Salience in Public Goods Games*

Deborah Kistler,‡ Su Nanxu,§ Christian Thöni¶

June 17, 2022

Abstract

We study the effect of three salience manipulations on cooperation in a standard public goods game. A standard social preferences model enriched by salience weights provides hypotheses about the expected effects of our salience manipulations. We test these predictions in a laboratory experiment using different techniques to manipulate the salience of either the highest or lowest contribution in the group. We find no systematic effect of the salience manipulation on cooperation, even though our regression analysis suggests that subjects' contributions are positively linked to the salient contribution. This is because subjects systematically reduce their contributions in the maximum condition relative the minimum condition. These two effects offset each other, resulting in contribution levels which are surprisingly unresponsive to our salience manipulations.

Keywords: salience, inequality aversion, experiment, public goods game
JEL codes: D83, D91, C91, C72, H41

*For helpful comments and discussion we thank Laure Athias, Adrian Bruhin, Urs Fischbacher, Isabel Günther, Arno Riedl, Christian Zehnder, the participants of the 7th Thurgau Experimental Economics Meeting, the participants of the ESA meeting in Bergen, and the participants of the Experimental Brownbag Research Seminar at the ETH Zurich. We gratefully acknowledge financial support from the Swiss National Science Foundation (grant no. 100017E-145109).

‡ETH Zurich, Switzerland, deborah.kistler@econ.gess.ethz.ch

§Stockholm Environment Institute, Sweden, nanxu.su@sei.org

¶*Corresponding author:* University of Lausanne, Quartier UNIL-Chamberonne, Internef, CH-1015 Lausanne; phone: +41 21 692 2843; mail: christian.thoeni@unil.ch; web: https://people.unil.ch/christianthoeni/.

1 Introduction

In August 1935 the Soviet miner Alexey Stakhanov reportedly exceeded his daily quota by an order of magnitude. His feat was widely popularized in the media with the goal to boost labor productivity across many industries in the Soviet Union. This *Stakhanovite movement* put the spotlight on a highly cooperative member of the workforce, and exceeding the daily quote supposedly became a salient phenomenon for the rest of the workforce. Did this movement achieve the goal of widespread productivity increases? In this paper we use a controlled laboratory environment to study the effect of interventions that increase the salience of cooperative (or uncooperative) behavior in a social dilemma.

Standard economic theory usually assumes that agents use all available information when making a decision, independent of the mode of presentation. In reality, however, our resources are limited. Hence, we hardly ever evaluate all attributes of available options before making a decision. Consequently, choices are often influenced by the features that are rendered salient. Professionals in marketing use this to their advantage and make favorable characteristics more salient than less favorable characteristics of their product. In economics, Schelling (1960) was among the first to study the role of salience for coordination in games with multiple equilibria. He asked his students to indicate where they would meet with a friend in New York. A significant majority answered at the Grand Central Terminal, which renders said location the most salient choice among all possible meeting points in New York City. Identifying and choosing the salient option allows people to solve coordination problems more efficiently. Akerlof (1991) applied the concept of salience to explain why people procrastinate. He postulated that future consequences of today's decisions are not salient and therefore underrepresented in the decision process.

It is only recently that economists started to include salience in formal models. A first strand of the literature views salience as arising endogenously within the set of available options (Bordalo et al., 2012). They assume that a characteristic of a good is salient if it stands out compared to the respective feature of a reference good. Meaning that the attribute that is furthest from the reference level is the most salient and will get more weight in the decision process. They apply the model to explain choices under risk, consumer choice, and judicial decisions.[1]

A second strand of the literature views salience as an exogenous characteristic of the choice environment. DellaVigna (2009) proposes a simple model to describe why people neglect shipping costs or taxes in purchasing decisions. In his model, each object contains a visible and an opaque com-

[1]For an empirical test of their model applied to choices under risk see Mormann and Frydman (2016).

ponent. Due to limited attention, the consumer processes the information of the opaque component only partially. Applying this model to sales taxes, for instance, means that the framing of the taxes affects the valuation of the respective product. When the price as displayed in the store does not include the tax, the model predicts that consumers neglect the tax, because it is not salient. Conversely, if the sales tax is included in the price, consumers process the tax in the valuation of the object fully. Empirical data supports this claim. In a field experiment with a grocery store, Chetty et al. (2009) observe that demand decreases , when the price includes the tax compared to the situation in which the tax is displayed separately.

These studies provide evidence that salience can play a role in consumer and lottery choices. Our study extends this literature by investigating salience in a strategic context. We apply the concept of salience to repeated social dilemma games and explore whether cooperative behavior in public goods games is affected by salience manipulations.

Why should salience play a role for the behavior of individuals in social dilemmas? Our claim roots in the observation that many people are conditional cooperators (Fischbacher et al., 2001; Thöni & Volk, 2018). Conditional cooperators are willing to contribute as long as they believe that others contribute as well. If this is the case, then the public goods game is effectively a coordination game. We study whether cooperation responds to manipulations in the salience of extreme contributions. We do so by focusing subjects' attention to either the highest or the lowest contribution in their group. We hypothesize that conditional cooperators who are instructed to focus on high contributions tend to be more cooperative in subsequent periods compared to when we emphasize the lowest contribution in the group.

While we are not aware of research which evaluates salience in social dilemmas such as the public goods game, there are a number of closely related studies. Engel et al. (2021) investigate the effect of providing participants with different pre-play information. In their experiment, subjects receive selected information about the behavior of other subjects in previous experiments. In one treatment, subjects are shown high contribution levels, and in the other treatment, subjects receive information about low contributing groups. The results suggest that different pre-play information lastingly affects cooperative behavior in a repeated public goods game.

Hoffmann et al. (2013) present participants in a repeated public goods game with exaggerated feedback, i.e., the actual average is multiplied by a factor larger than one. Participants received the information that the feedback may deviate from the actual average. The authors find that subjects do not change their contribution in response to exaggerated feedback. Hartig et al. (2015) evaluate how subjects react to different forms of feedback. They compare the provision of the group mean to the provision of the individual behavior of all group members. They find that subjects contribute on average more when they receive full information about the behavior of the other group members. Furthermore, they report that the minimum contribution in a group is decisive for the decision of conditional cooperators.

Irlenbusch et al. (2019) study the effect of partial contribution feedback in public goods games. Subjects either receive feedback about the maximum, minimum, or a randomly drawn individual contribution in the group. These authors also manipulate whether the process that selects the feedback is transparent. Their results suggest that selective feedback only affects contributions if it is not transparent.[2]

Related is also the study by Savikhin Samek and Sheremeta (2014), who provide participants of a public goods game with additional information about the highest or lowest contributors in their group. In the feedback stage participants see, besides the contribution level, a picture and the name of the other group members. Compared to the standard public goods game, only the treatment which reveals the identity of the lowest contributor in a group affects contributions. Participants in this treatment contribute significantly more compared to the standard public goods game. While, like in our study, their manipulation affects the salience of the maximum or minimum contribution, the identification of contributors is presumably the dominant driver of their treatment effect.

Summing up, this strand of the literature shows that the degree of detail and framing of contribution information can affect contributions in public goods games. While in most of these studies the information provided to participants differed across treatments, our aim is merely to shift the focus of attention, while holding the content of the information constant. To answer our research question, we start with proposing a theoretical framework to model the effect of salience manipulations in public goods games (Section 2). In the empirical part we will investigate three methods to manipulate salience. The three manipulations arguably increase the dosage of the intervention. In Study 1 we start with a comparably subtle method and ask subjects to recall either the minimum or maximum contribution in their group (Section 4); in Study 2 we elicit beliefs about the maximum or minimum contribution (Section 5); finally, in Study 3 we depart from the concept of complete information and provide only feedback about the extreme contributions (Section 6). Across the board we do not find evidence that contributions react to our salience manipulations. In Section 7 we combine the data of all three studies to show that this null result is due to two offsetting effects; Section 8 concludes.

[2]A related literature studies the effect of information about profits (as opposed to contributions (Bigoni & Suetens, 2012), and the impact of recommended contributions (Croson & Marks, 2001).

2 Theory

2.1 Game and Preferences

In a typical public goods game, each of $n > 2$ subjects in a group receives an endowment of y tokens. Each group member can choose to keep the endowment to herself or to contribute parts or all of to the public good. In addition to the tokens kept players earn the sum of all contributions multiplied by the marginal per capita return a ($\frac{1}{n} < a < 1$). Subject i's material payoff is:

$$x_i = y - g_i + a \sum_{j=1}^{n} g_j \quad i, j = 1, 2, \ldots, n, \tag{1}$$

where g_i is the contribution of subject i to the public good (with $g_i \in [0, y]$). Under standard assumptions this game has a unique Nash equilibrium in which all players contribute zero tokens to the public good. Numerous empirical studies provide evidence that people often deviate from the standard prediction and contribute positive amounts. Fehr and Schmidt (1999) propose a utility function, which can account for positive contributions. The utility function models inequality averse preferences and assumes that players suffer disutility whenever their payoff deviates from other players' payoffs. The function takes the following form:

$$U_i(\mathbf{x}) = x_i - \frac{\alpha_i}{n-1} \sum_{j \neq i} \max\left[x_j - x_i, 0\right] - \frac{\beta_i}{n-1} \sum_{j \neq i} \max\left[x_i - x_j, 0\right], \tag{2}$$

where α_i is a preference parameter weighing disadvantageous inequality, while β_i weighs advantageous inequality. Fehr and Schmidt assume that (i) both inequalities produce disutility ($\alpha_i, \beta_i > 0$), (ii) having less is worse than having more than another player ($\alpha_i > \beta_i$), and (iii) a player is never willing to burn her own money in order to restore equality ($\beta_i < 1$). In the public goods game with $n = 4$ and $a = 0.4$ (the parameters we will use in the experiments) this model predicts that the best reply of subject i is either a contribution of zero, or to match the lowest contribution within her group (i.e., $g_i = R(g_{-i}) = \min\{g_{-i}\}$).

