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Structuring communication effectively for environmental cooperation

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STRUCTURING COMMUNICATION EFFECTIVELY

FOR ENVIRONMENTAL COOPERATION

Ann-Kathrin Koessler^{1, 2}, Juan Felipe Ortiz-Riomalo², Mathias Janke², Stefanie Engel²

Abstract

Many environmental problems represent social dilemma situations where individually rational behaviour leads to collectively suboptimal outcomes. Communication has been found to alleviate the dilemma and stimulate cooperation in these situations. Yet, the knowledge of what type of information needs to be shared to ensure the beneficial effect is still incomplete. Previous research relies on *ex post* methods, i.e. after conducting an experiment researchers analyse what information was shared during the communication phase. By nature, this *ex post* categorization is endogenous. In this study, we aim to identify the elements of effective communication *ex ante* and evaluate their impact in a more controlled way. Based on the findings of previous studies, we identify four cooperation-enhancing elements of communication: (i) problem awareness, (ii) identification of strategies, (iii) agreement, and (iv) ratification. In a laboratory experiment with 560 participants, we implement interventions representing these components and contrast the resulting levels of cooperation with the outcomes under free (unstructured) or no communication. We find that the intervention facilitating agreement on a common strategy (combination of (ii) and (iii)) is particularly powerful in boosting cooperation. And if this is combined with interventions promoting problem awareness and ratification, similar cooperation levels as in settings with free-form communication can be reached. Our results are relevant not only from an analytical perspective, but also provide insights for effectively structuring communication in participatory processes aimed at improving environmental outcomes.

Keywords: social dilemma, public good, effective communication, cooperation, participatory process, deliberation, deliberative processes

JEL classification: C71, C92, H41, Q48, Q59

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1. INTRODUCTION

Many environmental problems represent social dilemma situations where individually rational behaviour leads to collectively suboptimal outcomes. A long tradition in social science research examines how cooperation can be facilitated and sustained in such situations. One finding in this stream of literature is that communication between the involved actors can promote cooperation (Balliet, 2009; Chaudhuri, 2011; Ledyard, 1995; Sally, 1995). Existing studies examine *why* communication enhances cooperation (Kerr & Kaufman-Gilliland, 1994). A first explanation is that communication promotes the emergence of cooperative social norms (which constrain the socially acceptable action space) (Bicchieri, 2002). A second explanation is that communication facilitates the emergence of a group identity, and that the resulting sense of belonging activates social preferences (Dawes, Van De Kragt, & Orbell, 1988; Orbell, van de Kragt, & Dawes, 1988). Finally, a third explanation is that communication helps actors to coordinate their beliefs, which is particularly powerful when the majority of actors are conditional co-operators (Cardenas, Ahn, & Ostrom, 2004; Chaudhuri, Paichayontvijit, & Smith, 2017).

But *what information*, when exchanged during the communication process, fosters cooperation? This question ties back to the definition of communication. With the origin in the Latin word *communicare* – to share – communication is understood as “a process by which *information* is exchanged between individuals through a common system of symbols, signs, or behaviour” (Merriam Webster, 2019). Typically, in social science experiments on communication, subjects exchange messages face-to-face or through an open text chat. In order to understand why the ‘black box’ of communication improves cooperation, researchers then analyse *ex post* the content of the conversations and categorize the messages exchanged during the communication phase (Pavitt, McFeeters, Towey, & Zingerman, 2005). By nature, this *ex post* categorization is endogenous (Janssen, 2013; Ostrom, Walker, & Gardner, 1992; Schill, Wijermans, Schlüter, & Lindahl, 2016). Hence, existing research can only provide hints about what kinds of information promote cooperation when shared.

In this study, we aim to identify the elements of effective communication and evaluate their impact in a more controlled way. We do not focus on which **channels** – such as group identity, social norms, social preferences, etc. – drive cooperation after communication, but we examine **what information** when shared during a communication phase promotes cooperation. For this

purpose, we take an *ex ante* approach. We start our study with a review of social dilemma studies which implemented free form communication and analysed *ex post* the content of the messages. Based on these studies, we identify four *information elements of communication* which have been recurrently listed as potentially important to promote cooperation, namely, *problem awareness*, *identification of strategies*, *agreement* and *ratification*. We then develop experimental interventions which represent these four information elements and test their impact on cooperation in a public good game. Through the controlled nature of a laboratory experiment, we can track the changes in individuals' behaviour following the elements implemented. Lastly, we contrast the performance of our interventions against two settings: no communication and free communication. We find that the intervention which facilitates agreement on a common strategy (*identification of strategies + agreement*) has the strongest effect on cooperation. Combined with the intervention promoting problem awareness and ratification, high levels of cooperation can be reached which are similar to what we observe under free communication.

Why is it important to identify the elements of effective communication? First, our findings contribute to the understanding of communication in social dilemma situations, especially regarding the question *what information* when shared fosters cooperation. This, in turn, may contribute to the widely discussed question *why* communication enhances cooperation. Second, we show that by offering mechanisms which resemble the basic elements of effective communication the cooperation-enhancing effect can (almost) be replicated. But, our mechanisms allow us to control what information is shared and with whom. This structured approach may be advantageous when (i) actors involved in the social dilemma are numerous, (ii) not all actors involved have the courage or power to speak up, (iii) factors concerning the social dilemma are complicated, and when (iv) meetings are time consuming, because they are poorly structured or organised, or logistically difficult. These conditions are prevalent in many environmental problem situations. In fact, the elements of effective communication we have identified bear a strong resemblance with methods used in *participatory processes*. For example, in the context of natural resource management, the social dilemma structure is highly prevalent and participatory processes are frequently implemented to raise problem awareness, build shared understanding, and to promote collaboration and coordination (Bodin, 2017; Dietz, Ostrom, & Stern, 2003; Reed, 2008). Less agreement, however, exists on how to best structure the participatory process (e.g. Beierle & Cayford, 2002; Reed, 2008; Von Korf, D'Aquino, Daniell, & Bijlsma, 2010). Our study contributes to this discussion by assessing the effectiveness

of different elements of effective communication and their combination in promoting cooperation.

The remainder of this paper is organized as follows. In Section 2 we review the insights from previous studies on communication and derive the cooperation-enhancing elements of effective communication. In Section 3 we describe our experimental design and implementation. We present and discuss our experimental results in Section 4 and summarize our conclusions in Section 5.

2. FOUR ELEMENTS OF EFFECTIVE COMMUNICATION

As stated above, a common way to analyse the content of communication is by examining the protocols of the discussion *ex post*. The aim of this analysis is to identify what information participants shared during the communication phase and hence understand what might drive the cooperation-enhancing effect of communication. Typically, researchers bundle and encode the recorded messages according to different information categories. The following section summarizes and describes the four information categories we encountered when reviewing the literature. Our review encompasses those social dilemma studies which have analysed the content of free communication, reported the coding results in the paper, and were available at the time of our review.

1.1. PROBLEM AWARENESS

At the beginning of a communication phase, it is observed that participants try to find a common understanding as a basis for the following discussion. Brosig et al. (2003) describe problem awareness as the first of three steps in which misunderstandings in a communication phase are clarified to ensure that the *“dilemma structure (is) common knowledge”* (p. 226). Pavitt et al. (2005) assign eight to 13 percent of their recorded information units, depending on the treatment variation, to the category *“Game understanding: Discussion relevant to the rules of the game, with the general intent of increasing game players’ understanding of how the game is played.”* A further four to six percent, depending on the treatment variation, were assigned to the information category *“Past or practice round: Discussion relevant to what occurred during past rounds in the game or during the practice round”* (pp. 352). Brandts et al. (2016) report that 42 to 50 percent of the group leaders in their experiment sent at least once a message to their group with *“content of comprehension”* like an *“[o]bservation of decline”* (p. 812) of the cooperation rate or *“[o]bservations*

of followers undercutting" (p. 812). Finally, Lopez and Villamayor-Tomas (2017) categorise 45 percent of the total of 1,493 messages recorded to the two information categories "*Game dynamics*" and "*Past result and actions*", with the former taking into account descriptions of free riding or "[s]tatements describing the dilemma between individual appropriation and group gains" (p. 73).

Taken together, messages in these categories describe the situation players found themselves in and aim at creating a common understanding of the game and the consequences of single actions.

1.2. STRATEGIES

In order to overcome the identified problem, participants subsequently communicated about how to address the social dilemma, i.e., they identified strategies. Lopez and Villamayor-Tomas (2017) assign 22 percent of their messages to the category "*Collective strategy*" or "*Individualistic strategy* [:] *Statements pointing to strategies wherein each participant decides what to do independently from other participants' decisions*" (p. 73). Pavitt et al. (2005) report that six to seven percent of the identified information units fit into the category "*General strategy: Discussion relevant to the general strategy to be used in subsequent rounds.*" (p. 352), while 52 to 57 percent include information on a "*[s]pecific strategy: Discussion relevant to specific proposed strategies; i.e., proposals including specific numbers of points to be harvested.*" (p. 352) and six to nine percent include "[s]tatements that ask for or are part of calculations relevant to proposals, along with acknowledgments following those statements." (p. 352). Koukoulmelis et al. (Koukoulmelis, Levati, & Weisser, 2012) formed a very similar category "*Payoff calculation: Calculation of the (period or overall) payoff associated with the proposal.*" (p. 386) and found that 67 to 78 percent of the team leaders in their experiment sent at least once a message containing such a calculation to their fellow team members. Brandts et al. (2016), in turn, adopted the coding scheme of Koukoulmelis et al. and found that payoff calculations occurred less frequently, that is only 42 percent of the team leaders sent at least once a calculation to their team members.³ Similar to the calculation category, Pavitt et al. (2005) formed an additional information category describing the results

³ Koukoulmelis et al. (2012) and Pavitt et al. (2005) use the term 'proposal' to refer to a strategy that a participant considers appropriate in the given situation.

of the individual proposals, *“Elaboration: Non-evaluative statements about previously offered proposals and their consequences”*, which occurred in 28 percent of their information units.⁴

In summary, two major topics are nestled within the categories above: First, strategies are formulated. Second, participants elaborate on the consequences of these strategies, specifically by calculating the resulting payoffs. The high observed frequencies suggest that the formulation and elaboration of strategies is an important element in communication which aims to solve the social dilemma. And, it forms the basis for the following step: the coordination.

