Inducing good behavior

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2. How to Subsidize Contributions to Public Goods: Does the Frog Jump out of the Boiling Water?[1]

2.1. Introduction

Governments around the world subsidize contributions to public goods. In some cases, the subsidy is abruptly introduced in one step. For instance, the European Commission abolished in one time the 66.1% import duty on energy saving compact fluorescent lamps from China in October 2008.[2] Similarly, in March 2009, the Chinese government announced the most aggressive subsidy on solar panels in the world. By providing a subsidy of 20 yuan per watt, the Chinese will essentially cover half the cost of entire installations at today's solar panel prices. In other cases, the subsidy is introduced gradually in many small steps. As an example, in the Netherlands the duty on petrol was enhanced in numerous tiny amounts from 46.1% in 1993 to 69.7% in 2008. By increasing the duty on petrol, the Dutch effectively subsidize people who opt for public transport. In January 2009, Japan launched a rather modest subsidy on solar panels that corresponds to about 10 percent of the costs. The subsidy turned out to be less effective than planned, and it is expected that Japan will raise the subsidy in the future.

In this chapter, we investigate how subsidies of contributions to public goods should be introduced. In a series of experiments, we compare the effectiveness of an instantaneous rise in the subsidy to a slow rise of the subsidy to the same ultimate level. Doing so, we test a conjecture formulated by Al Gore in the 2006 movie *An inconvenient truth*. Gore claims that humans have a tendency to ignore changes in the environment when these changes occur at a very slow pace. Therefore, there is a danger that humans fail to respond while the climate deteriorates by the very gradual process of global warming. Gore draws an analogy between the boiling frog story and the inertia of humans: "If a frog jumps into a pot of boiling water, it jumps right out again,

[1] This chapter is based on the identically titled paper joint with Theo Offerman and benefited from helpful comments of Rachel Croson, Tore Ellingsen, Guillaume Frechette, Andreas Leibbrandt, Charlie Plott, Andrew Schotter, Arthur Schram and Joep Sonnemans. We are grateful to CREED programmer Jos Theelen for programming the experiment.

[2] The European Commission decided to impose the duty in 2001 after the European Lighting Companies Federation, a trade group for European producers, complained that China was flooding the market with cheap bulbs. The anti-dumping tariff was a huge setback for Chinese producers, for whom the exports to the European Union formed a substantial share of their market.

because it senses the danger. But the very same frog, if it jumps into a pot of lukewarm water that is slowly brought to a boil, will just sit there and it won't move." He concludes: "Our collective nervous system is like that frog's nervous system. ... If it seems gradual, ... we are capable of just sitting there and not reacting." Gore eloquently formulates a concern that is bothering many people from time to time. For instance, in a recent contribution, Krugman (2009) provides the same conjecture about how humans will fail to respond to "the creeping threat" of climate change. Gore and Krugman actually formulate two conjectures, one about frogs and one about humans. Although the boiling frog story is currently challenged, actual investigations on frogs published in the 19^{th} century claim support for it (see Appendix A). The goal of our study is to investigate whether humans fail to react when slow changes in the environment increase the importance of contributions to the public good, as suggested by Gore and Krugman.[3]

In the real world, contributing to a public good is one of many decisions that people continuously make. For instance, when we are cold in winter we may at any moment decide to put on an extra sweater or to set the thermostat a few degrees higher. At the same time, other activities continuously compete for our attention. To mimic this situation in the laboratory, we provide our subjects with a dual-task procedure. Our subjects continuously and simultaneously earn money with an individual task (their daily activities) and with their contributions to a public good. They can switch from the one task to the other task whenever they wish. While they are playing the game, we increase the subsidy to the contributions of the public good. The most important treatment variable is whether this increase occurs instantaneously or gradually.

In our experiments, we make use of a linear public good game where selfish subjects have a dominant strategy to completely free ride in the stage game for any level of the subsidy that we employed. Although the game was repeated for an unknown number of seconds, selfish subjects could not support cooperation in equilibrium because subjects did not receive information about others' contributions during the public good game. Therefore, from a strategic point of view the game is essentially a one-shot game.

Nevertheless, there is a vast literature on public good games that furnished our conjecture that we would observe positive contributions when contributions were subsidized. One of the stylized facts in experiments on linear public good games is that subjects respond to how productive a contribution to the public good is. Isaac and Walker (1988) and Isaac, Walker, and Williams (1994) were among the first ones to find a positive effect of an increase in the Marginal Per Capita Return ($MPCR$), the marginal benefit that each player earns from the contribution of an extra dollar to the public good, on subjects' contributions to the public good. In essence, a subsidy on subjects' contributions to public goods corresponds to an increase in the $MPCR$. Therefore, it makes sense to expect a positive effect of a subsidy on subjects' contributions.

[3]We chose to address the question in a public good game. Another possibility would have been to make use of a strategically equivalent public bad game. Then the question would be how subjects respond to different ways of taxing undesired taking from a common pool. Andreoni (1995) started a literature comparing subjects' behavior in public good and public bad games. In many cases, subjects behave somewhat more cooperatively in the public good frame, but the evidence is not completely concurrent. Dufwenberg, Gächter, and Hennig-Schmidt (2008) discuss the literature.

There are two possible causes behind subjects' responsiveness to the $MPCR$. One possibility is that subjects do not only care about their own payoff but also about the material payoff of other subjects. Material altruists are more inclined to contribute with a higher $MPCR$ because it makes their contribution more effective (Goeree, Holt, and Laury, 2002). The other possibility is that a higher $MPCR$ boosts contributions because it changes the beliefs that subjects have about the extent to which others cooperate. The recent literature on public good games has identified the presence of a substantial number of conditional cooperators (Offerman, Sonnemans, and Schram, 1996; Fischbacher, Gächter, and Fehr, 2001; Brandts and Schram, 2001). If a larger $MPCR$ makes the conditional cooperators more optimistic that others will contribute, they will be more inclined to contribute.

In this chapter, the main focus is not on why people respond to the $MPCR$/subsidy but on whether subjects respond differently when the $MPCR$/subsidy is changed gradually or instantaneously. The two questions may be related though. If subjects are cool and calculating material altruists, they will solely respond to the level of the subsidy. In this case we would not expect that humans fall prey to the boiling frog phenomenon. Conditional cooperators may believe that others will only fail to respond to a change in the subsidy if it is introduced in tiny steps. With such beliefs, conditional cooperators may only respond to the subsidy when it is introduced in one big step. A boiling frog phenomenon for humans in public good games may thus be driven by conditional cooperators who expect that others are sensitive to the way that the subsidy is introduced.

There is, however, also a possibility that a boiling frog effect in public good games is not driven by expectations but by anchoring (Tversky and Kahneman, 1974). The initially chosen contribution level may serve as an anchor that prevents people from adapting their behavior unless a dramatic change in the subsidy occurs. Many studies have shown that people do not move sufficiently in the right direction away from their reference point or anchor. For instance, Northcraft and Neale (1987) find that respondents often quote a too high selling price for a house if they are given a reference point that is higher than the actual selling price and vice versa. Anchoring also explains why people often choose the firm's default in the 401(k) savings plan (Madrian and Shea, 2001). In a recent study, Schram and Sonnemans (2011) investigate how people choose their health insurance in a changing decision environment with a large set of alternatives that differ on a variety of dimensions. In a 2x2x2 design, Schram and Sonnemans vary the number of alternatives, switching costs, and the speed at which health deteriorates. With respect to the latter treatment variable, the authors find that if health deteriorates only gradually, individuals tend to stick to their chosen policy too long.