2.2 Inequality Aversion with Salience

To model varying degrees of salience we add a parameter θ_{ij} to each bilateral comparison. We posit the following utility function:

$$U_i^{\theta}(\mathbf{x}) = x_i - \alpha_i \sum_{j \neq i} \theta_{ij} \max\left[x_j - x_i, 0\right] - \beta_i \sum_{j \neq i} \theta_{ij} \max\left[x_i - x_j, 0\right], \quad \text{with} \sum_{j \neq i} \theta_{ij} = 1 \text{ and } \theta_{ij} \geq 0. \tag{3}$$

All the payoff-comparisons are now additionally weighted by θ_{ij}, which indicates how salient the comparison with player j is. We assume that all salience weights are weakly positive and the overall level of attention remains constant, such that any increase in the salience on one comparison must reduce the salience of another comparison. Setting a certain θ_{ij} equal to 0 means that the comparison with player j does not receive any attention and is hence not considered in the calculation of the utility. On the other hand, if all θ_{ij} are equal ($\theta_{ij} = \frac{1}{n-1}\ \forall\ j \neq i$), function (3) is equivalent to the original Fehr-Schmidt utility function (Equation 2).

To derive the best response function, consider a player i facing three other players l, m, and h, with contributions g_l, g_m, and g_h, such that $g_h \geq g_m \geq g_l$. Player i's best response depends not only on her α_i and β_i, but also on how salient the other players are:[3]

$$g_i = R(g_{-i}) = \begin{cases} 0 & \text{if } \beta_i \leq 1 - a \\ g_l & \text{else if } \theta_{il} \geq \hat{\theta}_{il} \\ g_m & \text{else if } \theta_{ih} \leq \hat{\theta}_{ih} \\ g_h & \text{else} \end{cases} \quad \text{with} \quad \begin{aligned} \hat{\theta}_{il} &= \frac{\beta_i + a - 1}{\alpha_i + \beta_i} \\ \hat{\theta}_{ih} &= \frac{\alpha_i + 1 - a}{\alpha_i + \beta_i} \end{aligned} \tag{4}$$

Figure 1 depicts the effect of the salience parameters on the best response graphically. On the horizontal axis we plot the salience of the comparison with l (θ_{il}), on the vertical axis the same for the highest contributor (θ_{ih}). As the salience parameters add up to one the third parameter is the residual and the set of all feasible parameter constellations has a triangular shape. The dashed lines indicate the thresholds, giving rise to three areas. Provided $\beta_i > 1 - a$ player i matches g_l if all comparisons are equally salient (indicated by the dot in the center of the triangle). Lowering the salience of l below the threshold $\hat{\theta}_{il}$ brings us to the region where the player seeks to match m's contribution. Increasing the salience of h above the threshold $\hat{\theta}_{ih}$ motivates the player to match the highest contribution in the group. Figure 1 also indicates the effects of the preference parameters on the salience thresholds.

[3] For notational convenience we assume that players match the lower of the two contributions whenever indifferent (i.e., when the conditions in Equation 4 are met with equality).

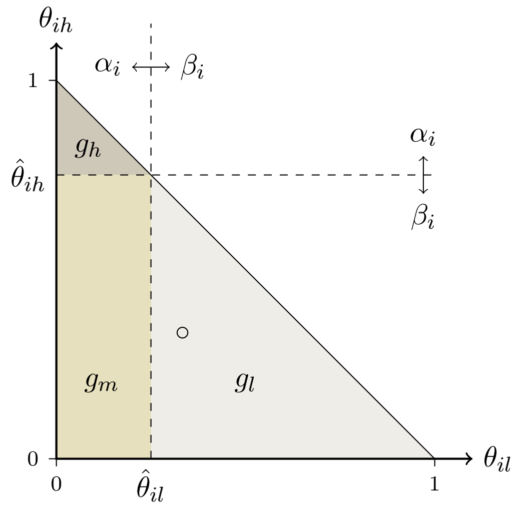

Figure 1: Salience parameters and best response contributions.

If α_i increases, the areas for g_m and especially g_h shrink, such that the player is only willing to match non-minimal contributions if the comparison with l becomes very unimportant for her utility. Likewise, an increase in β_i shifts the thresholds to the right and the bottom, enlarging the range of salience parameters for which it is optimal to match non-minimal contributions.

What does this mean for the Nash equilibria of the game? In the one-shot public goods game the Fehr-Schmidt model with salience produces a richer set of equilibria than the standard Fehr-Schmidt model. Assume we have a heterogenous group of four players, with one F player, who is sufficiently uninterested in inequality to always choose minimal contribution ($\beta_F < 1 - a$), and three C players with preference parameters above this threshold ($\beta_C > 1 - a$). With standard Fehr-Schmidt players this game has a unique Nash equilibrium in which all players contribute zero.[4] Introducing salience permits equilibria in which the three C players contribute a non-minimal amount, provided that the salience of the comparison with F is lower than the threshold defined in Equation (4), i.e., $\theta_{CF} < \hat{\theta}_{Cl}$ holds for all C players. In addition, there are also equilibria in which two F players contribute zero, while two players C choose a non-minimal contribution, provided that the latter two have sufficiently high salience parameters for their mutual comparison ($\theta_{CC} > \hat{\theta}_{Ch}$ for both C players, for details see Appendix A.1). Whenever the parameters permit an equilibrium with non-minimal contributions, the public goods game is no longer dominance solvable. The C players then play a coordination game, whereby any situa-

[4]This is not the case for larger group sizes or large marginal per capita returns, see Fehr and Schmidt (1999), Proposition 4 for details.

tion in which all C players contribute $\bar{g} \in [0, y]$ and the F players contribute zero constitutes a Nash equilibrium.

The theoretical analysis so far focused on a one-shot game with perfect information about the players' preferences and salience parameters. Putting the theory to test in a one-shot public goods game is complicated by the fact that we cannot easily implement perfect information about the preferences of the other participants in the group. Our approach is therefore to use a dynamic game, in which subjects can observe other subjects' contributions over time. In particular, we will repeat the one-shot public goods game described so far for ten periods in a partner matching. While we do not offer a theoretical treatment of the dynamic game, we conjecture that the reaction function described in equation (4) offers a prediction for the development of the contributions over time. If subjects in the experiment use the information about the current period's contribution to predict contributions in the next period, then our salience manipulation should systematically influence their contributions (provided there is some heterogeneity in the observed contributions). In the experiments that follow we test the hypothesis generated from our theoretical analysis.

The null hypothesis states that contributions are independent of our salience manipulation. Our alternative hypothesis states that average contributions in groups which are subject to salient maximum contributions are higher than in groups which are subject to the opposite condition. These hypotheses hold independent of the nature of the salience manipulation.

3 Experimental Design

3.1 Manipulating Salience

How do particular contributions become salient? In the literature we find two fairly distinct approaches to this question. First, salience can arise endogenously as proposed by Bordalo et al. (2012). According to their theory, the contribution which is furthest away from the average contribution of the group, is the salient contribution. Second, contributions can become salient due to an exogenous manipulation, which focuses players attention on a certain contribution. This explanation is in the spirit of the model proposed by DellaVigna (2009). In this study we focus on this second approach. Thus, a crucial challenge for an empirical test of our hypothesis is to find a way to exogenously manipulate salience. In an influential article Taylor and Thompson (1982) define salience as: "[...] the phenomenon that when one's attention is differentially directed to one portion of the environment rather than to others, the information contained in that portion will receive disproportionate weighing in subsequent judgments." Following this definition we explore three different designs aiming at increasing the salience of either the highest or lowest contribution of the other group members exogenously.

Before we introduce these designs, we make use of previous research in related experiments to estimate the effect size. This allows us to determine the number of observations required to attain conventional levels of statistical power.

3.2 Sample Size Calculation

To derive number of independent observations required to draw statistically meaningful conclusions, we perform a power analysis (Cohen, 1988). Since our theoretical model does not provide us with predictions about the size of the treatment effect, we rely on effect sizes reported in the related literature. We will test our hypothesis by comparing the mean contributions over the ten periods across the two conditions. To calculate the effect size we need the expected difference in means as well as the expected standard deviation of the means in the two treatments. For the standard deviation we make use of the data from our experimental condition *Baseline*, a normal public goods game without any salience manipulation, and use this as expected standard deviation for both treatments (3.23). For the expected difference in means we consult the related literature. We rely on three papers that are closest to our design: Hoffmann et al. (2013, p. 309) report a treatment effect of 1.8 out of 20 between their *IF0* and *IF25* treatment; Savikhin Samek and Sheremeta (2014, p. 679) report a treatment effect between TOP and BOTTOM of 21.3 out of 100 (4.3 out of 20); Engel et al. (2021) shows a treatment effect of 6.3 out of 20 (p. 9).[5] We aim for the middle range of the previous literature and assume a treatment effect of 4 units. Using 0.05 as significance level and aiming for a power of 0.8 we calculate a required sample size of 12 groups per treatment.

3.3 Procedures

The three series of experiments on different salience manipulations share the following procedural features. Subjects play a repeated public goods game for ten periods in a partner matching. Subjects are randomly allocated to groups of four, which remain stable throughout the experiment. Groups are randomly assigned to the condition that renders the maximum contributions salient (*Max*), or the condition that renders the minimum contribution salient (*Min*). Randomization is such that within each session we assign (close to) half of the groups to each condition. In some of the sessions we observe a second sequence of ten periods in which we reverse the *Max*/*Min* condition. Table A1 in the appendix reports the number of subjects and the number of independent groups per treatment and stimulus order for all three studies.

[5] At the time we conducted the power analysis Irlenbusch et al. (2019) was not available. Their results suggest much smaller effect sizes for our type of manipulation.

