J Bioecon (2013) 15:123–133
DOI 10.1007/s10818-012-9141-5

Is cooperation instinctive? Evidence from the response times in a public goods game

Gianna Lotito · Matteo Migheli · Guido Ortona

Published online: 23 June 2012

Abstract We use data on response times from a public goods experiment to test the hypothesis that cooperation is instinctive, under the assumption that the longer the time of the decision, the less instinctive the choice. Results seem to support the hypothesis that cooperation is instinctive, while defection is 'rational'. Moreover, as the experiment is designed also to assess the effects of the consumption of relational goods on cooperation, we are also able to state that some types of relational goods, like team working, produce additional cooperation, but make it less spontaneous. We also detect that females seem to behave less instinctively than males.

Keywords Response times · Cooperation · Public goods experiments · Gender effect

JEL Classification C91 · D03 · H41

1 Introduction

Economic experiments often produce interesting by-product data; among these the time taken by each subject to decide her/his move, that might shed some light on the processes which govern individual decision making. Indeed, surveying a series of games often used in the experimental literature, Rubinstein (2007, p. 1243) finds a direct correspondence between the player's time to make her/his choice and her/his emotions: his survey suggests "that choices made instinctively, that is, on the basis of an emotional response, require less response time than choices that require the

G. Lotito · M. Migheli (✉) · G. Ortona
Department of Public Policy and Public Choice, University of Eastern Piedmont, Via Cavour 84, 15100, Alessandria, AL, Italy
e-mail: matteo.migheli@sp.unipmn.it

use of cognitive reasoning."[1] In a public and private goods experiment, Brown et al. (2008) test the consistency between subjects' preferences and choices; they observe that consistent choices take less time than inconsistent ones. Eventually, in a modified dictator game, Piovesan and Wengström (2009) find that "faster subjects make egoistic choices more often than slower subjects in a non-strategic setting" (p. 196). The above findings suggest that in a non-strategic setting the instinctive choice is selfish, which is consistent with the behaviour of *homo oeconomicus*, as traditionally predicted by the classic economic literature.

However, human beings are social animals. Hence it is possible that in non-anonymous and/or iterated games the human instinct would suggest cooperation instead of defection. This is the well known theme of the *spontaneous cooperation.* Spontaneous cooperation has proved to be sustainable, at least since Sugden (1986, 1989) and Witt (1986), and the theory is well consolidated. In this paper we will test the hypothesis that cooperation is spontaneous in a classical setting of the economic literature, the private provision of a public good (see for instance Davis and Holt 1993), where full cooperation of all the players leads to the maximum possible payoff. While the economic theory predicts that people in such a framework would defect, this is not what the literature observes (at least up to a certain point of the game). What we aim at understanding is whether this spontaneous cooperation is more instinctive than reasoned, or viceversa.

According to the theory, a public good can not be produced by the market, since all the potential contributors would choose to free ride (i.e. to defect) rather than to contribute (i.e. to cooperate), this being the Nash equilibrium of the public goods game (PGG) (Selten 1978). However, the experimental economics literature provides large evidence against this prediction. The subjects involved in a PGG generally do not play the Nash equilibrium, although they tend to converge to it (see among many others Ledyard 1995), as the deterrence of retaliation weakens while the players approach the last round. Some scholars have introduced the possibility of reducing the payoff of the non-cooperative game partners (Fehr and Gächter 2000). These forms of "active" retaliation turn out to be more effective to maintain a high level of cooperation than the simple possibility of responding to a defector by defecting. Ottone (2008) and Lewisch et al. (2011) also find positive evidence for people punishing unfair behaviours. This is a consolidated result, despite several variations of the original design (see for instance Camerer 2003). The traditional design involves a limited number of participants (usually four to ten), which makes it plausible that the maintenance of cooperation in a PGG is a matter of reputation formation and signalling (see Camerer 2003 ; Fehr and Gächter 2004). Consequently, it is possible that the choice of cooperating under the threat of retaliation is more a reasoned than an instinctive choice.

Indeed, what may be true is that cooperation may be instinctive in some settings and not in others, possibly according to the ties with the other subjects - cultural, familial, or the like. For instance, Fehr and Gächter (2000) tested successfully the hypothesis that relational goods (namely acquaintance among the experimental subjects) enhance

[1] See also Rubinstein (2008), where data on response times of subjects are used to identify different types of economic agents.

cooperation.[2] Ottone (2008) actually shows that punishment and acquaintance complementarily increase and sustain cooperation in a PGG.

