedereen 12:28

B Sounds good

Mango tot Iedereen 12:28

M I volunteer to give 2 at the end

peach tot Iedereen 12:29

P I can also give 1 in the end

Apple tot Iedereen 12:29

A You only need to give 1 at the end

Strawberry tot Iedereen 12:29

S I don't mind giving a token or two at the end either

Apple tot Iedereen 12:29

A Mango and I maybe ?

Strawberry tot Iedereen 12:29

S I don't mind giving a token or two at the end either

Apple tot Iedereen 12:29

A Mango and I maybe ?

At the

Mango tot Iedereen 12:29

M Yes we can do that so for now collaborate with one right?

peach tot Iedereen 12:29

P sure

Melon tot Iedereen 12:29

M ok

Banana tot Iedereen 12:29

B ok

Melon tot Iedereen 12:29

ok

Banana tot Iedereen 12:29

ok

Apple tot Iedereen 12:29

Yes

Strawberry tot Iedereen 12:29

Sounds good

U tot Iedereen 12:30

You have one more minute to communicate. After, do not communicate until I allow you to. I will send a r in.

👍 1

U tot Iedereen 12:30

You have one more minute to communicate. After, do not communicate until I allow you to. I will send a message when round one can be filled in.

👍 1

Apple tot Iedereen 12:30

Keep the collaboration guys!

❤️ 3

Melon tot Iedereen 12:31

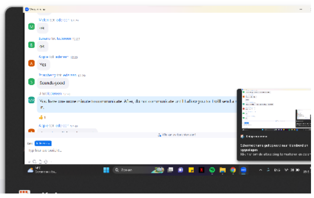
We fill in the google spreadsheet right?

Mango tot Iedereen 12:31

I believe we send via forms and we gonna see reflected on sheets

U tot Iedereen 12:31

No, fill in the google form. the results will be displayed on the spreadsheet



Wie kan uw berichten zien?

U tot Iedereen 12:31

No, fill in the google form. the results will be displayed on the spreadsheet

Melon tot Iedereen 12:31

Ok thx

U tot Iedereen 12:32

please fill in the form for round one.

👍 3

U tot Iedereen 12:34

please fill in the form for round two

👍 3

U tot Iedereen 12:35

please fill in the form for round three

U tot Iedereen 12:39

MR Please, take a look at the margins given in the sheet. They refer to the chances that player faces that they lose the endowment if the target is not reached. Please, communicate for a couple of minutes about your strategy.

Apple tot Iedereen 12:39

A I think we should still collaborate, my margin is lower 40% but I still think collaboration is best for everyone

Melon tot Iedereen 12:40

M Am I the only one that can't see changes in the spreadsheet?

Mango tot Iedereen 12:40

M I can see the changes, also the margins are at the very beginning of the spreedsheet

Apple tot Iedereen 12:40

A I can see it

Banana tot Iedereen 12:40

B I can see it

Banana tot Iedereen 12:40

B I can see it

Mango tot Iedereen 12:40

M I believe can can keep cooperating

U tot Iedereen 12:40

MR You should see contributions appear after each round, and margins in front of nicknames

Mango tot Iedereen 12:41

M I mandating my compromise to offer an extra point

Strawberry tot Iedereen 12:41

S We should keep cooperating,

Apple tot Iedereen 12:41

A Yes let's keep cooperating

A Yes let's keep cooperating

Banana tot Iedereen 12:41

B Yes lets keep on cooperating

👍 1

peach tot Iedereen 12:42

P also ok with it

Apple tot Iedereen 12:42

A I'll give 2 points next round so if we all keep giving one after this we can reach 50

As peach already gave 2 on the second round

U tot Iedereen 12:43

U tot Iedereen 12:43

MR You have one more minute to communicate. After, if you haven't yet, fill in your contribution for round 6. After this, communication is not allowed anymore

Melon tot Iedereen 12:43

M It has to be 50 or more right? Not exactly 50

Strawberry tot Iedereen 12:44

S But we should reach 50 and not over, right? So after we reach the goal, let's start contributing. Zero

Melon tot Iedereen 12:44

M Ohh ok

Strawberry tot Iedereen 12:44

S I don't know haha

Mango tot Iedereen 12:44

M Good question, after 50 we star contributing 0?

Mango tot Iedereen 12:44

Good question, after 50 we star contributing 0?

Alles samenvouwen

Strawberry 12:44

I say we keep it safe

Beantwoorden...

