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IGNORANCE IS NOT ALWAYS BLISS: FEEDBACK AND DYNAMICS IN PUBLIC GOOD EXPERIMENTS

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Ignorance is not always bliss: Feedback and dynamics in public good experiments.*

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Abstract

In this paper we study the effects of providing additional feedback about individual contributions and earnings on the dynamics of contributions in a repeated public good game. We include treatments where subjects can freely choose whether to obtain additional information about individual contributions or individual earnings. We find that, in the aggregate, contributions decline less fast when additional information about contributions and earnings is provided on top of aggregate information. We also find that there exist substantial but intuitively appealing differences in the way individuals react to feedback. Particularly, individuals with a high propensity to contribute tend to imitate the highest contributor more often and are more inclined to obtain feedback about individual contributions than about individual earnings than individuals with a lower propensity to contribute.

Keywords: voluntary contributions, experiment, repeated interaction, feedback, imitation

JEL codes: C91, D74

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1 Introduction

A recurrent theme in economic experiments is the study of cooperation in situations where there is a tension between the interests of individuals and the group. In public good experiments, for example, contributions mostly start at a relatively high level and gradually decline over time, as the game is being repeated. Given that it has recently been shown that this pattern of contributions is caused by the existence of imperfect conditional cooperators who match other players' past contributions only partly (see Fischbacher and Gächter, 2010), contributions and their dynamics might crucially depend on the type of feedback received after each repetition. As suggested by Nikiforakis (2010), whereas feedback about contributions might make more salient the cooperative side of the dilemma, and thus particularly appeal to conditional cooperators, feedback on individual earnings makes more prevalent the private benefit of (not) contributing. For the design of institutions aimed at increasing cooperation, e.g. contributions to a public good or effort in a team task, it is crucial to understand the potentially differential effects of the format of feedback provided to the individuals. Typically, participants in public good experiments receive feedback about aggregate contributions in their group after each round of play. We study whether and how providing additional feedback about past individual contributions and earnings of group members, affects contributions and the rate of their decline.

Two dynamics that have been suggested to play a role in repeated dilemma experiments where detailed feedback is provided are "imitation of the best performer" (the lowest contributor) and "imitation of the good example" (the highest contributor) (see e.g. Vega-Redondo, 1997; Selten and Ostmann, 2001; Offerman et al., 2002).[1] If players imitate the lowest contributor, making information about past individual contributions and earnings salient implies that *ceteris paribus* contributions decay faster in time and that, as a potential consequence, they are lower on average. If, however, players imitate the highest contributor, one should see a slower decline (or even an increase) in contributions and, potentially, higher average contributions when additional feedback is provided than when it is not provided. Hence, it is not clear *a priori* how the pattern of contributions will be affected by providing feedback about individual contributions and earnings on

[1] Another potential form of imitation, not within the scope of this paper, is imitation of like-minded players in other groups (see, e.g., Apesteguia et al., 2007).

top of aggregate information.[2] Furthermore, additional confounds are likely to be caused by different types of players reacting differently to feedback. For example, free riders—those who never contribute anything—react by definition much less to information about past behavior of others than conditional cooperators (see also Fischbacher et al., 2001, on conditional cooperation).

We report the results from an experiment that studies the effects of providing additional feedback about individual contributions and earnings on contributions in a public good game. In order to learn more about the microfoundations behind aggregate patterns of contributions, we include treatments where individuals have the option to obtain additional feedback on contributions and/or earnings. This allows us to study whether some types of players are more interested in obtaining additional feedback, and whether different types of players are interested in different pieces of information (contributions or earnings). To our knowledge, our paper is the first to let players freely choose whether to acquire feedback about past individual contributions or earnings.[3]

In our experiment contributions decline significantly less fast when additional information (about contributions and earnings) is provided on top of aggregate information. We identify the extent to which the two imitation forces are behind this pattern and show that different types of players imitate in different ways. Particularly, "imitation of the best performer" is relatively more common among players with a low to medium propensity to cooperate, while "imitation of the good example" among players with a high propensity to cooperate. Moreover, we find that different types of players are interested in different pieces of information. Specifically, players with a medium to high propensity to contribute are more likely to choose to obtain additional information about individual contributions as compared to information about individual earnings, while players who have a very low propensity to contribute are relatively more interested in individual earnings.

The paper proceeds as follows. In Section 2 we give an overview of experimental papers that study the effect of providing additional feedback about individual choices and earnings of group members on choices. In Section 3 we discuss our experimental design and the procedures. Section 4 presents

[2] If players would imitate the average (as in Huck et al., 2002), no effect will be observed of providing additional feedback.

[3] A similar approach was adopted in Bigoni (2010), where subjects could choose among various pieces of feedback information, but in the different framework of a repeated Cournot oligopoly game.

the experimental results and Section 5 concludes.

2 The effect of additional feedback

The effect of providing additional feedback about past choices and earnings of other players in the group has been a topic of study in the context of quantity- or price-setting games, which—like public good games—are characterized by a tension between self-interest and group efficiency. Results of these studies are mixed. The strongest support for the "imitation of the best performer" hypothesis comes from the experimental Cournot markets reported by Huck et al. (1999). They find that in Cournot markets where information about individual quantities and payoffs is provided, imitation of the best performer is prominent and even dominates the force of the best-reply dynamics when players have partial or no information about demand and cost conditions. The consequence is that players' choices are more competitive when additional information about individual quantities and earnings is provided compared to a treatment with aggregate information.[4] Offerman et al. (2002) also see players imitate the best performer in their treatment with information about individual choices and earnings. However, they also point out the importance of "imitation of the good example" because choices shift more to either side of the Nash equilibrium (more competitive *and* more collusive) compared to the benchmark with aggregate information.[5] Finally, in the Bertrand markets reported by Huck et al. (1999) no statistically significant difference in prices is obtained between treatments with and without additional information about individual prices.[6]

Studies using the public good game in the lab have looked at the effect on cooperation of providing feedback solely on individual choices, or have used other than aggregate feedback benchmarks. Sell and Wilson (1991), for example, find that providing feedback solely about individual choices increases cooperation compared to the case with only aggregate information (like Offerman et al., 2002). In a similar information setting Croson (2001)

[4] A similar result is obtained in the Cournot treatments of Huck et al. (2000).

