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This article presents an analysis of 35 years of published experiments testing decision making in prisoners' dilemmas. The objective is to begin to reconnect the theory and the evidence of rational behavior by accumulating the experience of the laboratory and examining this record for those factors that consistently altered subjects' choices. It is shown that a model of pure self-interest is usually inconsistent with the results of experimental decision making, predicting either the wrong sign, as in the case of monetary stakes, or ignoring influential variables, such as the content of instructions. This incongruity is widest with respect to the role of language in encouraging cooperation.

Conversation and Cooperation in Social Dilemmas

A META-ANALYSIS OF EXPERIMENTS FROM 1958 TO 1992

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1. THE HOLDING CELL: PRELUDE TO A PRISONERS' DILEMMA

Suppose you are a rookie police officer recently graduated from the academy where you were trained in police techniques, criminal psychology, and human behavior. You are on duty in the station house, and the first perpetrators of the night have just been brought in. The pair of offenders were nabbed coming out of a house with an armload each of electronics and jewelry. The arresting officers tell you to hold these guys for interrogation because they may be responsible for a string of burglaries in the neighborhood. While the pair are being fingerprinted, you consider the upcoming interrogation. Drawing on your training, you realize that the questioning will

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		Prisoner 2	
		Deny	Confess
Prisoner 1	Deny	1 , 1	5 , 0
	Confess	0 , 5	3 , 3

(Payoffs in years of jail time)

Figure 1: A Prisoners' Dilemma

be very straightforward because this situation is a prisoners' dilemma like the one shown in Figure 1. (The payoffs are lengths of jail time and represent disutilities.) If neither suspect confesses, they will do time for only this one B&E (breaking and entering), but if just one of the two confesses, the district attorney will go easy on him and lock his partner up for a long time. Mutual confession to the string of burglaries will lead to a moderate sentence for each. Therefore, whatever his partner does, a suspect is personally better off if he admits guilt and, so, each will confess.

Convinced by your analysis, you lead the suspects to the holding cells. Should you put them in the same cell? Again, your training comes in handy: Confession is the dominant move, a fact not changed by preinterrogation discussion. Divulgence is the only sensible thing for each prisoner to do: It will insure against getting double-crossed, and it might even get one off the hook.[1] Promising and cajoling and threatening might elicit a verbal agreement to cooperate in the holding cell, but when each suspect is alone in the interrogation room, that prior accord would be mere words and nothing more. In fact, both suspects would know the eventual outcome while they are talking, so their discussion would be without any truthful content whatsoever:

"Why, sure, pal, cross my heart, I would *never, ever* say anything to these cops."

Reassured, you open the door to one holding cell and push them both in. Your sergeant looks up from her paperwork, notices what you are doing, and rushes over berating you with each step. She orders you to put them in separate cells and asks you not to be so stupid next time: "Don't you know these guys may not confess, and, if they talk it over, neither is likely to accept any offer to testify against the other?" As your career flashes before your eyes, you wonder how your reasoning can differ so greatly from the experience of the sergeant.

2. THEORY AND EXPERIENCE

The contrast between the theory of the academy and the sergeant's streetwise observations carries over into the social sciences as well. In their famous series of experiments, *Marwell and Ames (1981)*[2] focused on this very dichotomy. They asked a panel of five economists and one sociologist to make both a theoretical and a personal prediction of the contribution rate in a public goods experiment. Five of the panelists felt that economic and game theories were strictly relevant and hypothesized a contribution rate in the neighborhood of zero. In stark contrast, the personal estimates of all six experts averaged approximately 20%. Although only one person saw no major gap between theory and reality, Marwell and Ames proceeded to demonstrate that even the five panelists who predicted positive contribution rates underestimated the degree of altruistic, non-self-interested behavior.[3]

This fissure between theory and experience is reflected in the origins of the Prisoners' Dilemma itself: Flood and Dresher devised the game one day in part as a test of Nash's solution concept (Poundstone 1992). The two inventors immediately tested their game on two subjects for 100 trials. One participant chose to cooperate 78 times, and the other subject, an economist, 68 times. Based on the comments in the running logs kept by the subjects, a reader can see that the initial impression of the economist concerned the dominance of defection, while the other subject perceived the opportunity for cooperation and the usefulness of a forgiving strategy.

From that point forward, theorists have focused on refining Nash's concept of an equilibrium while experimenters have tested how varying parameters affect the positive cooperation rates in a prisoners' dilemma. The two strands of research have rarely intersected over the last 40 years. Experimenters have been guided less by theory than by applications: One of the first analogies drawn was between the prisoners' dilemma and the arms race involving the Soviet Union and United States. Issues such as first strike capability and survivability were readily translated into tests estimating the effects of different levels of payoffs, varying numbers of trials, and alternate amounts of knowledge. Most importantly for my purposes, the obvious connection between the arms race and diplomacy led to a number of assays of the role of written messages or conversation in influencing people's decisions.