In a first series of experiments, we raised the subsidy level from 0% to 45%. Here, we do not observe significant differences between the treatment where the subsidy is introduced in one big step and the treatment where it is introduced in many small steps. With a maximum of 45%, the subsidy only marginally increases contributions in either case, though. Therefore, we decided to run an additional series of experiments where we raised the subsidy to 75%. Here,

there is a substantial effect of the subsidy when it is introduced instantaneously while there is at best a modest effect when it is introduced gradually. The difference in the fractions of people responding positively to the subsidy equals 27 percentage points. This difference is significant and persistent. Given that subject respond positively to the subsidy, they enhance their contributions to the same extent in both treatments.

Subjects may fail to respond to a gradual increase in the subsidy because they are distracted by a dual task.[4] We investigated this possibility in a control treatment where subjects were not distracted by the individual task while the subsidy was gradually raised to 75%. If we look at the average contribution levels, subjects respond similarly to the subsidy in the single-task treatment as they do in the dual-task treatment. There is, however, a difference in how often subjects change their decisions. When they are not distracted by the dual task, subjects change their contribution level substantially more often.

An analysis of the beliefs reported by a group of subjects who did not contribute to the public good themselves discredits the explanation that the effect is driven by the beliefs of conditional cooperators. Instead, subjects simply seem to ignore changes in the environment if they are very small in size.

The remainder of this chapter is organized as follows. In Section 2.2, we describe our experimental design. Section 2.3 provides the results and Section 2.4 concludes. Appendix A reviews the existing evidence on the boiling frog story and Appendix B the instructions of the experiment.

2.2. Experimental Design and Procedures

The computerized experiment started with on-screen instructions (see Appendix B). After reading the instructions and answering some control questions, subjects received a summary of the instructions on paper. With their decisions, subjects earned points that were exchanged at the end of the experiment at a rate of 1 euro for 1800 points. Table 2.1 on the facing page summarizes the details of the 6 treatments. In total, 259 subjects participated who earned on average 23.1 euros (s.d. 9.4) in about 1 hour and 45 minutes. Each subject participated in one treatment only.

Subjects participated in a public good game that we adapted in different ways. After the public good game was finished, subjects received additional instructions and we obtained measures on their beliefs and social preferences. The dual task procedure formed the core of most of our treatments. We first discuss the main features of this procedure. Subjects performed a group task and an individual task at the same time. Subjects earned money with both tasks and could switch between the two tasks whenever they wanted. Subjects were informed that the earnings

[4] Subjects who are distracted by a dual task sometimes behave differently. Darley and Batson (1973) find that students who were in a hurry to give a talk on the parable of the Good Samaritan were more likely to pass without stopping to help a shabbily dressed person in need than those who were not in a hurry. Mann and Ward (2004) report that dieters who have to remember a 9-digit number drink more from a high-calorie milkshake than dieters who are told to remember a 1-digit number (see also Ward and Mann, 2000).

Table 2.1.: Main Features of the Treatments

Treatment	max subsidy	increase subsidy	dual task?	group-size	#subjects
gradual-45	0.45	gradual	yes	6	48
quick-45	0.45	quick (start)	yes	6	54
gradual-75	0.45	gradual	yes	6	36
quick-75	0.75	quick (start)	yes	6	36
gradual-75-single	0.75	gradual	no	6	36
predict-75	predicted contribution levels gradual-75 and quick-75				49
				total	259

for the one task were independent of the earnings for the other task. To prevent an artificial endgame effect, we informed subjects that the two tasks would last between 25 and 40 minutes. It actually ended after exactly 28 minutes.

In the individual task, subjects earned money by keeping a randomly moving red dot inside a box. Subjects could move the box by pressing on one of the four buttons (up, down, left, right). At the end of each second the computer determined whether the dot was inside the box or not. The subject earned 15 points when the dot was inside the box and 0 points otherwise. Subjects could keep track of the total earnings for the individual task during the experiment.[5]

For the group task, subjects were randomly assigned to a group of 6 people. They were not rematched during the experiment. In every second, subjects received an endowment of 10 points and determined how much of this endowment to contribute to the public good. Each point contributed to the public good was multiplied by 1.2 and then equally divided between the 6 group-members. So each group-member received 0.2 from each point contributed to the public good. At the start, each subject decided how much to contribute by setting the level of a slider equal to a number in the range from 0 to 10. In every subsequent second each subject had the possibility to change the contribution by moving the slider. If the subject refrained from changing the contribution, this person's contribution automatically equaled the contribution in the previous period.

Subjects' contributions were subsidized at a varying rate. If the subsidy equaled s_t $(0 \leq s_t < 0.8)$ in second t, subject i actually paid a cost of $(1 - s_t)\, g_{i,t}$ for a contribution $g_{i,t}$ $(0 \leq g_{i,t} \leq 10)$. Thus, in second t subject i earned the amount:

$$\pi_{i,t}\left(g_{i,t}\right) = 10 - (1 - s_t)\, g_{i,t} + 0.2 \sum_{j=1}^{6} g_{j,t}$$

Subjects knew that the subsidy would start at 0 and that it might change during the experiment but that it would never exceed 0.8, so making a donation would never become a dominant strategy. Above the slider, subjects observed the subsidy of that second. When the subsidy

[5] The box game was developed by John Krantz,
see http://psych.hanover.edu/JavaTest/CLE/Cognition/Cognition/dualtask_instructions.html.

changed, the background of the subsidy-number turned red for a second. This way, subjects noted the change even when they were focused on the individual task. All subjects faced the same subsidy and they were explicitly informed that the change of the subsidy was outside of their control.

