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SOCIAL TIES IN A PUBLIC GOOD EXPERIMENT

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Abstract

The formation of social ties is examined in an experimental study of voluntary public good provision. The experimental design consists of three parts. In the first part the value orientation (attitude to a generalized other) is measured. In the second part couples play a multi-period public good game. In the third part the attitudes of subjects to their partners in the public good game is measured. The concept of social tie is operationalized as the difference between the measurements in the first and third parts. Evidence for the occurrence of social ties is found. These ties depend on the success of the interaction in the public good game.

Keywords: Public good, social ties, experiment

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Colleagues in office, partners in trade, call one another brothers; and frequently feel towards one another as if they really were so. Their good agreement is an advantage to all.
Adam Smith, The Theory of Moral Sentiments, Part VI, section II

1. Introduction

There is a growing attention among economists for social influences on individual behavior. The number of studies focusing on social factors such as loyalty, approval, imitation, status, interdependent preferences, and inequality aversion, is rapidly increasing (see, e.g., Akerlof 1983, Holländer 1990, Bikhchandani, Hirschleifer and Welch 1998, Bernheim 1994, Becker, 1996, Fehr and Schmidt 1998). A related strand of the literature focuses on the embeddedness of economic behavior in networks of affective interpersonal relationships. Contemporary sociologists have forcefully argued that this has a profound effect on the economic interaction in markets and organizations (see Coleman 1984, Granovetter 1985, Uzzi 1996). For instance, Coleman (1984, p86) argues that markets are socially structured. He notes that "... we all know that persons are resources to one another, and a given person values certain persons more than others". A variety of effects follow with as general theme that actors are willing to forsake narrowly defined self-interest to support specific others. In economics, the importance of social ties for economic behavior was already noticed by Adam Smith, as the above quote illustrates. In a similar vein Alfred Marshall (1961 [1890]) related labor market rigidity to the reluctance of workers to migrate due to old associations. More recently, economists have particularly paid attention to the impact of affective relations within the family (e.g., Barro 1974, Becker 1981). Interpersonal relations outside families have occasionally received attention, for instance, in the context of job search (Boorman, 1975), price formation (Okun, 1981) and the functioning of organizations (Rotemberg, 1994). Implicitly, such relations play a role in a wider range of topics, including efficiency-wage theory (Akerlof, 1982), private provision of insurance (Arnott and Stiglitz, 1991) and fairness (Rabin, 1993)[1]. Another type of economic interaction that would be expected to lead to and be affected by such relations is the private provision of small-scale public goods.

In this journal Van Dijk and Van Winden (1997) presented a model of the dynamics of social ties and local public good provision. In this model a social tie between two individuals is defined in terms of the extent to which they care about each other's well-being. This lends itself for an operationalization in terms of utility interdependence (see also Coleman, 1984). The multi-period model rests on the hypothesis that ties depend on the success of social interaction, in this case the joint provision of a public good. Positive as well as negative sentiments may develop depending on the contributions of both individuals to the public good. In equilibrium high provision levels and positive ties go together, as well as low provision levels and (asymmetric) negative ties. The results are in stark contrast with the standard model of private provision (e.g., Bergstrom et al., 1986).

As to the empirical validation of these ideas, it is difficult to test the dynamics of social ties and economic interaction by observing behavior in actual life[2]. It is, therefore, of interest to examine the occurrence and effects of social ties in an experimental context. To stay close to the Van Dijk and Van Winden model, we do this in a public good experiment. We focus on the underlying mechanism, and pose the question whether economically relevant (rudimentary) social ties develop during a repeated public good game, and whether these ties depend on the success of the interaction, measured in monetary terms.

To measure social ties, it is important to note that a social tie is not simply given by the weight an individual attaches to the well-being of another individual[3]. This would only be the case if individuals are neutral towards individuals they do not know. However, if actors harbor (positive or negative) sentiments towards strangers, a social tie with a specific individual can only be said to exist if the weight attached to the other's well-being differs from that attached to a stranger's well-being. In public good experiments there seems to be a growing consensus that different types of individuals exist (see the survey by Ledyard, 1995). There are subjects who (almost) never contribute to the public good in such an experiment, when it is a dominant strategy not to do so, whereas others (almost) always contribute. This may well be related to differences in attitudes towards strangers. Thus, to establish the existence of a social tie, two attitudes need to be measured: the attitude of an individual with respect to the interests of an unknown, generalized other, and the attitude towards the interests of a specific individual.

We use a so-called "social value orientation" test (Liebrand, 1984). In this test preferences of individuals for distributions of outcomes for themselves and others are derived using a decomposed game technique. The test measures the degree of utility interdependence. It has been extensively used to measure attitudes towards a generalized other. According to the test most subjects can be classified as follows, using the terminology of the test: "individualists", who try to maximize their own payoff; "cooperators", trying to maximize the joint payoff to themselves and others; and "competitors", who try to maximize the difference between their own payoff and that of others. Many studies have shown the predictive validity of the test, inside as well as outside the laboratory. For an application in a economic experiment see Offerman et al. (1996), who, for instance, find that cooperators are inclined to contribute more to a public good than individualists. We apply this social value orientation test or Ring-test, as it is also called, twice, before and after a public good experiment. In the first Ring-test subjects play against an anonymous other subject,

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[1] According to Rabin, fairness is the result of affective responses. In his static analysis, these responses are caused by beliefs about the behavior of the other. We will focus on sentiments in repeated interaction.

[2] Observational and control problems are particularly acute, due to the nature, time frame and continuity of social ties.