Unfortunately, the gap between theory and experience widens even further when considering the impact of communication on choices in prisoners' or social dilemmas.[4] In order to develop a model in which talking improves the success rate in coordination games, Farrell (1987) assumed that "if players' announced plans ever constitute a Nash equilibrium, then they are followed" (p. 35). Cooper et al. (1989) elaborated on this assumption with regard to the battle of the sexes game when they presumed, "If it is optimal for the row player to honor his announcement when the column player believes that the row player will honor it, then the announcement will be believed and honored" (p. 571). Because there is only one optimal move in the prisoners' dilemma in Nash's sense, the promise to cooperate will be neither believed nor followed. Hence, conversation between rationally selfish players is without content: While it occurs, it carries no information; after it occurs, it carries no influence. Nevertheless, as we shall shortly see, the experimental evidence shows quite clearly that discussion has an extremely positive effect on subjects' willingness to cooperate.

How can theory and experience be rejoined? A very useful first step would be to gather and summarize much of the relevant experience, which would eliminate many individual idiosyncrasies, and then, to contrast this history against the major predictions of theory. To this end, I have performed a meta-analysis of many of the prisoners' and social dilemma experiments published over the last 35 years. My hope was to buttress the many powerful conclusions of specific studies by finding those factors that consistently altered the preference for cooperation over the years and under diverse experimental conditions.

I analyzed over 100 studies in the principal journals of political science, social psychology, economics, and sociology, and I developed a data set consisting of 130 distinct treatments from 37 different studies. These studies are listed in chronological order in the appendix. Most of the studies were conducted by social psychologists, and a majority appeared in either the *Journal of Conflict Resolution* or the *Journal of Personality and Social Psychology*.[5] The two most common reasons for excluding studies were an insufficiently detailed description of the experimental conditions or results, which occurred more frequently for experiments early in my time period before the apparent standardization of reporting procedure and findings, and a sample of subjects designed to compare various personality traits, which might not reflect the proportion of altruists in the population as a whole.

The remainder of the article will proceed as follows: First, I shall describe the sample by discussing each category of experimental factors, the way in which I transformed them into variables suitable for interstudy comparison, and the predictions that game theory or the theory of rational self-interest makes about their magnitudes or signs.[6] Next, I shall report the results of the regression analyses and demonstrate that my findings are not consistent with the received theories of rational self-interest. Finally, I will offer an initial proposal as to how we might incorporate these results in a fuller understanding of rationality, self-interest, and language.

3. SAMPLE DESCRIPTION

3.1 DEPENDENT VARIABLE: COOPERATION RATE

The cooperation rate, COOPRATE, is defined as the percentage of total choices made in an experiment that benefit the overall group at the expense of the individual deciding. If there were two or more rounds of choices in the experiment, the cooperation rate I use is the average over all trials.[7]

Thirty of the studies confronted their subjects with the simple binary choice of the prisoners' dilemma: one choice dominant, but leading to a suboptimal group outcome, and another dominated, but benefiting the group as a whole. Three experiments gave subjects a third option, which would have benefited a subset of the total group, and the remaining four studies allowed a wider range of choices, either points harvested from a common resource pool or shares of capital invested in a group exchange.[8]

Figure 2 displays a frequency distribution of the cooperation rates found in the 130 pooled treatments. The mean cooperation rate for the entire sample is 47.4%, with a standard deviation of 23.7%. The minimum observation is 5% in *Brechner (1977)*, and the maximum is 96.9% in *Deutsch (1960)*. A slight majority of the treatments occur in the range from 20% to 50%, but it is clear that there are numerous experiments in which subjects cooperated very frequently and effectively.

3.2 INDEPENDENT VARIABLES: SUBJECT CHARACTERISTICS

Three variables fall into this category as shown in Table 1. SS is the number of subjects participating in a given treatment, and it will be used as