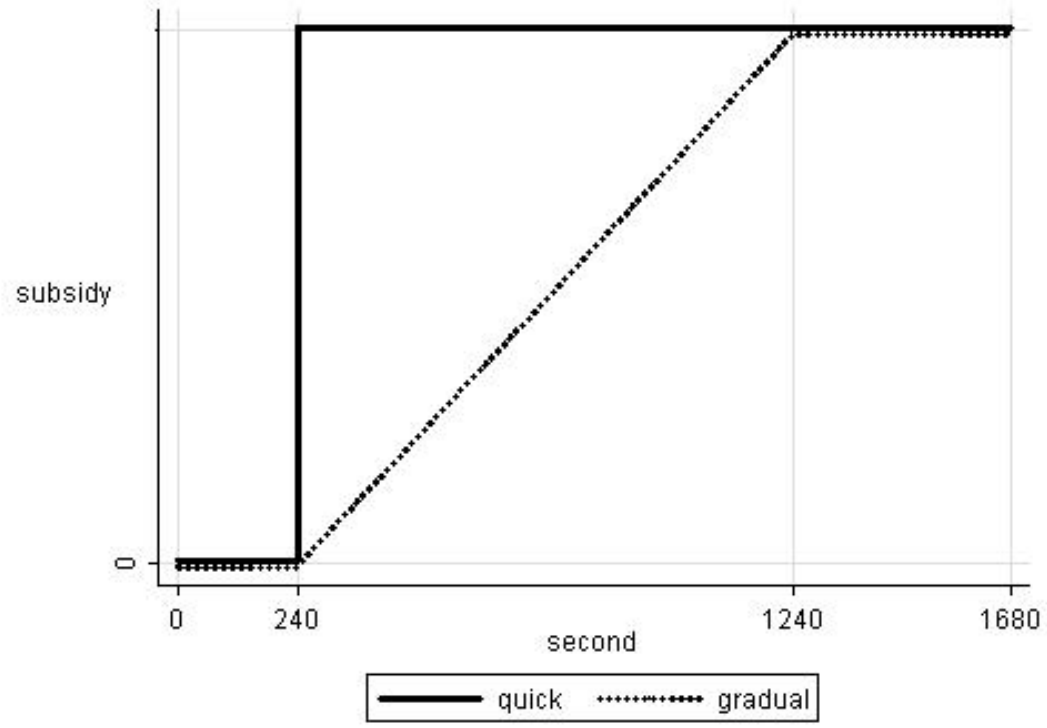
Subjects were NOT informed about the contributions made by the other group-members while they participated in the public good game. They were also not informed about their earnings for the group-task until the end. This feature of the design was motivated by the observation that most consumers in the real world receive little or no information about other people's private energy consumption. A convenient consequence of this feature is that contribution decisions are independent across subjects.

We now turn to the differences between the treatments. The main treatments, gradual-45, quick-45, gradual-75 and quick-75, allow us to determine which way of changing the subsidy is most effective. In all these treatments, the subsidy remained at 0 during the first 4 minutes. Then in the quick-treatments, the subsidy jumped in one second from 0 to the maximum of 0.45 in quick-45 and from 0 to the maximum of 0.75 in quick-75. In the gradual treatments, the subsidy was raised with 0.001 per 2.2 seconds until it reached 0.45 in gradual-45, while it was raised with 0.001 per 1.3 seconds until it reached 0.75 in gradual-75, so that in either case the maximum was attained after 20 minutes and 40 seconds. In the remainder the subsidy stayed at the maximum until the end. Figure 2.1 on the next page displays the development of the subsidy across treatments.

To investigate the potential effect of the dual task procedure, we included treatment gradual-75-single where subjects only performed a single task. Like in the main treatments, subjects earned money from the group task and the individual task. However, subjects only had to decide themselves how much to contribute to the public good in the individual task, as the computer replicated for them the movements of the red dot as presented to and the choices made by one of the subjects in the individual task in a previous dual task treatment. Subjects could observe the choices that were made for the individual task by their counter part in a previous experiment, but they could only affect their own earnings by their contribution decisions. This way, subjects could concentrate on the contribution task while their income was enhanced at the same pace as in the dual task experiment. A comparison of gradual-75-single and gradual-75 reveals the effect of the dual-task procedure.

After the public good game was finished, we obtained some measures that shed light upon the contribution decisions. We obtained a measure on subjects' social preferences by eliciting their value orientations. Here, subjects received two amounts, a first one determined by the own choice and a second one determined by another subject's choice. Subjects chose to allocate I points to one self and O points to a randomly chosen other person subject to the constraint $I^2 + O^2 = 4000^2$. In the experiment, subject used the mouse to select a point on a circle where

Figure 2.1.: Development of Subsidy over Time



the horizontal axis represented money given to one self and the vertical axis represented money given to the other. We explicitly clarified that the person who was affected by a subject's decision was not the same person as the one who decided about the subject's second amount.[6] Finally, we collected some background information about our subjects.

In addition, we elicited the beliefs that subjects had about the contribution levels at the start and at the end in other quick and gradual groups. As expected, we found a positive correlation between beliefs about others' contributions and own contributions. These data do not yet allow us to assess the role of conditional cooperators, because it is not clear whether the causal relation runs from beliefs to behavior or in the opposite direction.

To unravel the potential role of beliefs in the boiling frog phenomenon, we ran an additional treatment pred-75 where subjects neither played the public good game nor the box game. Instead, their task was to predict how much subjects had contributed in gradual-75 and quick-75 at specific moments. Subjects first received the instructions provided to the subjects in quick-75 and gradual-75 and then they received a handout that explained the development of the subsidy across time in the gradual mode and in the quick mode (see Figure 2.2 on page 15). We elicited subjects' subjective beliefs about how much subjects contributed on average in previous sessions.

[6] This circle test has been used for the first time by Sonnemans, Dijk, and Winden (2006).

We did this for the following three statements that refer to particular moments shown in the handout:

1. Your probability judgment for the statement: at the START, the average contribution was in the interval [0..2]; [2..4]; [4..6]; [6..8]; [8..10].

2. Your probability judgment for the statement: at the END, the average contribution in the GRADUAL groups (see hand-out) was in the interval [0..2]; [2..4]; [4..6]; [6..8]; [8..10].

3. Your probability judgment for the statement: at the END, the average contribution in the QUICK groups (see hand-out) was in the interval [0..2]; [2..4]; [4..6]; [6..8]; [8..10].

After providing the 5 probabilities connected to one statement, subjects were provided with a graphical presentation of the implied probability density, and they were allowed to make changes to their reported probabilities before they proceeded to the next statement. For half the subjects questions 2 and 3 were posed in the opposite order. Subjects were rewarded for reporting their beliefs seriously. In total, subjects reported 15 probabilities (3 statements $\times$ 5 intervals). At the end of the experiment, one of these 15 probabilities was drawn at random and every subject received a payment generated by the quadratic scoring rule. To correct the reported beliefs for risk attitudes, we employed the correction procedure described in Offerman, Sonnemans, van de Kuilen, and Wakker (2009). Basically, that procedure filters out the risk component in subjects' reported beliefs. This is done by asking subjects to make probability judgments for an additional series of questions with given objective probabilities. These judgments are then used to map the originally reported probabilities into risk-corrected probabilities.