In this paper we will test the hypothesis that cooperation is instinctive, at least in some settings, analysing reaction time in a public goods experiment. The data are drawn as by-products from an experiment aiming at studying the role of relational goods in promoting cooperation. We find support for the hypothesis that the nature of cooperation in a PGG is instinctive. We also detect a not irrelevant gender effect.

2 Experimental design and procedure

A total of 128 undergraduate students of the Faculty of Economics of the University of Torino, half males and half females, took part in the experiment in 32 sessions, 8 for each of 4 treatments. The groups were made of subjects of the same gender, to avoid possible chivalry (see Eckel and Grossman 2001) or jealousy effects. The computerized experiment was conducted in a dedicated laboratory by means of a Z-tree program.

The game. A standard PGG was played by groups of four subjects.[3] Each of them was initially endowed with 60 experimental monetary units (EMU) worth 0.01€ each; the participant had to decide which part (from 0 to all) of the initial amount he/she wanted to allocate to a common fund; the sum of all the four contributions was then doubled and equally shared between all the participants, irrespectively of the individual allocations to the fund. Letting E be the initial endowment, S the sum of the contributions of the four subjects, and c_i the EMUs allocated by individual i to the fund, in each round i's payoff (P_i) was then $P_i = E - c_i + 2/n\ S = E - c_i + 1/2S$. The total earnings in a session were given by the sum of the payoffs gained in the ten rounds of the game. The participants received no participation fee.

The treatments. We implemented four different treatments, combining the following two different features: (1a) the subjects were already acquainted before registering to the experiment, in which case they were required to register together as a group for the same session; (1b) they had no previous acquaintance, in which case they registered individually; (2a) before playing the PGG the subjects were requested either to perform a team work or (2b) to engage in a cheap talk. The team work was to perform a budget analysis on the balance sheets of three different companies, by calculating the return on sales (ROS), return on investment (ROI) and return on equity (ROE) ratios, and the cash flow margins for each company. They were also asked to write down a short report and ranking of the companies on the basis of the calculated ratios. This task took them about 45–50 min. For the cheap talk treatments the subjects were gathered in a separate room and left to chat together for 20 min (the usual duration of

[2] In some cases also altruism might play some role (Brañas et al. 2010).

[3] Four to ten is the standard group size for PGG experiments of this kind. We adopted the lowest figure to make the requisite of previous acquaintance more cogent (see below and Lotito et al. (2011) for more details).

a cheap talk found in the literature). At the beginning of each session the subjects met in front of the lab. In the team work treatment they were asked to sit together in the centre of the lab around a single computer terminal. In the cheap talk treatment they were taken to a different small room (with no computers) and asked to wait while the experimenters set the lab; they were then conducted back after 20 min. In sum, we have four treatments: cheap talk without acquaintance (CT), cheap talk with acquaintance (CTA), team work without acquaintance (TW) and team work with acquaintance (TWA).

After the pre-play task was over, the participants were made to sit at the four computer terminals at the extreme corners of the lab, so to avoid any communication. At the beginning of the game the instructions appeared sequentially on each participant's computer screen and were read aloud by the experimenter at the same pace; the instructions would proceed on to the following page only when all the four participants had clicked on the 'Continue' button on the screen. Before beginning, the participants played on their computer a trial round, whose results did not contribute to the final payoff. A paper summary of the instructions was also distributed just before the game started. At the end of each of the ten rounds of the game each subject could see summarized in a table the total amount of the common fund (but not the amount allocated by each subject), her/his earnings for that repetition, the amount of EMU kept and the division of the common fund and the total profit up to that repetition in EMU and euros. At the end of the 10 repetitions the total profit (in EMU and euros) appeared on the screen. The subjects were paid at the end of the experiment, separately, individually and under the usual conditions of anonymity: they were asked to leave the room and come back individually to be paid[4].

The experiment aimed at assessing the effect of relational goods on cooperation; this paper is concerned only with the inference that may be drawn from the response time. We will consider the role of relational goods only with reference to this topic. A detailed analysis of the effect of relational goods on cooperation as observed in the experiment may be found in Lotito et al. (2011).