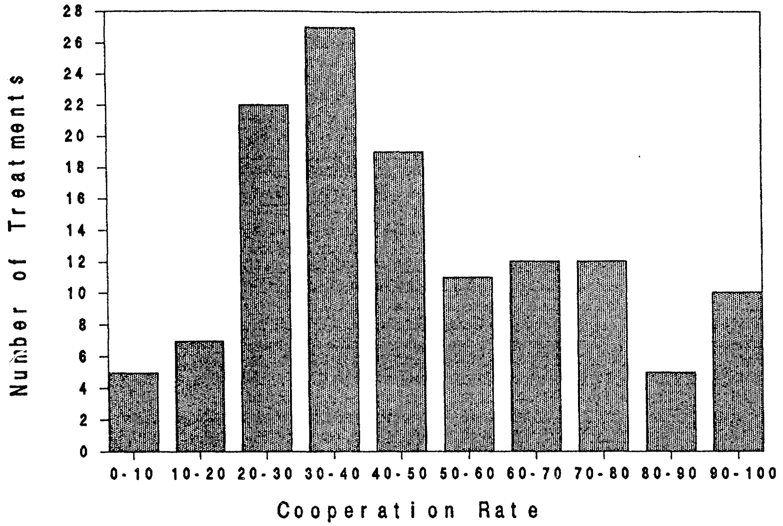

Figure 2: Distribution of Sample Cooperation Rates

a weight in the forthcoming general least squares regressions. PSYCH and ECON represent whether the subjects were students taking a psychology course or a business and economics course, respectively. Of the treatments, 34% involved psychology students, whereas 8%, economics students. From the perspective of game theory, the background of the subjects is irrelevant because the payoffs and strategies remain unchanged. However, the counter-argument is that the self-selection and socialization of these two disciplines might lead to disparate interpretations concerning self-interest and cooperation. For example, *Marwell and Ames (1981)* found that economics graduate students cooperated far less frequently than other types of people. *Frank (1988)* has eloquently stressed the normative implications of these results for the economics and business professions. Also, in response to the tendency, especially in economics, to identify self-interest as the universal motive in rational choice, Mansbridge (1990) wrote,

> We seriously underestimate the frequency of altruism when, having designed our lives to make self-interest and altruism coincide, we interpret such coincidences as demonstrating the pervasiveness of self-interest rather than altruism. And because thinking that another has acted unselfishly often leads people to behave unselfishly themselves, underestimating the frequency of altruism can itself undermine unselfish behavior. (P. 141)

TABLE 1

Variable	*Number of Cases*	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
SS	130	43.4	31.9	4(Isaac et al. 1984)	182 (Orbell et al. 1988)
PSYCH	130	0.34	0.48	0	1
ECON	130	0.08	0.27	0	1
GIVE	130	0.11	0.31	0	1
COOP	130	0.04	0.19	0	1
MAX	130	0.37	0.48	0	1
COMP	130	0.02	0.15	0	1
ITERATIO	130	28.8	40.1	0	149 (Goehring and Kahan 1976)
KNOWN	130	0.26	0.44	0	1
MONEY	130	0.66	0.48	0	1
GPLOSS	130	73.3%	46.0	0 (Goehring and Kahan 1976)	200 (Deutsch 1960)
TEMPT	130	41.7%	55.8	−14.3 (Bornstein 1992)	320 (Dawes et at. 1977)
VISUAL	130	0.29	0.46	0	1
EXPOST	130	0.43	0.50	0	1
SIZE	130	7.59	14.88	2	80 (Marwell and Ames 1981)
GPID	130	0.08	0.27	0	1
SUBGPID	130	0.16	0.37	0	1
SUBGPINC	21	23.7%	24.5	0	57 (Orbell et al. 1988)
FREQDISC	26	0.83	0.36	0.03	1
DISCUSS	26	16.1	18.4	2	75 (Bonacich 1972)
FREQMESS	15	0.69	0.45	0.01	1
PROMISES	41	0.24	0.44	0	1
SUBGPDIS	21	2.52	3.47	0	10 (Orbell et al. 1988)

3.3 INDEPENDENT VARIABLES: INSTRUCTIONS

A strictly self-interested player should be unaffected by the instructions given in a social dilemma experiment because the instructions do not modify the payoffs of the game. However, if cooperation is an integral part of human motivation in certain circumstances, then the directive from the experimenter to "earn as much money as you can for yourself," places the subject in the uncomfortable position of choosing between cooperation with the experimenter or with the other subjects in his group (Dawes, van de Kragt, and Orbell 1990, 100). So, the decision to defect, in this case, may be prompted by cooperation as much as by self-interest.

The influence of the experimenter can confound the results even further if he or she is perceived as an authority figure. Given the willingness with which many subjects administered electric shocks to a victim on command of an experimenter (Milgram 1974), we might also expect to see the subjects in a prisoners' dilemma follow directions accordingly.

Finally, the language used in the instructions may have normative significance for the players, and if they are motivated to "do the right thing," the description of the choices may influence them to pick one over the other.

Accordingly, I have defined the following four variables shown in Table 1:

GIVE: equal to 1 if the subjects are told that to pick the dominated choice is to "give" or to "cooperate." Fourteen treatments used these words, while the others used neutral labels such as various colors or letters.

COOP: equal to 1 if the subjects are directed to work together or help each other, or if there is an additional reward over and above the game payoffs encouraging players to cooperate.

MAX: equal to 1 if the study contained any of the following: (1) A phrase in the instructions similar to "win as many points as you can" or "maximize your earnings," (2) directions providing "an individualistic set" *(Voissen and Sistrunk 1971)*, and (3) an additional reward for the highest scoring player.[9]

COMP: equal to 1 if the experimenter asked each player to do better than the others. *Deutsch (1958, 1960)* used this directive in three treatments.

3.4 INDEPENDENT VARIABLES: REPETITION

Game theory does have some specific predictions concerning the consequences of repeating a prisoners' dilemma. First, the notion of backward induction suggests that cooperation at any point in an iterated prisoners' dilemma is dominated because defection is certain on the last trial (Luce and Raiffa 1957, 98). The variable, KNOWN, which is equal to 1 if there are two or more trials and the subjects are fully informed, should be significantly negatively related to the cooperation rate among selfish players (see Table 1).