1.3. AGREEMENT

After the strategies are described, participants made proposals to agree about what strategy is most favoured within the group. Here, Lopez and Villamayor-Tomas (2017) consider the following information categories, *“Evaluation”*, *“Proposal: Statements suggesting a strategy to be followed in the subsequent rounds of the experiment”* and two categories describing associated approval or disapproval named *“Positive maintenance”* and *“Negative maintenance”* (p. 74). These four categories were observed in six to 16 percent of all messages, respectively. Pavitt et al. (2005) distinguish between the information category *“Evaluation: Statements that ask for or provide explicit or implicit acceptance or rejection of the proposal under consideration, or asks for an evaluation”* and *“Suggestion: Statements that introduce or ask for a proposal, along with acknowledgments following those statements”* (p. 352), 11 percent of the information were identified to belong to these two categories. Also, Koukoulmelis et al. (Koukoulmelis et al., 2012) observed that 94 percent of the leaders in their experiment sent at least once a *“[s]uggestion (point or interval) of how much to contribute to the project”* and 78 to 83 made at least once an *“[e]fficient suggestion: Implicit or explicit suggestion to contribute the whole endowment”* (p. 386). Following Koukoulmelis coding, Brandts et al. (2016) find that 83 to 91 percent of the leaders made at least once a suggestion and 36 to 42 percent an efficient suggestion.⁵ Brosig et al. (2003) describe that *“some subjects first observed that it would be best if all group members contribute their whole endowment in every round.”* (p. 225).

⁴Payoff calculations are also mentioned in other papers. Ostrom et al. (Ostrom et al., 1992), for example, conclude that the participants in their experiment focused on two tasks; *“calculat(ing) coordinated yield-improving strategies”* and *“determining the maximal yield available”* (p. 410). Also, Cardenas et al. (Cardenas et al., 2004) find that participants calculate the outcome of different strategies to clarify *“to all group members that a lower level of aggregate extraction can increase individual earnings”* (p. 275). And Brosig et al. (2003) state that a typical communication phase incorporated that *“the payoffs for full cooperation were computed and, qualitatively or quantitatively, compared to payoffs that would follow after no cooperation. In addition, some groups computed the maximal individual payoff from free-riding.”* (p. 225).

⁵ However, they also find that in 50 to 73 percent of all communication phases, depending on the treatment condition, participants demanded to maximize the group payoffs. Thus, it is one thing to call for maximizing group payoff and another to identify the maximizing strategy.

Finally, Bochet et al. (2006) find that *“about a quarter of substantive messages are concerned with discussion of what the best strategy would be”* (p. 21).

Overall, in the component *agreement*, participants *evaluated* the previously defined strategies and made *proposals* about which of the strategies should be implemented in the group. In the discussions, participants tried to *agree* upon the most favoured strategy.

1.4. RATIFICATION

Agreeing on the most favoured strategy does not automatically imply also implementing it. The ratification category captures whether communication is used to *“devise verbal agreement [were given] to implement these strategies”* (Ostrom et al., 1992). This communication element is regarded as an important factor in facilitating cooperation (Kerr & Kaufman-Gilliland, 1994; Orbell et al., 1988; Sally, 1995). Cardenas et al. (Cardenas et al., 2004) state that an *“agreement or ratification of the need for every player to choose a low level of extraction”* is the second of two steps to *“build an effective agreement for co-operation”* (p. 275). In line with this, Bochet et al. (2006) find that beside those messages which were posed to identify the most favourable strategy *“most of the remaining messages [were] statements of commitment to the common strategy”* (p. 21). Brosig et al. (2003) even state that promises were made in *all* groups of their experiment: *“In this group all subjects promised to fully cooperate until round 9; in all other groups all subjects promised to cooperate (either explicitly in all rounds or not).”* (p. 226). But promises were not in all studies so frequent. Pavitt et al. (2005) find that only three to four percent of their information units categorise as *“Confirmation: Statements that either state the decision in its final form or ask for or provide an explicit group acceptance of a proposal.”* (p. 352). In Koukouvelis et al. (2012) a *“Promise: Pledge to contribute some specific amount.”* (p. 386) was made at least once by eleven percent of the leaders, while Brandts et al. (2016) detected that 18 to 25 percent of their leaders made such a promise. In summary, participants express in this final element their intention to abide by the previously reached agreement. The way in which this public commitment takes place varies from group to group, depending on the specific dynamics of their communication process.

Taken together, all previous studies that examined the communication content ex post identified problem awareness, identification of strategies, agreement on a common strategy and ratification as important contributors for the positive impact communication can have on cooperation in social dilemmas. This observation is particularly interesting when one takes into account that the studies employed different designs and framings. Koukouvelis et al. (2012)

and Brandts et al. (2016), for example, allowed only one actor, the leader, to communicate via written messages in a public good game, whereas in Pavitt et al. (2005) and in Lopez and Villamayor-Tomas (2017) all group members in the associated common pool resource game could communicate and did so face-to-face. Furthermore, the studies were conducted in culturally different locations and used different categorization and coding schemes. Figure 1 summarizes the four elements and indicates their typical chronological sequence in communication protocols.

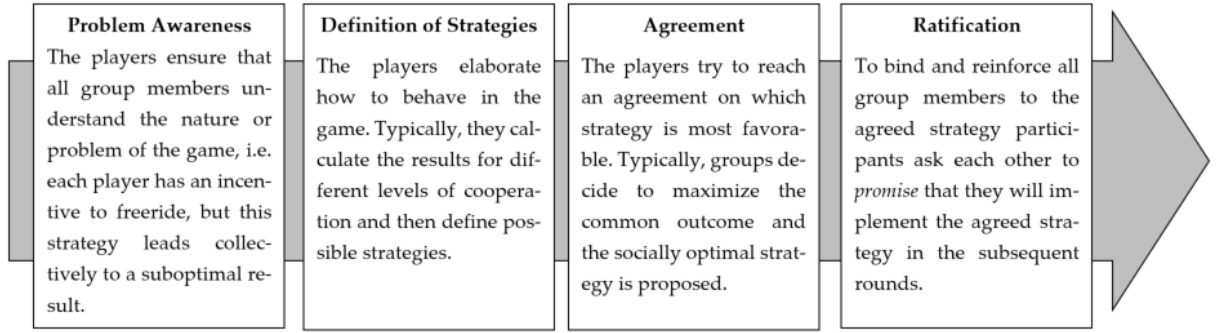


Figure 1: The four elements of communication when solving a social dilemma (rectangular fields). The arrow in the background indicates their typical chronological sequence.

3. EXPERIMENTAL DESIGN AND IMPLEMENTATION

Our experimental design is built on a two-stage design. In the first stage, participants are randomly assigned to groups of four and play ten rounds of a standard linear public good game (see Ledyard, 1995). The payoff structure is $\pi_i = 20 - g_i + 0.4 \sum_{j=1}^4 g_j$. After each round, participants receive feedback on the sum of total contributions to their group project, the average contribution of the other players and their own potential payoff from this round. At the end of the experiment only one round of each stage is randomly selected to determine the actual payment.

After the tenth round, participants learn that the first stage of the experiment is over and that the second stage will employ the same game as before. We have chosen to keep the group composition across the two stages constant. Although this design decision potentially reduces the magnitude of our treatment effects, in all applications for which our results may have implications, such as participatory processes in natural resource management, actors have a history of interactions. In the analysis we will control for exactly this previous levels of cooperation.

Groups in the control group *No Communication* start directly after this information with the second set of ten rounds of the public good game. Groups assigned to the treatment groups, in contrast, receive the treatment-specific information before starting with the second stage of the game. The treatments consist of a mechanism resembling one or a combination of the identified elements of effective communication: (a) *problem awareness*, (b) *identification of strategies*, (c) *agreement*, and (d) *ratification*. We also implement a treatment ‘Free communication’, in which participants could, like in previous studies, communicate through an open text box with their group members. The chat was open for 10 minutes and messages sent were visible to all group members.⁶ In the following, we describe how we implemented each of the four information elements of effective communication in our treatments.

1.5. PROBLEM AWARENESS

In the treatment *Problem Awareness (PA)*, subjects were first confronted with their group’s behaviour in stage 1: a chart delineated how their groups’ total contribution to the project developed over the first ten rounds (see Figure 1 in the appendix). Afterwards, a stylized curve was displayed showing the typical decay of contributions commonly observed in public goods games (see Figure 2 in the appendix).⁷ This second graph was accompanied by a text explaining why the curve was downward sloping. The explanation highlighted that participants, who are not willing to accept free riding, commonly decrease their contributions when they detect that there are free-riders among their group members. In consequence, contributions deteriorate over time.

In an actual communication process, one actor may describe how total contributions to a project developed in recent times and explain why this trend is unsustainable. Or, in a participatory process, stake-holders may derive these points themselves under professional facilitation and hence create *problem awareness*.

1.6. STRATEGIES

For the identification of strategies we presented to the participants three potential ways on how to contribute to the public good: (i) the *socially optimal* strategy, i.e., all group members contribute their entire endowment to the project, (ii) the *self-interested* strategy, i.e., all group

⁶ In the treatment combining all four elements (*Problem Awareness + Strategy + Agreement + Ratification*) participants needed on average 10 minutes to pass through the treatment stage. This is why the chat time in ‘Free Communication’ was 10 minutes.

⁷ We used a graph similar to the one used in Brandts et al. (2016)’s treatment.

members contribute nothing to the project, and (iii) a *laissez-faire* strategy, where the group members contribute to the project whatever they want.