[3] In the aforementioned sociological literature a social tie is generally seen as a mutual, two-sided relationship. The tie between two individuals *i* and *j* would then consist of *i*'s sentiments about *j* and *j*'s sentiments about *i*. However, for ease of exposition, we will speak of *i*'s social tie with *j* without immediate reference to *j*'s sentiments about *i*, and vice versa. It is noted that sentiments are often not symmetric (see Wellman, 1988).

whereas in the second test they play against the person they interacted with in the public good experiment. The difference between the two tests is a measure of the social tie that has developed. It is important to emphasize here that ties are measured in an economic context by having subjects allocate scarce resources, and not by letting subjects just fill-out questionnaires about their sentiments. The public good experiment is a repeated two-person game with an interior Nash equilibrium, like in Andreoni (1993), but with the Pareto optimum at a corner.

The first Ring-test is also used to replicate the earlier findings that subjects differ and that these differences affect their contributions to the public good. In contrast with existing studies we will not group individuals into types, but do this analysis at the individual level. To investigate the stability of the test and the crucial nature of interaction for the development of social ties, a control group of subjects is used that are faced with an individual decision-making experiment, instead of the public good experiment, in between the two tests. Furthermore, we investigate whether evidence can be obtained for the presumed underlying mechanism of social ties, which concerns the success of the interaction for the subjects involved. Several conditions are used to check the robustness of the results. As a further check, we conducted an additional experiment which had the same set-up as the baseline experiment with the exception that the public good game lasted 32 periods and was interrupted after 25 periods to conduct the second Ring-test. After the test, the public good game was resumed. The interruption was not announced in advance. The purpose of this experiment was to study social-tie formation during interaction and, in particular, to test whether the turbulent end-effect typical for public good experiments was responsible for affective responses.

The main result of the baseline and additional experiment is that evidence for the occurrence of social ties is found and that these ties do depend on the success of the interaction in the public good game. Further, ties do not occur due to the end effect of the public good game, but arise during interaction. Especially when one takes the relative short duration of the experiment and the minimal interaction into account, this supports the general idea that social ties develop due to economic interaction and affect its outcome. If these results are robust, they are important for economic theory, in particular, because evidence is provided of the dynamic and social nature of preferences.

The organization of the paper is as follows. Section 2 goes into the design and the procedures of the Ring-tests and the individual decision-making and public good experiments. Section 3 presents the results of the baseline experiment, while section 4 discusses the design and results of the additional experiment. Section 5 concludes.

2. Design Baseline Experiment

In 10 sessions a total number of 140 subjects participated, of which about 2/3 were students of economics. On average 51.2 Dutch guilders (approximately US$ 34) were earned by the subjects in about two hours.

The experiment was completely computerized, and took place in the CREED-laboratory of the University of Amsterdam. The experiment comprised 3 conditions, and each session consisted of

three parts (see table 1). In the first and third part of each session the Ring-test was administered, while the second part was either a two-person public good experiment (experimental conditions) or an individual decision-making experiment (control condition). We will now discuss these parts in more detail.

Table 1. The design of the baseline experiment.

	Unequal endowment condition	**Equal endowment condition**	**Control condition**
Part 1	Ring-test in which a subject is coupled with an unknown other (randomly determined)		
Part 2	Public good experiment in which one subject has to divide 8 markers and the other 12 markers between a private and a public account. 25 periods are announced and played.	Public good experiment in which both subjects have to divide 10 markers between a private and a public account. 25 periods are announced and played.	Individual decision-making experiment
Part 3	Ring-test in which a subject is coupled with the same subject as in part 2		Ring-test in which a subject is coupled with an unknown other (randomly determined)
Partici-pants:	58 subjects in 4 sessions	52 subjects in 4 sessions	30 subjects in 2 sessions

Parts 1 and 3: Ring-test

In the first and third part of the experiment each subject was coupled with one other subject, and had to make 32 choices between two 'own-other' payoff combinations. Each own-other payoff combination allocates an amount of money to the decision maker and to the subject with which the individual is linked. During the experiment, subjects did not receive any feedback about the other's choices. The 32 pairs of allocations lie on a circle with the origin as centre and a radius of 500 cents (which explains the name of the test). The horizontal axis measures the amount of money allocated to oneself (x) and the vertical axis the amount of money allocated to the other (y). For all outcomes $x^2+y^2=500^2$. As a result, the total amount to be allocated (x+y) is not constant over combinations. For example, subjects have to choose between the combination 397 cents for self and 304 cents for the other (total of 701 cents) and the combination 433 cents for self and 250 cents for the other (total of 683 cents). In Appendix 1 the 32 questions are listed. Each allocation can be considered as a vector. If for each subject the 32 preferred allocations are added, the angle of the resulting vector with the horizontal axis is a measure of the extent the individual cares about other. The length of this vector is a measure of the consistency of the 32 choices (the maximum length is 1000). For example, the

vector of a 100% consistent individualist will be (1000, 0), which means 1000 cents for herself and nothing for the other, corresponding with an angle of 0º.

The test we used is an adaptation of the one developed by Liebrand (1984). Originally the goal of this test is to measure "social value orientation", which is seen as a stable psychological trait. Psychologists have used this test intensively and recently experimental economists have begun using this test as well (Offerman et al., 1996, Sonnemans et al., 1998). On the basis of this test subjects are classified as individualistic (only concerned about their own payoff), cooperative (concerned about the sum of own and other's payoff), altruistic (only concerned about the other's payoff), competitive (concerned about the difference between own and other's payoff) or aggressive (only concerned in minimizing the earnings of the other). For an elaborate discussion of this test we refer to Liebrand (1984) and Offerman et al. (1996). To make a more precise measurement possible, a test with 32 (instead of 24) questions was used. In this adapted Ring-test the outcomes are not equally spaced on the circle (as in the original test) but distributed in such a way that the most common value orientations (individualistic, cooperative and competitive) are measured more precisely than the rare other orientations[4].