If there is a small probability that one player will not play "rationally" but will use a tit-for-tat strategy, it has been demonstrated that cooperation can be motivated by rational self-interest in a finitely repeated prisoners' dilemma (Kreps et al. 1982). According to this model, cooperation becomes more likely and more prevalent the more often the game is repeated. However, when Gallo and McClintock (1965) reviewed the published research at that time, they concluded that the cooperation rate decreases over a series of trials. Consequently, I defined ITERATIO as the number of times the game is repeated (zero for a one-shot game), and I used LNITER, that is, log(1 + ITERATIO) = log(total trials), in the regression analysis. Figure 3 displays the total number of trials for each observation in the sample; about one third of my database are single-trial games.

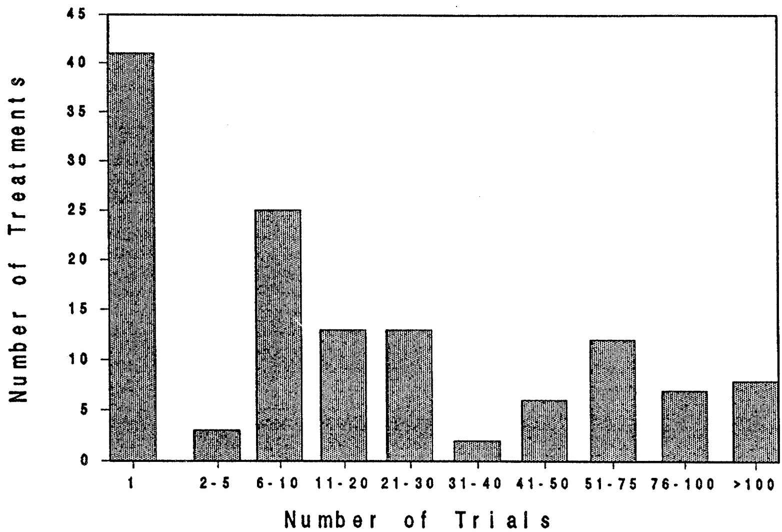

Figure 3: Distribution of Sample Iterations

3.5 INDEPENDENT VARIABLES: PAYOFF MATRIX

One of the variables in Table 1, MONEY, captures the nature of the payoffs: It equals 1 if the players earned money, and it equals 0 for all other rewards. Almost two thirds of the sample treatments rewarded subjects with cash. From the perspective of rational selfishness, MONEY will be negatively related to the observed cooperation rate because the stakes are real and, thus, nonselfish behavior becomes more costly.

Numerous authors have tried to develop a single measure of the conflict inherent in the payoff structure of a given 2×2 game (e.g., *Komorita, Sweeney, and Kravitz 1980*). I believe the effort to develop a single index is misguided because it naturally assumes that there is a single objective held by the players of the game. *Bonacich et al. (1976)* developed a much more sound approach. Given an n-person prisoners' dilemma, these authors let x be the number of cooperators ($0 \leq x \leq n$), and they specified C(x) and D(x) to be the payoffs to each of the x cooperators and n – x defectors, respectively, when x players chose to cooperate. They then defined the gain in pareto optimality to be C(n) – D(0), and the temptation to defect as D(x – 1) – C(x). Because I am pooling experiments with a wide variety of matrices and iterations and different types of payoffs, I alter these two indices to the following:

GPLOSS = (C(n) – D(0))/C(n), and
TEMPT = (D(n – 1) – C(n))/C(n).

The average loss in my sample if all players selected defection instead of cooperation is 73.3%, and the average temptation to defect from unanimous cooperation is 41.7%. I did not incorporate any factor representing the level of payoffs because of the presence of both monetary and nonmonetary compensation; however, there is some evidence that the level of reward, over a certain range, does not affect observed rates of cooperation (Oskamp and Kleinke 1970).

3.6 INDEPENDENT VARIABLES: ANONYMITY

Some researchers have been very concerned about insuring the anonymity of subjects' choices so as to defuse any social pressure to conform. In prisoners' dilemma assays, decisions were always identifiable unless the players' rewards were withheld until the last trial. Anonymity was preserved in only 13% of the two-player treatments in my sample. In social dilemmas, the outcome for the group could be announced while individual results are not: 80% of the social dilemma treatments preserved anonymity. EXPOST is the variable in Table 1 capturing whether the players knew each individual's choice after every round. From the standpoint of economic theory, this ex post knowledge is a necessary component of agreement enforcement and strategic reciprocity supporting cooperation among rational players. The tit-for-tat strategy is useless without this information.