3 Results

As suggested in Sect. 1, we use the response times as a proxy for how instinctive is the contribution of a player. In particular, we argue that the faster the subject makes the decision about how much to contribute, the more instinctive this decision is. Both the dependent variables used in the analysis are "artificially" upper bounded. The experimental subjects were obliged to contribute a maximum of 60 EMUs and to make their decisions in a maximum of 120 s. As a consequence, the contributions and the response times could have abnormally massed on the upper extreme values. Possibly, some subjects would have liked to contribute more or to think longer before deciding, if allowed; hence, they contributed the whole amount of money and consumed all the available time before making their decision. From an econometric point of view, this means that the observed masses in correspondence of the upper bounds of the two

[4] For a broader description see Lotito et al. (2011).

variables may be artificial, and this must be considered when running the estimations. Moreover, each subject played ten rounds, what means that there may be some path dependence that must be considered. For the aforementioned reasons, panel tobit[5] estimations are computed[6] censoring at the highest level[7], but not at the 0 level, because the 0s are genuine monetary contributions.[8] Since the players are matched in groups of four, there is dependence between the individuals within each group, from the second round on. Although other authors[9] analysed similar data simply using panel tobit, in order to control for this interdependence, we added two variables to capture both the interdependence within the groups and the reaction to the average behaviour of the other components. These variables are calculated following Chaudhuri et al. (2006); Canegallo et al. (2008) and Ottone and Ponzano (2010): the first (named $\Delta C_{i,t-1}pos$) captures the difference between one's contribution and the average contribution in the previous round, when this is positive; the second variable (called $\Delta C_{i,t-1}neg$) captures the same difference as before, but when it is negative. Operationally, they are computed as follows:

$$\Delta C_{i,t-1}pos = \max\left\{0, \frac{1}{4}\sum_{j=1}^{4} C_{j,t-1} - C_{i,t-1}\right\}$$

$$\Delta C_{i,t-1}neg = \max\left\{0, C_{i,t-1} - \frac{1}{4}\sum_{j=1}^{4} C_{j,t-1}\right\}$$

where $C_{i,t-1}$ is the contribution of the ith player at round t−1. The other controls are: the gender of the respondent, the round (to capture the usual reduction of contribution over time), and a series of dummies that control for the treatments. Although this method is not optimal to account for interdependence of the observations within each group, we deemed that this was the best choice. Indeed an alternative option could have been a clustered tobit regression. However this would have sensibly reduced the number of observations, rendering the estimates too weak and scarcely reliable. A second alternative (considering the results observed in the first rounds only) would have incurred the same problem. On the contrary, the strategy proposed in our paper tries to compensate for the presence of interdependence making it captured by the two differences presented above. Since each subject reacts to the choices of his group only, and since the effect of the others' contributions in round t−1 affects one's choice in round t, then the two variables that represent the difference of one's contribution with respect to the mean of the group capture this effect. Unfortunately this does not

5 As a maximum contribution to the public good is imposed by the initial endowment, this is the most appropriate technique. Indeed a simple panel OLS would have been biased by the massing of observations on the upper bounds. Moreover, a skewness-kurtosis test on the residuals of the regression shows that they are normally distributed.

6 STATA 10 was used for all the statistical and econometric computations.

7 The data are censored at contributions equal to 60 EMUs (i.e. 33.2 % of the total observations).

8 For the analysis of extreme behaviours we used panel probit estimations.

9 See for instance Carpenter (2007).

Table 1 Descriptive statistics: means and standard errors (in brackets)

	Contribution [a]	Response time[b]	Free riders[c]	Full cooperators[c]
Cheap talk with acquaintance	33.95	17.17	0.097	0.281
	(22.31)	(16.62)	(0.296)	(0.450)
Cheap talk without acquaintance	29.10	17.07	0.250	0.287
	(24.64)	(15.81)	(0.434)	(0.453)
Team work with acquaintance	44.62	16.87	0.041	0.569
	(21.43)	(22.58)	(0.198)	(0.496)
Team work without acquaintance	25.05	19.07	0.216	0.191
	(23.75)	(21.29)	(0.412)	(0.393)

[a] EMUs
[b] Seconds
[c] Proportion of free riders / full cooperators (absolute values)

dissolve the covariance between the choices within each group. This entails inflated standard errors for the observed coefficients, what may have rendered apparently non significant some coefficients that are in fact significant. However, since this problem would concern variables that are not relevant for the focus of the paper, we deemed this as a minor shortcoming, and used the estimation strategy described before. The four treatments (CT, CTA, TW and TWA) are introduced as dummies in the analysis; interaction controls between the gender (male) and treatments are also included, to capture possible gender effects.