In an actual group discussion, actors might name possible strategies and then jointly evaluate each strategy – for instance, by comparing the payoffs resulting from each strategy. In our experiment, we allowed for this evaluation by visualising the individual and group payoffs resulting from each strategy. The participants could look at the visualisation of each strategy as often as they liked to. (Please see the appendix for a detailed description of the scenarios and the screenshots, Figure 3).

1.7. AGREEMENT

After participants could make themselves familiar with the potential consequences of the three strategies, they were directed to a voting stage in which participants were asked which strategy they would like to see implemented in their group. Because it is not possible to vote on strategies before first learning about them, we implemented the *Agreement* element always in combination with the *Strategies* element. With help of a multistage voting mechanism, the groups could agree on what strategy was the most favourable. If the four group members agreed unanimously on the socially optimal strategy in the first vote, the group moved on with the experiment. If this was not the case, then the group members learned the voting result and were asked to take a second vote. Thus, the participants are encouraged to rethink any choice that is not socially optimal. We have implemented this weak normative feature due to the similarity of our elements to participatory processes. These processes usually have the aim to facilitate agreements at the socially optimal levels, or at least an improvement of the current situation.

After the second vote, participants received again feedback on the voting result. If the voting behaviour was stable, that means all group members voted exactly the same way as they did before, the group moved on. If, in contrast, at least one group member changed her voting behaviour, the group was asked to vote for a third and last time. Subsequently, the voting result was shown and the group was directed on. (Please see the Figure 5 in the appendix, for an illustration of the voting mechanism).

In an actual communication phase, the agreement represented by our voting stage may take place in discussions about how to best address the social dilemma. By being confronted either with voting results or others' contribution to the discussion, subjects learn about the preferences of their fellow group members. This information is likely to change actors' expectations about

the behaviour of the other actors and this potentially alters the behaviour (due to the principle of conditional cooperation).⁸

1.8. RATIFICATION

In our experiment, the *Ratification* element only became active when the majority of the group members voted previously for the socially optimal strategy and naturally could only be implemented in combination with the other three elements. The implementation followed a mechanism developed by Koessler et al. (2018): First, subjects were asked whether they wanted to promise that they will follow the socially optimal strategy in all rounds of the following game. If they agreed, they had to key-in the following statement: “I promise to contribute 20 points in all subsequent rounds.” (see Figure 6 in the appendix). Previous research has shown that engaging individuals pro-actively in the act of promise-making induced a higher commitment to the promised behaviour (Kiesler, 1971). After all group members made their decision about the promise, feedback was provided on which group members made the promise. Then the second stage of the experiment started. Table 1 summarizes all treatments and outlines the respective elements of effective communication we have implemented in each treatment group.

⁸ To illustrate the impacts of learning about others’ viewpoints, participants in our experiment were asked to vote again. If the voting behaviour remained the same, the experiment moved on. In an actual participatory process, the participants would stop discussing the topic and move on. On the contrary, if a change in viewpoints is observed, group members would be expected to go on with the discussion and try to reach a stable agreement. In our experiment this corresponds to one more round of voting. For practical reasons, we did not implement further rounds of voting after that, although in reality, there may well be multiple more iterations.

Table 1: Treatment overview

Treatment	Description	Observations	Groups
No Communication	Control	80	20
Problem Awareness (PA)	Understanding the social dilemma	80	20
Strategies	Identification & exploration of strategies	80	20
Strategies + Agreement	Adds agreement via voting	80	20
PA + Strategies + Agreement	Combination of the 3 elements	80	20
Full Set	Combination of all 4 elements	80	20
Free Communication	Open chat	80	20
TOTAL		560	140

The experiment was conducted at the experimental laboratory of the University Osnabruck using the experimental software SOPHIE (Hendriks, 2012). Subjects were students recruited from the local database of potential subjects via ORSEE (Greiner, 2015). Average earnings were 9 € and one session lasted about 45 minutes. In total, we conducted 33 sessions with a total of 560 subjects. The appendix contains descriptive statistics across treatments.

1.9. IDENTIFICATION STRATEGY

Our treatment conditions allow us to evaluate how the four elements change the consequent cooperation behaviour. By their nature, some mechanisms representing the four information elements of effective communication could only be implemented in combination. For example, an agreement by voting on the most favourable strategy requires that the available strategies are previously known, and a common strategy can only be ratified if it has been established in advance.

In the experimental evaluation, we can probe whether the four elements which have been identified by previous studies as cooperation-enhancing, are indeed beneficial. The conditions *No communication* and *Free Communication* serve hereby as controls for both ends of the spectrum, that is no communication and free, unstructured communication. Against the resulting cooperation levels in these conditions, we can assess what impact our structured

elements of effective communication have, individually (for *PA* and *Strategies*) and in combination (*PA* + *Strategies* + *Agreement* and *Full Set*).

With our two stage design, we can assess how groups change their cooperation levels after being treated with one or more structured elements, while controlling for the group's baseline cooperation level. Specifically, we formulate the following hypotheses: Our interventions mimicking effective element of communication have a positive effect on cooperation. **(H1)** In combination the interventions have a stronger effect. **(H2)** As previous studies have indicated, the sequential combination may be needed for a positive effect to unfold: "*while communication is an effective tool for enhancing collective action, it can only work through a series of steps that start from the understanding of the mapping of actions into outcomes in the social dilemma to the crafting of the agreement*" (Cardenas, Rodriguez, & Johnson, 2011).

With comparison to Free Communication we will explore whether our structured interventions perform better or worse in promoting cooperation than free unstructured communication. Finally, the repeated interactions allow us to study (i) how the groups adjust their level of cooperation immediately after treatment, and (ii) how the cooperation levels develop over time, that is how sustainable our treatment effects are.

4. RESULTS

In the following, we first analyse the average treatment effects on cooperation based on the total group contributions to the public good. Subsequently, the dynamic development of cooperation is examined.

3.1 AVERAGE TREATMENT EFFECTS

Compared to the first stage of the game, cooperation increased in the second Stage in all treatment conditions, except in the *No Communication* group (see Figure 2 and first three columns of Table 2). It seems that the interventions mimicking the elements of effective communication were successful in increasing cooperation. Specifically, for the *Problem Awareness* and for the *Strategy* intervention, the change in cooperation between Stage 1 and Stage 2 was different from that under *No Communication*, although at 10% level only (Wilcoxon rank sum test on Diff avg; $p=0.09$ and $p=0.08$, respectively). For the other treatments the effect was significant at 1% level (*No Communication* vs. treatment: $p<0.01$ for all other treatments).

Figure 2: Difference in average group contributions before and after treatment

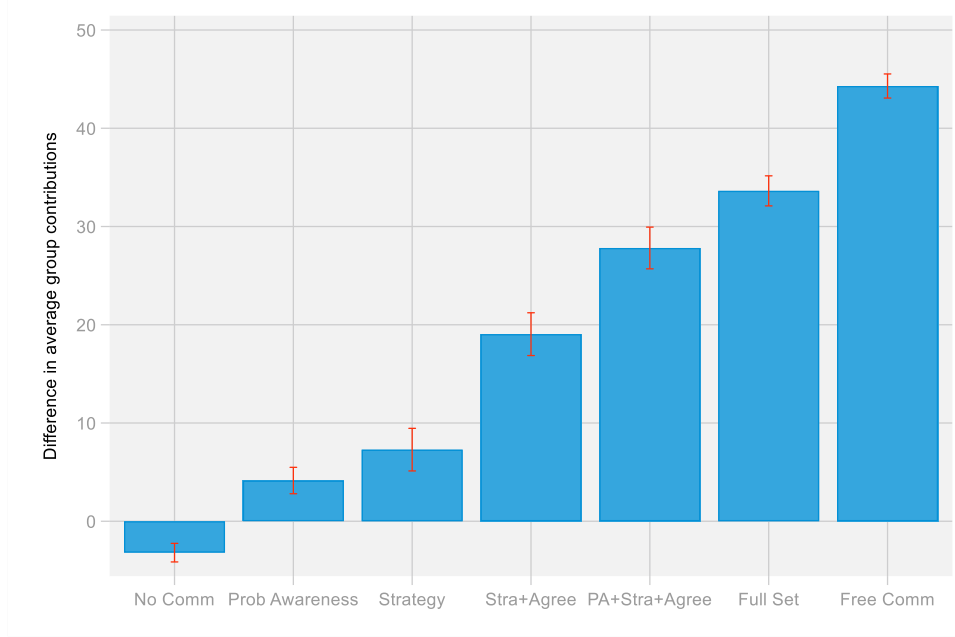


Table 2: Average treatment effects in average group contributions

Treatment	Average contribution in Stage 1	Average contribution in Stage 2	Diff. btw average contribution in Stage 2 vs Stage 1	First round contribution in Stage 2	Jump from last round in Stage 1 to first round in Stage 2
No Communication	33.39	30.2	-3.19	37.95	16.75
	21.26	21.58	9.55%	20.28	14.6
Problem Awareness	40.66	44.81	4.15	53	28.35
	20.49	23.46	10.21%	13.38	17.67
Strategies	31.37	38.66	7.29	57.75	39.4
	18.4	26.24	23.23%	13.51	19.27
Strategies + Agreement	33.47	52.51	19.05	68.88	46
	19.48	27.35	56.91%	14.13	20.94
PA + Strategies+ Agreement	42.19	70	27.81	76.7	50.05
	23.24	16.72	65.93%	6.49	24.52
Full Set	34.16	67.79	33.63	75.8	53.3
	17.64	22.44	98.44%	12.34	17.51
Free Communication	30.97	75.27	44.3	78.5	58.5
	17.94	12.74	143.04%	4.89	11.71

Note: The socially optimal contribution level is 80. Please note the baseline contributions in Stage 1 differ slightly between the treatment groups due to heterogeneities within single groups. We address this point in the following regression models.