In the first part of the experimental conditions and in the third part of the control condition, subjects did not know with whom they were paired. They were only informed that the pairing would stay the same throughout the 32 decisions. In the third part of the experimental conditions subjects again did not know the identity of their partner, but they knew that they were coupled to the same subject as in part 2 of the experiment (the public good experiment). In these conditions subjects could still browse through their decisions and results concerning the public good experiment. To make it less clear to the subjects that the 32 questions were the same as in part 1, the order of the questions was changed in part 3.

As noted, in this experiment the Ring-test is used in a different way than in other studies. In the first part of the experiment it measures the attitude of the subject towards an unknown other (social value orientation), like in the original Ring-test. In the third part of the experimental conditions, the test measures the attitude of the subject to her/his partner in the public good experiment (social tie). In this way we can learn whether the public good experiment changed the attitudes of the subjects. If they like (dislike) their partner more than they like or dislike others in general, they would sacrifice more money to help (hurt) the other subject.

Part 2: Public good experiment

In the second part of the two experimental conditions 25 periods of a public good game were played. Subjects were randomly coupled and these two-person groups stayed constant for all 25 periods. In each period a subject had to distribute 10 markers (in the equal endowment condition) or 8 or 12 markers (in the unequal endowment condition) over two activities *X* and *Y*. Activity *X* generated

[4] Measurement will be more precise if the distance between the alternative outcomes is smaller. However, this means more questions which may decrease the concentration and motivation of the subjects. Our setup compromises between these two effects.

earnings exclusively for the subject her/himself (private account), whereas activity *Y* generated earnings for both group members (public account). For each subject the endowment was the same in all periods. Every marker in the public account earned 14 cents for both group members, while the value of *i* markers in the private account was: $28*i-i^2$. Fixed costs of 110 cents were substracted each period.

The first period started after everybody had finished the computerized instructions. Each period subjects had to type in how many markers they wanted to spend on activities *X* and *Y*. After each period they received feedback about the total number of markers both spent on activity *Y* and their own earnings. In the lower part of the screen the decisions and results of previous periods were displayed. Subjects could access information about all previous periods by using the page-up and page-down keys.

The Nash equilibria of the one shot games are characterized by dominant strategies. The dominant strategy in the equal endowment condition is to put 3 markers in the public account and 7 markers in the private account. In the unequal endowment condition the dominant strategy for subjects with 12 markers is to put 5 markers in the public account and 7 in the private account, and for subjects with 8 markers to put 1 into the public and 7 in the private account. In both conditions the Pareto optimal solution is that the players put all markers into the public account. In both conditions both players earn 121 cents in the Nash equilibrium and 170 cents in the Pareto optimal solution[5].

Part 2: Individual decision-making (Control Condition)

The second part of the control condition is an individual decision-making experiment (a computerized sequential search experiment) which has the same duration as the public good experiment. The mental resources of subjects that are required are also comparable with those in the public good experiment. The crucial difference with the public good experiment is that it is an individual experiment with no interaction between subjects.

The control condition was included in the design to check the stability of the Ring-test measures. A change in Ring-test measures between the first and the third part of the experimental conditions cannot be attributed unambiguously to the public good experiment without a control condition. Alternative explanations based on the repetition of the test and the duration of the experiment, leading to tiredness or boredom, could then perhaps be formulated. And it would be impossible to differentiate between these explanations.

Procedures

Subjects were recruited by announcements on information boards in university buildings and an advertisement in the university newspaper. After all subjects were seated, computerized instructions for the first part (Ring-test) were started. The instructions contained some questions to check understanding. After the instructions all subjects took the 32 decisions of the test. Subjects did not

receive any feedback about the results of part 1 until the whole experiment was finished. Information about parts 2 and 3 was given after the end of, respectively, part 1 and part 2.

After part 1, the instructions of part 2 were started. A translation of the instructions is provided in Appendix 2. The payoff structure of the public good experiment was explained with a table on the computer screen and on a handout, and subjects had to calculate some outcomes to check understanding. This table was also projected on the wall to assure subjects that everybody had the same table. In addition, a handout with a normal form table of the payoff structure was distributed (see Appendix 3). The number of periods (25) was also public knowledge. In the control condition part 2 was an individual decision-making experiment (a computerized sequential search experiment). Details about this experiment can be found in Sonnemans (forthcoming).

In part 3 subjects had to make again the 32 decisions of the Ring-test, but now in a different order. In the experimental conditions subjects were coupled with the same participants as in the second part of the experiment, and they were informed about this. The results of all periods of part 2 remained accessible to them on the lower part of the screen. In the control group subjects were told that they were randomly coupled, and the lay-out of the screen was exactly the same as in part 1.

After part 3 the subjects filled in a short questionnaire and were subsequently paid, one at a time, in another room.

3. Results

Reliability and validity of the instruments

Before we can investigate the influence of the public good game on the development of social ties, we first need to check the reliability and validity of the Ring-test. Each test provides two numbers: the angle and the consistency of the choices made. In some cases the consistency was very low. A random sequence of choices results in an average consistency of 500. Following Liebrand (1984) measurements with a consistency lower than 600 were not included in the analyses (15 of the first part and 12 of the third part; in total 23 subjects had a consistency lower than 600 in at least one part). As one would expect, consistency is typically higher in the third part than in the first (Wilcoxon test on all 140 subjects, 2-tailed P = .0072, Wilcoxon test on 117 subjects with both consistencies >600, 2-tailed P = . 0108). The control group and the experimental groups do not differ in the Ring-test of the first part. The mean angle of the first ringtest is 3º, and 95% of the angles is located between -45º and 45º (80% between -20º and 20º).