Table 1 presents descriptive statistics by treatment. While the contributions to the public good vary, the average response times are almost constant between the treatments. Note that the proportions of free-riders (who contribute nothing) and full cooperators (who contribute all their 60 EMUs) are affected by the treatments, with the largest share of the first in the CT treatment, and the largest share of the second in the TWA treatment.

Contributions and response times are negatively and significantly related (Table 2), i.e. the shorter the time needed by the subject to make the decision, the higher the contribution. As expected and commonly found, the contributions are decreasing during the game (the "round" variable has a negative and significant coefficient). The effect of $\Delta C_{i,t-1}$pos and of $\Delta C_{i,t-1}$neg is also noteworthy: if in round t−1 player *i* contributed more than the average, he/she will contribute less in round t, while the opposite holds if the difference in t−1 was negative. Moreover, $\Delta C_{i,t-1}$pos affects also the response time (second column of Table 2): here the coefficient is positive, indicating that if a player contributed more than the average in the previous round, then at round t he/she thinks of how much to put in the common pool more than the average. This is consistent with previous results: as the players who contributed more than the average in round t−1 tend to decrease their contribution in round t, and since $\Delta C_{i,t-1}$pos correlates positively with the response time, this suggests that choosing a low contribution, or deciding to lower it with respect to the previous round, requires more thinking than choosing a high contribution, or increasing it with respect to the

past.[10] In other words subjects respond to cooperation more quickly than to defection, suggesting that cooperating with other co-operators is more instinctive than not cooperating. While on the one hand cooperation fosters itself, on the other an "excess" of it is detrimental. Experience (captured by the "round" variable) reduces the response time, as well as the average level of cooperation (in line with the previous findings of the literature). To sum up, our results suggest that cooperation is the default, "natural" attitude, while the consumption of some types of relational goods (in our case team working) "produces" additional co-operation,[11] that requires more reasoning. Instead, the previous acquaintance has no significant effect.[12] Males seem to be more instinctive than females. According to experimental evidence, women are more risk averse than men (Croson and Gneezy 2009), hence it is plausible that they think more before making a choice that could produce a loss. The suggestion is that risk aversion reduces the instinctive content of a decision.

Table 3 shows the results on the extreme behaviours (i.e. full cooperation and full free riding) of the previous variables and of the two relational goods. We define full cooperation the contribution of the whole initial endowment (i.e. 60 EMUs) to the common fund, while full free riding is defined as contributing nothing. This definition applies to each round (and does not change from round to round), i.e. we consider full cooperation and full free riding within each round and for each player.

The coefficient of the response time is negative in the case of perfect cooperation, and positive when the subject free rides. On this last effect we must highlight that the coefficient is significant in the first seven rounds only (and this explains why the sample used in the estimation contains 640 observations only). Indeed after the seventh round the response time becomes completely irrelevant in determining the decision of free riding. This evidence is consistent with the results presented in Table 2, and confirms that free-riding is a behaviour more reasoned than cooperation. The fact that full free riding does not depend on the deviations of i's contributions from the group mean and the decreasing significance of the effect of the response time suggests that free riding is less determined by what happens during the game than full cooperation. Albeit this is not the subject of this paper, it is worth observing that the consumption of relational goods also confirms its importance in determining individual behaviour: previous acquaintance and working together before playing the PGG increase the probability of full cooperation.[13]

[10] Note however that the negative correlation of $\Delta C_{i,t-1}$neg with the response time is not significant.

[11] Note that this occurs mainly when team work is combined with acquaintance or with male. However, we will not deal further with the features of the four treatments because this point is not the focus of the paper.

[12] What above is highly coherent with the theory of norms, according to which the possibility to punish is crucial to sustain the cooperation (see Sugden 1986, and for a recent survey, see Lotito et al. (2011)). For the punishment to be applied it is necessary to check whether it is requested, what requires reasoning and consequently time.