The small effect of *Problem Awareness* is consistent with the findings of Brandts et al. (2016), whose mechanism design we employed in the *Problem Awareness* intervention. Based on the results of their experiment, the authors concluded that advice giving has only a significant

positive effect if the advice is given by a peer, but not when it is provided by an expert. In our experiment, the explanation of why contributions deteriorate was given by the experimenter, i.e., an expert.

Also the identification and exploration of available strategies alone (treatment *Strategies*) lead only to an incremental improvement in cooperation. However, in combination with the subsequent opportunity to agree on a common strategy (treatment *Strategies+Agreement*), cooperation was facilitated ($p=0.07$) and an increase of 57% was achieved compared to the before- treatment level of cooperation. Adding *Problem Awareness* to this sequence leads again only to a small incremental improvement (average cooperation increases by 67% compared to 57% under *Strategies+Agreement*, $p=0.25$). The increase in cooperation becomes then statistically significant when a further element of communication is added to the core element *Strategies+Agreement*, namely the *Ratification* element— in which players reaffirmed with a pledge their intention to contribute (Wilcoxon rank sum test on Diff avg; *Strategies+Agreement* vs. *Full Set* $p=0.04$).

In sum, going through the full set of our elements resembling effective communication (*Full Set* = *PA+Strategies+Agreement+Ratification*) produced an increase in cooperation by 98% compared to cooperation levels before treatment. Despite this remarkable increase, the treatment *Free Communication*, in which groups could communicate freely for 10 min via a chat box, still achieved significantly higher cooperation levels (Wilcoxon rank sum test: *Full Set* vs. *Free communication*: $p=0.04$).

Since baseline cooperation levels differed between groups, we will assess the robustness of our observations with help of a multivariate regression analysis. Table 3 presents the estimates from a Random effects Tobit model, censored at the lower limit (0) and the upper limit of group contributions (80). All models estimate the change in average group contributions in Stage 2 (i.e., *after* the treatment interventions) controlling for the heterogeneity among groups in the baseline contributions. In Stage 1, all groups received the identical instructions and played the baseline, any differences in the contribution levels *before* treatment are thus to be attributed to varying group compositions and differences in the group dynamics developed during Stage 1.⁹

⁹ Baseline contributions in the treatment conditions do not statistically differ from the contributions in the control group *No Communication*. However, among the treatment groups, we have to reject the Null hypothesis of

Model 1 focuses on the average treatment effect and estimates the effect of each intervention on the subsequent contribution behaviour. In addition, we control for the dynamic effects in model 2 (discussed in the next section) and exclude in model 3 the last two rounds to preclude end round effects. In this section we focus on the discussion of the average treatment effects, i.e. the coefficients on our treatment dummies, based on model 1. We use cooperation levels in *No Communication* as reference point.

We find support for our previous findings. In all treatment groups cooperation increases after the interventions, compared to *No Communication*. The effect of *Problem Awareness* and *Strategies* is hereby not statistically significant, while all other interventions lead to a significant increase in cooperation at the 1% level ($p < 0.01$ for *Strategies+Agreement*, *PA+Strategies+Agreement* and *Full Set*).¹⁰ We thus find partly support for hypothesis 1, the *Agreement* element is necessary for a significant positive effect to unfold.

RESULT 1 (average effect): *Structured interventions mimicking the elements of effective communication lead to a significant increase in cooperation if groups are given the possibility to agree on a common strategy.*

When we assess whether the interventions had a stronger effect in combination, we find that the performance of the core element *Strategies+Agreement* is indeed significantly improved when *Problem Awareness Strategies+Agreement* vs. *PA+Strategies+ Agreement*: $p=0.008$) and Ratification is added (*Strategies+Agreement* vs. *Full Set*: $p < 0.01$).

RESULT 2 (average effect): *The combined sequence with all interventions leads to a stronger increase in cooperation than the intervention facilitating agreement on a common strategy alone.*

Lastly, the analysis reveals that when heterogeneities in baseline contributions are taken into account, the combined set of our interventions: *Problem Awareness+ Strategies+ Agreement+ Ratification*, produces a cooperation-enhancing effect which is no longer statistically different to the effect of *Free Communication* (*Full Set* vs. *Free Communication*: $p=0.14$).

uniformity between *Problem Awareness* and *Strategy* ($p=0.08$), *Problem Awareness* and *Free Communication* ($p=0.07$), *Strategy* and *PA+ Strategies+Agreement* ($p=0.06$), and between *PA+ Strategies+Agreement* and *Free Communication* ($p=0.05$). Please note that these differences limit the magnitude of our effect rather than increasing it.

¹⁰ For the tests on the average treatment effects we consider model 1.

Table 2: Estimations of cooperation levels after treatment

TOBIT Panel, censored

Random effects Tobit model on group contributions after treatment (group contributions in Stage 2 in the control group "No Communication" serve as a reference), censored at upper and lower limit of scale

	(1) average	(2) dynamic	(4) dynamic no end rounds
Problem Awareness	10.916 (7.073)	12.987* (7.772)	9.723 (8.586)
Strategy	8.843 (7.396)	17.718** (8.089)	16.320* (8.927)
Strategy + Agreement	27.305*** (7.075)	43.296*** (7.893)	41.217*** (8.710)
PA + Strategy + Agreement	46.537*** (7.228)	53.144*** (8.125)	47.868*** (9.031)
Full Set	56.972*** (7.314)	86.500*** (9.014)	83.362*** (10.091)
Free Communication	68.912*** (7.721)	109.811*** (10.805)	83.784*** (12.056)
Round		-2.543*** (0.352)	-2.429*** (0.428)
Round × Problem Awareness		-0.408 (0.499)	0.260 (0.605)
Round × Strategy		-1.686*** (0.504)	-1.471** (0.609)
Round × Strategy + Agreement		-2.826*** (0.533)	-2.415*** (0.648)
Round × PA + Strategy + Agreement		-1.401** (0.556)	0.299 (0.695)
Round × Full Set		-4.571*** (0.709)	-3.689*** (0.879)
Round × Free Communication		-5.912*** (0.930)	1.400 (1.266)
Avg. group contribution before treatment	0.636*** (0.123)	0.644*** (0.126)	0.717*** (0.148)
Constant	7.259 (6.951)	20.691*** (7.385)	18.703** (8.344)
Without last two rounds	no	no	yes
Observations	1,400	1,400	1,120
Number of groups	140	140	140

Note: This table presents the results of Tobit panel estimations of group contributions after the treatment. Group contribution in Stage 2 of the control group 'No communication' serve as reference. The 'round' variable accounts for the round iteration in which the contribution was made. All models include experimenter fixed effects. Robust standard errors, clustered on the group level, are shown in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

3.2 DYNAMIC DEVELOPMENT OF COOPERATION OVER TIME

Model 2 and 3 take into account the dynamic of how contributions evolved in the rounds after the treatment. Figure 2 shows the corresponding average group contribution per round across all treatment conditions. Individual graphs describing the development for each single group across the treatments can be found in the appendix.

Figure 2: Average group contributions ac time (incl. confidence intervals)



A visual inspection of the development over time reveals that cooperation decreased over time in both stages and in all treatment groups; this decline is commonly observed in repeated public good games and occurs because participants are on average imperfect conditional contributors (Fischbacher & Gächter, 2010). At the end of Stage 1, cooperation levels are similar across all treatment groups. At the first round of Stage 2, cooperation increased in all groups. However, in line with our earlier results, the cooperation levels at which groups started Stage 2 vary greatly across treatments (see also last two columns of Table 2). The increase is significantly stronger after our interventions than in the *No Communication* treatment ($p < 0.05$ for *Strategy* and $p < 0.01$ for all combined treatment)¹¹, suggesting that the interventions lead to an increase

¹¹ We consider here model 2. In model 3, in which the end rounds are not considered, the increase in *Strategy* is only significant at the 10 % level.

additional to the usual restart effect¹². The difference between the increase in cooperation in *Problem Awareness* and *No Communication* is not statistically robust.

Moreover, the maintenance of the achieved contribution levels over time varied among the treatment groups. Looking at models 2 and 3 in Table 3 we find the following. The coefficient on *Round*Problem Awareness* indicates that the deterioration rate in *Problem Awareness* is similar to the decline observed in *No Communication*. By contrast, the deterioration in all other treatment groups is steeper than in *No Communication* ($p < 0.05$ in model 2).

In model 3 we do not consider the last two rounds in which typically the end-game effect takes place, i.e. cooperation collapses towards the end of the game (Andreoni 1988). Although in our case this should not impact behaviour, since at the end of the experiment only one round is chosen randomly to determine the payoffs, we still observe, like other studies, the end game effect in all treatment groups. When excluding the last two rounds from the analysis, we find that the deterioration of cooperation in *PA+Strategy+Agreement* and in *Free Communication* is no longer steeper than in *No Communication* ($p = 0.67$ and $p = 0.27$, respectively).¹³ In combination with the higher starting level of cooperation in the first round of Stage 2, this indicates that *Free Communication* and *PA+ Strategy+ Agreement* hence manage to sustain the cooperation increase as compared to *No Communication*. The initial increase in cooperation in *Free Communication* was hereby stronger than in *PA+ Strategy+ Agreement* ($p = 0.04$).

3.3 ACHIEVEMENT OF SOCIAL OPTIMUM

Another dimension of contribution behaviour is how often groups in the respective treatment groups reached the social optimum. We briefly discuss results from inspecting this measure of successful cooperation across treatments. In the first stage, the baseline stage, only four out of the 140 groups managed to reach the social optimum in at least one of the ten rounds.¹⁴ After the interventions in Stage 2, in *Problem Awareness* and *Strategy*, four out of 20 groups reached the social optimum at least once. In *Strategy+Agreement* half of the groups reached the social optimum at least once, while in *PA+Strategy+Agreement* and in the *Full Set* a clear majority of 18 groups, and in *Free Communication* all 20 groups managed to reach the social optimum in at least

¹²The restart effect describes the fact that contributions increase simply because participants were told that something new starts (Chaudhuri, 2018).