The Ring-test results of the first and third part of the control condition show the reliability of the test. The value orientations (angles of the resulting vectors) in these parts do not significantly differ (Wilcoxon 2-tailed P = .35), and both measurements are highly correlated (the Pearson

[5] This invariance result is not caused by our payoff schedule, but holds generally, see for example Warr (1982).

correlation is .8728, and the Spearman rank correlation is .9188). This confirms that the Ring-test is a reliable instrument, at least in the short term.

The Ring-test of the first part is supposed to measure the social value orientation of the subject. Its outcome should correlate with the behavior of the subject in the public good game. To make the behavior of subjects with different endowments comparable, we look at the number of markers subjects allocated to the public account minus the number they should have allocated according to their dominant strategy (for all subjects the dominant strategy is to allocate 7 markers to the private account; see the previous section). We find statistically significant correlations with the first as well as the first 5 decisions in the public good game (the Spearman rank correlations are, respectively, 0.28 and 0.30, $P<.01$). The correlation with all decisions in the public good game is lower (the Spearman rank correlation is 0.19 which is not statistically significant). This is in accordance with earlier findings (e.g., Offerman et al. 1996) and with the idea that when subjects learn to know each other through interaction, the social value orientation starts to play a less important role, whereas the importance of social ties increases. The correspondence of the first Ring-test and the decisions in the early periods of the public good game confirms the validity of the measurement of the social value orientation.

The social tie that may be created by the public good game is measured by comparing the results of the second Ring-test with those of the first test: an increased (decreased) angle indicates a positive (negative) social tie. To check whether this measurement is related with the concept as used by sociologists, the following question was asked in the questionnaire after the experiment: "If the second part of the experiment were to be repeated, would you like to continue with the participant you were coupled with, or rather with an arbitrary other?". This is a type of question sociologists freqently use in their studies to establish social ties. The 7-point answering scale was dichotomized. Subjects who liked to have a new partner have a more negative social tie than subjects who wanted to stay with their present partner (Mann-Whitney ranktest 2-tailed P =.0564). This implies that our measurement of social ties is indeed related to the sociological concept.

The public good game

Figure 1 shows the contributions to the public account in excess of the dominant strategy, by period and condition. We make the following observations. The first thing which strikes the eye is that subjects contribute substantially more than the Nash-equilibrium, and that the contributions rapidly decline in the final periods. Both phenomena have been observed in many other public good experiments as well (see Ledyard, 1995). Another interesting observation is that subjects with a 12-markers endowment in the Unequal Endowment (UE-12) condition contribute significantly less (in excess of their dominant strategy) than the subjects with an 8-markers endowment in the Unequal Endowment (UE-8) condition do (Wilcoxon ranktest 2-tailed P=.0000)[6] and also less than the

[6] As a consequence, subjects with a 12-marker endowment earned on average more than subjects with an 8-markers endowment. The difference (5.77 Dutch guilders) is statistically significant (Wilcoxon ranktest 2-tailed P =.0001).

subjects in the Equal Endowment (EE) condition do (Mann Whitney rank test 2-tailed P=.0134). There is no statistical significant difference between UE-8 and EE. These results are in line with the tentative conjecture in the experimental literature that heterogeneity lowers the rate of contribution (Ledyard, 1995, p 160**)** and is also in line with the results of the Van Dijk and Van Winden (1997) model.

In the EE condition the Nash equilibrium was played in 11% and the Pareto optimal solution in 16% of the periods. In the UE condition the Nash equilibrium was played in 13% and the Pareto optimal solution in 11% of the periods.

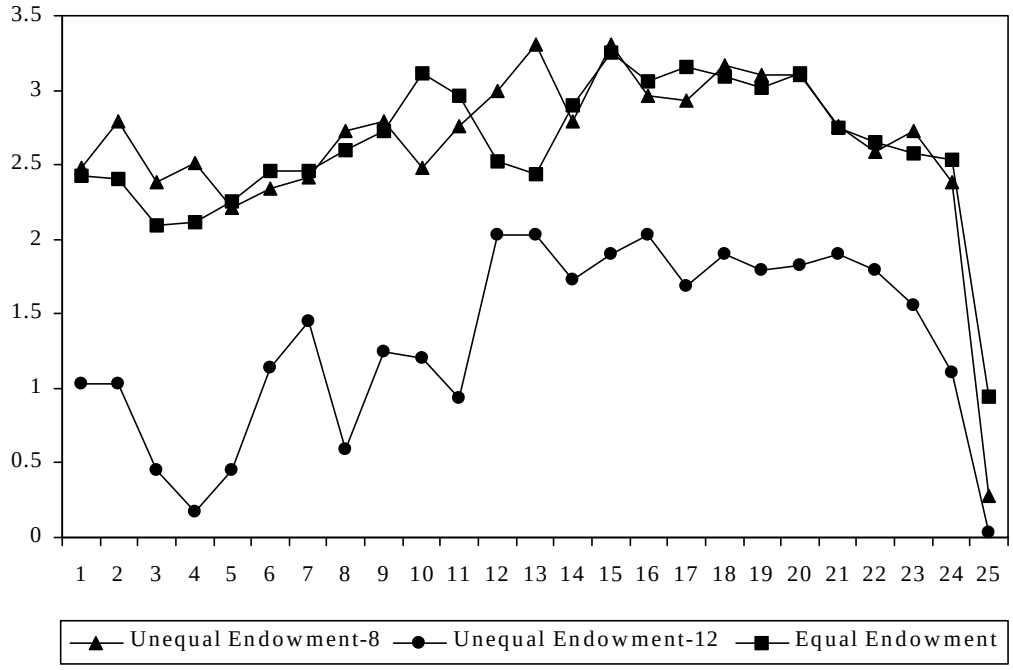

Figure 1. Average contribution level to the public good per period. The number of tokens allocated to the public account according to the dominant strategy is subtracted to make the different conditions comparable.