VISUAL equals 1 if the subjects could see their fellow players when they were making their decisions. Partitions and booths were often used to block the view of the participants: Fewer than one third of the sample treatments allowed visual contact. One unpublished study reported a doubling in the rate of cooperation when subjects had a constant view of each other as against no view (Durkin et al. 1967). Seeing one's partner should not affect the rationally selfish individual, but, if visual contact creates empathy and narrows the social distance between subjects, then a subject may account for the payoff of the partner and rationally cooperate.

3.7 INDEPENDENT VARIABLES: GROUP IDENTITY

Group size has been a crucial factor over the last 35 years. Prisoners' dilemmas were the focus of testing initially, but in the latter half of this time period, social dilemmas have become much more prevalent. In fact, within my sample, from 1958 to 1972, only 1 study out of 15 total tested a group size greater than two, but from 1973 to the present, only 3 studies out of 22 used a two-person game as a treatment. The overall frequency distribution is shown in Figure 4. As also shown in Table 1, the largest group size used was 80, by *Marwell and Ames (1981)*, and these observations bring the mean for SIZE over 7. The median for SIZE is 4. In my analysis, I used the natural logarithm of group size (LNSIZE) because of these outlying data. From the standpoint of self-interested behavior, Olson (1971) has emphasized the deleterious effects of larger group size on the attainment of the common interest.

Beyond the size of the group, the very perception of "membership" may influence an individual's choice. Social identity theory suggests that belonging to a group may cause "a shift towards the perception of self as an inter-changeable exemplar of some social category and away from the perception of self as a unique person" (Turner 1987, 50, quoted in Brewer 1989). An in-group may be demarcated by relatively permanent borders such as race or religion, or it may be transiently delineated through a flip of a coin. It might also be created by a social act such as discussion. Positive personal characteristics are projected upon fellow in-group members: They are acknowledged to be "friendlier, more trustworthy, and more honest" (Caporael et al. 1989, 693).

I have calculated two variables to capture the effects of social identity, GPID and SUBGPID. GPID equals 1 if the entire decision-making group is manipulated to create an in-group bias.[10] There are 10 such treatments in my sample, and in each case, there was an out-group with which the in-group had no further interaction following group identification.[11] There were 21 treatments in which one or more groups within the decision group had positive identities, and so, SUBGPID is equal to 1.[12] In all these instances, the subgroups interacted in some way after they were created. SUBGPINC measures the incentive in the payoff structure for subgroup defection. The descriptive statistics for SUBGPINC for these 21 treatments are shown in Table 1. Under social identity theory, GPID should be significantly positive, and SUBGPID, significantly negative. The incentive for subgroup defection can reinforce the individual incentive for defection, and thus should also be negatively related to the cooperation rate.

3.8 INDEPENDENT VARIABLES: COMMUNICATION

Although Gallo and McClintock's (1965) review concluded that "opportunities for communication may, but do not necessarily, ameliorate the

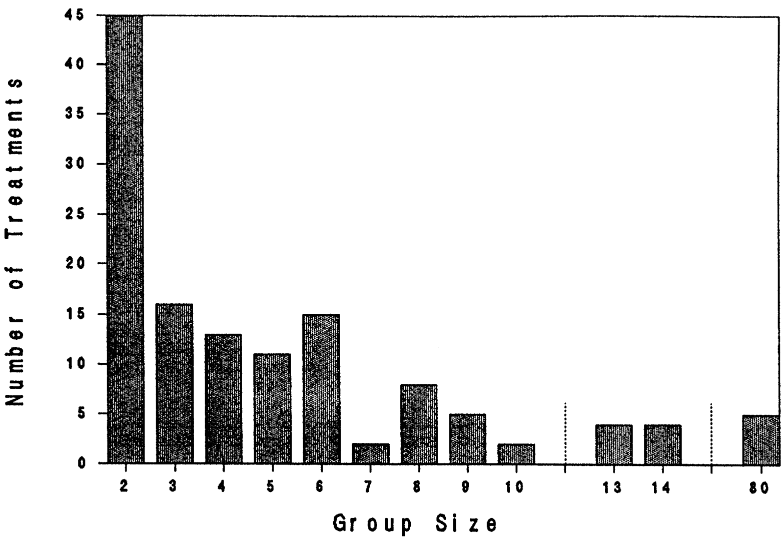

Figure 4: Distribution of Sample Group Size

conflict present in the game" (p. 75), many studies have found powerful effects attributable to communication. One of the first published investigations found that subjects who exchanged notes with prewritten promises on them were much more likely to perceive trust in their partner and then to cooperate (Loomis 1959). In addition, the act of communicating itself influences people's preferences: Conversation is a form of social contact that may create empathy among participants, even those belonging to groups with different social identities (Desforges et al. 1991); effective coordination of responses within a conversation can lead to the perception of greater intimacy among the discussants (Davis and Perkowitz 1979). Almost one third of the sample treatments involved communication among the subjects. There are 26 observations in which conversation was allowed, and 15 in which participants were permitted to exchange written messages. The variables, FREQDISC and FREQMESS (Table 1), represent the frequency of discussion and written message exchange, respectively. The frequency is measured on a per trial basis, so a 10-round game with only preplay conversation would have FREQDISC = 0.1. Conversely, an experiment in which notes were exchanged before every trial would have FREQMESS = 1.