The stage game payoff function follows equation (1). Subjects receive an endowment of $y = 20$ tokens and the marginal per capita return is $a = 0.4$. In the end of the experiments subjects were paid their accumulated earnings at an exchange rate of CHF 0.08 per token. The experimental sessions lasted 1.5 hours and subjects earned on average CHF40 (approx. $40).

We conducted all the experiments for this article at the LABEX of the University of Lausanne in Switzerland, using zTree for the interface (Fischbacher, 2007) and ORSEE for recruiting (Greiner, 2015). Subjects were undergraduate students from the University of Lausanne and the EPFL.

4 Study 1: Recall

4.1 Design and Procedures

In our first salience manipulation we ask subjects to recall either the highest or lowest contribution in their group. This method is inspired by results from research in cognitive psychology. The act of recall does not only activate the memory and cognition of the recalled target, but also inhibits the memory of its interfering competitors (Anderson & Spellman, 1995; Murayama et al., 2014; Roediger, 1974). Studies of brand salience showed that salience of certain brands can inhibit the recall of the remaining brands in the same category, hence increasing customers' likelihood of purchasing the salient brands (Alba & Chattopadhyay, 1986; Vieceli & Shaw, 2010). The excitatory and inhibitory functions of recall can also increase the salience of the recalled object, making it easier to access for later recall and decision making. For example, Dutch students reported using their bike more often after recalling instances of bicycle use.[6] In the study by Mukhopadhyay et al. (2008), students changed their responses to food-related temptations after recalling their past responses to similar temptations.

Inspired by this research we manipulate the salience of contributions by asking subjects to recall either the minimum or maximum contribution in their group. After the contributions stage subjects are informed about the contributions of the other three group members. The corresponding screens are shown in Figure A4 and A7 in Appendix A.3. In the *Min* (*Max*) condition subjects are instructed to remember the lowest (highest) contribution among the contributions of the three other group members. In the subsequent screen subjects have to enter the contribution they had to recall, and correct recalls are rewarded with one token (see Figures A10 and A9 in the appendix for an example). While the recall task is obviously very simple, it should clearly focus the attention towards either high or low contributions (provided there is some variance in the contributions of the other group members).

[6] According to Schwarz (2004) the effect is only present when the recalling task is simple, i.e., when the items to recall come to mind easily.

The instructions were identical for the *Max* and *Min* treatment. The instructions explained that participants will need to memorize a specific information and that they will receive more information about this task directly on the screen once the experiment started; see Appendix A.3 for the instructions.

4.2 Results

We conducted four sessions and observe the behavior of 108 individuals. For all inferential analysis we treat a group of four as the unit of independent observation, thus we observe 27 independent groups. In the first sequence 13 groups are in the *Min* condition and 14 groups in the *Max* condition; in the second sequence conditions are reversed. We contrast the results to the *Baseline*, where we have observations from three sessions with a total 64 subjects (16 groups) who played ten periods of the public goods game without any salience manipulation (one sequence only).

Figure 2 shows the behavior of the participants in the first sequence. The thin lines depict the average contributions, which participants recalled under the two conditions, i.e., the average stimuli. The mean contribution to recall in the *Max* (*Min*) condition was 12.9 (4.54), and the difference between the two conditions is highly significant ($n = 27$; $p = .001$).[7]

The means of the numbers recalled are 12.8 in the *Max* condition and 4.75 in the *Min* condition, respectively. The small difference between the actual and recalled contributions suggests that subjects were able to recall the correct values. Indeed, in the overwhelming majority of the cases (93.2%) subjects recalled the correct value and earned the additional profit of one token.[8] Like the correct values, the recalled contributions significantly differ across condition ($p = .001$). We conclude that the salience manipulation worked well in the sense that the stimuli are substantially different across condition and subjects memorized the respective information. Both results are important prerequisites for our manipulation to work. If participants were not able to recall contributions, or if there was no variance between the *Max* and *Min* stimulus, then there would be no reason to expect differences in the contributions.

The thick lines in Figure 2 show the average contributions. Despite the large differences in stimuli contributions are almost identical across treatment. The mean contribution with the maximum stimulus is 8.76 tokens

[7] Throughout the text we report exact p-values of Wilcoxon rank-sum tests for comparisons of the *Min* and *Max* condition within a sequence (between subjects). When testing for difference across sequence we report exact p-values of Wilcoxon signed-rank tests. All p-values refer to two-sided tests, and all non-parametric inference is based on independent group averages.

[8] 52% of the participants answered the recall question correctly in all ten periods and 33% made one mistake, and the remaining subjects answered between 6 to 8 times correctly.

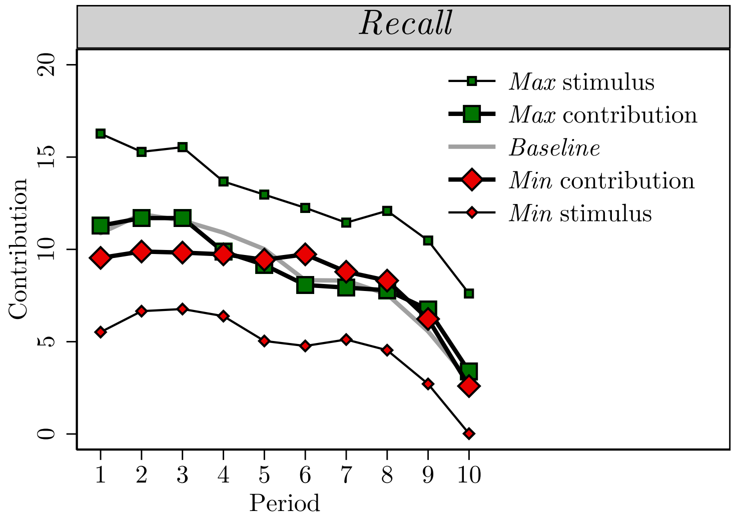

Figure 2: Average stimuli (contribution to recall) and contributions in the *Recall* experiment, first sequence.

(*SD*: 7.37) compared to an average of 8.41 tokens (*SD*: 7.78) with the minimum stimulus ($p = .685$). In addition, both treatments result in contributions which are very close to the *Baseline* experiments, a ten periods public goods game without any salience manipulation. Thus, neither of the two conditions in the *Recall* treatment does seem to have an influence on average contributions.[9]

We conclude from our *Recall* experiment that contributions are surprisingly stable with respect to our exogenous salience manipulation. In a next step we investigate an alternative method to increase the salience of minimum and maximum contributions.

[9]The results of the second sequence are qualitatively similar (Figure A1 in Appendix A.1). The average contribution, which subjects had to recall under the maximum stimulus is 8.99 (*SD*: 7.92) compared to 4.29 (*SD*: 6.13) under the minimum stimulus. The difference is not as pronounced as in the first sequence and weakly statistically different ($p = .080$).[10] Again we do not observe differences in contributions. The average contribution with the minimum stimulus is 6.93 (SD: 7.30), which is even higher than the average of 5.80 (*SD*: 7.59) with the maximum stimulus. The difference is statistically not significant ($p = .625$). Moreover, so far we discussed the between-subject effects (or, more precisely, between-group effects). Recall that groups in the *Max* condition played the *Min* condition in the second sequence and vice versa. This allows us to calculate within-group tests, i.e., to check whether on the level of a group the *Max* condition results in higher contributions than the *Min* condition. The differences are insignificant ($p = .940$).

5 Study 2: Belief

5.1 Design and Procedures

Our second salience manipulation, *Belief*, is very closely linked to the literature on conditional cooperation (Fischbacher et al., 2001; Thöni & Volk, 2018). This literature shows that the majority of subjects behave conditionally cooperative in public goods games. In a simultaneous move public goods game, beliefs about the behavior of the other group members become decisive for the behavior of conditional cooperators. While our previous manipulation focused the attention on the contributions in the previous period, this manipulation aims at focusing the attention on the contributions in the present period.

In every period we asked subjects to indicate their belief about either the maximum or the minimum contribution in their group. We assume that entering the belief about the maximum or minimum contribution focuses the attention correspondingly. Subjects had to enter their belief at the same time as they chose their contribution. We incentivized the belief question with an additional point for correct guesses. After their contribution, participants received full information about the contributions of the other group members (analogous to the *Recall* experiment).[11]

5.2 Results

We conducted four sessions with a total of 108 subjects, and 27 independent observations. In the first sequence 13 groups are in the *Min* condition and 14 groups in the *Max* condition; in the second sequence conditions are reversed. None of these subjects participated in the *Recall* or the *Baseline* experiment.

Figure 3 shows the average beliefs and contributions under the two conditions in the first sequence. In the *Max* condition subjects estimate a highest contribution of 8.56 on average. This number seems rather low, but note that it is across all periods. In the first period, subjects on average estimate a maximum contribution of 15.3, compared to 6.05 for the last period. Under the minimum stimulus, the overall estimation is on average 5.42. At the beginning of the experiment participants' beliefs about the lowest contribution in their group are 7.38 on average, whereas in the last period the average drops to 1.90. Beliefs significantly differ between the *Max* and the *Min* condition ($p = .048$).

In the *Max* condition average beliefs are close to the true values (8.56 vs. 9.00, Wilcoxon signed-rank test, $p = .296$). In contrast, subjects in the *Min* condition systematically overestimate the minimum contribution of their fellow group members (5.42 vs. 3.58, $p = .000$).