Social ties

The main question of this study is whether social ties develop as a result of interaction in a repeated public good game. The idea is that the degree of success of the interaction in the public good game may influence the attitude towards the partner in the public good game, compared with the individual's general social value orientation. The degree of success in the public good game can be operationalized by the earnings in the game[7]. Table 2 shows the results of linear regressions where

[7] An alternative would be to use a subject's value orientation to calculate her/his measure of success as a weighted average of own and other's earnings. Note, however, that for prevalent value orientations between -45^0 and $+45^0$ these measures always correlate positively with own earnings. Due to the development of social ties, measures based on the first ringtest are only relevant in early periods of interaction.

the angle measured by the second Ring-test is the dependent variable, and the social value orientation (angle measured by the first Ring-test) and the earnings in the last 5 periods of the public good game are the independent variables. Apparently the score on the second Ring-test correlates highly with the score on the first one. Earnings in the public good game have an additional positive effect on the score of the second Ring-test. This suggests that subjects who have earned well (not well) have a tendency to "like" ("dislike") their partners. So, it seems that social ties are formed through the interaction in the public good game.

A few remarks are in order. First, results are qualitatively the same if we use other measures of success in the public good game such as the other's contributions in the last 5 periods or earnings in all periods, but the fit is much weaker. Second, on average negative social ties were formed, since the average angle slightly decreased (-3.8°). Apparently, many subjects were (slightly) disappointed by the interaction in the public good game. Third, the impact of the public good game depends on the social value orientation. For example, in case of an individualist (angle is zero) a Nash equilibrium in the public good game results in no social tie, and positive contributions (in excess of the dominant strategy) of the other result in a positive social tie. For a cooperator (angle is 45°) the Nash equilibrium results in a negative social tie, and higher contributions are needed to result in a positive tie.

Table 2. Linear regressions with the angle measured by the second Ring-test as dependent variable and, as independent variables, the social value orientation (angle measured by the first Ring-test) and earnings in the last 5 periods of the public good game.

Equal Endowment	*B*	*SE B*	*â*	*t*	*sign. t*
Social value orientation	.832	.110	.752	7.574	.000
Earnings period 21-25	.039	.019	.200	2.013	.051
Constant	-30.128	9.992		2.191	.035
Multiple R: .785					
Adjusted R Square: .597					

Unequal Endowment	*B*	*SE B*	*â*	*T*	*sign. T*
Social value orientation	.511	.091	.603	5.632	.000
Earnings period 21-25	.027	.012	.241	2.247	.029
Constant	-20.519	8.253		5.815	.000
Multiple R: .704					
Adjusted R Square: .474					

Both conditions	*B*	*SE B*	*â*	*T*	*sign. T*
Social value orientation	.696	.072	.692	9.663	.000
Earnings period 21-25	.029	.011	.189	2.632	.010
Constant	-22.439	6.558		4.929	.000
Multiple R: .743					
Adjusted R Square: .542					

Note: Only subjects with consistencies higher than 600 are included.

Adaptive play in the public good game

It is very clear from the data that subjects reacted to the decisions of their partner during the 25 periods. Table 3 shows that an increase (decrease) of the contribution by the partner is typically answered by an increase (decrease) in the own contribution. These reactions can be interpreted as providing evidence for a continuous development of social ties[8], but they may also (partly) represent some form of strategic behavior.

Table 3. Reactions of subjects to an observed change in the contribution to the public good by their partner in the previous period.

Contribution partner in previous period	*Reaction on contribution by partner in previous period*		
	decreases	*same as previous*	*increases*
decreased	42% (241)	33% (188)*	25% (140)
same as previous	20% (261)	65% (845)	15% (193)
increased	15% (99)	36% (239)**	49% (324)

Note: * in 10 cases the contribution to the public account is 0 and stays 0
** in 27 cases the contribution is already maximal and stays so

The influence of the last period on the social tie

Social ties between partners are developed in the 25 periods of the public good game. However, the very last period is typically rather turbulent (the contribution level often drops dramatically). Therefore, the last period may influence the social tie more than any other period. Subjects may feel "cheated" if a partner plays the dominant strategy in the last period, or contributes less than in the 24th period. If we define "cheating" in this way, than in most cases both partners cheated, and on average negative social ties resulted (see table 4). If somebody did not cheat, but the partner did, a more negative social tie developed, whereas the social tie of the cheater did not change. If both partners did not cheat, a positive social tie was created. Interestingly, although the results of the last period seem to have a substantial impact on the social tie, they do not completely overshadow the other periods. In regressions like those in table 2, the last period performs less well (in terms of significance) than the last 5 periods or all periods.

Table 4. Effect of last-period cheating on social ties.

Who cheated?	*Effect*			*Mean change in angle*	*Number of cases*
	Positive	*neutral*	*Negative*		
Both cheated	35%	12%	43%	-4.40	60
Only the other cheated	25%		75%	-8.08	12
Only the subject cheated	40%	27%	33%	-.86	15
Nobody cheated	40%	20%	40%	7.13	5

Note: By definition somebody cheated if in the last period (s)he played the dominant strategy or contributed less to the public good than in the 24th period. Only subjects with consistencies larger than 600 are included.