DISCUSS is the total time spent in discussion for the entire game. The average verbal interaction for those cases with discussion was 16 minutes.

Because there was one study with a much longer discussion time, LNDISC was defined as 0 when DISCUSS was 0, and as ln(DISCUSS) when conversation occurred.

PROMISES equals 1 if the experimenter specifically elicited promises from the subjects, as occurred in a quarter of the communication treatments.[13] It is important to note that if PROMISES is 0 for a given treatment with discussion subjects may still have made pledges, but without the encouragement of the experimenter.

Lastly, subgroup discussion was allowed in 9 of the 21 treatments with a positive subgroup identity, and SUBGPDIS records the time spent by the subgroup in conversation.

3.9 INDEPENDENT VARIABLES: INDIVIDUAL STUDIES

The final category consists of dummy variables indicating specific studies. The reasons for marking a particular study are as follows:

SITTING: Equal to 1 if a subject was not faced with a binary choice, but could sit on the fence in terms of being partially selfish and partially cooperative.[14] The coefficient to this variable might contain both a measurement effect, because cooperation rates had to be calculated differently than for all other treatments, and a real effect from the greater options given to the subjects.

NOTWORK: Equal to 1 if the investigators interfered with the natural workings of cooperation. A number of studies paired subjects with either a computer programmed or a confederate instructed to play tit-for-tat, but *Gahagan and Tedeschi (1968)* did not allow mutual cooperation to continue for more than three or four consecutive rounds.

KELLEY72: In almost all of the assays, subjects were tested on their knowledge of the instructions and any mistakes were addressed. However, *Kelley and Grzelak (1972)* explicitly stated that their subjects lacked an understanding of the game (p. 195).

Finally, as detailed above in the section on COOPRATE, those studies that deviated from the norm with regard to the calculation of the rate of cooperation were individually represented by dummy variables.

3.10 SUMMARY OF VARIABLES AND PREDICTIONS

A correlation matrix for the independent variables is shown in Table 2. There are a number of significant correlations: The subgroup identity variables have correlation coefficients greater than .5, FREQDISC and LNDISC are highly interrelated, subjects are often told to maximize for themselves if MONEY equals 0, participants who can see each other are frequently con-

TABLE 2: Correlation Matrix for Independent Variables (Entire Sample)

	SS	*PSYCH*	*ECON*	*GIVE*	*COOP*	*MAX*	*COMP*	*LNITER*
SS	1.00							
PSYCH	0.09	1.00						
ECON	–0.12	–0.15	1.00					
GIVE	0.27	0.07	–0.01	1.00				
COOP	0.03	–0.06	–0.06	0.06	1.00			
MAX	0.09	0.40	0.02	–0.21	–0.15	1.00		
COMP	–0.01	–0.11	–0.04	–0.05	–0.03	–0.12	1.00	
LNITER	–0.20	0.29	–0.06	–0.17	–0.15	0.33	–0.13	1.00
KNOWN	–0.31	0.13	0.16	0.13	0.06	–0.24	0.03	0.16
MONEY	0.03	–0.42	–0.04	0.14	–0.20	–0.63	–0.21	–0.08
GPLOSS	–0.06	–0.22	–0.15	–0.10	0.40	–0.04	0.42	–0.14
TEMPT	0.04	–0.03	–0.10	0.02	–0.06	–0.10	–0.08	–0.15
VISUAL	0.25	–0.10	0.07	–0.01	–0.13	–0.04	–0.10	–0.32
EXPOST	–0.07	0.13	–0.13	–0.05	0.23	0.27	0.18	0.30
LNSIZE	0.40	–0.14	0.15	0.04	–0.18	–0.21	–0.14	–0.37
GPID	–0.14	–0.21	–0.08	0.09	0.09	–0.16	–0.04	–0.30
SUBGPID	0.14	–0.09	–0.13	0.12	–0.09	–0.16	–0.07	–0.35
SUBGPINC	0.31	–0.21	–0.09	0.12	–0.06	–0.23	–0.05	–0.38
FREQDISC	0.23	–0.16	0.07	0.22	–0.09	–0.09	–0.07	–0.30
FREQMESS	–0.18	–0.08	–0.09	–0.09	0.24	0.03	0.15	–0.02
LNDISC	0.17	–0.05	0.09	0.31	–0.09	–0.12	–0.07	–0.23
PROMISES	–0.17	0.10	–0.08	0.09	–0.06	0.08	–0.04	0.21
SUBGPDIS	0.25	–0.09	–0.07	0.22	–0.05	–0.10	–0.04	–0.27

(continued)

versing, and larger groups usually are unaware of the decisions made by each member. Multicollinearity is not a major problem for the entire sample, but, as I will note, it is a major hindrance in the analysis of the subsample involving only nonrepeated games.