[11] The instructions for this experiment are in Appendix A.3. Figure A5 and A8 show the screens used in the instructions for the *Belief* experiment. Figure A12 for a screen

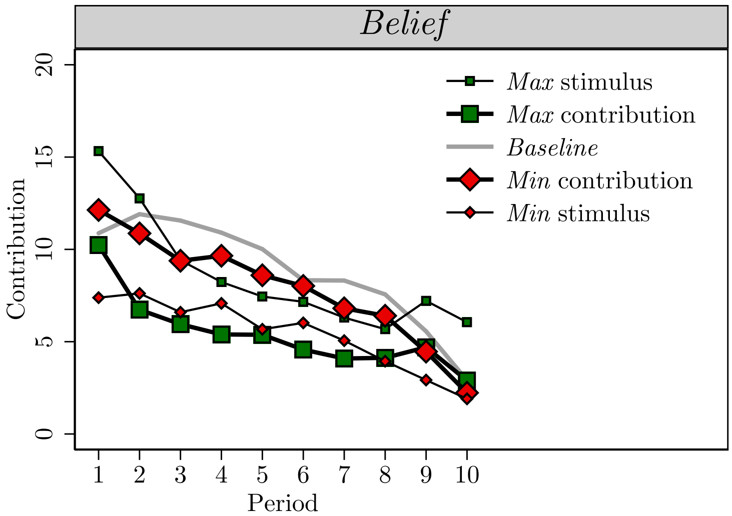

Figure 3: Average stimuli (subjects' beliefs about the maximum or minimum) and contributions in the *Belief* experiment, first sequence.

Given the significant differences between the beliefs across treatment we conclude that the participants were subject to different stimuli. According to our hypothesis this should lead to differences in contributions. The thick lines in Figure 3 reveal, however, that contributions are not higher when subjects state their belief about the maximum, if at all, we observe the opposite effect. In the *Max* condition participants contribute on average 5.41 (*SD*: 6.76); in the *Min* condition the average contribution is 7.86 (*SD*: 7.72), and the difference is weakly significant ($p = .061$).

Compared to the *Baseline* we observe significantly lower average contributions in *Belief* ($p = .026$), suggesting that the presence of a belief question lowers cooperation. While there is previous research suggesting that eliciting beliefs tends to reduce pro-social behavior,[12] it is still puzzling that this effect seems to be stronger when eliciting beliefs about the maximum contribution compared to eliciting beliefs about the minimum contribution in the group.[13]

shot from the actual experiment.

[12]Croson (2000) finds lower contributions in public goods games with belief elicitation. However, Gächter and Renner (2010) find either no effect or even a positive effect.

[13]In the second sequence of this experiment we observe weakly significantly different beliefs across condition (7.76 in *Max* vs. 5.42 in *Min*, $p = .074$, see Figure A2 in Appendix A.1).This is despite the fact that the true minimum and maximum contributions differ substantially across condition (10.5 vs. 2.27, $p = .000$). In both conditions subjects' beliefs are systematically biased towards the overall average contribution, $p < .001$. With respect to contributions the second sequence does not confirm the reversed trend from the first phase (contributions higher under *Min* than under *Max*). Average contributions

We conclude that our second salience manipulation does also not confirm our hypotheses. Focusing subjects' attention to high contributions by eliciting their respective beliefs does not results in systematically higher contribution trajectories. For our third manipulation we depart from the full information framework and inform subjects only about the minimum or maximum contribution of the other group members.

6 Study 3: Limited Information

6.1 Design and Procedures

The basis of the experiments in Study 3 is again the standard repeated public goods game from the previous experiments, but now we change the information subjects receive at the end of each period (*LimitedInfo*). Unlike in Study 1 and 2 we provided participants only with limited feedback about the behavior of the other group members. In the *Max* condition we informed subjects only about the highest contribution in the group. Likewise, in the *Min* condition we only communicated the lowest contribution in the group.[14] Note that unlike in the previous experiments, all group members receive the identical stimulus. Because the period earnings allow subjects to infer the average contribution in the group we did not provide earnings information during the game in this experiment. Subjects learned their accumulated earnings only at the very end of the experiment.

The motivation for this design comes from Mehta et al.'s (1994) study on salience in coordination games. Recall that our salience inequality aversion model changes the character of the public goods game from a dominance solvable game to a coordination game among the players with sufficiently strong social preferences and salience parameters. In the *Max* condition subjects learn the highest contribution in the previous round. For subjects with sufficiently strong social preferences this information should constitute a strong focal point for the actual period. In the *Min* condition, the contribution displayed is likely to be much lower, leading cooperative subjects to adjust their contribution downwards. The *LimitedInfo* treatments are arguably the strongest among the three salience manipulations we study in this paper, and let us to expect strongest differences in the contributions as hypothesized.[15]

under *Max* are 6.66, while 5.32 under *Min*. The difference is not significant ($p = .325$). Furthermore, comparing the *Max* and *Min* condition within group (and across sequence) does not show significant effects either (Wilcoxon signed rank test, $p = .843$).

[14] The instructions are in Appendix A.3 and Figure A11 shows the information screen.

[15] At the time we designed this study and formed the hypotheses we were not aware of the results of Irlenbusch et al. (2019). Their *transparent* MIN and MAX treatments are very close to the design of our Study 3. Their results indicate that such a manipulation has little effects on contributions.

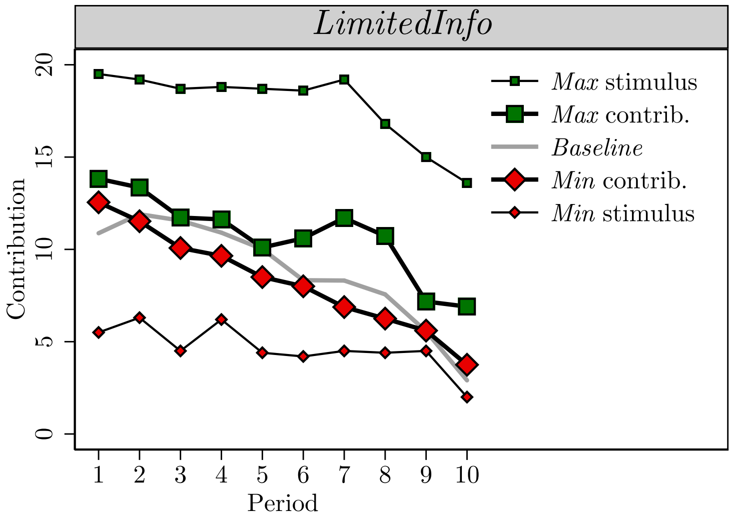

Figure 4: Average stimuli (displayed maximum or minimum contribution) and contributions in the *LimitedInfo* experiment, first sequence.

6.2 Results

For this experiment we ran four sessions with a total of 80 subjects in 20 independent groups. The subjects in this experiment participated in none of the above mentioned experiments.

Figure 4 shows the results of the first sequence. The thin lines depict the stimuli, i.e., the average maximum or minimum contribution in a group. The average stimulus under *Max* is 17.8, and for most of the groups the contribution displayed is the maximum contribution during the first seven periods. In *Min* the average displayed contribution is 4.65 token with a standard deviation of 6.71 tokens. The difference between the displayed contribution in *Min* and *Max* is highly significant ($p = .000$).

Do the substantial differences in the stimuli lead to differences in the contributions? The thick lines in Figure 4 show that the average contribution in *Max* (10.8, *SD*: 8.80) is consistently higher than in *Min* (8.28, *SD*: 7.76), which might be interpreted in favor of our hypothesis. However, the difference does not reach significance ($p = .123$). In addition, in the second sequence the *Min* treatments shows higher contributions (12.0) compared to the *Max* treatment (10.5), albeit far from significant ($p = .413$, see Figure A3 in Appendix A.1). In addition, within group comparisons of the first and second sequence do also not support the hypothesis ($p = .820$).

To sum up, all three attempts to provide evidence for the importance of salience for cooperation in public goods game failed to support our hypothesis. In a next step we take a deeper look at the data to shed some light on the reasons for the lack of overall results.

7 Synthesis

To take a closer look at the impacts of our salience manipulation we estimate random effects models. The estimates are based on the whole sample (Study 1 to 3, including *Baseline*). Table 1 shows the results. Dependent variable is the contribution and we report cluster-robust standard errors. In Model (1) we estimate the effect of the presence of the maximum stimulus, controlling for treatment dummies, a dummy for the second sequence, and the period. In the overall sample with 90 independent clusters the overall effect of rendering the maximum salient (dummy *Max*) relative to rendering the minimum salient is close to zero.

What might be the reason behind the ineffectiveness of our various salience manipulations? One possibility is that the stimuli were not strong enough to shift subjects' attention in the desired direction. In Model (2) we include the stimuli as explanatory variable. Depending on the study, this is either (i) the recalled contribution, (ii) the belief about the minimum or maximum contribution, or (iii) the minimum/maximum contribution from the previous period. For the (i) and (iii) we have to drop the first period data, because these salience manipulation cannot affect play at the beginning of the game. The coefficient for the stimuli is positive and highly significant, suggesting that subjects did factor in this information when choosing their contribution. Interestingly, now the coefficient for the treatment dummy *Max* becomes negative and highly significant. This suggests that there are two offsetting effects, which in combination lead to our null result: subjects do react positively to the stimulus (following to some extent the salient contribution), but they seem to correct for the treatment they are in. When they are in the treatment where we make the maximum salient, they significantly lower the contribution relative to the subjects in the minimum condition.