[13] On this see note 11 above.

Table 2 Analysis of contributions and response times

Dependent variable	Contribution	Response time
Response time	−0.129	
	(0.055) ∗∗	
Male	−21.556	−9.485
	(9.348) ∗∗	(4.894) ∗∗
Team work	−28.325	−4.142
	(9.332)∗∗∗	(4.892)
Team work * acquaintance	57.524	3.863
	(13.523)∗∗∗	(6.927)
Team work * male	41.742	11.267
	(13.134)∗∗∗	(6.920)∗
Team work * male * acquaintance	−51.574	−10.711
	(18.868)∗∗∗	(9.787)
Acquaintance	−5.020	−0.405
	(9.390)	(4.892)
Acquaintance * male	18.730	−0.590
	(13.150)	(6.916)
Round	−1.900	−1.481
	(0.269)∗∗∗	(0.131)∗∗∗
$\Delta c_{i,t-1}$pos	−0.149	0.114
	(0.088)∗	(0.048) ∗∗
$\Delta c_{i,t-1}$neg	0.292	−0.043
	(0.086)∗∗∗	(0.047)
Constant	61.927	28.869
	(7.129)∗∗∗	(3.570)∗∗∗
sigma_u	25.035	13.289
	(2.075)	(0.907)∗∗∗
sigma_e	19.991	11.470
	(0.553)	(0.254)∗∗∗
rho	0.611	0.573
	(0.041)	(0.035)
Observations	1152	1152
Wald χ^2	101.09	148.85

Panel tobit regressions (s.e. in brackets)

4 Conclusions

Relying on the assumption that the longer is the decision time the less instinctive is a choice, our results suggest that in public good provision the instinctive behaviour is cooperation rather than defection. However, our evidence is far from being conclusive.

Table 3 Analysis of extreme behaviours

Behaviour (dependent variable)	Full cooperation	Free riding
Response time	−0.012	0.010
	(0.005)***	(0.005) **
Male	−1.427	0.797
	(0.601) **	(0.478)*
Team work	−1.711	0.568
	(0.612)***	(0.479)
Team work * acquaintance	3.559	−0.723
	(0.882)***	(0.721)
Team work * male	2.429	−1.696
	(0.855)***	(0.703) **
Team work * male * acquaintance	−3.136	0.000
	(1.208)***	(0.000)***
Acquaintance	−0.729	−0.215
	(0.600)	(0.504)
Acquaintance * male	1.428	−0.732
	(0.845)*	(0.698)
Round	−0.098	0.051
	(0.023)***	(0.060)
$\Delta c_{i,t-1}$pos	−0.004	0.008
	(0.007)	(0.010)
$\Delta c_{i,t-1}$neg	0.016	−0.006
	(0.007) **	(0.010)
Constant	0.582	−2.166
	(0.460)	(0.484)***
sigma_u	1.470	0.959
	(0.173)	(0.183)
rho	0.684	0.479
	(0.051)	(0.095)
Observations	1152	640
Wald χ^2	53.75	14.42
Loglikelihood	−448.00	−183.75

Panel probit regressions (s.e. in brackets)

Other explanations are possible for our data[14]; hence this paper must be considered mostly as a piece of not-denying evidence. Also, as relational goods enhance cooperation but require reasoning, we argue that the probability for the cooperative instinct to

[14] For instance, an anonymous referee suggested that our data may be explained by the existence of "simple" and "sophisticated" subjects: the first type adheres to a simple rule, be it to cooperate or not, and being this rule not-meditated they employ less time to decide. To our opinion this hypothesis is more demanding than that of the paper, nevertheless it may not be ruled out.

be displaced by more reasoned choice (that may also suggest cooperation) increases as does the consumption of relational goods.

These results allow for a couple of suggestions for more ample inquiries. First, if confirmed they could contribute to explain the emergence of opportunistic behaviours in (relatively) large communities. Second, they provide support to an increasing non-economic literature that supports the hypothesis of the instinctive nature of spontaneous cooperation (see Bowles and Gintis 2011, for a state-of-the-art discussion). For many years both economics and biology have been accused of supporting the assumption that human selfishness is "natural". Presently both sciences are increasingly providing evidence that goes against that assumption. For instance, very recently Schmidt and Sommerville (2011) found that their experiments which show that fairness feelings are already present in 15-month-old infants "support arguments for an evolutionary basis […] of human egalitarianism, given the rapidly developing nature of other-regarding preferences and their role in the evolution of human-specific forms of cooperation" (from the abstract). Our results point to the same direction.