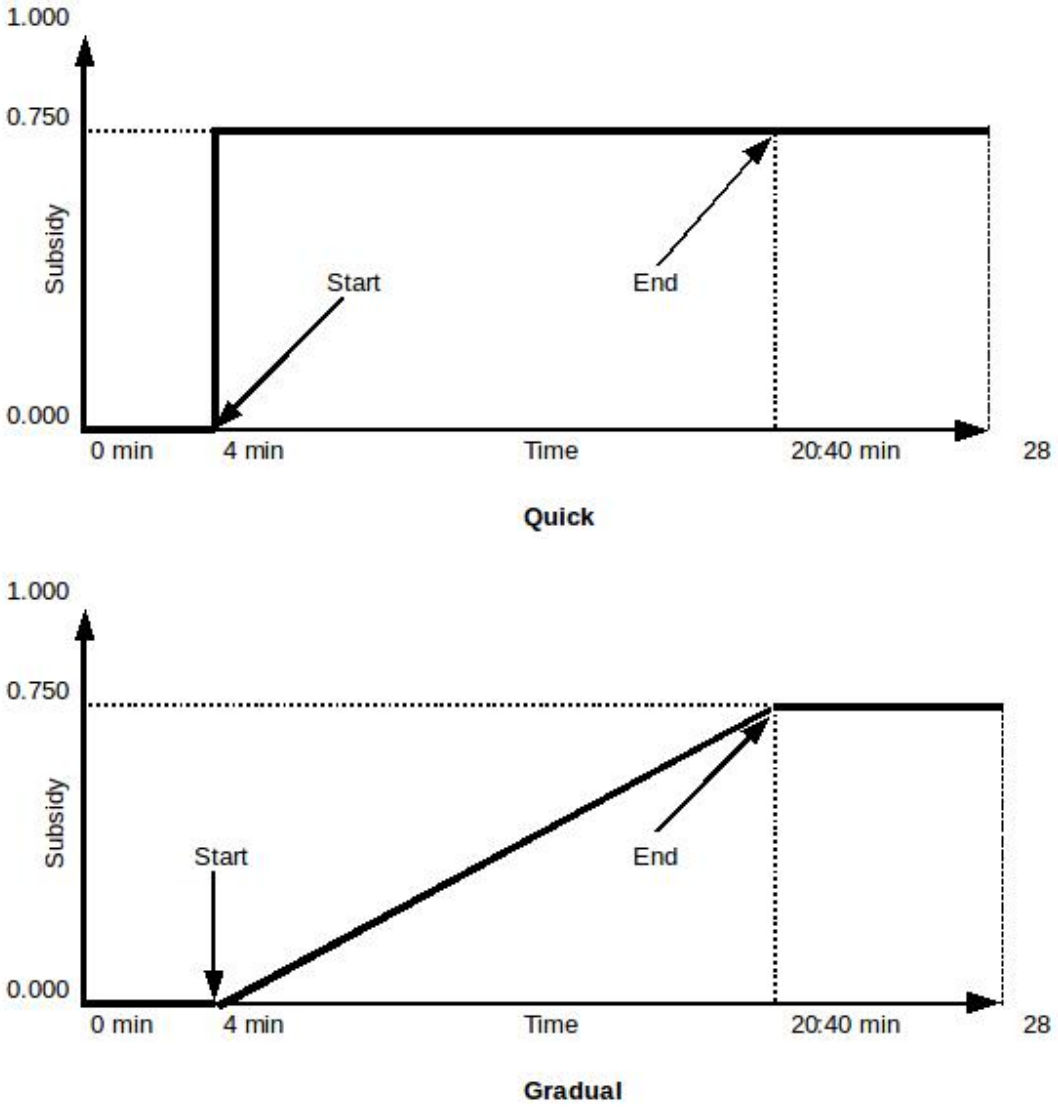
2.3. Results

We present the results in three parts. In Section 2.3.1, we look at how responsive our subjects are to the subsidy and we investigate whether subjects react stronger when the subsidy is quickly increased than when it is gradually enhanced. There we deal with our main treatments gradual-45, quick-45, gradual-75 and quick-75. In Section 2.3.2, we discuss the results of the control treatment that allows us to investigate whether the results are sensitive to the introduction of the dual task. In Section 2.3.3, we provide the evidence obtained in treatment pred-75 and we unravel the role that beliefs play in explaining the boiling frog phenomenon.

2.3.1. How to Subsidize Contributions to Public Goods

We chose to start with a low $MPCR$ of 0.2 to allow for a positive effect of a subsidy on the contributions in all experiments. In gradual-45 and quickly-45, we increased the subsidy to a maximum of 0.45. This corresponds to an almost doubling of the $MPCR$ from 0.2 to $0.2/(1-0.45) = 0.364$. In their treatments with an $MPCR$ of 0.3, Isaac and Walker (1988) and Isaac, Walker, and

Figure 2.2.: Handout for Treatment Pred-75



Williams (1994) find a contribution level of roughly 35%-40% when their data of group sizes 4, 10 and 40 are pooled.

Table 2.2 on the next page shows how subjects responded to the increase of the subsidy. For each subject, we calculated the average contribution in the 50 seconds prior to the start of the rise of the subsidy and the average contribution in the 50 seconds after the subsidy reached its maximal level in a treatment. The columns "Pre" and "Post" report these statistics averaged across subjects. In the treatments with a maximum subsidy of 0.45, we observe a modest increase in the contribution level which reaches a weakly significant level in quick-45 but not in gradual-

Table 2.2.: Responses to the Subsidy

	Gradual				Quick			
Max Subsidy	N	Pre (SD)	Post (SD)	WMP	N	Pre (SD)	Post (SD)	WMP
0.45	48	2.16 (2.94)	2.54 (2.85)	0.16	54	1.76 (2.87)	2.31 (2.94)	0.09
0.75	36	1.85 (2.86)	2.58 (3.75)	0.12	36	1.46 (2.01)	4.32 (3.98)	0.00

Notes: table is based on data from gradual-45, quick-45, gradual-75, and quick-75; Pre [Post] gives the average contribution in the 50 seconds before the start [after the end] of the rise in subsidy; WMP: Wilcoxon Matched-Pairs Signed-Ranks Test; standard deviations between brackets.

45.[7] Because our subjects responded less to the subsidy than we had expected we decided to run treatments where the subsidy increased to a maximum of 0.75. The table shows that in gradual-75 the increase in contributions is again modest and only weakly significant (at best). The increase in contributions in quick-75 is substantial and significant though.

Figure 2.3 on the facing page displays the average contributions across time in the four main treatments. The figure shows that there is a substantial and lasting effect of the subsidy in quick-75. In the other treatments there is only a modest effect of the introduction of the subsidy. A first glance at the data suggests that the boiling frog phenomenon only appears when the subsidy is increased instantaneously to a sufficiently high level.