¹³ In the *Full Set*, we on contrast observe a steeper decay. This decrease may be triggered by disappointment resulting from broken promises. We also find that

¹⁴One group in *No Communication* and three groups in *PA+ Strategy+ Agreement*.

one of the ten rounds. This indicates that our interventions helped groups in reaching the social optimum. But could the groups maintain these high levels of cooperation? We find that, on average, groups in *No Communication* and in *Problem Awareness* reached the social optimum in less than 10% of the rounds. In *Strategy* and in *Strategy+Agreement* groups reached the social optimum in 30% of the rounds, while in the treatments comprising the combined sequence of elements (*PA+Strategy+Agreement* and *Full Set*) groups reached the social optimum in 51% and 69% of the ten rounds, respectively. Finally, in *Free Communication*, groups reached the social optimum in an overwhelming 83% of the rounds.¹⁵ Hence, the analysis on this measure of cooperation supports Result 1 and 2: the combined interventions (and free communication) lead to a positive effect on cooperation.

3.4 EXPLORATIVE ANALYSIS OF CHATS IN FREE TEXT AND THE UNCOVERED ELEMENT: SOCIAL CHIT CHAT

In summary, we find that the combined sequence of interventions representing elements of effective communication promotes a statistically significant increase in cooperation and contributes to the maintenance of relative high cooperation levels which are similar to what we observed under *Free Communication*. However, free communication still somewhat outperforms this structured process of information exchange. Under *Free Communication*, cooperation levels reached the social optimum more often. We speculate that Free-communication offers something that promotes cooperation in addition and that we do not capture this element in our proposed elements for effective communication. To shed more light on the missing element, we analysed the content of the group chats in a similar way as the studies we reviewed in Section 2. To do this, we first asked two research assistants to go through the protocols and suggest categories to codify the messages of the participants. The first two authors then reviewed the categories and created a revised list of categories to analyse the content of the messages. We present the categorisation protocol in the supplementary material.

With this revised list at hand, another set of three research assistants codified the total of 893 messages. The purpose of this exercise was to identify which elements the participants exchanged during the chat, i.e. the topics they discussed and the way they did it. The following observations are based on the coding with the highest consensus among our coders. We are

¹⁵Average amount of rounds in which the groups in the respective treatment reached the social optimum: *No Communication*: 0.4 rounds, *PA*: 0.65 rounds, *Strategy*: 1.2 rounds, *Strategy+ Agreement*: 2.75 rounds.

able to categorise 42% of the messages to the elements of effective communication we have discussed in this paper:

1. 4% of the messages relate to *Problem Awareness* and describe either (a) the tension between individual and group interest (3%), (b) the decline and effects of conditional cooperation (6%), or (c) former experiences from the baseline stage (79%) or (d) from previous experiments (12%).
2. 19% of the messages link to our *Strategies* element, (a) identifying potential strategies (41%) or (b) arguing for or against them (59%).
3. 10% link to our *Agreement* element and 9% link to our *Ratification* element.
4. 10% of the messages could be not categorised.

To identify the additional elements that are exchanged in *Free Communication*, which may cause open communication being more effective in maintaining cooperation than our structured process of information exchange, we take a closer look at the remaining 48% of messages which our coders categorised as “Other”. Within this category the coding team derived the following subcategories: (a) messages related to compliance and consequences (4%), (b) messages about insecurities and previous mistakes (7%), (c) nonsense (2%) and (d) social chit chat (87%). Thus, the majority of ‘other’ messages included some sort of social chit chat. Messages in this category aimed to spread good vibes (smileys, good wishes, greetings, whooping, praise), or were classified as small talk (regarding the weather, study majors, jokes, or concerning the experiment: possibility to chat, anonymity of chat, remaining time).

Overall, the content analysis of the free chat shows that about half of the messages exchanged in *Free Communication* are related to our previously identified elements of effective communication. The other half, however, is largely used for social chit chat. With reference to the aforementioned debate about why communication improves cooperation, this social chit chat may have a function of its own, such as building a group identity (Dawes et al., 1988; Orbell et al., 1988) and/or allowing “individuals to increase (or decrease) their trust in the reliability of others” (Ostrom, 1998, p. 13). Future research may want to examine how “social chit chat” links to these functions.

In this paper, we focused on the *information* content that promotes cooperation when shared. We saw that with the combined sequence of our interventions we reach similar levels as under

Free Communication. This aspect becomes particularly interesting if we think about settings where the process of free communication may not be as clean and equal as in our small groups of relatively homogenous. We will explore this point further in the discussion.

5. DISCUSSION AND CONCLUSIONS

What information promotes cooperation in social dilemmas when it is exchanged in a communication process? In this paper, we have designed interventions resembling those elements of communication that have previously been identified as likely drivers of the positive impact of communication on cooperation. In an experimental setup, we tested how these interventions mimicking the potential elements of effective communication work individually and in combination in promoting cooperation in a social dilemma setting.

Our results also suggest that it is not enough to be aware of a problem, one also needs measures at hand to solve the dilemma. We find that the intervention facilitating an understanding of the available strategies and building an agreement upon them has the most positive impact on cooperation. Combined with the interventions promoting problem awareness and ratification, high levels of cooperation were achieved. The observed pro-social behaviour is similar to what we observed when individuals could communicate freely via chat. In our view, there are two interesting ways how to read this result. On the one hand, we find that cooperation in our experiment reached high levels and could be sustained best when the group members could simply chat with each other; our mimicking interventions could not fully reach this combination of boosting and maintaining cooperation. We believe that this result indicates that there is more about communication than simply sharing information; communication also promotes social bonding; social chat helps to build trust and a shared group identity (Ostrom, 1998; Sally, 1995). But, we also see that with the combined sequence of our interventions reached an increase that is not statistically different to the increase free communication triggered. This finding becomes interesting when we consider the environment in which the result of free communication was generated. In our experiment, a small group of relatively homogenous individuals (university students) interacted anonymously and with financial resources provided by us. In the real world, interacting actors may not have identical options at hand. They may be more heterogeneous in their endowments, action spaces, and preferences, and furthermore, the social dilemmas they face may be more complex. Previous studies, for example, have documented that free communication may not be sufficient to attain

socially optimal outcomes when settings are complex (Ostrom, Gardner, & Walker, 1994; Ostrom et al., 1992; Schill et al., 2016). Cardenas et al. (2011), for example, illustrate this point in their lab-in-the-field experiment in Colombian and Kenyan watersheds. The problem was not that participants did not honour agreements commonly made in the communication phase, but they had difficulties to reach an agreement in the first place. In cases like this, structured and controlled facilitation may help to steer participants towards common agreements and cooperative patterns of interaction (Cardenas et al., 2004; Schill et al., 2016). The elements in our experiment are such *controlled information-sharing mechanisms* with which external institutions can facilitate the process.

Structuring a communication process and/or managing the flow of information can have at least three effects. First, it avoids inefficiencies. For example, our interventions consisted only of the relevant information that was believed to improve cooperation. In an open communication phase, non-topic-related and redundant information may also be exchanged and potentially distract from the issue in question. Second, the risk of incorrect information being disseminated is lower when the flow of information is controlled. In an actual communication phase, incorrect or confusing information may be exchanged. And third, anyone can have a say if the structured communication process is designed accordingly. In an open forum with many actors, usually only dominant and powerful actors dare to speak out. Studies on participatory processes warn that loud and powerful actors may use the platform to pursue their own goals (Hickey & Mohan, 2005; Reed, 2008) and argue that external facilitation should prevent this.

The interventions in our experiment are similar to the measures that institutions can take to facilitate information exchange or to the role of facilitators in a participatory process. Thus, our analysis provides insights into which elements should be considered when structuring and facilitating communication and information exchange in order to promote cooperation between actors.

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APPENDIX I

1. Sample Statistics

Table 1: Sample statistics

<i>Treatment/ Demographics</i>	Female	Econ major	Observations
Full Sample	0.59	0.23	540
No Communication	0.59	0.26	80
Problem Awareness	0.50	0.26	80
Strategy	0.59	0.21	80
Strategy + Agreement	0.61	0.19	80
PA + Strategy + Agreement	0.65	0.24	80
Full Set	0.60	0.16	80
Free Communication	0.60	0.28	80