[5] Both imitation forces—imitation of the best performer and imitation of the good example—are also at work in the experiment of Selten and Apesteguia (2005) on local price competition. Bosch-Domènech and Vriend (2003) reject imitation of the best performer in a duopoly experiment.

[6] Rassenti et al. (2000) do not find a difference either, but the Nash equilibrium is not stable in their game (and costs are asymmetric).

does not find a difference in the level of cooperation but points out a difference in variability: it is higher when individual information about contributions is provided. Nikiforakis (2010) finds that in a public goods game with a punishment phase, providing feedback about individual contributions alone increases contributions and reverses the decline in time compared to cases where individual earnings are included. Finally, no effect at all is obtained by Weimann (1994) in a public good experiment with feedback about individual contributions and earnings, compared to a benchmark with information on the player's own payoff and the average contribution in the group.

Albeit results from these studies are mixed, the following two general tendencies can be recovered. First, providing feedback about individual choices (but not earnings) tends to increase cooperation. Second, providing feedback about individual earnings (but not choices) tends to decrease cooperation.

3 Experimental design and procedure

The experiment was run in June and September 2008 in CentERlab at Tilburg University with a total of 57 subjects, mainly from the field of economics.[7] After being randomly seated at a computer terminal, participants received written instructions (see Appendix A).[8] To make sure that the participants understood the instructions, they had to correctly answer a number of control questions before the experiment could start.

The experiment consisted of three parts. Instructions for the last two parts were only given on the computer screens at the time the concerned part started. In each of the three parts participants were grouped with two other participants to play 10 rounds of a linear public good game. Groups were reshuffled after each part such that participants would never meet again in another part.[9] In all parts, the payoff of participant i who contributes in period t an amount of x_i to the public good is calculated as follows:

$$\pi_{it} = 10 - x_{it} + 0.5 \sum_{i=1}^{3} x_{it}. \tag{1}$$

[7]The fact that mainly economics students are included in the participant pool does not lead to a different aggregate pattern of contributions than the one typically observed in public good experiments.

[8]We used *z-Tree* software (see Fischbacher, 2007) to program the experiment.

[9]This implies that groups can be considered as independent observations in Part One, but not so in Part Two and Part Three.

In order to examine whether providing individual information about the other group members' contributions and earnings leads to different contribution behavior as in the case where only aggregate information is provided, we have two main conditions: *AggrIndi* and *IndiAggr*. In condition *AggrIndi*, at the end of each of the periods of Part One participants received information about the total amount contributed in their group in that period. In Part Two, at the end of every period participants also received information about individual contributions and earnings of each of the three group members, in addition to aggregate information about the group's contribution.[10] In the second main condition, referred to as *IndiAggr*, the order of the feedback conditions was reversed. That is, in Part One subjects received information both about the aggregate group's contribution, and about group members' individual contributions and earnings, while in Part Two they only received information at the aggregate level. This design allows us to study differences in behavior depending on the feedback between and within treatments.

In Part Three of the experiment, the subjects received aggregate information and had the *choice* to obtain (costless) additional individual information by clicking on a button on the computer screen.[11] We let subjects choose to see additional information in Part Three in order to learn more about who actually wanted to obtain individual information. Is it the (conditional) cooperators or rather the defectors who obtain additional individual information? Is there a relation between choosing to obtain individual information and contributions?

In Part Three of treatments *AggrIndi1* and *IndiAggr1*, at the end of each period participants had a choice to either not see additional individual information or to see individual contributions *and* earnings. In Part Three of treatments *AggrIndi2* and *IndiAggr2* participants had a choice to either not see additional individual information, to see individual contributions *or* to see individual earnings.[12] The latter treatments allow us to study whether subjects mostly choose to obtain information about individual contributions

[10] Appendix B contains a print of an example of the screen that was shown to subjects in the case they received additional individual information.

[11] The initial conditions in Part Three of the experiment are the same across *AggrIndi* and *IndiAggr*. At the point that subjects made their choices in Part One and Part Two, they did not have the instructions for Part Three. They only knew that there would be a third part.

[12] The computer screens included two buttons: one that would reveal information about individual contributions and one that would reveal information about individual earnings.

Table 1: Experimental design

	Type of feedback	# Participants	# Groups	# Indep. obs.
AggrIndi				
Part One	Aggregate	30	10	10
Part Two	Aggregate + individual	30	10	3
Part Three				
AggrIndi1	Aggregate + optional individual contributions *and* earnings	18	6	2*
AggrIndi2	Aggregate + optional individual contributions *or* earnings	12	4	1
IndiAggr				
Part One	Aggregate + individual	27	9	9
Part Two	Aggregate	27	9	2
Part Three				
IndiAggr1	Aggregate + optional individual contributions *and* earnings	15	5	1
IndiAggr2	Aggregate + optional individual contributions *or* earnings	12	4	1

* In this session, the 18 participants were split into two matching groups of 9, so that each subject never interacted with subjects in the other matching group. For this reason, the two matching groups can be considered as two independent observations.

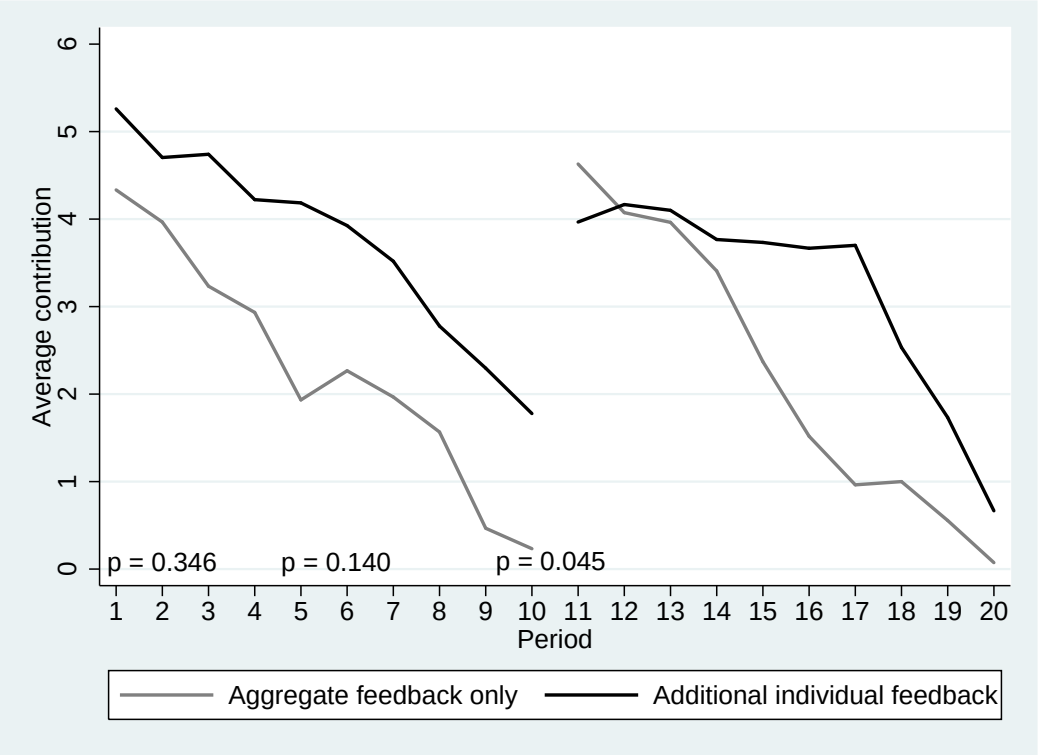
or about individual earnings and to which extent these choices are related to decision-making and patterns observed in the repeated public good game.