In Model (3) we check whether the reaction to the stimulus depends on the treatment. The interaction term suggests that the link between stimulus and contribution is significantly smaller in the *Max* condition. This is in line with our theoretical argument, because there is a wide range of salience parameters for which the best response function matches the minimum of the other players' contributions, while the same for the maximum requires high salience for the maximum contribution. Empirically the effect is similar to the results of Thöni and Gächter (2015), who also find that reactions to observing co-players' strategies are stronger when they align with self interest compared to when they are more pro-social. There is an important caveat with Model (3). As the salient contribution is most likely correlated with the general level of cooperation in the group, we do not measure its effect in isolation. To control for this confound we add the lagged own contribution

Table 1: Estimates in the combined sample

	Dependent variable: Contribution			
	(1)	(2)	(3)	(4)
Period	-0.787^{**}	-0.601^{**}	-0.596^{**}	-0.248^{**}
	(0.055)	(0.049)	(0.049)	(0.039)
Second sequence	-0.663	-0.345	-0.470	-0.073
	(0.563)	(0.384)	(0.376)	(0.105)
Recall	-0.764	0.758	1.223^{+}	0.587^{**}
	(1.245)	(0.826)	(0.712)	(0.190)
Belief	-2.169^{+}	-0.075	0.238	0.203
	(1.162)	(0.778)	(0.696)	(0.195)
LimitedInfo	1.504	1.535	2.186^{*}	0.781^{**}
	(1.494)	(0.968)	(0.865)	(0.261)
Max	-0.035	-2.513^{**}	-0.989^{*}	-0.052
	(0.490)	(0.335)	(0.399)	(0.203)
Stimulus (c^*)		0.409^{**}	0.507^{**}	0.190^{**}
		(0.028)	(0.035)	(0.027)
Max $\times$ c^*			-0.184^{**}	-0.094^{**}
			(0.041)	(0.022)
g_i^{t-1}				0.479^{**}
				(0.024)
$\bar{g}_{-i}^{t-1}$				0.247^{**}
				(0.034)
Constant	13.124^{**}	8.306^{**}	7.350^{**}	1.405^{**}
	(0.851)	(0.676)	(0.645)	(0.342)
χ^2-test	308.3	682.3	937.2	5678.8
p	0.000	0.000	0.000	0.000
R^2	0.119	0.348	0.358	0.561
N	5680	5328	5328	5112

Notes: Random effects estimates. Independent variables are period and a dummy for the second sequence; *Recall*, *Belief*, and *LimitedInfo* are treatment dummies (with the treatment without salience manipulation as baseline case), and *Max* is a dummy for the salience manipulation (set to zero for *Baseline* observations). The stimulus is, dependent on the treatment, the recalled contribution from the previous period, the belief about the maximum or minimum contribution in the current period, or the minimum or maximum contribution in the previous period, for *Baseline* we use the average contribution in the previous period; g_i^{t-1} is the subject's contribution in the previous period and $\bar{g}_{-i}^{t-1}$ is the average contribution of the other three subjects in the group in the previous period. Robust standard errors, clustered on group, in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

as well as the lagged average contribution of the other subjects in Model (4). The coefficient for the stimulus becomes a lot smaller, but remains highly significant. Likewise, the interaction with the treatment dummy *Max* is much smaller but remains qualitatively similar and highly significant.

In Table A2 in the Appendix we show the results of random effects estimates for the three salience manipulations separately. In all models the point estimates confirm that the stimulus positively affects contributions and that the interaction with the *Max* dummy is negative. Summing up, we find that once we control for the previous contribution and the stimulus, participants contribute less under the maximum stimulus than under the minimum stimulus. This result likely explains why we do not observe an overall effect in the first place. Both stimuli influence behavior in the desired direction, but subjects counteract the treatment by a general shift of their contributions towards the middle.

8 Conclusions

Inspired by the relatively recent theoretical attempts to incorporate salience in economic models we study the role of salience as a means to facilitate (or impede) cooperation in social dilemma games. Based on DellaVigna's (2009) model on salience in consumer choice, we extended the Fehr-Schmidt model to include salience. This extended Fehr-Schmidt model provides us with testable predictions for how salience affects behavior in a standard public goods game. If the lowest contribution in a group is most salient compared to the other contributions, this contribution level will get more weight in the decision-making process. Hence, contributions will be biased towards the minimum in the group. The predictions for the case where the highest contribution in a group is most salient are vice versa.

We test this prediction in a series of laboratory experiments. We exogenously increase either the salience of the maximum or the minimum contribution and use three methods for salience manipulation: In *Recall*, we manipulated salience by letting subjects remember and recall contributions. In the *Belief* experiment we focus subjects' attention to maximum or minimum contributions by eliciting their respective beliefs. Finally, in the *LimitedInfo* experiment we withhold all contribution feedback but the one we seek to render salient.

In turns out that contributions are highly robust against our salience manipulations. The overall treatment effect is virtually zero. Regression analysis suggests that subjects do take the salient contribution into account, but at the same time respond to the two conditions in a systematic way which offsets the direct effect. Thus, on the one hand being exposed to high contributions in the maximum condition increase contributions, but on the other hand the fact that subjects know they are in a condition emphasizing high contributions leads them to lower their contributions in general, which offsets the first effect.

Another interpretation is that the two stimuli might created an upper or lower bound for the contribution decision. Subjects under the maximum stimulus might perceive the maximum contribution as some kind of upper bound and consider it justified to contribute somewhat less than the maximum. In contrast, participants under the minimum stimulus might perceive the minimum as the lowest acceptable contribution and contributed somewhat more than the minimum. This interpretation receives support by the results of Jones and Linardi (2014), who find that many subjects in their experiment are averse to standing out in either a negative or a positive way. Which of these interpretations is more appropriate has to be left for future research. A simple test would be to conduct the same experiments but to not label the salience stimuli as minimum or maximum. This would allow to disentangle the effect generated by the labeling from the effect of the stimulus itself. Additionally, more research is needed to understand how participants perceived the salience manipulation. This would also help to understand the contrast between our results and the effects observed in Savikhin Samek and Sheremeta (2014). Based on our results, we conjecture that the loss of anonymity drives their results and not the labeling of the contributions. Finally, following standard practice in experimental economics we abstained from deception and constructed environments in which it was obvious to the subjects that we would focus their attention to either the maximum or the minimum contribution in the group. Many salience manipulations outside the laboratory are presumably much less transparent, and might therefore have a stronger impact on behavior.

Finally, returning to our opening question whether the shining example of Stakhanov's outstanding productivity did motivate others to follow suit. We are not aware of rigorous empirical research on the productivity gains of the Stakhanovite movement. On the grand scheme, it certainly looks like the movement was at least not sufficiently effective to demonstrate the superiority of the socialist economic system. Our results provide suggestive evidence for why it may not have been as effective as hoped. Highlighting the most cooperative behaviors may not enhance average cooperation, when people are aware that they are subject to a deliberate attempt to manipulate their behavior.

References

Akerlof, G. A. (1991). Procrastination and obedience. *American Economic Review, 81*(2), 1–19.

Alba, J. W., & Chattopadhyay, A. (1986). Salience effects in brand recall. *Journal of Marketing Research*, *23*(4), 363–369. https://doi.org/10.2307/3151812

Anderson, M. C., & Spellman, B. A. (1995). On the status of inhibitory mechanisms in cognition: Memory retrieval as a model case. *Psychological Review*, *102*(1), 68–100. https://doi.org/10.1037/0033-295X.102.1.68

Bigoni, M., & Suetens, S. (2012). Feedback and dynamics in public good experiments. *Journal of Economic Behavior & Organization*, *82*(1), 86–95. https://doi.org/10.1016/j.jebo.2011.12.013

Bordalo, P., Gennaioli, N., & Shleifer, A. (2012). Salience theory of choice under risk. *Quarterly Journal of Economics*, *127*(3), 1243–1285. https://doi.org/10.1093/qje/qjs018

Chetty, R., Looney, A., & Kroft, K. (2009). Salience and taxation: Theory and evidence. *American Economic Review*, *99*(4), 1145–1177. https://doi.org/10.1257/aer.99.4.1145

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Lawrence Erlbaum Associates.

Croson, R. (2000). Thinking like a game theorist: Factors affecting the frequency of equilibrium play. *Journal of Economic Behavior & Organization*, *41*(3), 299–314. https://doi.org/10.1016/S0167-2681(99)00078-5

Croson, R., & Marks, M. (2001). The effect of recommended contributions in the voluntary provision of public goods. *Economic Inquiry*, *39*(2), 238–249. https://doi.org/10.1093/ei/39.2.238

DellaVigna, S. (2009). Psychology and economics: Evidence from the field. *Journal of Economic Literature*, *47*(2), 315–372. https://doi.org/10.1257/jel.47.2.315

Engel, C., Kube, S., & Kurschilgen, M. (2021). Managing expectations: How selective information affects cooperation and punishment in social dilemma games. *Journal of Economic Behavior & Organization*, *187*, 111–136. https://doi.org/10.1016/j.jebo.2021.04.029

Fehr, E., & Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. *Quarterly Journal of Economics*, *114*(3), 817–868. https://doi.org/10.1162/003355399556151

Fischbacher, U. (2007). Z-tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, *10*(2), 171–178. https://doi.org/10.1007/s10683-006-9159-4

Fischbacher, U., Gächter, S., & Fehr, E. (2001). Are people conditionally cooperative? Evidence from a public goods experiment. *Economics Letters*, *71*(3), 397–404. https://doi.org/10.1016/S0165-1765(01)00394-9

Gächter, S., & Renner, E. (2010). The effects of (incentivized) belief elicitation in public goods experiments. *Experimental Economics*, *13*(3), 364–377. https://doi.org/10.1007/s10683-010-9246-4

Greiner, B. (2015). Subject pool recruitment procedures: Organizing experiments with ORSEE. *Journal of the Economic Science Association*, *1*(1), 114–125. https://doi.org/10.1007/s40881-015-0004-4

Hartig, B., Irlenbusch, B., & Kölle, F. (2015). Conditioning on what? Heterogeneous contributions and conditional cooperation. *Journal of Behavioral and Experimental Economics*, *55*, 48–64. https://doi.org/10.1016/j.socec.2015.01.001

Hoffmann, M., Lauer, T., & Rockenbach, B. (2013). The royal lie. *Journal of Economic Behavior & Organization*, *93*, 305–313. https://doi.org/10.1016/j.jebo.2013.03.020

Irlenbusch, B., Rilke, R. M., & Walkowitz, G. (2019). Designing feedback in voluntary contribution games: the role of transparency. *Experimental Economics*, *22*(2), 552–576. https://doi.org/10.1007/s10683-018-9575-2

Jones, D., & Linardi, S. (2014). Wallflowers: Experimental evidence of an aversion to standing out. *Management Science*, *60*(7), 1757–1771. https://doi.org/10.1287/mnsc.2013.1837

Mehta, J., Starmer, C., & Sugden, R. (1994). The nature of salience: An experimental investigation of pure coordination games. *American Economic Review*, *84*(3), 658–673.