Apple tot Iedereen 12:44

Yes but if I'm the only one contributing now with 2 we can all just keep giving 1 in all rounds

Melon tot Iedereen 12:44

My problem is that I can't actually see changes in the spreadsheet

Ok I will just keep giving 1 then

Melon tot Iedereen 12:44

My problem is that I can't actually see changes in the spreadsheet

Ok I will just keep giving 1 then

Apple tot Iedereen 12:45

At the moment we have 31 points

For round 5

We can get 7 more in round 6 if I give 2

U tot Iedereen 12:45

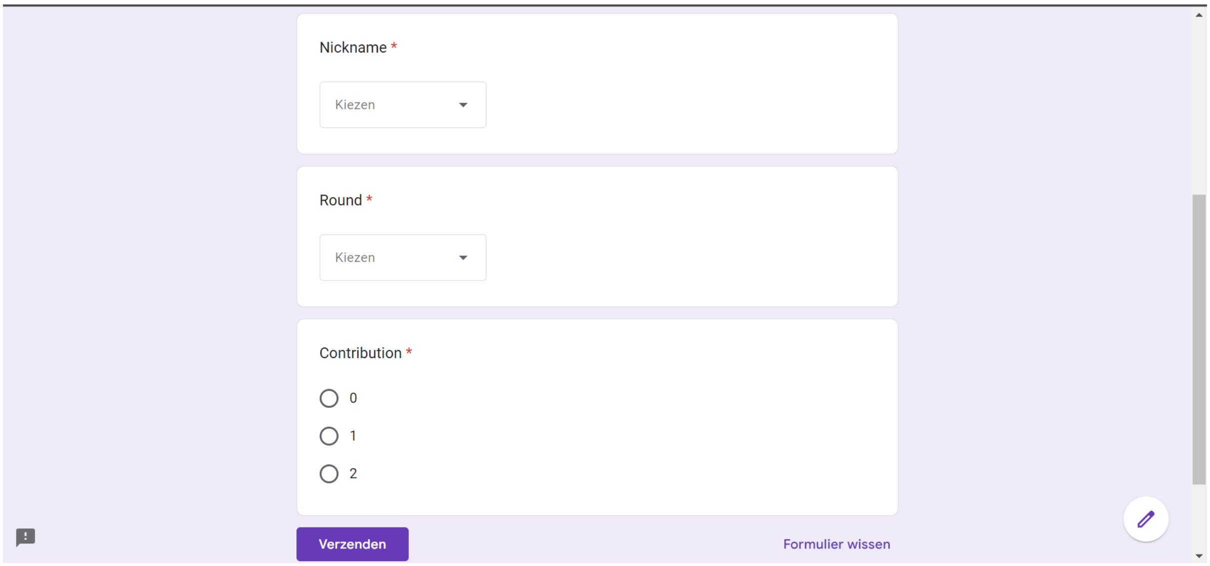
please, stop communicating and fill in the form for round 6.

👍 1

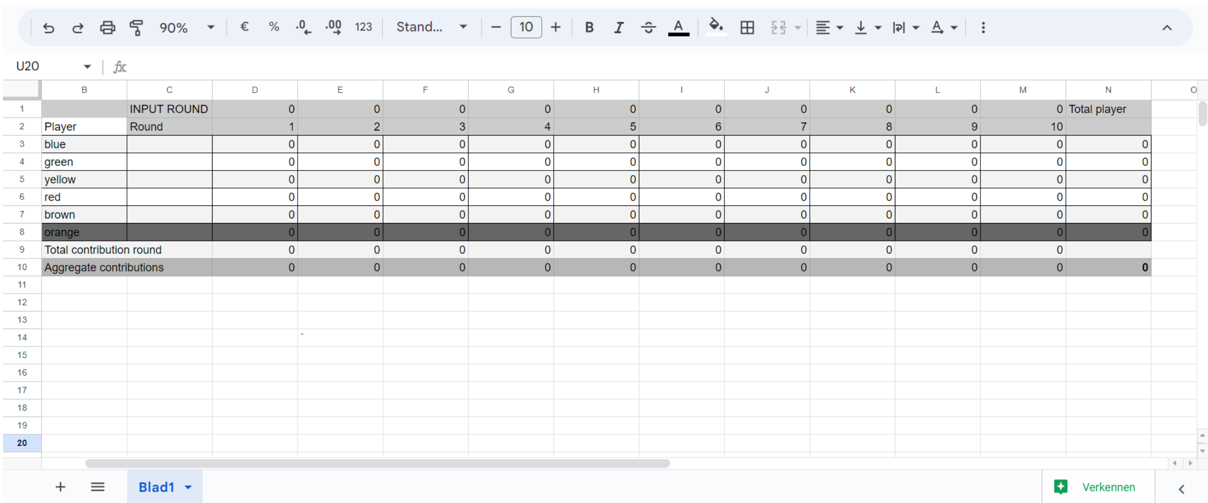
U tot Iedereen 12:47

Please, fill in the form for round seven

## *Appendix no. 5: software use (screenshots)*




Example of answer form. This form was to be filled in ten times by each participant for every game.




| | B | C | D | E | F | G | H | I | J | K | L | M | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | INPUT ROUND | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Total player |
| 2 | Player | Round | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| 3 | blue | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | green | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | yellow | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | red | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | brown | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | orange | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Total contribution round | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 10 | Aggregate contributions | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |

Example of blank results form. As the game progressed, results would appear once the host would fill in the corresponding INPUT ROUND number in the original sheet (Sheets shown here and shared with participants are the exported files.)