Table 1 gives an overview of the four treatments (*AggrIndi1*, *IndiAggr1*, *AggrIndi2* and *IndiAggr2*) included in the experiment.

4 Results

We start our discussion in Subsection 4.1 by performing a between-treatments comparison of behavior in Part One and Part Two of the experiment. In Subsection 4.2 we identify the importance of each of the imitation theories discussed previously ("imitate the best performer" and "imitate the good example") and relate the extent to which players follow a certain imitation

process to their general propensity to cooperate. Finally, in Subsection 4.3 we analyze the results of Part Three of the experiment, in which players were free to choose whether to receive or not receive additional information on individual earnings and/or contributions. We relate the choice of feedback in Part Three to the players' general propensity to cooperate.



Note: The figure depicts the evolution of the average contribution in Part One (periods 1 to 10) and Part Two (periods 11 to 20) of the experiment.

Figure 1: Average contribution per period

4.1 The effect of additional feedback on contributions

Figure 1 depicts how average contributions evolve in Part One (period 1 to 10) and Part Two (periods 11 to 20) of the experiment, in each of the two feedback conditions. The figure shows that in our experiment the typical pattern of contributions decaying in time is recovered. In the case where additional individual information is provided in Part One (*IndiAggr*), the

average contribution starts at a level above 5 and decreases to a level below 2. In the case where only aggregate information is provided (*AggrIndi*), the average contribution decreases from above 4 to almost 0. Similar patterns are observed in Part Two. Also, in line with previous studies, a significant restart effect is observed at the beginning of Part Two, in period 11 (see, for example, Andreoni, 1988; Croson, 1996).

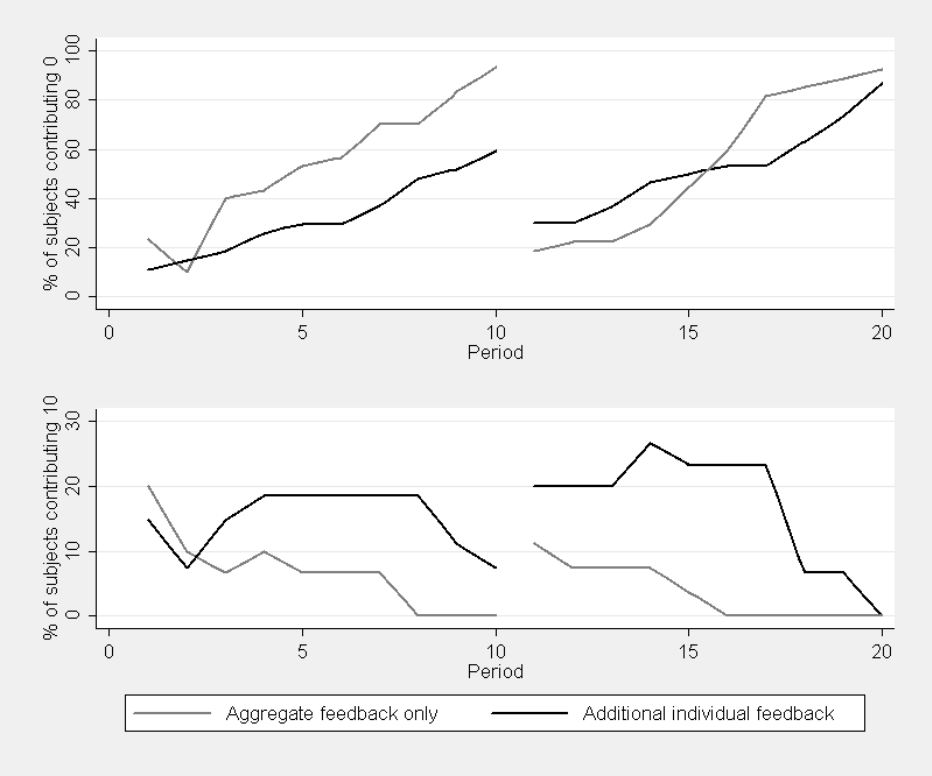
The figure also reports the p-values obtained from Mann-Whitney-U tests based on independent observations (groups) in periods 1, 5 and 10 (in Part One).[13] These numbers indicate that, in the beginning of the game, the difference between both treatments is statistically not significant and, as the game proceeds, the statistical significance grows. In the final period of the game, the difference is statistically significant.

Figure 1 only displays the average level of contribution per period, but it does not tell us anything about how contributions are distributed. A closer look at the data reveals that most of the subjects (almost 60%) choose extreme contributions, either 0 or 10 (to illustrate, see Appendix C). Figure 2 provides additional insights about the effects of individual feedback on how contributions are distributed. It shows that when subjects receive information about past individual contributions and earnings of the other group members, they tend to choose the maximum possible contribution substantially more often, while the pace of increase in the number of subjects contributing nothing is slower.[14]

In order to study whether the effect of additional information on the rate of decline of contributions is statistically significant, we conducted a regression analysis where the dependent variable is a subject's individual contribution to the public good. We include data from Part One and Part Two of the experiment. The independent variables comprise a dummy called "Individual feedback" which equals one when additional feedback on individual contributions and earnings is provided (i.e., in condition *IndiAggr*) and zero when only aggregate feedback is provided (i.e., in condition *AggrIndi*). Also included are a linear time trend (measured by the period number) and

[13] The reason why we only include p-values for Part One is that only in this part, groups can be seen as independent observations.