Mormann, M. M., & Frydman, C. (2016). The role of salience and attention in choice under risk: An experimental investigation.

Mukhopadhyay, A., Sengupta, J., & Ramanathan, S. (2008). Recalling past temptations: An information-processing perspective on the dynamics of self-control. *Journal of Consumer Research*, *35*(4), 586–599. https://doi.org/10.1086/591105

Murayama, K., Miyatsu, T., Buchli, D., & Storm, B. C. (2014). Forgetting as a consequence of retrieval: A meta-analytic review of retrieval-induced forgetting. *Psychological Bulletin*, *140*(5), 1383–1409. https://doi.org/10.1037/a0037505

Roediger, H. L. (1974). Inhibiting effects of recall. *Memory & Cognition*, *2*(2), 261–269. https://doi.org/10.3758/BF03208993

Savikhin Samek, A., & Sheremeta, R. M. (2014). Recognizing contributors: An experiment on public goods. *Experimental Economics*, *17*(4), 673–690. https://doi.org/10.1007/s10683-013-9389-1

Schelling, T. C. (1960). *The strategy of conflict*. Harvard University Press.

Schwarz, N. (2004). Metacognitive experiences in consumer judgment and decision making. *Journal of Consumer Psychology*, *14*(4), 332–348. https://doi.org/10.1207/s15327663jcp1404_2

Taylor, S. E., & Thompson, S. C. (1982). Stalking the elusive "vividness" effect. *Psychological Review*, *89*(2), 155–181. https://doi.org/10.1037/0033-295X.89.2.155

Thöni, C., & Gächter, S. (2015). Peer effects and social preferences in voluntary cooperation. *Journal of Economic Psychology*, *48*, 72–88. https://doi.org/10.1016/j.joep.2015.03.001

Thöni, C., & Volk, S. (2018). Conditional cooperation: Review and refinement. *Economics Letters*, *171*, 37–40. https://doi.org/10.1016/j.econlet.2018.06.022

Vieceli, J., & Shaw, R. N. (2010). Brand salience for fast-moving consumer goods: An empirically based model. *Journal of Marketing Management*, *26*(13-14), 1218–1238. https://doi.org/10.1080/0267257X.2010.523009

A Appendix

A.1 Mathematical appendix

Proposition 1

Players with the utility function $U_i^{\theta}(\mathbf{x})$ (defined in Equation 3) have a reaction function as characterized by Equation (4).

Proof

The partial derivative of player i's utility with respect to his contribution is:

$$\frac{\partial U_i^{\theta}}{\partial g_i} = \begin{cases} -1 + a + \beta_i & g_i \in [0, g_l) \\ -1 + a - \theta_{il}\alpha_i + (\theta_{im} + \theta_{ih})\beta_i & g_i \in (g_l, g_m) \\ -1 + a - (\theta_{il} + \theta_{im})\alpha_i + \theta_{ih}\beta_i & g_i \in (g_m, g_l) \\ -1 + a - \alpha_i & g_i \in (g_l, y] \end{cases} \tag{5}$$

Using $\theta_{il} + \theta_{im} + \theta_{ih} = 1$, we can rewrite the expression as

$$= \begin{cases} -1 + a + \beta_i & g_i \in [0, g_l) \\ -1 + a - \theta_{il}\alpha_i + (1 - \theta_{il})\beta_i & g_i \in (g_l, g_m) \\ -1 + a - (1 - \theta_{ih})\alpha_i + \theta_{ih}\beta_i & g_i \in (g_m, g_l) \\ -1 + a - \alpha_i & g_i \in (g_l, y] \end{cases} \tag{6}$$

In case the first part of the derivative is zero or negative ($\beta_i \leq 1 - a$) the player contributes zero (recall from Footnote 3 that we assume that in case of indifference the player chooses the lowest contribution). In case of $\beta_i > 1 - a$ the first derivative is positive and the player can increase utility by matching at least g_l. Whether it makes sense to increase the contribution beyond g_l depends on the sign of the derivative in the second case. For sufficiently low salience of the lowest contribution $\theta_{il} < \frac{a+\beta_i-1}{\alpha_i+\beta_i} = \hat{\theta}_{il}$ the expression is positive and the best response is to match at least g_m. Given the parameter restrictions of the Fehr-Schmidt model ($0 \leq \alpha_i, 0 \leq \beta_i < 1$, and $\beta_i \leq \alpha_i$) we can derive the highest possible threshold for θ_{il} as 0.2 (with $a = 0.4$, $\alpha_i = 1$, and $\beta_i \to 1$). Recall that the standard Fehr-Schmidt model corresponds to the case of $\theta_l = \frac{1}{3}$. Consequently, the Fehr-Schmidt model without salience cannot explain contributions above g_l in the public goods game with our parameters.

Beyond g_m the derivative changes again and if the salience of the highest contributor is sufficiently strong, such that $\theta_{ih} > \frac{\alpha_i+1-a}{\alpha_i+\beta_i} = \hat{\theta}_{ih}$ then the player is best of matching g_h. The parameter restrictions ensure that there is no ambiguity between these three cases, as it is not possible that both θ_l and θ_h are above their respective thresholds. To see this note that $\hat{\theta}_{ih} + \hat{\theta}_{il} = 1$, which renders the combination of $\theta_{ih} > 0$ and $\theta_{il} \geq 0$ impossible. Figure 1 illustrates this point. The point where the two dashed lines cross always follows the diagonal.

Finally, the last line of the derivative in Equation 6 cannot be positive (since $a < 1$ and $\alpha_i > 0$), which means that a player i will never choose a contribution beyond g_h. ■

Proposition 2

Assume there is one F player with $\beta_F < 1 - a$, and three C players with $\beta_C \geq 1 - a$. An equilibrium exists where all C players contribute an identical positive amount $\bar{g} \in (0, y]$ and the F player contributes zero, provided that $\theta_{CF} < \hat{\theta}_{Cl}$ holds for all C players.

Proof

According to the reaction function in Equation (6) F has a dominant strategy to contribute zero, i.e., $g_F = g_l = 0$. Assume player i is a C player and the two remaining C players j and k contribute $g_j = g_k = \bar{g} \in (0, y]$. According to the expression in Equation (6) player i's utility must be increasing in g_i for $g_i \in [0, \bar{g})$ if her preference parameter satisfy $\theta_{CF} < \hat{\theta}_{Cl} = \frac{a+\beta_C-1}{\alpha_C+\beta_C}$. Choosing a contribution above the contribution of the other C player ($g_i > \bar{g}$) is strictly dominated. Consequently, the unique best response is to choose $g_i = \bar{g}$. By symmetry this holds also for the remaining C players, such that the strategy combination $\{g_F, g_i, g_j, g_k\} = \{0, \bar{g}, \bar{g}, \bar{g}\}$ constitutes a Nash equilibrium.

With the game parameters used in our experiment ($a = 0.4$) this equilibrium is not possible with standard Fehr-Schmidt preferences, as it requires $\theta_{CF} < 0.2$ (for more detail see proof of Proposition 1). ■

Proposition 3

Assume there are two F players with $\beta_F < 1-a$, and two C players with $\beta_C \geq 1 - a$. An equilibrium exists where both C players contribute an identical positive amount $\bar{g} \in (0, y]$ and the F players contribute zero, provided that $\theta_{CC} > \hat{\theta}_{Ch}$ holds for both C players.

Proof

The two F players p and q chose their dominant strategy and play $g_p = g_q = 0$. Player i and j are C players, and j contributes $g_j = \bar{g} \in (0, y]$. The condition $\theta_{CF} < \hat{\theta}_{Cl}$ is in this case not sufficient to ensure that i is willing to contribute. This is the case if (in addition) $\theta_{CC} > \hat{\theta}_{Ch} = \frac{\alpha_C+1-a}{\alpha_C+\beta_C}$ holds. If this is the case then i's unique best response is to match j's contribution ($g_i = \bar{g}$). By symmetry this holds also for player j, which makes the strategy combination $\{g_p, g_q, g_i, g_j\} = \{0, 0, \bar{g}, \bar{g}\}$ a Nash equilibrium.

With $a = 0.4$ and the restrictions on α_C and β_C we can calculate the minimum θ_{CC} necessary for this equilibrium as 0.8 (for $\alpha_C = 1$ and $\beta_C \to 1$). Consequently, this equilibrium is not feasible with standard Fehr-Schmidt preferences. ■

A.2 Additional Tables and Figures

Table A1: Number of subjects by treatment.

Study	Treatment	Order	1. Sequence	2. Sequence
1	*Recall*	$Min \to Max$	52 (13)	32 (8)
		$Max \to Min$	56 (14)	32 (8)
2	*Belief*	$Min \to Max$	52 (13)	52 (13)
		$Max \to Min$	56 (14)	56 (14)
3	*LimitedInfo*	$Min \to Max$	40 (10)	16 (4)
		$Max \to Min$	40 (10)	20 (5)
	Baseline	–	64 (16)	–

Notes. Number of subjects per treatment and stimulus order. Numbers in parenthese indicate independent observations (number of groups).

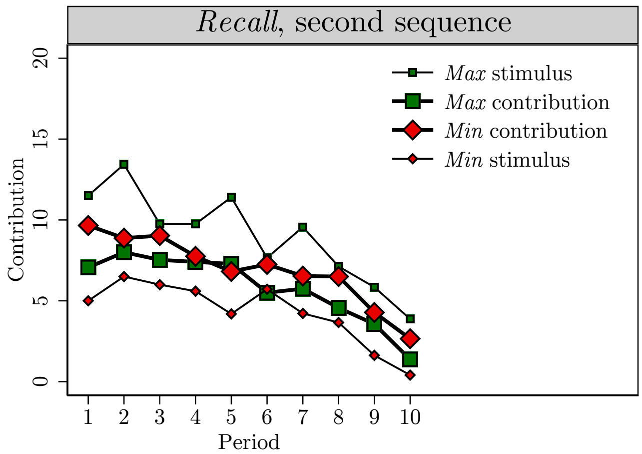

Figure A1: Behavior in the *Recall* experiment, second sequence.