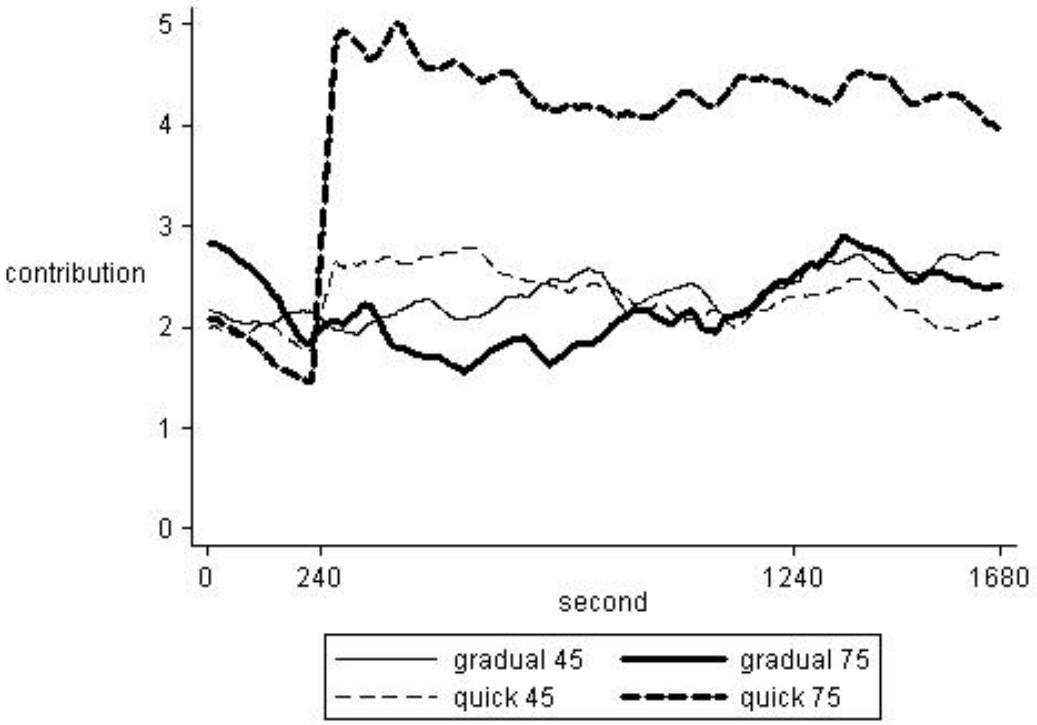
To make the first impression from the figure statistically precise and to control for subjects' background, we ran a regression that employed a "hurdle specification" (Papke and Wooldridge, 1996; McDowell, 2003). In our data, a fraction of the subjects responds positively to the subsidy. Given that subjects react to the subsidy, they do so at different absolute levels. A natural interpretation of such data is that the subjects first decide whether or not to respond to the subsidy. Only in case that they do respond to the subsidy, they decide on how much to increase their contribution. So the second decision is only made if the hurdle of the first decision is passed. Hurdle models are common in medical applications, where the factors that affect a patient's decision to see a doctor may be different from the factors that affect the doctor's and patient's decision on how much to spend on medical care. As far as we know, Botelho, Harrison, Pinto, and Rutström (2009) were the first ones to apply hurdle models to public good games.[8]

In all our treatments, subjects experienced the absence of the subsidy until the 240^{th} second and the maximal subsidy after the 1240^{th} second. Thus, all treatments are comparable before the 240^{th} second and after the 1240^{th} second. For each subject, we constructed 8 "periods" of 50 seconds after the 1240^{th} second. For each of these 8 periods we computed the average contribution level, and from these levels we subtracted the subject's average contribution level in

[7] After running the treatments with a maximum subsidy of 0.45, we discovered that the modest response of our subjects to the subsidy is actually in line with the responses of subjects in Goeree, Holt, and Laury (2002) who also report substantial contributions for higher $MPCR$ levels only.

[8] In the paper of Botelho, Harrison, Pinto, and Rutström (2009), the factors that affect a subject's decision to contribute or not are viewed as separate one the ones that affect a subject's decision how much to contribute.

Figure 2.3.: Average Contributions over Time in Main Treatments



Notes: for each second, the average of contributions in the interval [second – 25, second + 25] is displayed.

the 50 seconds just prior to the 240^{th} second. This way we use normalized contributions that are corrected for individual differences in initial contributions. Because our data form a panel we use a clustering specification that takes into account the dependence of the data within subjects and the independence of the data across subjects. We estimate the fraction that positively responds to the subsidy separately from the increase in the contribution conditional on a positive response on the subsidy. McDowell (2003) shows that this approach provides the same consistent and efficient estimates as the procedure where the overall hurdle model is estimated in one time.

As explanatory variables we include dummies for the treatments that reveal the treatment effects relative to the omitted treatment gradual-45 as well as dummies for some background variables and dummies for the periods. Table 2.3 on the next page reports the results. The first column presents the estimates of the marginal effects of the explanatory variables on the probability that the subjects respond positively to the subsidy as calculated in a probit-regression. The second column reports the estimates of the marginal effects of the variables on the increase in contribution conditional on a positive response to the subsidy as calculated in an OLS-regression. The third column displays the estimates of the total marginal effects of the variables on the (un-

Table 2.3.: Estimates of the Main Treatment (hurdle model)

Y = change in contribution	$\Pr\{Y>0\}$		$Y\mid(Y>0)$		Y	
X	marginal effect (s.e.)	p	marginal effect (s.e.)	p	marginal effect (s.e.)	p
quick-45	0.03 (0.09)	0.73	0.23 (0.53)	0.67	0.03 (0.49)	0.95
gradual-75	0.01 (0.10)	0.94	2.33 (0.76)	0.00	0.40 (0.65)	0.54
quick-75	0.28 (0.10)	0.01	2.67 (0.60)	0.00	2.43 (0.66)	0.00
Female	0.05 (0.07)	0.48	-1.65 (0.55)	0.00	-0.29 (0.44)	0.51
Cooperator	0.21 (0.08)	0.01	1.14 (0.50)	0.02	1.28 (0.54)	0.02
Economics	-0.07 (0.07)	0.31	0.23 (0.45)	0.61	-0.02 (0.47)	0.97
period-2	-0.02 (0.02)	0.36	0.32 (0.22)	0.15	0.05 (0.09)	0.62
period-3	0.01 (0.02)	0.57	0.32 (0.24)	0.18	0.18 (0.12)	0.11
period-4	-0.01 (0.02)	0.59	0.47 (0.24)	0.05	0.11 (0.13)	0.36
period-5	-0.02 (0.03)	0.34	0.24 (0.27)	0.36	-0.03 (0.14)	0.81
period-6	-0.05 (0.03)	0.09	0.41 (0.29)	0.17	-0.10 (0.15)	0.48
period-7	-0.04 (0.03)	0.21	0.39 (0.26)	0.14	-0.07 (0.14)	0.62
period-8	-0.04 (0.03)	0.15	0.34 (0.28)	0.24	-0.11 (0.15)	0.44
Wald-tests						
quick-45	0.03 (0.09)	0.73	0.23 (0.53)	0.67	0.03 (0.49)	0.95
quick-75−grad-75	0.27 (0.11)	0.02	0.34 (0.83)	0.68	2.03 (0.83)	0.01
R^2	0.07		0.26		0.11	
N	1392		524		1392	

Notes: period-2-8 indicates second - eight period blocks of 50 seconds after the 1240^{th} second; for each subject, the average contribution in the 50 seconds before the subsidy starts changing is subtracted from each average contribution level in periods-2-8; regression based on gradual-45, gradual-75, quick-45 and quick-75; Column $\Pr\{Y>0\}$ shows the fraction of observations passing the hurdle $Y>0$; $Y\mid(Y>0)$ displays the marginal effects given that the hurdle is passed; Column Y reports the total marginal effect; the omitted treatment is gradual-45; Female = 1 if subject is female, female = 0 if subject is male; 61% of the subjects were male; Cooperator = 1 if subject is altruistic or cooperative, coop = 0 if subject is individualistic or competitive; Economics = 1 if subject studies economics, econ = 0 if subject studies something else or does not study; the R^2 for the column $\Pr\{Y>0\}$ is a Pseudo R^2.

conditional) increase in contributions in an OLS-regression. For the behavioral reasons discussed above, we think that the results in the third column are based on an "incorrect" specification. We include them because they provide a summary of the overall marginal effect of the variables on the increase in contribution.