[14] According to the results of two logit regressions, the positive effect of individual feedback on the fraction of subjects choosing the maximum contribution is significant (at the 1% level) only in Part Two of the experiment, while the negative effect on the rate of growth of the fraction of subjects contributing nothing is significant (at the 1% level) both in Part One, and in Part Two.



Note: The figure depicts the evolution of the frequency of subjects choosing to contribute 10 or 0 in Part One (periods 1 to 10) and Part Two (periods 11 to 20) of the experiment.

Figure 2: Percentage of subjects contributing all or nothing.

an interaction term of these two regressors. To verify whether the effects of the feedback condition and the time trend are different in Part One and Part Two of the experiment, we include a dummy taking value one for Part Two of the experiment and zero for Part One, and its interactions with the three regressors mentioned above. Table 2 contains the results from an ordered probit regression including random effects at the subject level.[15] Standard errors are robust to potential interdependence within independent observa-

[15]The choice of an ordered probit model was dictated by the consideration that the dependent variable is highly concentrated at extreme values. Moreover, the effect of having additional feedback about individual contributions and earnings is not linear: it mainly affects the extreme contributions (see also Appendix C). Therefore, a linear regression does not capture the effect.

tions (sessions).[16]

Results in Table 2 provide support for what we previously observed about the dynamics in contributions across treatments. Receiving additional feedback on individual choices and earnings of all group members does not affect the level of the players' contributions to the public good in a statistically significant way. However, it does significantly reduce the rate of decline of the contributions.[17] The individual feedback dummy variable is not signifi-

Table 2: Feedback and level of contributions in Part One and Part Two

	Dependent variable: Contribution		
Independent variables	Coefficient	(S.E.)	p-value
Part Two	0.205***	(0.024)	< 0.001
Individual feedback (Part One)	0.096	(0.310)	0.757
Individual feedback (Part Two)	-0.273	(0.322)	0.396
Period (Part One)	-0.241***	(0.042)	< 0.001
Period (Part Two)	-0.296***	(0.055)	< 0.001
Individual feedback x Period (Part One)	0.108**	(0.055)	0.050
Individual feedback x Period (Part Two)	0.137***	(0.051)	0.007
N	1140		
log-likelihood	-1796.1		

Note: The table reports results from an ordered probit panel regression that includes random effects at the subject level. The regression is based on data from Part One and Part Two of the experiment. Standard errors are robust to potential dependency within independent observations (sessions).

cantly different from zero in neither of the parts. In both parts, a negative and significant time trend in contributions emerges. The terms that measure the interaction between the linear time trend, the individual feedback

[16] All regressions are performed using GLLAMM (Skrondal and Rabe-Hesketh, 2004). Also, * denotes significance at the 10-percent level, ** at the 5-percent level and *** at the 1-percent level.

[17] In this regression and in the ones reported below we always check whether the time trend is potentially non-linear by including the square of the period number among the regressors. When this squared term is not statistically significant, we only present results from regressions where it has been dropped.

dummy, and the Part One and Part Two dummies, instead, are both positive and highly significant.[18] This implies that, in both Part One and Part Two, contributions decrease to a lesser extent when additional individual feedback is provided. Therefore, we can conclude that the effect of providing additional feedback on contributions and earnings is the same, regardless of whether players experience the individual feedback condition before or after the aggregate feedback condition. Our first result is summarized as follows.

Result 1 *When subjects receive additional feedback about other players' individual contributions and earnings, the pace at which contributions decrease is significantly slower than when only aggregate feedback is provided.*

4.2 Information and imitation

The result that detailed information on other players' past choices and earnings slows down the rate of decline in contributions could imply that players imitate the highest contributor more often when additional feedback about individual contributions and earnings is provided than when it is not provided. In this subsection we investigate whether this is indeed the case by studying the relative importance of each of the imitation processes "imitate the best performer" and "imitate the good example". For this purpose, we follow an approach similar to the one adopted by Huck et al. (1999) and estimate the following equation:

$$c_{it} - c_{it-1} = \beta_0 + \beta_1 \text{Dmin}_{it} + \beta_2 \text{Dmax}_{it}, \tag{2}$$

where c_{it} denotes subject's i contribution in period t, and Dmin_{it} represents the difference between the lowest contribution in the group in the previous period and subject's i contribution in the current period, and Dmax_{it} represents the difference between the highest contribution in the group in the previous period and subject's i contribution in the current period. A subject who strictly imitates the best performer would have $\beta_1 = 1$ and $\beta_k = 0$, $k \neq 1$. Analogously, a subject imitating the good example would have $\beta_2 = 1$ and $\beta_k = 0$, $k \neq 2$. To summarize, β_1 and β_2 measure the relative importance of imitation of the best performer and imitation of the good example.[19]

[18] The estimated coefficients of the two variables are not significantly different. A standard t-test yields a p-value of 0.529.

[19] We do not include "imitation of the average" because the average is highly correlated with the minimum and the maximum, which causes problems of multicollinearity in the regression.

Given that providing additional feedback about individual contributions and earnings has similar effects in Part One and Part Two of the experiment, we estimate equation 2 on the basis of pooled data from Part One and Part Two.[20] In order to see whether the weight of each of the imitation processes is affected by the feedback condition, we include a dummy in the regression indicating whether additional feedback about individual earnings is provided or not, and its interactions with Dmin_{it} and Dmax_{it}. Results are displayed in Table 3.

The estimated coefficients related to Dmin and Dmax indicate the importance of the imitation processes when only aggregate feedback is provided.[21] The estimated coefficients related to the interaction of Dmin and Dmax with the individual feedback dummy indicate the extent to which the aggregate weights of the imitation processes change by providing individual feedback. Table 3 shows that the coefficients of Dmin and Dmax have the expected sign and are statistically significant, suggesting that changes in contributions in time seem to be driven at least to some extent by one of the imitation processes. Particularly, "imitate the best performer" gets the highest weight overall, significantly higher than the weight of "imitate the good example".[22] Interestingly, the interaction of the individual feedback dummy with Dmax has a positive sign and is significant, while this is not the case for the interaction with Dmin. This clearly suggests that the force of "imitate the good example" is stronger—while not so the force of "imitate the best performer"—when additional feedback about individual contributions and earnings is provided than when only feedback about aggregate contributions

[20]For each i and t, only data points are included for which $\text{Dmin}_{it} \neq \text{Dmax}_{it}$ because for $\text{Dmin}_{it} = \text{Dmax}_{it}$ the imitation process cannot be identified. This gives 726 (out of 1026) data points.