Using the descriptives applied by *Marwell and Ames (1981)* to free riding, I can classify the orthodox theories I have been discussing up to this point, strong self-interest and weak self-interest. Strong self-interest predicts that no cooperation should occur because it is a dominated choice. This theory cannot hold because, as detailed above, every experiment has found a positive rate of cooperation.

A theory of weak self-interest would allow for a positive, but suboptimal, amount of cooperation, which should be affected only by those factors changing the individual's personal payoff. Most of the implications of economic theory and game theory have been noted above in the descriptions of my study variables. A reasonable summary of the predictions of these theories

TABLE 2: Continued

	KNOWN	*MONEY*	*GPLOSS*	*TEMPT*	*VISUAL*	*EXPOST*	*LNSIZE*	*GPID*
SS								
PSYCH								
ECON								
GIVE								
COOP								
MAX								
COMP								
LNITER								
KNOWN	1.00							
MONEY	0.24	1.00						
GPLOSS	0.32	–0.15	1.00					
TEMPT	–0.04	0.14	0.02	1.00				
VISUAL	–0.15	0.25	–0.18	0.23	1.00			
EXPOST	0.26	–0.23	0.48	–0.03	–0.12	1.00		
LNSIZE	–0.29	0.30	–0.28	0.05	0.25	–0.49	1.00	
GPID	–0.04	0.21	0.03	–0.03	0.07	–0.13	0.19	1.00
SUBGPID	–0.07	0.18	–0.14	–0.04	0.18	–0.21	0.08	–0.13
SUBGPINC	–0.18	0.21	–0.17	–0.13	0.31	–0.26	0.18	–0.09
FREQDISC	–0.14	0.10	–0.10	0.29	0.45	–0.14	0.12	0.03
FREQMESS	0.23	–0.05	0.44	–0.05	–0.19	0.29	–0.28	0.13
LNDISC	0.03	0.13	–0.08	0.27	0.45	–0.10	0.09	–0.01
PROMISES	0.09	–0.10	–0.04	0.23	–0.12	0.22	–0.22	–0.08
SUBGPDIS	–0.15	0.09	–0.14	–0.09	0.09	–0.22	0.14	–0.07

concerning the significance and sign of the appropriate coefficients is as follows:

PSYCH	0	KNOWN	–	GPID	0	SUBGPDIS	0
ECON	0	MONEY	–	SUBGPID	0		
GIVE	0	GPLOSS	0	SUBGPINC	0		
COOP	0	TEMPT	–	FREQDISC	0		
MAX	0	VISUAL	0	FREQMESS	0		
COMP	0	EXPOST	+	LNDISC	0		
LNITER	+	LNSIZE	–	PROMISES	0		

NOTE: Where 0 = no effect on cooperation, + = increases cooperation, and – = decreases cooperation.

For instance, a theory of weak self-interest would predict that rewarding rationally selfish subjects with money would lower the frequency of cooperation, whereas more trials would allow players to invest in reputations by cooperating.[15] Conversation should have no impact among self-interested players.

TABLE 2: Continued

SUBGPID	*SUBGPINC*	*FREQDISC*	*FREQMESS*	*LNDISC*	*PROMISES*	*SUBGPDIS*
1.00						
0.67	1.00					
0.20	0.33	1.00				
0.10	–0.09	–0.14	1.00			
0.08	0.19	0.89	–0.14	1.00		
–0.05	–0.09	–0.05	0.28	–0.05	1.00	
0.56	0.51	0.10	–0.07	0.05	–0.07	1.00

4. REGRESSION ANALYSIS

For analytical purposes, I view my sample in the following way: Each observation consists of a number of subjects exposed to a unique set of experimental conditions. The number of times these subjects decided to cooperate divided by the total number of decisions is the cooperation rate, which can also be considered the probability of cooperation. If the sample size is large enough, the observed probability can be used to estimate the true probability, and a probability function can be derived using least squares with weights equal to the standard deviation of the probability of cooperation (Maddala 1983, 29). If a linear function is calculated, then this technique is called the minimum chi-square method; for a logistic function, it is known as the minimum logit chi-square method. The coefficients of the two functions can be compared by multiplying the logit coefficients by .25, and, for the intercept only, then adding .50 (Maddala 1983, 23). Finally, a pseudo-R^2

TABLE 3: Linear Probability Regression on COOPRATE for 37 Studies from 1958 to 1992