The treatment effects are listed in the bottom rows of the table (below "Wald tests"). The results are in line with the pattern emerging from the figures. The effect of the subsidy is in the expected direction for quick-45 and gradual-45, but rather small and far from significant. There, a quick increase in the subsidy neither affects the probability of reacting to the subsidy nor the level of the increase given that subjects reacted to the subsidy. The result is very different for the comparison of quick-75 and gradual-75. With a maximum subsidy of 0.75, the contributions are more than doubled when the subsidy is introduced instantaneously while there is only a modest effect when it changes gradually. The difference between the treatments is substantial and significant. We find that the fraction of subjects who respond positively to the increase in the subsidy is significantly larger in quick-75 than in gradual-75. The difference is 27 percentage

points. Interestingly, given that subjects do respond positively on an increase in the subsidy, there is no difference in how much they increase their contribution. Thus, the treatment effect is completely due to the enhanced probability of responding to the subsidy in quick-75.

The estimation results control for period and background effects. Females are as likely as men to react to the subsidy, but their conditional increase in contribution is smaller. Subjects who are identified as cooperator by the independent measurement of their value orientation are more likely to respond to the subsidy than those identified as individualists, and given that they do respond, they increase their contribution to a larger extent. The reported results are robust to excluding subjects' value orientation. When we run the regression without the dummy for cooperator, we get approximately the same results.

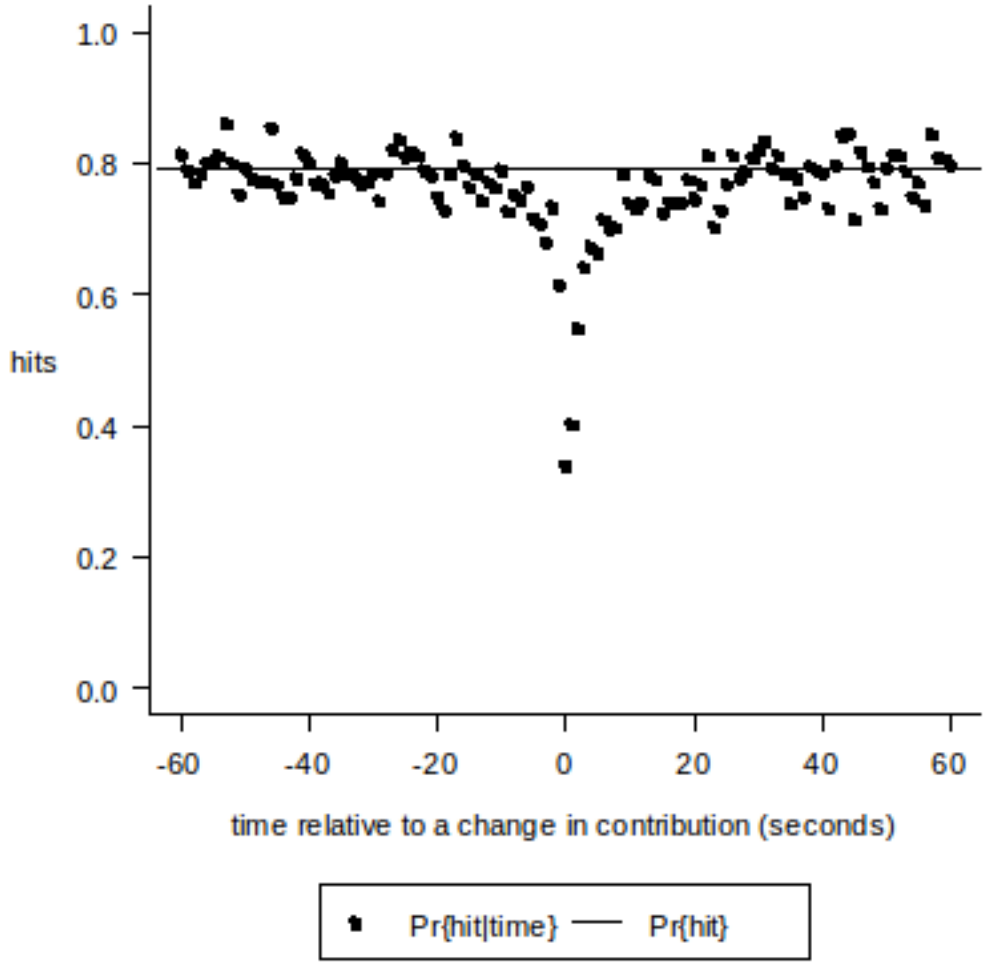
Economics students react slightly less to the subsidy but given that they do, they increase their contributions by a slightly larger amount. In total, the effect is small and not significant. The estimates of the coefficients for the period dummies are small and insignificant, in accordance with the fact that contribution levels were roughly stable after the 1240^{th} second.

One possibility is that the difference in behavior between quick-75 and gradual-75 is completely determined by the switching costs between the two tasks. Switching costs between the two tasks may limit the number of times that subjects change the contribution level in the public good game. As a result, subjects may be further away from their subjectively optimal contribution level in gradual-75 where many changes are needed to accommodate the slowly changing subsidy. Figure 2.4 on the following page displays the decrease in hits around the time that a subject changed the contribution. In a time window of 20 seconds, subjects lose on average 36 points or 2 eurocents. Thus, the material switching costs seem to be rather limited. Still, subjects may behave differently when they are not distracted by the dual task. This is the topic of the next section.

2.3.2. Control Treatment

In this section, we deal with the sensitivity of the results with respect to the dual task procedure. This procedure may prevent subjects in gradual-75 to choose the subjectively optimal contribution level that they would have chosen when only faced with the public good task. To investigate this possibility, we ran treatment gradual-75-single, where subjects could concentrate on the public good task while they automatically received the same earnings for the individual task as one of the subjects in the dual-task treatments. Figure 2.5 on page 21 shows the average contribution levels over time in gradual-75-single together with the contributions in gradual-75. In gradual-75-single average contributions are slightly higher than in gradual-75 throughout the experiment. This is not surprising given that initial contributions are accidentally slightly higher (in the first 50 seconds, the difference in contribution levels is not significant, Mann-Whitney test, $p = 0.28$). More importantly, the pattern in how people change their contributions when the subsidy is introduced is remarkably similar. In both treatments, the subsidy has only a modest effect on the long run contribution levels.