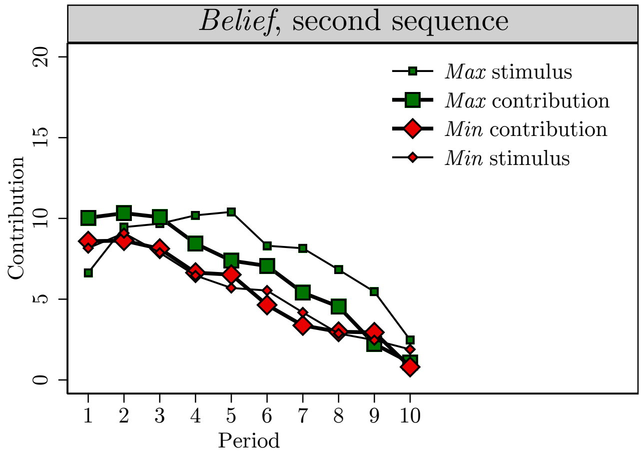

Figure A2: Beliefs and behavior in the *Belief* experiment, second sequence.

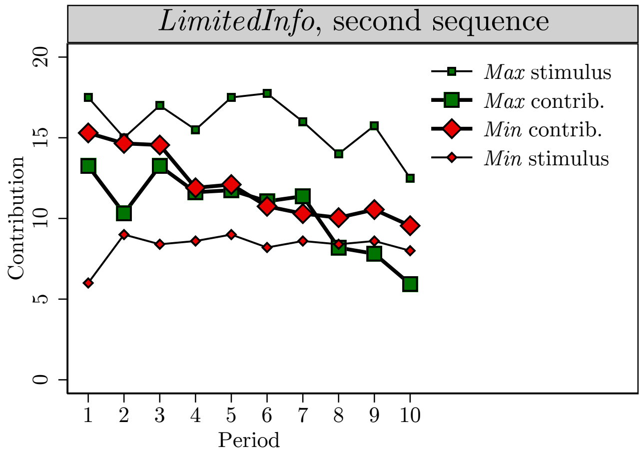

Figure A3: Displayed contributions and behavior in the *LimitedInfo* experiment, second sequence.

Table A2: Estimates by study

	Recall		*Belief*		*LimitedInfo*	
	(1)	(2)	(3)	(4)	(5)	(6)
Period	-0.596^{**}	-0.339^{**}	-0.566^{**}	-0.160^{**}	-0.660^{**}	-0.220^{*}
	(0.087)	(0.080)	(0.084)	(0.051)	(0.096)	(0.093)
Second sequence	-1.607^{*}	-0.290^{+}	-0.490	-0.129	1.095	0.358
	(0.791)	(0.153)	(0.388)	(0.159)	(1.049)	(0.370)
Max	-1.003	0.669^{+}	-1.154^{*}	-0.200	-0.333	-0.212
	(0.669)	(0.362)	(0.497)	(0.269)	(1.339)	(0.954)
Stimulus (c^*)	0.476^{**}	0.096^{*}	0.454^{**}	0.202^{**}	0.609^{**}	0.253^{**}
	(0.069)	(0.039)	(0.056)	(0.041)	(0.069)	(0.080)
$Max \times c^*$	-0.203^{**}	-0.115^{**}	-0.079	-0.060	-0.306^{**}	-0.128^{**}
	(0.070)	(0.030)	(0.058)	(0.036)	(0.108)	(0.049)
g_i^{t-1}		0.455^{**}		0.432^{**}		0.541^{**}
		(0.043)		(0.044)		(0.046)
$\bar{g}_{-i}^{t-1}$		0.381^{**}		0.266^{**}		0.152
		(0.045)		(0.055)		(0.095)
Constant	9.379^{**}	2.257^{**}	7.452^{**}	1.147^{**}	8.968^{**}	1.844^{+}
	(1.088)	(0.557)	(1.031)	(0.366)	(1.053)	(1.043)
χ^2-test	232.2	7238.2	298.7	1357.8	263.6	2123.8
p	0.000	0.000	0.000	0.000	0.000	0.000
R^2	0.342	0.571	0.340	0.553	0.378	0.563
N	1548	1548	2160	1944	1044	1044

Notes: Random effects estimates. Independent variables are period and a dummy for the second sequence; *Max* is a dummy for the salience manipulation. The stimulus is, dependent on the treatment, the recalled contribution from the previous period, the belief about the maximum or minimum contribution in the current period, or the minimum or maximum contribution in the previous period; g_i^{t-1} is the subject's contribution in the previous period and $\bar{g}_{-i}^{t-1}$ is the average contribution of the other three subjects in the group in the previous period. Robust standard errors, clustered on group, in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

A.3 Instructions

Note. Translation of the instructions (original in French available upon request). Text in normal font was identical in all three experiments. *Text in italics indicates treatment specific information.*

Introduction

You are now taking part in an economic experiment financed by various research foundations. If you read the following instructions carefully, you can depending on your decisions, earn a considerable amount of money. It is therefore very important that you read these instructions with care.
These instructions are solely for your private use. It is prohibited to communicate with the other participants during the experiment. Should you have any questions, please ask us. If you violate this rule, you will be dismissed from the experiment and forfeit all payments.
During the experiment, we will not speak in terms of Swiss Francs, but in Points. During the experiment, your entire earnings will be calculated in Points. At the end of the experiment, the total amount of Points you have earned will be converted to Swiss Francs at the following rate:

$$1 \text{ Point} = 0.08 \text{ CHF}$$

At the end of the experiment, your entire earnings from the experiment plus the show-up fee will be paid to you in cash.

Detailed Information About the Experiment

The experiment is divided into 10 separate periods. In each period all participants are divided into groups of four. You will, therefore, be in a group with 3 other participants. The composition of the groups will stay the same for all ten periods. In the following pages, we describe the experiment in detail.
At the beginning of each period, each participant receives 20 tokens. We call this his or her endowment. Your task is to decide how to use your endowment. You have to decide how many of the 20 tokens you want to contribute to a project and how many of them to keep for yourself. The consequences of your decision are explained in detail below. At the beginning of each period the following input-screen will appear:

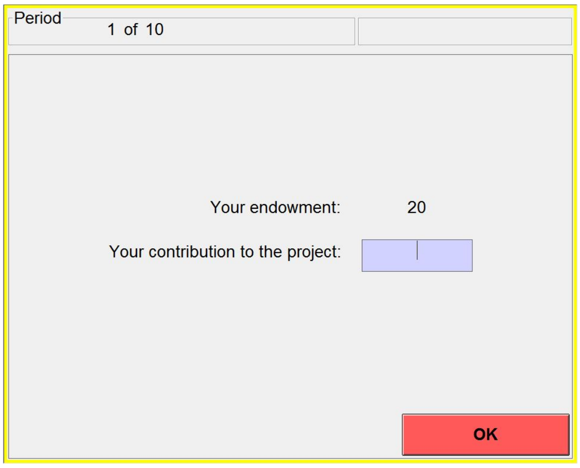

Figure A4: Decision screen in the *Recall* and *LimitedInfo* experiment.

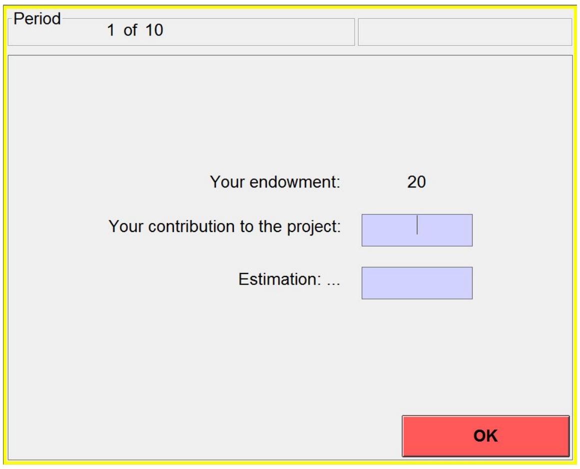

Figure A5: Decision screen in the *Belief* experiment.

The period number appears in the top left corner of the screen. In the top right corner, you can see how many more seconds remain for you to decide on your contribution. You will have 90 seconds in the first two periods and 60 seconds in the remaining periods. Your decision must be made within the time limit.
Your endowment in each period is 20 tokens. You have to decide how many tokens you want to contribute to the project by typing a number between 0 and 20 in the input field. This field can be reached by clicking it with the mouse. As soon as you have decided how many tokens to contribute to the project, you have also decided how many tokens you keep for yourself: This is (20 - your contribution) tokens. After entering your contribution, you must click the O.K. button. Once you have done this, your decision can no longer be revised.

Belief Experiment: *Below the contribution input field there is another input field called "Estimation". You will have to enter an estimation about the behavior of a group member. You will get the detailed information directly on the screen.*

Recall Experiment and Belief Experiment: *After all members of your group have made their decision the following screen will show you the total amount of tokens contributed by all four group members to the project (including your contribution). This screen also shows you how many Points you have earned in this period.*

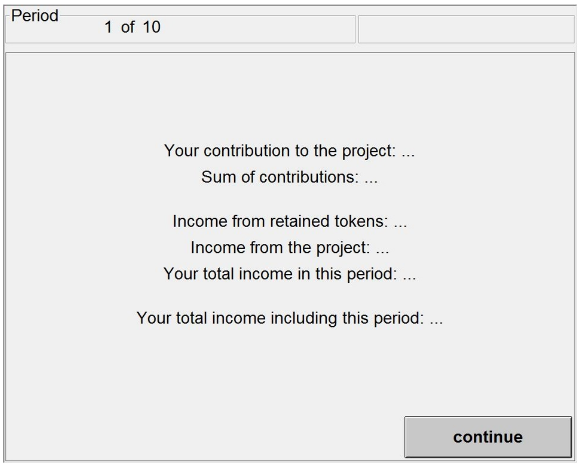

Figure A6: Feedback screen in the *Recall* and *Belief* experiment.