[21]One might argue that when subjects are not provided with individual information about past contributions and earnings, it is not possible for them to imitate the best performer or the good example, which makes including Dmin and Dmax *per se* redundant. However, subjects may form beliefs about the distribution of contributions in their group and act according to these beliefs. Moreover, there is a methodological reason for including Dmin and Dmax. That is, we are interested in explaining the difference in dynamics between conditions with aggregate and detailed feedback, particularly, in studying the relative importance of both imitation processes for explaining the difference.

[22]The estimated coefficient of Dmin is significantly different from the one of Dmax, and the sum of the estimated coefficients of Dmin and Individual feedback x Dmin is significantly different from the sum of Dmax and Individual feedback x Dmax (both with $p < 0.001$).

Table 3: Imitation

	Dependent variable: $c_{it} - c_{it-1}$		
Independent variables	Coefficient	(S.E.)	p-value
Constant	-0.294***	(0.076)	< 0.001
Dmin	0.490***	(0.033)	< 0.001
Dmax	0.215***	(0.036)	< 0.001
Individual feedback	0.059	(0.177)	0.737
Individual feedback x Dmin	-0.004	(0.030)	0.896
Individual feedback x Dmax	0.099***	(0.027)	< 0.001
N	726		
Log-likelihood	-1625.4		

Notes: The table reports the results from a panel regression of equation 2 that includes random effects at the subject level. The regression is based on data from Part One and Part Two of the experiment. Standard errors are robust to potential dependency within independent observations (sessions).

is provided.

In a pooled analysis it is assumed that all players adopt the same "hybrid" model of imitation. However, this is not necessarily the case. Different players might follow different models. In order to examine whether different imitation processes are used by different types of players, we define types of players according to their general propensity for contributing. We measure the players' general propensity for contributing by their contributions in period 1 of Part One.[23] The reason is that in period 1, players have not yet interacted with others and social learning has thus not yet set in. On the basis of these contributions, we sort players into five classes of types.[24] The distribution of players in these five classes is presented in Table 4.

Then we created a dummy variable for each of these five classes, and interacted it with a dummy that indicates whether additional feedback about individual contributions and earnings is provided and with both regressors in

[23]Contributions in period 1 of Part One are not significantly different across treatments *AggrIndi* and *IndiAggr*, according to a two-sided Mann-Whitney-U test ($\alpha = 0.10$, n_1=30, n_2=27).

[24]Given that the subjects play a repeated game within each part of the experiment—the composition of the groups does not change—these general propensities for contributing do not necessarily fall together with social preferences to cooperate.

Table 4: Types of players

Type	Contribution in period 1	Freq.	Percent	Cum.
1	0	10	17.54	17.54
2	1 to 4	13	22.81	40.35
3	5	14	24.56	64.91
4	6 to 9	10	17.54	82.46
5	10	10	17.54	100
Total		57	100	

Notes: The table provides data on the distribution of the types of players. Types of players are defined according to their general propensity to contribute proxied by their contribution in period 1.

equation 2. This allows us to study whether different types of players react to information in different ways under both feedback regimes. Results are displayed in Table 5.

Table 5 shows that under the aggregate feedback condition, imitation of the best performer gets the highest weight for all types of players. However, under the individual feedback condition, differences emerge among different types of players. On the one hand, Type-3 players (who contribute 5 in period 1) imitate the best performer more often when additional feedback about individual contributions and earnings is provided. On the other hand, for Type-4 and Type-5 players (who contribute more than 5 in period 1) the importance of "imitate the good example" is increased significantly by providing additional feedback. Particularly for Type-4 players "imitate the good example" is a more important force than "imitate the best performer" in the case additional feedback is provided. For Type-1 and Type-2 players (who contribute below 5 in period 1), adding individual information does not have any significant effect on their imitation behavior. Overall, for these players, the weight of "imitate the best performer" is higher than the one of "imitate the good example". We summarize our second result as follows.

Result 2 *"Imitation of the good example" becomes relatively more important compared to "imitation of the best performer" when feedback about individual contributions and earnings is provided than when only aggregate information is provided. This effect is driven by players with a high general propensity to*

Table 5: Imitation and types of players

	Dependent variable: $c_{it} - c_{it-1}$		
Independent variables	Coefficient	(S.E.)	p-value
Type 1 x Dmin	0.532***	(0.173)	0.002
Type 2 x Dmin	0.611***	(0.182)	0.001
Type 3 x Dmin	0.354***	(0.071)	< 0.001
Type 4 x Dmin	0.462***	(0.057)	< 0.001
Type 5 x Dmin	0.605***	(0.133)	< 0.001
Type 1 x Dmin x Individual feedback	-0.027	(0.247)	0.912
Type 2 x Dmin x Individual feedback	0.036	(0.084)	0.669
Type 3 x Dmin x Individual feedback	0.228***	(0.064)	< 0.001
Type 4 x Dmin x Individual feedback	-0.005	(0.176)	0.980
Type 5 x Dmin x Individual feedback	-0.231	(0.179)	0.195
Type 1 x Dmax	0.160**	(0.073)	0.030
Type 2 x Dmax	0.327**	(0.131)	0.013
Type 3 x Dmax	0.381***	(0.104)	< 0.001
Type 4 x Dmax	0.229***	(0.054)	< 0.001
Type 5 x Dmax	0.043	(0.050)	0.368
Type 1 x Dmax x Individual feedback	-0.006	(0.096)	0.954
Type 2 x Dmax x Individual feedback	-0.095	(0.165)	0.564
Type 3 x Dmax x Individual feedback	0.033	(0.130)	0.800
Type 4 x Dmax x Individual feedback	0.403***	(0.142)	0.005
Type 5 x Dmax x Individual feedback	0.323***	(0.119)	0.007
N	726		
Log-likelihood	-1605.4		

Notes: The table reports the results from a panel regression of equation 2 that includes random effects at the subject level. The regression is based on data from Part One and Part Two of the experiment. The independent variables are the type dummies as defined in Table 4, their interactions with an individual feedback dummy, their interactions with Dmin and Dmax as defined in Table 3, and their interactions with the individual feedback dummy *and* Dmin and Dmax. For convenience, only the estimations related to the interactions with Dmin and Dmax are included in the table. Standard errors are robust to potential dependency within independent observations (sessions).

contribute.