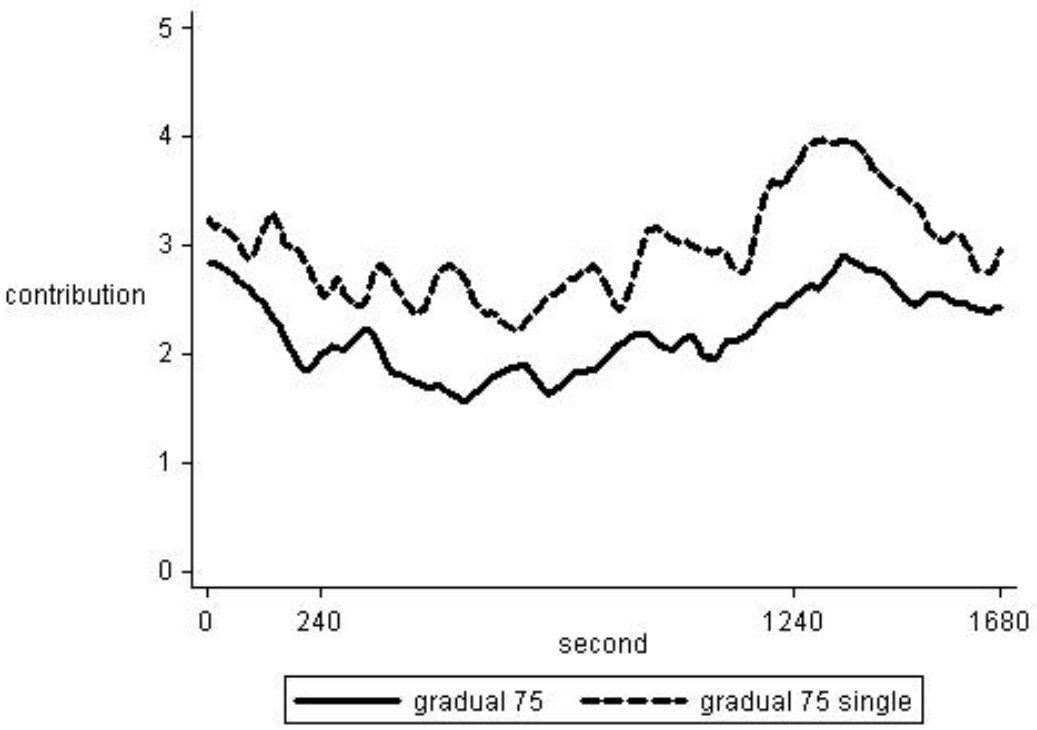
Figure 2.4.: Interaction Individual and Group Task



Notes: this graph indicates the average number of hits in the individual task for each second in the period of 60 seconds before and 60 seconds after a second in which the slider indicating the contribution in the groups task moved; movements of the slider in successive seconds are taken as one; the graph is based on gradual-75 and quick-75.

We assessed the statistical importance of the dual task procedure in a hurdle regression similar to the one reported in Table 2.3 on page 18. In Table 2.4 on page 22, the dummy for treatment gradual-75 measures the treatment effect of the dual task compared to the omitted treatment gradual-75-single. There is neither a significant difference in the probability that subjects respond to the subsidy nor a significant difference in the extent to which subjects increase their

Figure 2.5.: Controlling for the Dual Task Procedure in Gradual



Notes: for each second, the average of contributions in the interval [second – 25, second + 25] is displayed.

contribution given that they do.[9] Again, the regression results appear to be robust to excluding the dummy variable that independently measures whether a subject is cooperative.

The average contribution levels in Figure 2.5 mask some interesting patterns at the micro-level. Table 2.5 on the next page shows some statistics on the fractions of people that change their contribution at least once during the experiment and on how often these people change their decisions. In the single task experiment, the fraction of people changing their decisions exceeds the one in the dual-task experiment. The most remarkable difference is in how often subjects change their decisions (given that they do this at least once).

In the world outside the laboratory people are involved in multiple tasks all the time. The results of our experiment suggest that people change their decisions much more often when they face a single task. The reassuring news for previous experiments on public good games is that

[9] In addition to the control treatment reported in this chapter, we ran a control to investigate whether the results in quick-45 are affected by the timing of the subsidy. We included treatment quick-45-end that was the same as quick-45, except that the change in subsidy occurred after 20 minutes and 40 seconds instead of after 4 minutes. We did not find any difference in how subjects responded to the subsidy in quick-45 and quick-45-end. We also ran controls for the dual task procedure in quick-45 and gradual-45, and also here we did not identify an effect of the dual task on subjects' responses to the subsidy.

Table 2.4.: Estimates of the Dual Task Effect - Control Treatment - (hurdle model)

Y = change in contribution	$\Pr\{Y>0\}$		$Y\|(Y>0)$		Y	
X	marginal effect (s.e.)	p	marginal effect (s.e.)	p	marginal effect (s.e.)	p
gradual-75_{dual}	-0.01 (0.10)	0.93	0.04 (1.12)	0.97	0.24 (0.82)	0.77
Female	0.17 (0.10)	0.09	-1.26 (1.02)	0.22	0.62 (0.83)	0.46
Cooperator	0.34 (0.11)	0.00	0.00 (1.08)	1.00	1.59 (0.93)	0.09
Economics	0.13 (0.10)	0.20	1.58 (0.79)	0.05	0.62 (0.84)	0.46
period-2	-0.01 (0.03)	0.56	0.44 (0.38)	0.25	0.10 (0.16)	0.56
period-3	-0.03 (0.04)	0.40	0.74 (0.62)	0.23	0.16 (0.29)	0.59
period-4	-0.06 (0.04)	0.18	0.61 (0.66)	0.35	-0.01 (0.34)	0.97
period-5	-0.06 (0.05)	0.22	0.39 (0.67)	0.56	-0.20 (0.33)	0.54
period-6	-0.09 (0.05)	0.06	0.42 (0.74)	0.58	-0.35 (0.35)	0.31
period-7	-0.12 (0.05)	0.02	0.60 (0.69)	0.39	-0.45 (0.34)	0.18
period-8	-0.10 (0.05)	0.05	0.15 (0.63)	0.81	-0.55 (0.33)	0.33
R^2	0.12		0.14		0.05	
N	576		200		576	

Notes: period-2-8 indicates second – eight period blocks of 50 seconds after the 1240^{th} second; for each subject, the average contribution in the 50 seconds before the subsidy starts changing is subtracted from each average contribution level in periods-2-8; regression based on gradual-75_{single} and gradual-75_{dual}; Column $Pr\{Y>0\}$ shows the fraction of observations passing the hurdle $Y>0$; $Y|(Y>0)$ displays the marginal effects given that the hurdle is passed; Column Y reports the total marginal effect; the omitted treatment is gradual-75_{single}; Female = 1 if subject is female, female = 0 if subject is male; Cooperator = 1 if subject is altruistic or cooperative, coop = 0 if subject is individualistic or competitive; Economics = 1 if subject studies economics, econ = 0 if subject studies something else or does not study; the R^2 for the column $Pr\{Y>0\}$ is a Pseudo R^2.

average contribution levels do not seem to be affected by artificially limiting people to a single task.

2.3.3. Toward an Explanation of the Boiling Frog Effect

In the introduction we offered two possible explanations of a boiling frog effect in public good games. One possibility is that some subjects are conditional cooperators who want to match the expected contribution provided by the others. If conditional cooperators expect that others will not respond to a gradual increase but will react to an instantaneous increase in the subsidy, they will match their expectations and a boiling frog effect is born. The other possibility is that

Table 2.5.: Dual Task Procedures and Frequency of Changes

	Single	Dual	Single vs Dual
N	36	36	
fraction subjects changing	0.89	0.61	χ^2: p =0.01
numbers of changes per subject	72	11	MW: $p=0.00$

Notes: a "subject" is recorded to be changing when there is at least one second, not being the first second, in which the contribution is different from that in a previous second; number of changes per subject is calculated on the basis of the persons who change; table based on gradual-75_{single} and gradual-75_{dual}; χ^2 provides the result of a Chi-Square Test for $r \times c$ Tables and MW presents the result of a Mann-Whitney rank test.

subjects start with a subjectively optimal initial contribution level when the subsidy is 0. When the subsidy is introduced, they only change their previously optimal decision if the change in subsidy in two subsequent seconds is sufficiently large. Such a myopic decision-making process may be the driving force behind a boiling frog phenomenon in public good games. Notice that the two explanations differ in the role assigned to subjects' beliefs.