[8] A higher contribution by the other leads to a more positive sentiment which induces an increase in one's own contribution, and vice versa.

4. Design and results of the additional experiment

In the first experiment social ties were measured after the interaction in the public good game ended. We found that the results of the (turbulent) last period had a large impact on social ties. A second experiment was run to study social ties during ongoing interaction.

Design

The second experiment is the same as the Equal Endowment Condition of the first experiment, with one important difference: 32 periods of the public good game were announced (instead of 25) and after the 25th period the experiment was interrupted for part three, the second Ring test. This interruption was not announced in advance. After part three the public good game was resumed for periods 26-32. Table 5 displays the procedure of the second experiment.

The subjects were 54 students out of the same subject population as experiment 1, who had not participated in the first experiment. They earned on average 57 guilders (approximately US$33) in two hours.

Table 5. The design of experiment 2.

	Equal endowment condition 32 periods
Part 1	Ring-test in which a subject is coupled with an unknown other (randomly determined)
Part 2	Public good experiment in which both subjects have to divide 10 markers between a private and a public account. 32 periods are announced but the game is interrupted after period 25.
Part 3	Ring-test in which a subject is coupled with the same subject as in part 2
Part 2 continued	periods 26-32
Participants:	54 subjects in 4 sessions

Results

As in the first experiment, we excluded measurements of the Ringtest with a consistency lower than 600 (6 of the first part and 1 of the third part; in total 6 subjects had a consistency lower than 600 in at least one part). Again, consistency is typically higher in the third part than in the first (although not statistically significant). We find statistically significant correlations of the value orientation (first ring test) with the first decision, the first 5 decisions, and all decisions in the public good game (the Spearman rank correlations are, respectively, 0.44, 0.42, and 0.40).

Figure 2 shows the average contribution level to the public good per period. The contributions in this experiment are typically higher than in the baseline experiment. Note also that the interruption after period 25 does not seem to influence the behavior in the periods directly thereafter. The Nash equilibrium was played in 9% and the Pareto optimal solution in 44% of the periods.

Table 6 displays the result of a linear regression where the angle measured by the second Ring-test is the dependent variable, and the social value orientation (angle measured by the first Ring-test) and the earnings in the last 5 periods of the public good game are the independent variables. The results are very much like the results of the first experiment (table 2). Also in this experiment social ties are formed during the first 25 periods of the public good game.

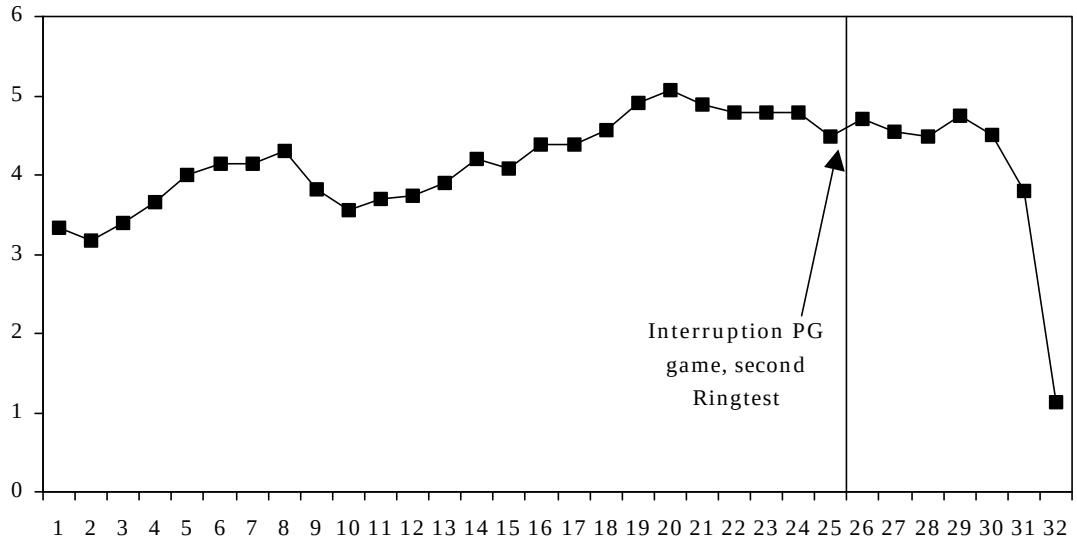

Figure 2. Average contribution level to the public good per period in the second experiment. The number of tokens allocated to the public account according to the dominant strategy is subtracted.

Table 6. Linear regressions with the angle measured by the second Ring-test as dependent variable and, as independent variables, the social value orientation (angle measured by the first Ring-test) and earnings in the last 5 periods of the public good game.

Experiment 2	*B*	*SE B*	*â*	*t*	*sign. t*
Social value orientation	.715	.141	.564	5.056	.000
Earnings period 21-25	.048	.019	.283	2.536	.015
Constant	-33.074	14.661		-2.256	.029

Multiple R: .712
Adjusted R Square: .484

5. Conclusion

In this paper we investigated whether the development of social ties can be established in an experiment. Through interaction people form positive or negative sentiments about each other, dependent on whether the interaction is positively or negatively valued. Sentiments are here considered to represent the extent to which individuals care about the well-being of others. This establishes a relationship between the sociological notion of a social tie (which concerns a specific other) and the psychological notion of a social value orientation (concerning distributional preferences involving an arbitrary, generalized other). Psychologists have been successful in measuring social value orientation by using so-called decomposed game techniques, such as the Ring-test. Our results corroborate the validity and reliability of this test. However, the gist of this paper is that by applying the test twice -before and after an experiment with interaction - the development of social ties may be traced, given the aforementioned relationship between the two concepts.