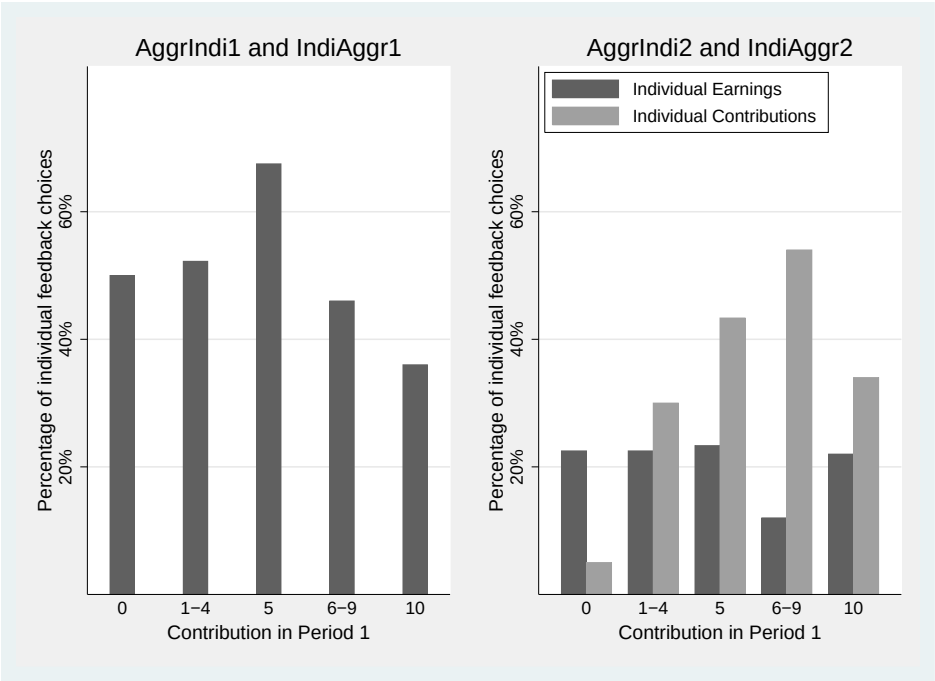
4.3 Choice of feedback condition

In Part Three of the experiment, obtaining additional feedback on individual contributions and/or earnings was optional. In *AggrIndi1* and *IndiAggr1*, players who chose to receive individual feedback were informed both about individual earnings *and* individual contributions. In *AggrIndi2* and *IndiAggr2* we asked players to choose between not getting any type of additional individual feedback, getting feedback on individual contributions only, *or* getting feedback on individual earnings only. This choice was made at the end of each period. We have 10 data points per subject, which adds up to 330 data points for *AggrIndi1* and *IndiAggr1*, and to 240 for *AggrIndi2* and *IndiAggr2*.

As in Subsection 4.2, we use the players' contributions in period 1 as a proxy for the players' types related to the general propensity for contributing. We investigate the relation between the types of players and their interest in the different pieces of information available in Part Three.

Figure 3 displays the relation between a subject's type and the percentage of times one chooses to obtain additional feedback about individual contributions and/or earnings. The left graph refers to treatments *AggrIndi1* and *IndiAggr1* where additional feedback about individual contributions *and* earnings could be obtained. The right graph refers to treatments *AggrIndi2* and *IndiAggr2* where additional feedback about individual contributions *or* earnings could be obtained. The figure shows that the relation between information acquisition and the players' types is not linear. Specifically, the relation seems to have an inverted U-shape. For *AggrIndi1* and *IndiAggr1* we see that "middle" types, i.e. those players who have a "medium" propensity to contribute, look more at additional feedback about contributions and earnings than "low" and "high" types. This makes sense if the middle types are guided relatively more by contributions of other players than other types, i.e., if they are conditional cooperators.

The graph based on data from treatments *AggrIndi2* and *IndiAggr2* shows that those players who contribute nothing in period 1 are more interested in individual earnings than in individual contributions. For players who contribute something in period 1, however, the opposite holds: they are more interested in individual contributions than in individual earnings. Especially those types who contribute between 6 and 9 in period 1 look much more



Notes: The figure depicts the relation between a subject's type (proxied by the contribution in period 1) and the percentage of times one chooses to obtain additional feedback. The left graph refers to treatments *AggrIndi1* and *IndiAggr1* where additional feedback about individual contributions *and* earnings could be obtained. The right graph refers to treatments *AggrIndi2* and *IndiAggr2* where additional feedback about individual contributions *or* earnings could be obtained.

Figure 3: Percentages of individual feedback choice in Part Three

often at individual contributions than at individual earnings.

Next, we report the results of regressions that support the graphical visualization. Table 6 reports the result of a logit regression where the choice whether or not to receive information on individual contributions and feedback in Part Three of treatments *IndiAggr1* and *AggrIndi1* is the dependent variable and the independent variables are the type dummies as defined in Table 4. Also included are Period and Period^2 in order to control for a possibly non-linear time trend. Type-1 players serve as a benchmark. The

Table 6: Additional feedback and types of players

	Dependent variable: Feedback vs. No Feedback		
Independent variables	Coefficient	(S.E.)	p-value
Constant	4.947***	(0.984)	< 0.001
Type 2	0.319	(1.467)	0.828
Type 3	2.543*	(1.493)	0.089
Type 4	1.002	(1.595)	0.530
Type 5	0.006	(1.633)	0.997
Period	-1.433***	(0.243)	< 0.001
Period^2	0.066***	(0.025)	0.009
N. obs.	570		
Log-likelihood	-255.3		

Notes: The table reports results from a logit regression where the dependent variable takes value 1 when the player chose to obtain feedback about individual contributions or earnings, and takes value 0 otherwise. The regression includes random effects at the subject and the group level. The regression is based on data from Part Three of the experiment. Standard errors are robust to potential dependency within independent observations (sessions).

results in Table 6 confirm that the relation between the general propensity to contribute and the choice to obtain additional feedback indeed has an inverted U-shape. Type-3 players choose (weakly) significantly more often to obtain additional feedback than Type-1 players, and than Type-2 players ($p = 0.015$ in the latter case). Other differences between type dummies are not statistically significant, however.