2. Dynamic development within groups

Figure 1: T0 NO COMMUNICATION - Development of Group contributions

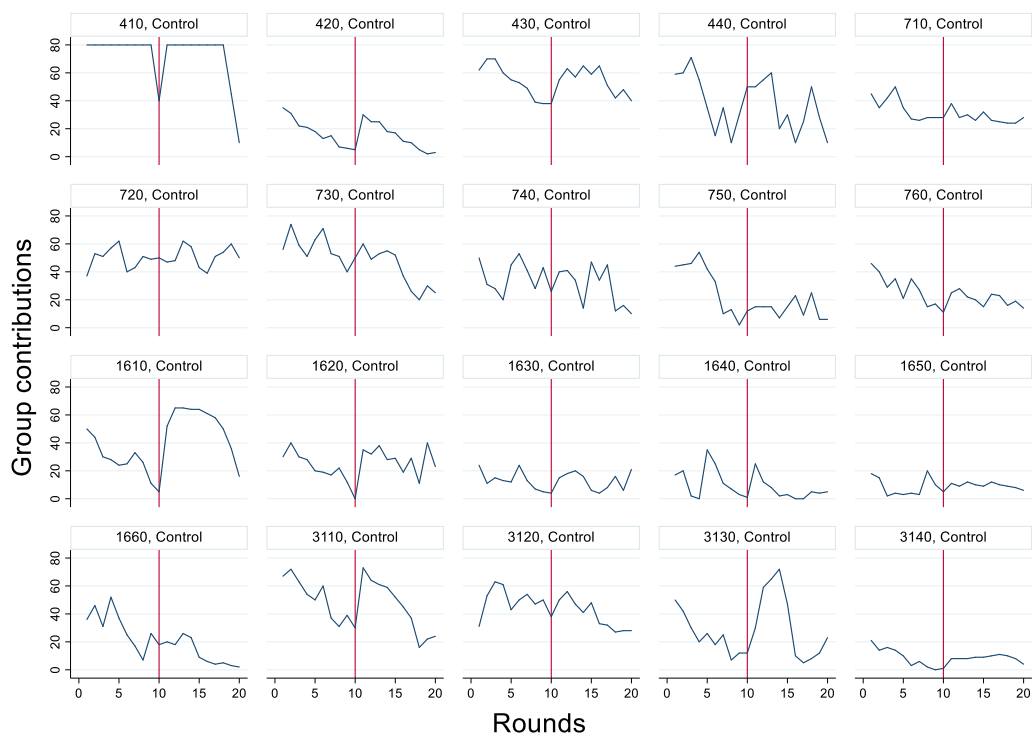


Figure 2: T1 PROBLEM AWARENESS - Development of Group contributions

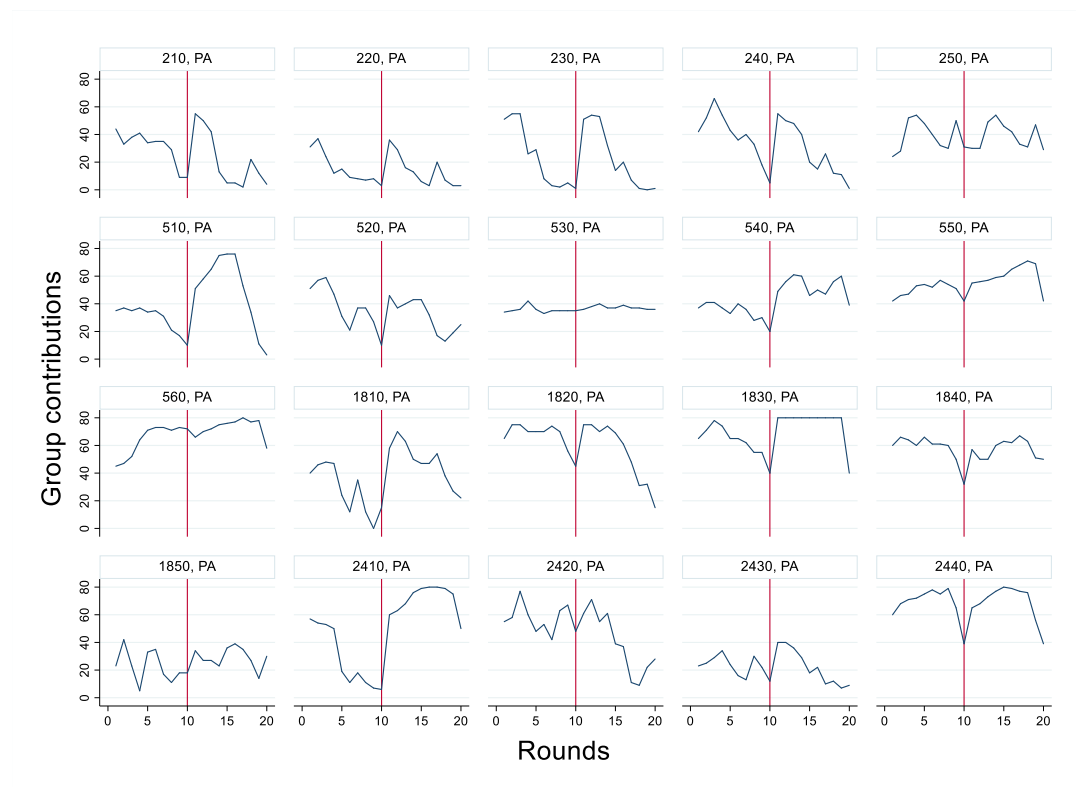


Figure 3: T2 STRATEGY- Development of Group contributions

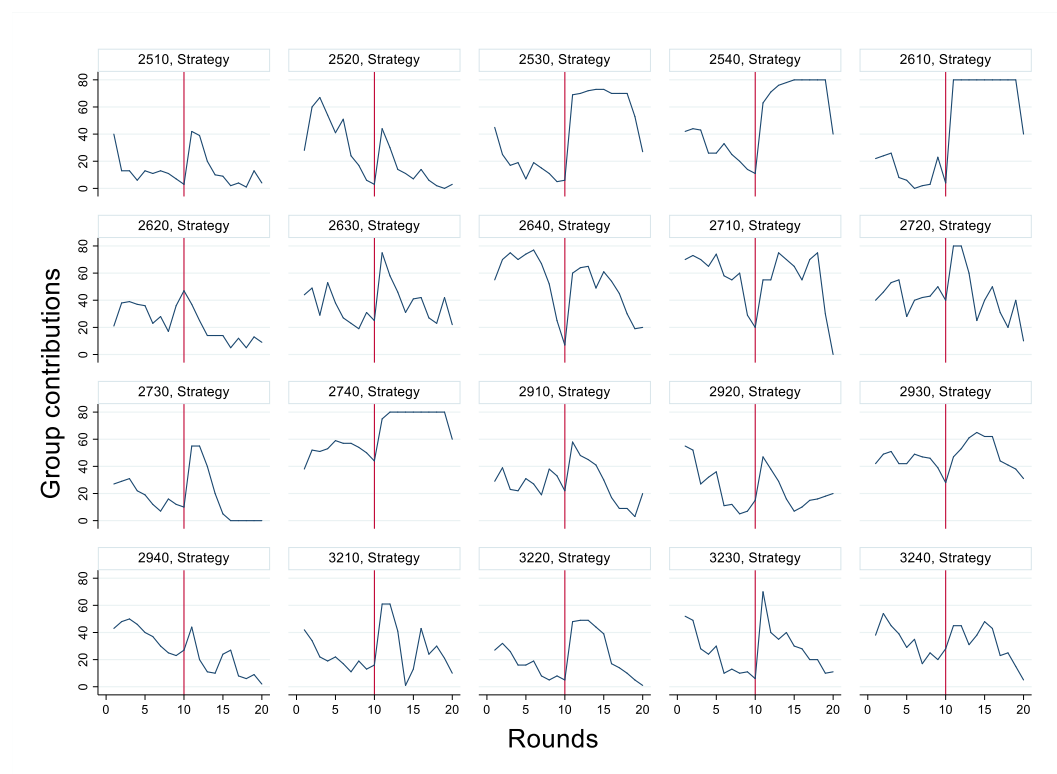


Figure 4: T3 STRATEGY+AGREEMENT - Development of Group contributions

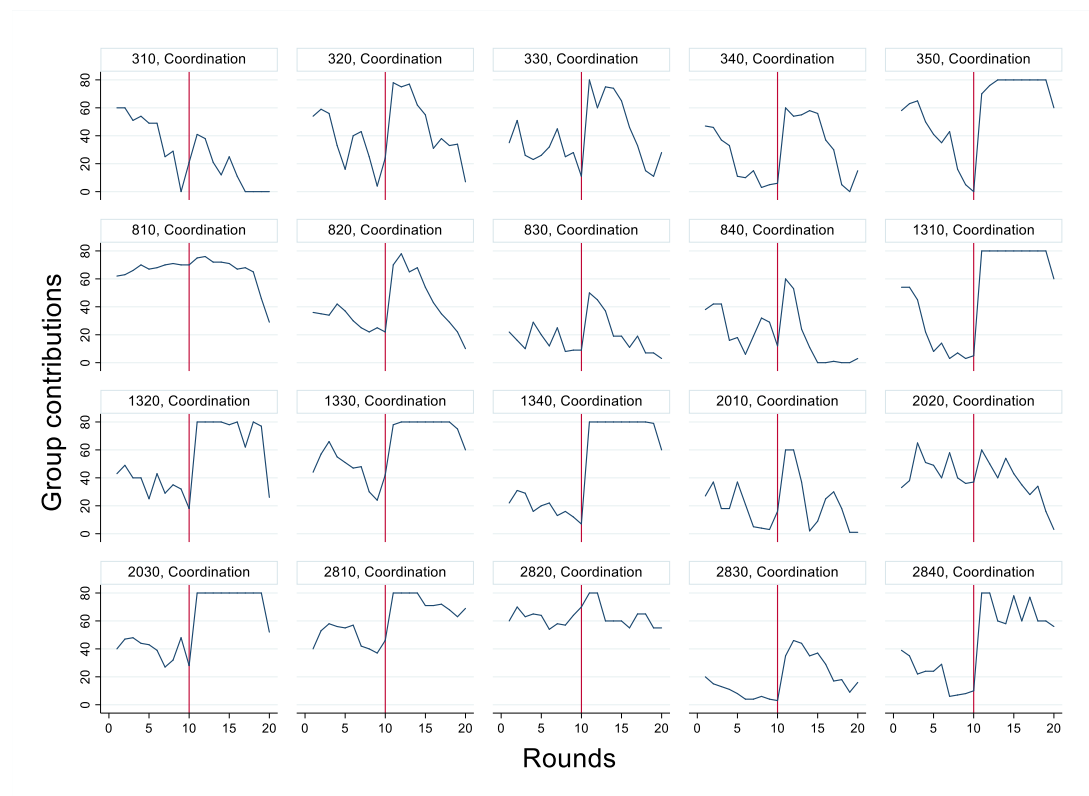


Figure 5: T4 PA+STRATEGY+AGREEMENT - Development of Group contributions