Limited Information Experiment: *After all members of your group have made their decision you will get some information about the contributions of the other group members.*

Your income consists of two parts:
(1) The tokens which you have kept for yourself ("Income from retained tokens") whereby

1 token = 1 Point.

(2) The "income from the project". This income is calculated as follows:

Your income from the project = 0.4 times the total contributions to the project.

Your income in Points of a period is, therefore:

(20 - your contribution to the project) + 0.4*(total contributions to the project)

The income of each group member from the project is calculated in the same way, i.e., each group member receives the same income from the project. Assume, for example, that the sum of the contributions of all group members is 60 tokens. In this case, each member of the group receives an income from the project of: 0.4*60 = 24 Points. If the total contribution to the project is 9 tokens, then you and all other members of the group receive an income of 0.4*9 = 3.6 Points from the project.
For each token, which you keep for yourself you earn an income of 1 Point. Suppose you contributed this token to the project instead, then the total contribution to the project would rise by one token. Your income from the project would rise by 0.4*1=0.4 Points. However, the income of the other group members would also rise by 0.4 Points each, so that the total income of the group from the project would rise by 1.6 Points. Your contribution to the project therefore also raises the income of the other group members. On the other hand, you earn an income for each token contributed by the other members to the project. For each token contributed by any member you earn 0.4*1=0.4 Points.
In the first two periods you have 45 seconds and in the remaining periods 30 seconds to view this income screen. If you are finished before the time is up, please click the "continue"-button.

Recall Experiment and Belief Experiment: *Next, the information screen appears, which reveals the contributions of the other group members.*

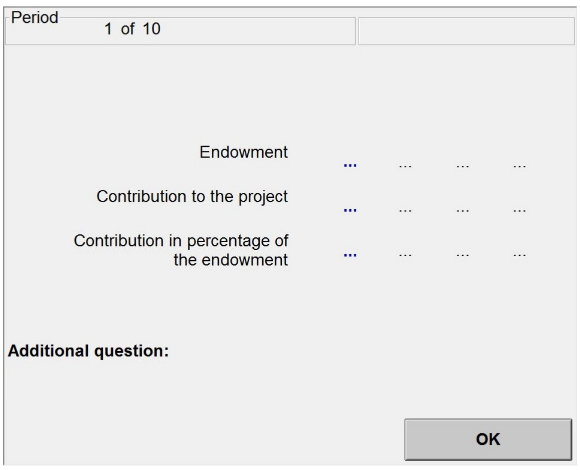

Figure A7: Information screen in the *Recall* experiment with the additional question.

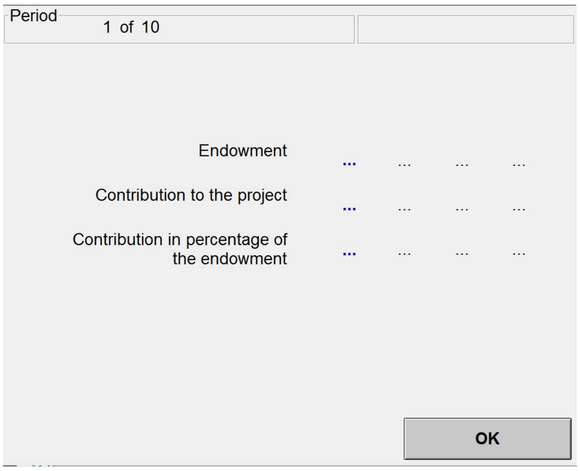

Figure A8: Information screen in the *Belief* experiment.

This screen shows how much each of the other group members contributed to the project. Your contribution is displayed in blue in the first column, while the contributions of the other group members are shown in the remaining three columns. Please note that the order in which contributions are displayed is changed randomly in each period. The contribution in the second column, for example, in general, stems always from a different group member. The same holds for the contributions in the other columns. Besides the absolute contributions, the contributions as a percentage of the endowment are also displayed.

Limited Information Experiment: *The profit will be calculated each period, but it will not be displayed to you. The profits of all periods will be added up, and you will get informed about your final profit at the end of the last period.*

Recall Experiment:
ADDITIONAL QUESTION
In each period you can earn an additional Point by responding correctly to the additional question. You will need to memorize some information about the behavior of the other group members. You will receive the detailed information directly on the screen.
In the following screen, you are asked to enter your response. You will receive an additional Point if you answer the question correctly.

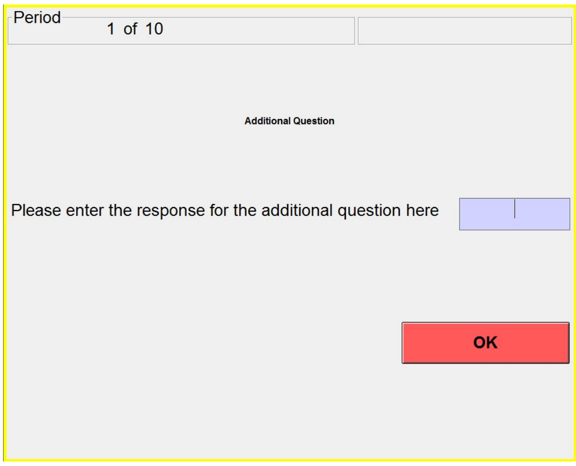

Figure A9: Screen with the additional question in the *Recall* experiment

Do you have any questions?

A.4 Examples of the zTree Screens

Recall Experiment

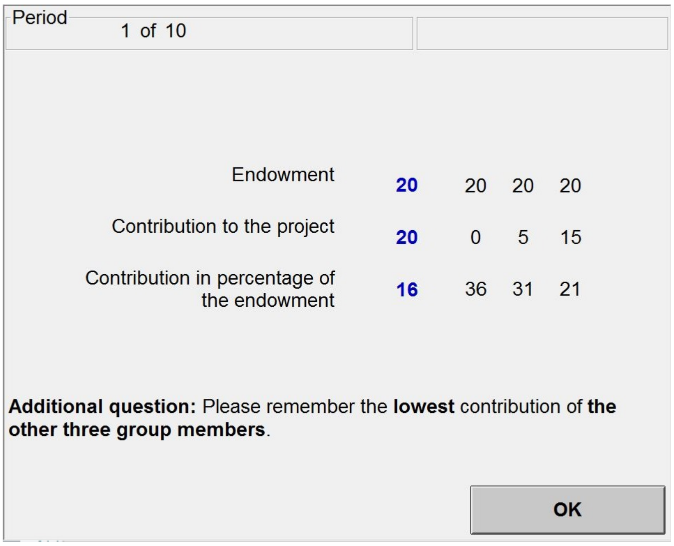

Figure A10: Example of the screen with the additional question, *Min* condition.

Limited Information Experiment

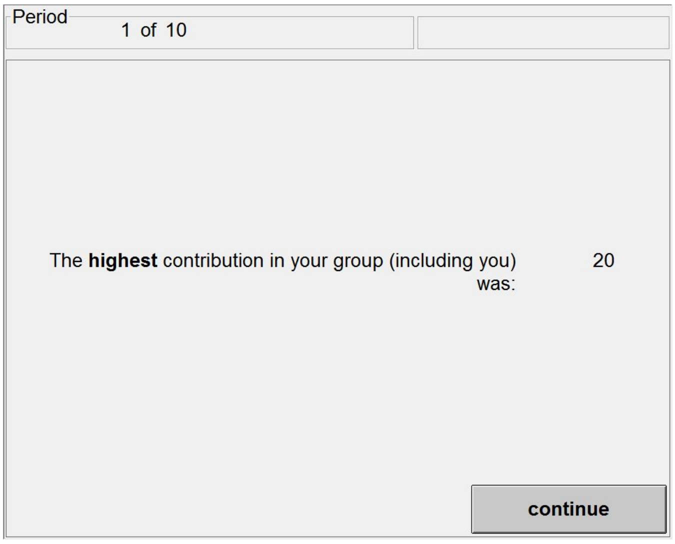

Figure A11: Example of the feedback after the contribution stage, *Max* condition.

Belief Experiment

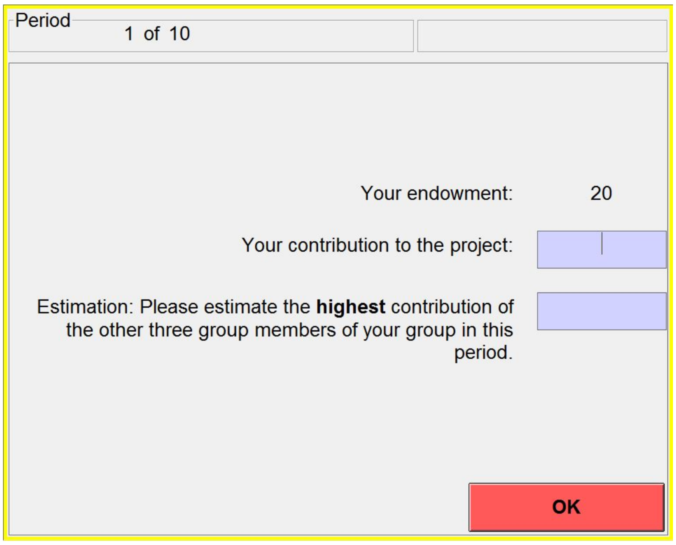

Figure A12: Screen with the additional belief estimation, *Max* condition.