Our main result is that we find, indeed, clear evidence of the development of (positive and negative) social ties in a public good experiment, under different experimental conditions. Subjects are more willing to help (hurt) another subject if their interaction with this individual has been more (less) advantageous to them. As a matter of fact, this willingness not only shows up in their allocation of real money in the second (ex post) test. It also manifests itself in their answers to the debriefing question whether they would like to be matched again with the subject they were paired with in the public good experiment, if the experiment were to be repeated, or with an arbitrary other subject.

In the baseline experiment, we found an effect of the last period of the public good game on the social tie: if the other player 'cheated' in the last period, on average a negative social tie was formed. Although the effect of the result of this last period is not as significant as the results of the last 5 periods, we ran an additional experiment, in which social ties were measured during ongoing interaction. In this second experiment the social tie was measured unannounced after period 25 (of 32 periods) of the public good game, before the turbulent last periods of the game (the end-effect). The results of this experiment are in line with the results of the first experiment.

Readers may wonder how these results relate to the reciprocity found in other studies (e.g. Fehr et al. 1993). In part 2 of the experiment, the public good game, we also found that behavior tends strongly towards reciprocity. In the Van Dijk and Van Winden (1997) model reciprocity is brought about by the development of positive or negative social ties. We clearly find support for this link. This does not rule out that other driving forces of reciprocity, such as strategic behavior or social norms, may also be at work. It is stressed that, while there are possibilities for strategic behavior in the public good game, it cannot occur in the first and third part of the experiment. Thus, strategic behavior cannot explain the changes in the Ring-tests. With regard to social norms[9], we note that such norms as well as other moral considerations are likely to influence the formation of social ties (e.g., one may feel a positive sentiment to someone who acts rightly). This mechanism might be an important reason why people stick to norms.

[9] Cf. Sugden (1984), Hoffman, McCabe and Smith (1996).

The present experiment only allows for minimal interaction during a short period of time. Even in this setting the development of social ties was observed. This may seem surprising, but it is in line with findings in social-psychology that it takes very little for social attachments to form (Baumeister and Leary, 1995). Many economic phenomena take place over longer periods of time and involve richer interaction, so we expect social ties to be of even greater importance in these situations.

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Appendix 1
The 32 questions of the Ring-test

number question		Alternative A		Alternative B	
part 1	**part3**	**self**	**other**	**self**	**other**
1	32	000	+500	+304	+397
29	5	+304	+397	+354	+354
4	2	+354	+354	+397	+304
24	29	+397	+304	+433	+250
15	22	+433	+250	+462	+191
30	3	+462	+191	+483	+129
9	16	+483	+129	+496	+65
10	24	+496	+65	+500	0
5	13	+500	000	+496	-65
12	25	+496	-65	+483	-129
22	6	+483	-129	+462	-191
23	26	+462	-191	+433	-250
21	1	+433	-250	+397	-304
16	8	+397	-304	+354	-354
11	9	+354	-354	+304	-397
13	28	+304	-397	000	-500
7	31	000	-500	-304	-397
32	19	-304	-397	-354	-354
18	17	-354	-354	-397	-304
2	4	-397	-304	-433	-250
28	20	-433	-250	-462	-191
8	15	-462	-191	-483	-129
27	21	-483	-129	-496	-65
25	11	-496	-65	-500	0
19	23	-500	000	-496	+65
26	12	-496	+65	-483	+129
17	7	-483	+129	-462	+191
31	27	-462	+191	-433	+250
6	14	-433	+250	-397	+304
20	18	-397	+304	-354	+354
3	30	-354	+354	-304	+397
14	10	-304	+397	000	+500

Appendix 2
Translation of instructions of part 2 (Public good experiment)

To save space, we only present the instructions of the equal endowment condition, which are almost completely the same as for the unequal endowment condition.

Introduction
In a moment you will see the instructions for the second part of the experiment on your computer screen. Your decisions will again have financial consequences for you. These consequences can be read from the summary that I will show now via the overhead projector and distribute to you on a handout. The use of this summary will be explained in the instructions.
We start now with the instructions.

Welcome at the practice program of part 2
PART 2 of the experiment consists of 25 periods. In each period you are asked to make a decision. This decision always concerns the distribution of 10 markers over two activities: activity X and activity Y.

Activity X leads to a payoff for yourself only. Activity Y leads to a payoff not only for yourself but also for another participant. This other participant has to take similar decisions: activity X leads to a payoff for her- or himself only. Activity Y leads to a payoff not only for this participant but also for you. After each period you are informed about the decision of the other. During the whole part 2 you are paired with the same person. You will be paid after the end of the experiment.

To avoid any misunderstanding: the participant you will be paired with is not the same as the 'other' in PART 1 of the experiment. PART 1 and PART 2 are completely independent of each other.

Before starting PART 2, you are now first asked to go through some exercises. We want to make sure that this part of the experiment is clear to you. In case of any questions, please raise your hand, and we will come to your table.

<After each exercise subjects had the option to go to the next or to return to previous exercises.>

Payoff information
The upper-left corner of the screen shows you a summary of how your payoffs from the activities X and Y are determined. This is illustrated hereafter.

Your payoff from activity X depends on the number of markers that you yourself spend on this activity. The column "value" shows the payoff of each marker that you spend on activity X. As you see, every extra marker pays you less.

The column "sum" shows you the total payoff for each number of markers that you spend on activity X. If you do not spend any marker on activity X your payoff from this activity will be zero.