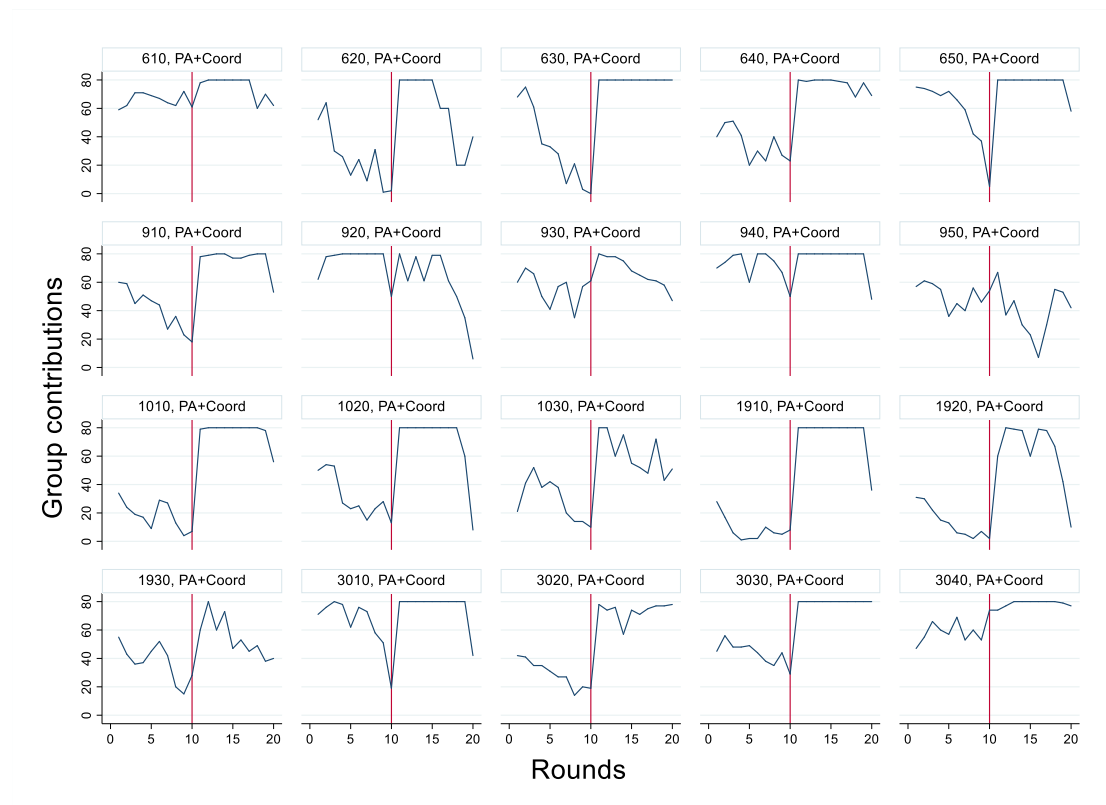


Figure 6: T5 FULL SET - Development of Group contributions

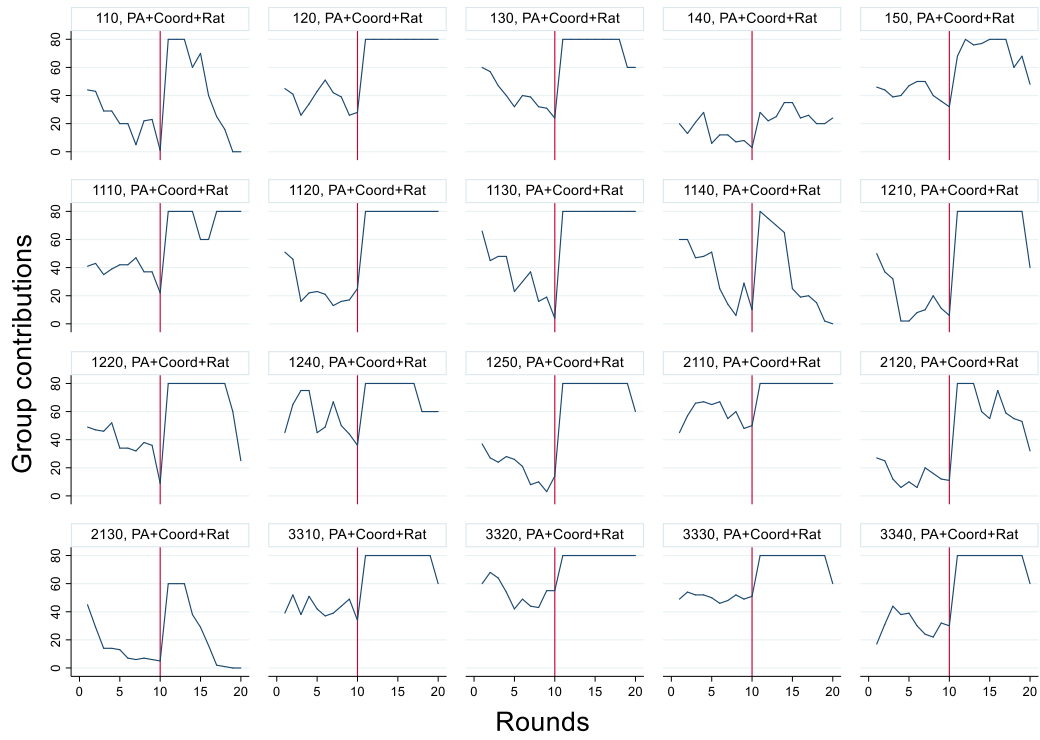
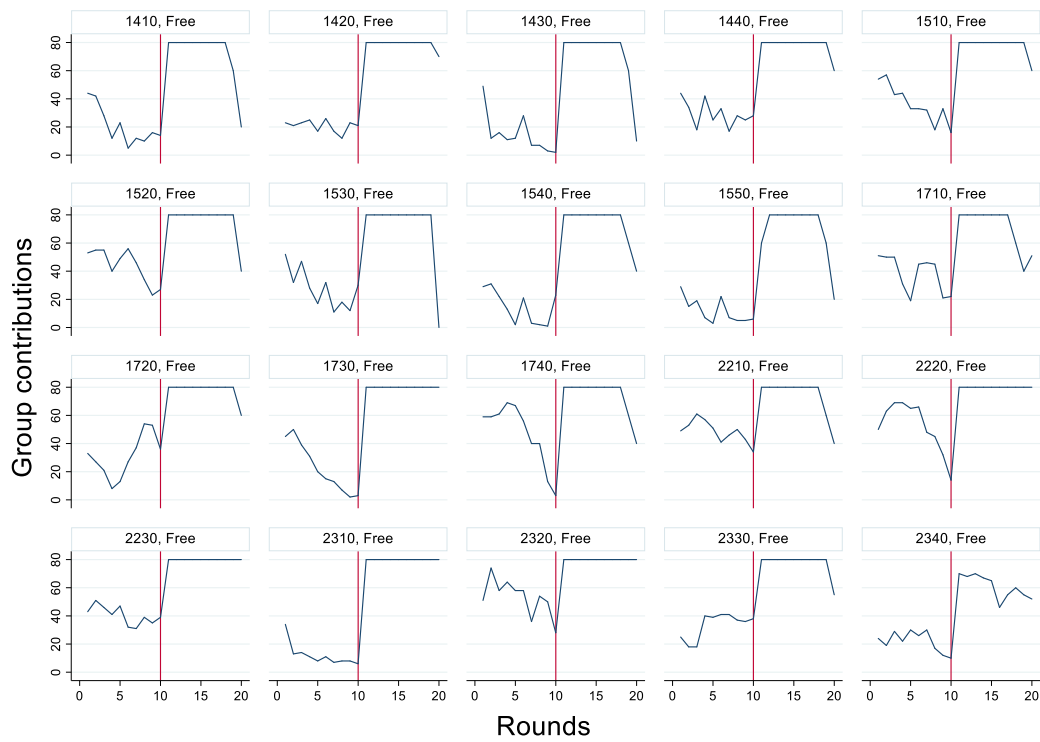


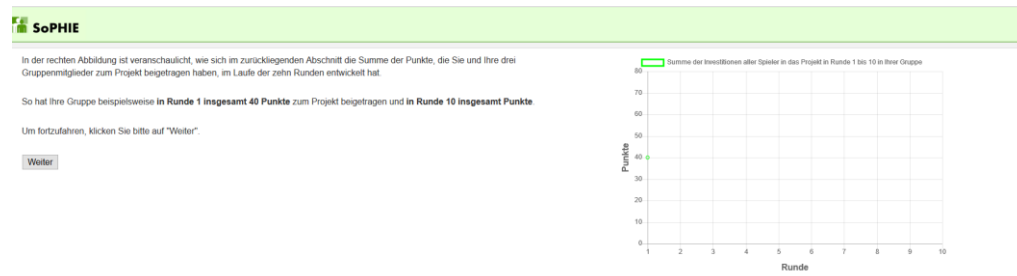
Figure 6: T6 FREE COMMUNICATION - Development of Group contributions



7. APPENDIX II –EXPERIMENTAL MATERIAL

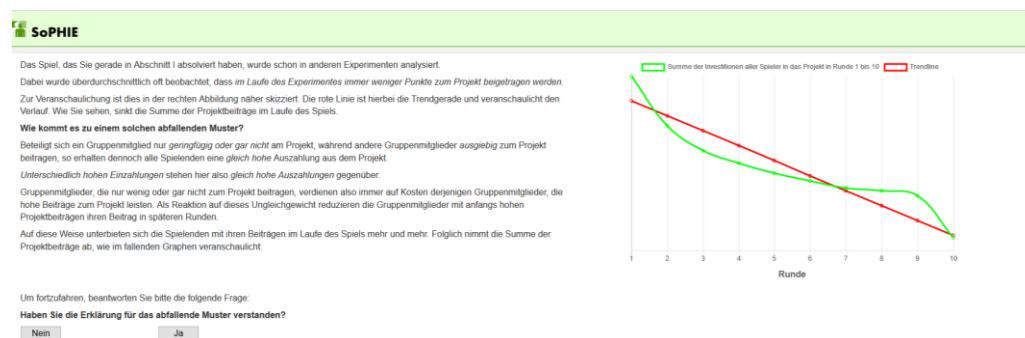
1. Problem Awareness

Figure 1: First screen of the element ‘Problem Awareness’



Note: As the graph differed between groups the chart is not populated in this example.