References

Bowles, S., & Gintis, H. (2011). *A cooperative species: Human reciprocity and its evolution*. Princeton: Princeton University Press.

Brañas, P., Cobo_Reyes, R., Espinosa, M. P., Jiménez-Jiménez, N., Kovárik, J., & Ponti, G. (2010). Altruism and social integration. *Games and Economic Behavior, 69*(2), 249–257.

Brown, T. C., Kingsley, D., Peterson, G. L., Flores, N. E., Clarke, A., & Birjulin, A. (2008). Reliability of individual valuations of public and private goods: Choice consistency, response time, and preference refinement. *Journal of Public Economics, 92*(7), 1595–1606.

Camerer, C. F. (2003). *Behavioral game theory*. Princeton: Princeton University Press.

Canegallo, C., Ortona, G., Ottone, S., & Ponzano, F. (2008). Competition versus cooperation: Some experimental evidence. *Journal of Socio-Economics, 37*(1), 18–30.

Carpenter, J. (2007). Punishing free-riders: How group size affects mutual monitoring and the provision of public goods. *Games and Economic Behavior, 60*(1), 31–51.

Chaudhuri, A., Graziano, S., & Maitra, P. (2006). Social learning and norms in a public goods experiment with inter-generational advice. *Review of Economic Studies, 73*(2), 357–380.

Croson, R., & Gneezy, U. (2009). Gender differences in preferences. *Journal of Economic Literature, 47*(2), 448–474.

Davis, D., & Holt, C. (1993). *Experimental economics*. Princeton: Princeton University Press.

Eckel, C. C., & Grossman, P. J. (2001). Chivalry and solidarity in ultimatum games. *Economic Inquiry, 39*(2), 171–188.

Fehr, E., & Gächter, S. (2000). Cooperation and punishment in public goods experiments. *The American Economic Review, 90*(4), 980–994.

Fehr, E., & Gächter, S. (2004). Fairness and retaliation: The economics of reciprocity. *Journal of Economic Perspectives, 14*(3), 159–181.

Ledyard, J. (1995). Public goods: a survey of experimental research. In J. Kagel & A. Roth (Eds.), *Handbook of experimental economics* (pp. 111–194). Princeton: Princeton University Press.

Lewisch, P. G., Ottone, S., & Ponzano, F. (2011). Free-riding on altruistic punishment? An experimental comparison of third-party punishment in a stand-alone and in an in-group environment. *Review of Law and Economics, 7*(1), 1–8.

Lotito, G., Migheli, M., & Ortona, G. (2011). *An experimental inquiry into the nature of relational goods*. POLIS Working Paper 160. Institute of Public Policy and Public Choice POLIS.

Ottone, S. (2008). Are people samaritans or avengers? *Economics Bulletin, 3*(10), 1–8.

Ottone, S., & Ponzano, F. (2010). Competition and cooperation in markets. The experimental case of a winner-take-all setting. *Journal of Socio-Economics, 39*(2), 163–170.

Piovesan, M., & Wengström, E. (2009). Fast or fair? a study of response times. *Economics Letters, 105*(2), 193–196.
Rubinstein, A. (2007). Instinctive and cognitive reasoning: A study of response times. *The Economic Journal, 117*(523), 1243–1259.
Rubinstein, A. (2008). Comments on neuroeconomics. *Economics and Philosophy, 24*, 485–494.
Schmidt, M. F. H., & Sommerville, J. A. (2011). Fairness expectations and altruistic sharing in 15-month-old human infants. *PloS ONE, 6*(10), no indication of pages.
Selten, R. (1978). The chain store paradox. *Theory and Decision, 9*(2), 127–159.
Sugden, R. (1986). *The economics of rights, cooperation and welfare*. Oxford: Basil Blackwell.
Sugden, R. (1989). Spontaneous order. *Journal of Economic Perspectives, 3*(4), 85–97.
Witt, U. (1986). Evolution and stability of cooperation without enforceable contracts. *Kyklos, 39*(2), 245–266.