Table 7 reports the result of a logit regression based on data in Part Three of *IndiAggr2* and *AggrIndi2*. The dependent variable is, given that one chooses to obtain additional feedback, the choice whether to receive information on individual contributions *or* individual earnings. The independent variables are again the type dummies as defined in Table 4, and Period and Period^2. Also, Type-1 players serve again as a benchmark.

Table 7: Additional feedback on contributions or earnings and types of players

	Dependent variable: Request of information about Contributions vs. Earnings		
Independent variables	Coefficient	(S.E.)	p-value
Constant	-2.903	(3.190)	0.363
Type 2	3.326	(2.816)	0.238
Type 3	3.055*	(1.744)	0.080
Type 4	3.916**	(1.606)	0.015
Type 5	3.048***	(1.163)	0.009
Period	0.487	(0.837)	0.561
Period^2	-0.053	(0.057)	0.344
N. obs.	133		
Log-likelihood	-68.8		

Notes: The table reports results from a logit regression where the dependent variable takes value 1 when the player chose to obtain feedback about individual contributions, and takes value 0 when the player chose to obtain feedback about individual earnings, given that the player chose to obtain additional information. The regression includes random effects at the subject and the group level and is based on data from Part Three of treatments *IndiAggr2* and *AggrIndi2* of the experiment. Standard errors are robust to potential dependency within independent observations (sessions).

Table 7 also confirms that players whose propensity to contribute is above 0 in period 1 are more interested in receiving information about individual contributions than about individual earnings. For Type-3, Type-4, and Type-5 players the difference with Type-1 players is statistically significant.

We summarize our final result as follows.

Result 3 *Players who have a general propensity to contribute above zero favor feedback about individual contributions as compared to individual earnings more than players who have a general propensity to contribute of zero.*

5 Conclusive remarks

In our experiment we find that contributions decline less fast when information about contributions and earnings of group members in the previous period is provided on top of aggregate information. We find that imitation of the best performer is relatively more common among players with a low propensity to cooperate, while imitation of the highest contributor among players with a higher propensity to cooperate. Moreover, we find that different types of players are interested in different pieces of information, and that the endogenous choice of information is correlated with the type of players. Specifically, players with a medium to high propensity to contribute are more likely to obtain additional information about past individual contributions than about earnings.

Our results fit well with the finding of Nikiforakis (2010) that cooperation decreases faster when information about individual earnings is provided than in cases where information about individual contributions is provided. Whereas feedback about individual contributions makes more salient the cooperation side of the dilemma, feedback about individual earnings makes more prevalent the private benefit of (not) contributing. We go a step further by showing that different types of players select different types of information. Specifically, uncooperative players—players who do not contribute anything in the first period of play—look relatively more often at individual earnings as compared to individual contributions than more cooperative types of players.

Furthermore, our findings can provide an explanation for the difference that exists at first sight between the results obtained by Weimann (1994)—who does not find any significant difference in the contributions' trend across treatments with and without additional individual feedback—and by Sell and Wilson (1991) and Croson (2001)—who find that providing players with feedback on past individual contributions induces significant behavioral differences as compared to treatments with aggregate information. The reason behind this discordance might lay in an apparently minor difference in the design: while in his treatment with individual feedback, Weimann (1994) pro-

vides players with feedback on both individual contributions *and* earnings, Sell and Wilson (1991) (and also Croson, 2001) provide feedback on individual contributions only and not on earnings. Our results show that these two feedback formats have different effects on different types of players, which might have counterbalanced each other in Weimann (1994)'s experiment, but much less so in Sell and Wilson (1991)'s.

Our results call for further research on the behavioral impact of different feedback formats on subjects' actions. If our findings were to be confirmed, and their external validity supported by future lab and field experiments, they might have relevant policy implications. In situations in which individual and collective interest collide—such as team production, voluntary contribution to a public good, or use of common pool resources—the provision of detailed information about individual actions may be beneficial, as it induces those who are more incline to pro-social behavior to persist. On the contrary, putting emphasis on individual profits may accelerate the collapse of cooperation, by leading less cooperative individuals to focus even more on their own interest.

Appendix A: Instructions

You are participating in an experiment on economic decision making and will be asked to make a number of decisions. If you follow the instructions carefully, you can earn money. At the end of the experiment, you will be paid your earnings in private and in cash.

The experiment is strictly anonymous: that is, your identity will not be revealed to others and the identity of others will not be revealed to you. You are not allowed to communicate with other participants. If you have a question, raise your hand and one of us will help you.

During the experiment your earnings will be expressed in points. Points will be converted to Eur at the following rate: 30 points = 1.00 EUR.

The experiment consists of three parts. The instructions below are those for the first part. Later on, you will receive instructions for the other parts.

In the experiment, participants are divided into groups of 3. You will therefore be in a group with 2 other participants.

The first part of the experiment is divided into 10 periods. At the beginning of each period you receive 10 points. In each period you decide how many points you want to contribute to a project and how many points you want to keep for yourself. You can allocate your 10 points in any way between the project and yourself. All participants in your group have the same decision to make. The composition of the groups will remain the same during the 10 periods.

In each period, for every point you contribute to the project, the earnings of all participants in your group (including your own) increase by 0.5 points. For every point you keep for yourself, your earnings increase by 1 point and the earnings of others do not change. Note that the same is true for other participants. Every point another participant contributes to the project increases your earnings by 0.5 points. If instead he/she keeps that point for him/herself, your earnings remain unchanged.

Your total earnings in points in each period are thus calculated as follows: 0.5 x (sum of points contributed by all 3 group members) + points you keep

Examples:

- If you contribute all your 10 points to the project and each of the other 2 group members keeps all their 10 points for him/herself, you earn 0.5 x 10 = 5 points.

- If you contribute nothing to the project and each of the other 2 group

members contribute all their 10 points, you earn 10 + 0.5 x (10 + 10) = 20 points.

- If you and the other 2 group members contribute all their 10 points to the project, you earn 0.5 x (10 + 10 + 10) = 15 points.