Figure 2: Second screen of the element ‘Problem Awareness’



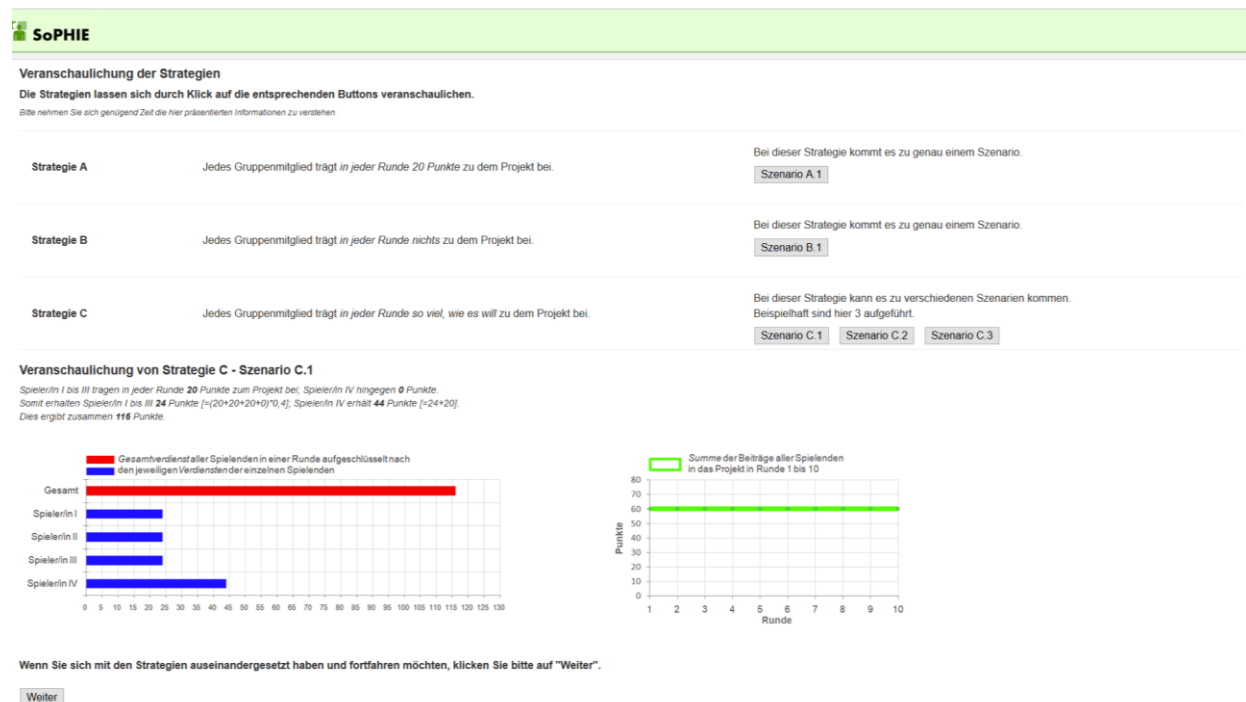
2. Identification of Strategies

In the visualisation of the three strategies, namely the *socially optimal strategy*, the *self-interested strategy* and the *laissez-faire strategy*, we offered corresponding scenarios which illustrated the consequences in terms of individual and group payouts. Scenario A showed that when all group members contributed their entire endowment, a total payout of 128 points could be achieved and the payout for each group member would be 32 points. Scenario B depicted that when all group members contribute nothing, the total payout would be 80 points and the corresponding individual payout 20 points. For the *laissez-faire strategy*, we presented three scenarios. Scenario C.1 elaborated on the incentive to free-ride. It showed that if three group members contributed their entire endowment and one group member contributed nothing, the total payout would be 116 points. The group members contributing would receive 24

points while the free-rider would receive 44 points. Hence, the scenario also showed that even when a free-rider was present, it was still beneficial for the other group members to contribute their entire endowment. Scenario C.2 depicted that a moderate cooperation of all group members would be also still be beneficial compared to no cooperation. It showed that when all group members contributed 10 points, the total payout would be 104 points and each group member would receive 26 points. Lastly, scenario C.3 adopted the same level of contribution to the public good as C.2, but unequally distributed among the group members. In the scenario, one group member contributed 20, another 13, the third 7 points while the last group member contributes 0 points. Hence, the total payout reached 104 points and the four group members receives 16, 23, 29, 36 points, respectively.

The labels of all three strategies A, B, C and their scenarios A.1, B.1, C.1, C.2, C.3 were randomized among subjects as well as groups. Thus, the same strategy labelled as A for one player, may have been strategy A, B or C for other players. Consistently, the order in which the strategies were presented was randomized as well. For the sake of a better understanding, we however refer to the strategies by A, B and C in the paper as presented above.

Figure 3: Second screen of the 'strategy' element, showing the definition of strategies and the consequences for the *laissez fair* strategy (scenario C.1).

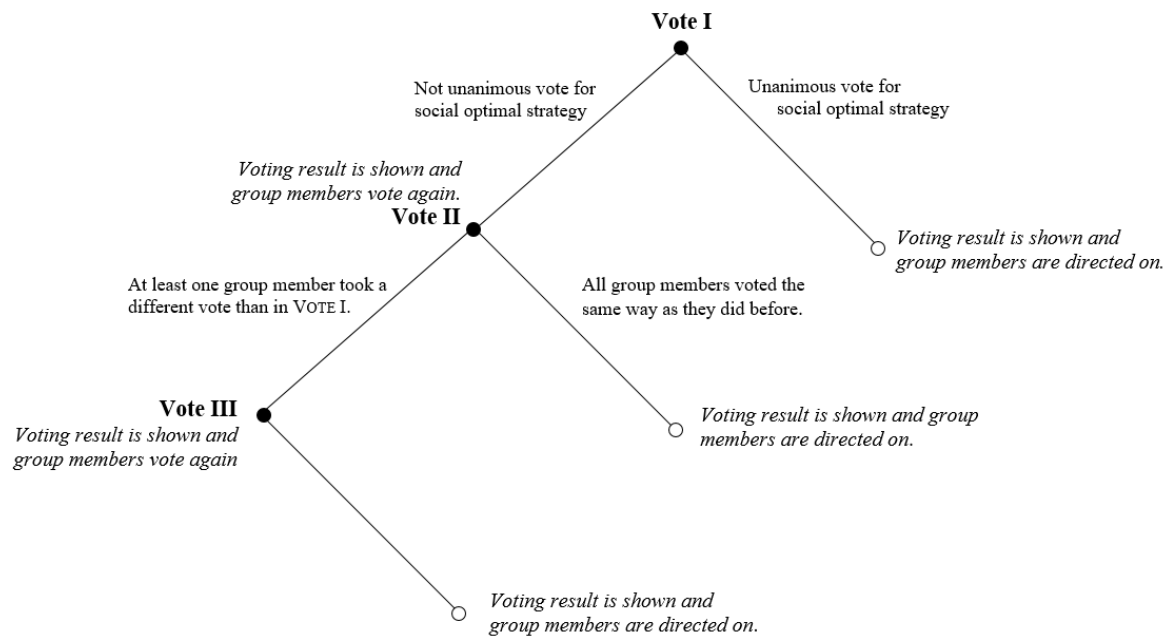


3. Agreement (Voting)

Figure 4: Screen of the 'Agreement' component in case the first vote had no unanimous outcome

SoPHIE			
Da Sie nun die Präferenzen Ihrer Mitspielenden kennen, wird Ihnen und Ihren Mitspielenden die Frage noch einmal gestellt: Von welcher dieser Strategien würden Sie sich wünschen, dass sie von Ihrer Gruppe befolgt wird?		Angaben der Spielenden	Bitte wählen Sie die gewünschte Strategie:
Strategie A	Jedes Gruppenmitglied trägt in jeder Runde 20 Punkte zu dem Projekt bei.	Ihre Wahl: Mitspieler/in 1 Mitspieler/in 2	<input type="button" value="A"/>
Strategie B	Jedes Gruppenmitglied trägt in jeder Runde nichts zu dem Projekt bei.		<input type="button" value="B"/>
Strategie C	Jedes Gruppenmitglied trägt in jeder Runde so viel, wie es will zu dem Projekt bei.	Mitspieler/in 3	<input type="button" value="C"/>

Figure 5: Illustration of the voting process in the 'agreement' element



4. Ratification

Figure 6: Screen of the 'Ratification' element after agreeing to promise social contribution in all following rounds

SoPHIE

Ihre Gruppe liegt die folgende Strategie vor:

"Jedes Gruppenmitglied trägt in jeder Runde 20 Punkte, also das komplette Budget, zum Projekt bei."

Sind Sie bereit, Ihren Gruppenmitgliedern ihr Versprechen zu geben, diese Strategie einzuhalten?
(Diese Frage wird nicht nur Ihnen, sondern jedem Gruppenmitglied gestellt.)

Nein ☒ Ja

Bitte leisten Sie ihr Versprechen, indem Sie den folgenden Satz eintippen:

"Ich verspreche, in jeder der nachfolgenden Runden 20 Punkte beizutragen."

Figure 7: Feedback screen of the Ratification stage

SoPHIE

Ihre Gruppe hat wie folgt reagiert:

	Bereitschaft zu versprechen:	Versprechen:
Ihre Aktion	Ja	Ich verspreche, in jeder der nachfolgenden Runden 20 Punkte beizutragen.
MitspielerIn 1	Ja	Ich verspreche, in jeder der nachfolgenden Runden 20 Punkte beizutragen.
MitspielerIn 2	Ja	Ich verspreche, in jeder der nachfolgenden Runden 20 Punkte beizutragen.
MitspielerIn 3	Nein	

Note: In this example, one participant ("MitspielerIn 3") was not willing to make a promise.