In the treatments where the subsidy was raised to a level of 0.45, we asked subjects to report their beliefs about how much other subjects contributed at particular moments in the experiment (before we communicated the results of the actual contribution levels). Like Croson (2007) and Dufwenberg, Gächter, and Hennig-Schmidt (2008), we find a positive relationship between beliefs about other's contributions and own contributions. The Spearman-rank correlation between subject's beliefs and the own behavior is substantial (0.31 at the start, 0.45 at the end in quick and 0.44 at the end in gradual) and significant ($p = 0.00$ in all three cases).[10] This evidence is consistent with the explanation based on conditional cooperators. The evidence is far from conclusive, though, because the direction of the causality between beliefs and behavior remains unclear. We cannot exclude that subjects behave as they do because they myopically fail to respond to small changes in the environment, and, when asked about their beliefs of others' contributions, simply project their own behavior on others.[11]

To shed light upon the causality between beliefs and contributions, we ran treatment pred-75 where subjects played the role of predictor only. In pred-75, subjects were provided with the instructions received by subjects in quick-75 and gradual-75. In addition, these subjects were informed about the development of the subsidy in quick-75 and gradual-75. As shown in Figure 2.2 on page 15, they were then asked to predict the average contribution level in quick-75 and gradual-75 for three occasions: (i) at the 240^{th} second, just before the subsidy started rising in either treatment; (ii) at the 1240^{th} second in gradual-75, just after the subsidy stopped rising in gradual-75 (iii) at the 1240^{th} second in quick-75. Notice that the predictors' beliefs are not biased by their choices, because predictors never decided how much to contribute.[12]

Table 2.6 on the next page presents the beliefs of the predictors together with the choices of the subjects in quick-75 and gradual-75. The upper-panel of the table shows that the predictors expect a substantial and significant effect of the subsidy in gradual-75 as well as in quick-75. This is only partly in agreement with the data, because the subsidy had a substantial and significant effect on contribution level in quick-75, but not in gradual-75. The lower-panel of the table presents statistics about how much the beliefs and the contribution levels changed as a result of the subsidy. Predictors expect a slightly larger effect of the subsidy in quick-75 than in gradual-

[10] In this analysis, we excluded subjects when in the correction procedure the correlation between the subjects' reported beliefs for the objective probabilities and the objective probabilities was lower than 0.35, when they had reported a probability of 50% for each of the 15 beliefs question or when they reported 50% for at least 9 of the 10 lottery questions.

[11] A comparison of subjects' beliefs and actual behavior of the other subjects reveals that subjects were on average too optimistic about the contributions of the others. The same bias in beliefs is reported in Offerman, Sonnemans, and Schram (1996) and Palfrey and Rosenthal (1991).

[12] The procedure to investigate the causal direction between beliefs and contributions was developed by Dawes, McTavish, and Shaklee (1977).

75. The difference is weakly significant at $p = 0.07$. So predictors expect a weak boiling frog effect but the actual data reveal a strong effect. Predictors are better able to predict the effect of the subsidy in quick-75 than in gradual-75. In quick-75, predictors anticipate on average a smaller effect of the subsidy than actually exists, but the difference is far from significant. In gradual-75, predictors overestimate the effect of the subsidy substantially and significantly.

Table 2.6.: Beliefs and Contributions in Treatments with Maximum Subsidy 0.75

	start(I)	quick (II)	gradual (III)	I vs II	I vs III	N
beliefs predictors	3.76 (1.56)	5.85 (1.40)	3.53 (1.53)	WC: p =0.00	WC: p =0.00	42
contributions gradual-75	1.85 (2.86)	–	2.58 (3.75)	–	WC: p =0.18	36
beliefs predictors	1.46 (2.01)	4.32 (3.98)	–	WC: p =0.00	WC: p =0.00	36
	Increase quick (ΔQ)		Increase gradual (ΔG)		ΔQ vs ΔG	
beliefs predictors (B)	2.09 (1.87)		1.77 (1.93)		MW: p =0.07	
contributions players (C)	2.86 (3.56)		0.74 (3.25)		MW: p =0.03	
B vs C	MW: $p = 0.66$		MW: $p = 0.01$			

Notes: table is based on subjects in treatments quick-75, gradual-75 and pred-75; standard errors in parentheses; 7 from 49 subjects in pred-75 were excluded because of the criterion mentioned in footnote 10 on the preceding page; Columns I, II and III report the expectation of the reported probability distributions (for details, see the end of Section 2.2); WC provides the result of a Wilcoxon rank test and MW presents the result of a Mann-Whitney rank test.

The evidence makes it less likely that the explanation based on conditional cooperators drives the boiling frog result. Subjects whose beliefs are not biased by their choices expect a substantial effect of the subsidy in gradual-75. If the explanation of conditional cooperators would drive the boiling frog phenomenon, we should have observed a substantial effect of the subsidy on contributions in gradual-75, which we did not. The results do not discredit the explanation based on anchoring. When subjects are actually absorbed in the game, they fail to respond to minor changes in the environment. Predictors who look at this process from a distance fail to appreciate this effect, and instead tend to think that people will respond in the same rational way as when the subsidy is introduced instantaneously.[13]

[13]This result is in line with some recent findings on the distinction between decision utility and experienced utility and findings on focusing illusion that are summarized by Kahneman and Thaler (2006). When making a decision, people often fail to accurately predict the utility that they will experience, or they mispredict how they will respond to changes in the environment. For instance, respondents think that people living in California are happier than people living in areas with a lesser climate such as the East or the Midwest, while this is actually not true (Schkade and Kahneman, 1998). Current assistant professors tend to overpredict the life satisfaction of obtaining a tenured position compared to being denied one (Gilbert, Pinel, Wilson, Blumberg, and Wheatley, 1998).

2.4. Conclusion

In this chapter, we investigated how humans react to an instantaneous versus a very gradual introduction of a subsidy to contribute to a public good. When the subsidy was raised to an intermediate level, we did not find support for the boiling frog story. This is not surprising, however, because even when the subsidy was introduced instantaneously, the effect of the subsidy on the contribution level was modest at best. When the subsidy was raised to a substantial level, a clear boiling frog effect emerged. Subjects hardly responded to the subsidy when it was introduced gradually while they reacted strongly when it was introduced in one shot. In particular, by introducing the subsidy in one time the fraction of subjects responding to the subsidy increased by 27%. Given that subjects did respond to the subsidy, there was no difference in the extent to which they increased their contribution between the two ways of introducing the subsidy.

Subjects who did not play the public good game but who were asked to report their beliefs about what contributors would do, predicted the effect of the subsidy more or less correctly when it was introduced at once. In contrast to what would be expected if the phenomenon were mediated by the beliefs of conditional cooperators, predictors failed to predict that the subsidy would not have an effect on the contributions when the subsidy was introduced gradually. The evidence does not discredit the explanation that the boiling frog phenomenon is caused by anchoring. In accordance with Al Gore's and Paul Krugman's conjecture, people simply fail to respond to tiny changes in the environment.