After each period, you receive feedback about the sum of contributions of all members of your group in that period.

Appendix B: Screenshot

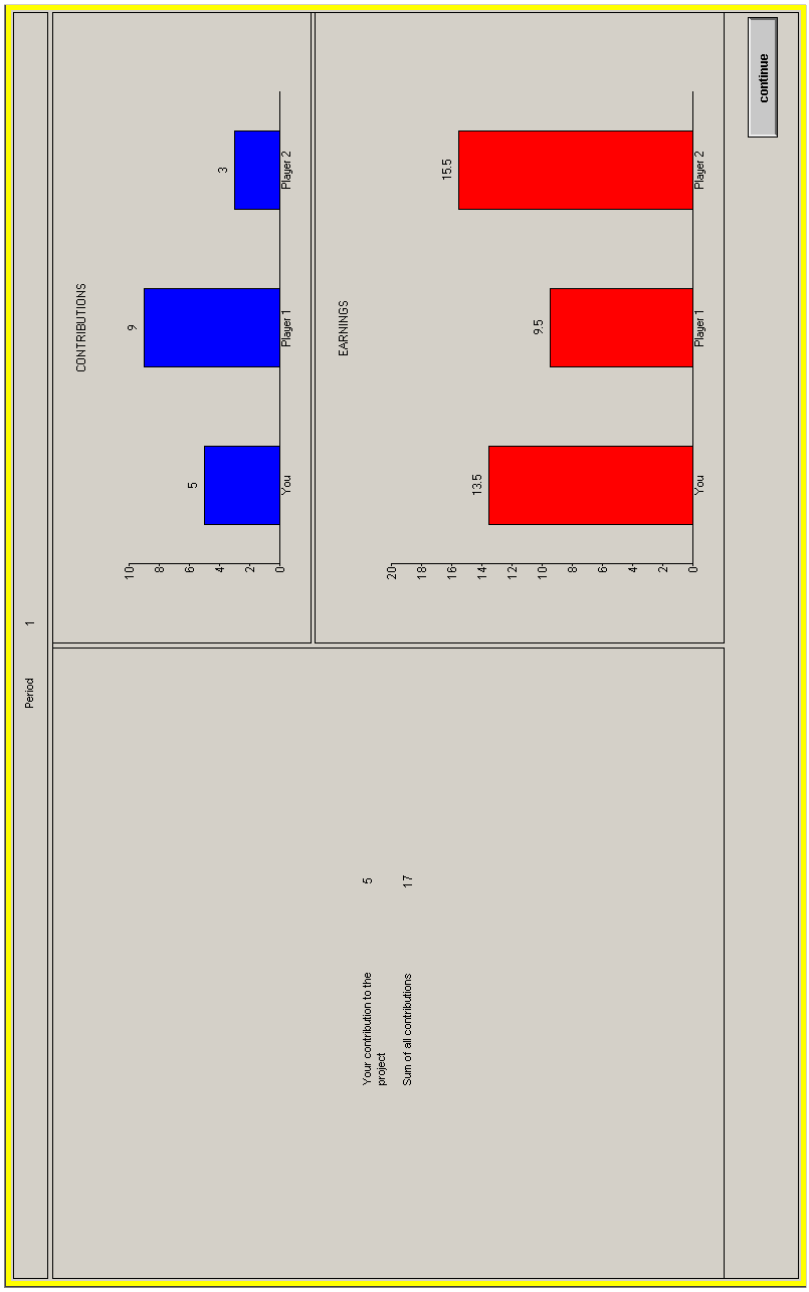
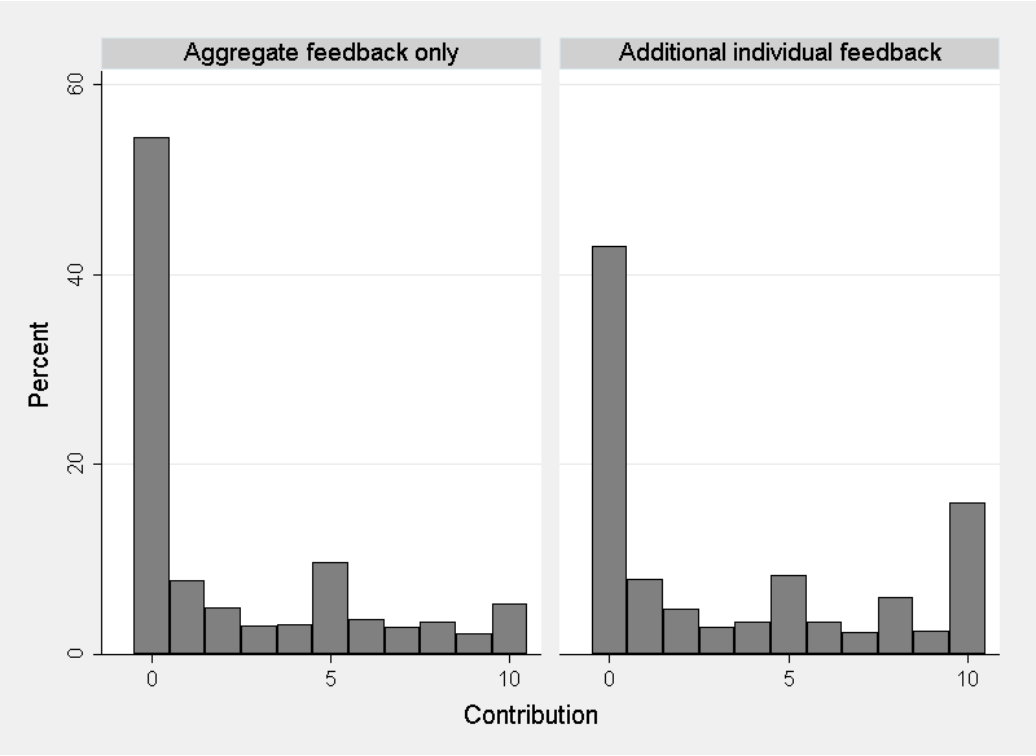


Figure 4: Screen shown to the subjects when they received information about individual contributions and earnings.

Appendix C: Frequency distribution of contributions



Note: The figure depicts the frequency distribution of contributions in Part One (periods 1 to 10) and Part Two (periods 11 to 20) of the experiment by condition.

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