Your payoff from activity Y depends on the total number of markers that you and the other participant spend on this activity. Each marker pays you AND the other participant 14 cents.

In each period some costs will be subtracted from your payoffs, namely 110 cents. Thus, your total earnings per period will be: the payoff from activity X PLUS the payoff from activity Y MINUS the costs (110 cents). On your handout "Summary of Payoffs and Costs per Period" you find the same information as you can see now in the upper-left corner of your screen.

Making a decision
We will now practice how decisions are taken. At the bottom of the next screen you are instructed how to type your decision. In the upper-right corner you will see the DECISION-WINDOW. In this window you type in the number of markers that you want to spend on activities X and Y. The decision-window appears on your screen at the beginning of each period.

First you type in how many of your 10 markers you want to spend on activity X. This number must be between 0 and 10 and should always be typed as two figures: 00, 01, 02,...,10. Then, press the Enter-key and type in your decision concerning activity Y in the same way. Note that the two numbers, for X and Y, should add up to 10. Thereafter, press again the Enter-key. You will then be asked to confirm your decision. After confirmation you cannot change your decision anymore.

Registration-table

Below, you see now the REGISTRATION-TABLE. In this table your decision and the results are registered. This table will always be visible. The decision you have just taken is now registered for period Test 1.

The decision of the other
You have now taken a decision regarding the distribution of your markers. Your payoff from activity Y in a period is co-determined by the markers that the other participant spends on Y in that period. To show this, we ask you now in this exercise to choose yourself a number for the markers that the other participant has spent on Y. Note that this number cannot exceed 10, since the other participant has no more markers than 10. Choose a number and press then the Enter-key.

Registration-table
You see now in the REGISTRATION-TABLE how the decision of the other participant is registered. In this exercise this is the number that you just chose.

We want to make sure that you fully understand what is registered in the registration-table. Therefore, we ask you now a few questions.

<questions plus feedback about the determination and registration of payoffs, followed by 2 individual practice rounds>

During the experiment you will only see the results of the LAST period in the registration-table. However, you can use the PageUp- and PageDown-keys to look up earlier results. Your total earnings from all past periods are shown at the bottom of the registration-table. Also for this part of the experiment it holds that your earnings will be paid to you, confidentially and in cash, after the whole experiment is finished.

End of exercises
You are now ready with the exercises. We wait until all the participants are ready.

Appendix 3
SUMMARY OF PAYOFFS AND COSTS PER PERIOD

PAYOFF OF MARKERS FOR X

MARKER	VALUE PER MARKER	SUM
1	27	27
2	25	52
3	23	75
4	21	96
5	19	115
6	17	132
7	15	147
8	13	160
9	11	171
10	9	180

PAYOFF OF MARKERS FOR Y

MARKER	VALUE PER MARKER	SUM
1	14	14
2	14	28
3	14	42
4	14	56
5	14	70
6	14	84
7	14	98
8	14	112
9	14	126
10	14	140
11	14	154
12	14	168
13	14	182
14	14	196
15	14	210
16	14	224
17	14	238
18	14	252
19	14	266
20	14	280

COSTS PER PERIOD: 110 CENTS

Explanation: You distribute your budget of 10 markers over X and Y. Your payoff from activity X only depends on the number of markers that you yourself spend on this activity. In the column "SUM" of the left table you see the payoff of each number of markers that you spend on activity X. If you do not spend any marker on activity X, your payoff from this activity is zero.
Your payoff from activity Y depends on the total number of markers that you and the other participant spend on this activity. Each marker gives you AND the other participant a payoff of 14 cents, irrespective whether the markers comes from you or the other participant. In the column "SUM" of the right table you see the payoff from activity Y.
In each period 110 cents are subtracted from your payoffs as costs. Your total earnings per period are, thus: your payoff from activity X plus your payoff from activity Y minus the costs of 110 cents.
For example, if you spend 4 markers on X and 6 markers on Y, and the other participant spends 8 markers on Y, then your total earnings are equal to 182 cents, namely 96 (payoff of 4 markers for X) plus 196 (= payoff from 6+8=14 markers for Y) minus the costs of 110.

In the table below your total earnings are shown for all possible combinations of your decisions and the decisions of the other participant. We show this table because sometimes participants prefer it. You need not use this table; you can also compute your earnings yourself, if prefer to do so.

TOTAL EARNINGS TABLE
(figures in cents)

		MARKERS OF THE OTHER PARTICIPANT										
	X	10	9	8	7	6	5	4	3	2	1	0
X	Y	0	1	2	3	4	5	6	7	8	9	10
10	0	70	84	98	112	126	140	154	168	182	196	210
9	1	75	89	103	117	131	145	159	173	187	201	215
8	2	78	92	106	120	134	148	162	176	190	204	218
7	3	79	93	107	121	135	149	163	177	191	205	219
6	4	78	92	106	120	134	148	162	176	190	204	218
5	5	75	89	103	117	131	145	159	173	187	201	215
4	6	70	84	98	112	126	140	154	168	182	196	210
3	7	63	77	91	105	119	133	147	161	175	189	203
2	8	54	68	82	96	110	124	138	152	166	180	194
1	9	43	57	71	85	99	113	127	141	155	169	183
0	10	30	44	58	72	86	100	114	128	142	156	170

Note that in each cell the **total earnings** are shown that **you** will get if that combination is chosen by you and the other participant. For example, if you divide your budget of 10 markers into 8 markers for X and 2 markers for Y, and the other participant divides her or his budget of 10 markers into 5 markers for X and 5 markers for Y, then **your total earnings** are 148 cents. These are your actual earnings. You do **no longer** have to subtract the costs of 110 cents.