Category	*Variable*	*Equation 1*	*Equation 2*	*Equation 3*	*Equation 4*
	Intercept	.455	.213	.265	.236
		(.075)	(.131)	(.088)	(.131)
Subjects	PSYCH	.011	.141**	.124***	.128**
		(.048)	(.063)	(.044)	(.063)
	ECON	–.017	–.048		–.070
		(.075)	(.072)		(.074)
Instructions	GIVE	–.031	–.005		–.010
		(.054)	(.054)		(.054)
	COOP	.341***	.381***	.389***	.409***
		(.094)	(.102)	(.084)	(.099)
	MAX	–.030	.080	.063	.095
		(.061)	(.075)	(.058)	(.073)
	COMP	–.334***	–.254*	–.271**	–.213*
		(.123)	(.131)	(.117)	(.127)
Repetition	LNITER	–.023	–.028*	–.029**	–.030*
		(.014)	(.016)	(.011)	(.016)
	KNOWN	.055	–.029		–.000
		(.057)	(.071)		(.070)
Payoff matrix	MONEY	.106*	.249***	.235***	.242***
		(.063)	(.091)	(.061)	(.089)
	GPLOSS	.092	.125**	.140***	.077
		(.056)	(.059)	(.038)	(.060)
	TEMPT	–.137***	–.158***	–.160***	–.149***
		(.027)	(.029)	(.024)	(.028)
Anonymity	VISUAL	–.068	.021		.019
		(.042)	(.052)		(.052)
	EXPOST	–.057	.050		.061
		(.046)	(.054)		(.054)
Group identity	LNSIZE	–.047**	–.018	–.031	–.017
		(.024)	(.026)	(.021)	(.026)
	GPID	.061	.016		–.028
		(.066)	(.065)		(.066)
	SUBGPID	–.051	–.081	–.085	–.085
		(.069)	(.066)	(.056)	(.065)
	SUBGPINC	–.156	–.191	–.201	–.197
		(.152)	(.146)	(.132)	(.142)
Communication	FREQDISC	.425***	.429***	.479***	.461***
		(.106)	(.106)	(.034)	(.104)
	FREQMESS	.045	.045		.083
		(.075)	(.071)		(.070)
	LNDISC	.024	.022		.014
		(.040)	(.040)		(.040)
	PROMISES	.302***	.299***	.312***	.305***
		(.075)	(.075)	(.067)	(.076)

TABLE 3: Continued

Category	*Variable*	*Equation 1*	*Equation 2*	*Equation 3*	*Equation 4*
Communication	SUBGPDIS	–.010	–.009	–.009	–.007
		(.008)	(.008)	(.007)	(.008)
Individual studies	SITTING		.076		.028
			(.137)		(.155)
	NOTWORK		–.327	–.301	–.334
			(.243)	(.225)	(.236)
	KELLEY72		–.438***	–.343***	–.434***
			(.149)	(.082)	(.147)
	EDNEY78		–.307*	–.190**	–.273
			(.178)	(.094)	(.188)
	BRECH77		–.575***	–.444***	
			(.202)	(.115)	
Other studies			n.s.		n.s.
Number of observations		130	130	130	110
Number of subjects		5,639	5,639	5,639	5,435
Buse R^2		.782	.823	.818	.851
Standard error of estimate		2.452	2.312	2.200	2.234

NOTE: Standard errors shown in parentheses.
* Significant at a 10% level; ** significant at a 5% level; *** significant at a 1% level.

measure attributable to Buse can be calculated to assess the accuracy of the model in fitting the grouped data (Maddala 1983, 41).

The first set of analytical results is contained in Table 3. These four equations all use the linear functional form but are distinguished in these ways: Equation 1—no variables pertaining to individual case study characteristics; Equation 2—all defined variables; Equation 3—only those variables with t statistics greater than or equal to 1; Equation 4—only those treatments with at least 20 subjects. The last equation eliminates those observations whose small number of subjects may make the observed cooperation rate a poor estimate for the true probability. The same equations in logistic functional form are displayed in Table 4.

These eight regressions clearly do not support the view that thousands of subjects in tens of experiments over three decades were motivated solely by self-interest or their own individual payoffs. The one major consistency with rational self-interest is that the temptation to defect decreases the level of cooperation: The opportunity to double one's reward by defecting from unanimous cooperation decreases the likelihood of cooperation by 11%-16% (excluding Equation 5). Whether an intercept of 20%-30% (for those equations using case study variables) is consistent with weak self-interest could

TABLE 4: Logistic Probability Regression on COOPRATE for 37 Studies from 1958 to 1992

Category	*Variable*	*Equation 5*	*Equation 6*	*Equation 7*	*Equation 8*
	Intercept	.192	–.892	–.798	–.807
		(.307)	(.513)	(.357)	(.544)
Subjects	PSYCH	–.212	.361	.381**	.348
		(.193)	(.259)	(.166)	(.280)
	ECON	–.220	–.207		–.265
		(.306)	(.301)		(.338)
Instructions	GIVE	–.005	–.034		–.049
		(.226)	(.228)		(.242)
	COOP	1.371***	1.584***	1.569***	1.595***
		(.421)	(.435)	(.374)	(.455)
	MAX	.039	.399	.324	.388
		.221)	(.268)	(.220)	(.280)
	COMP	–1.237**	–.790	–.888*	–.799
		(.525)	(.549)	(.495)	(.572)
Repetition	LNITER	–.120**	–.120**	–.111**	–.126**
		(.053)	(.057)	(.045)	(.060)
	KNOWN	.446*	.215		.280
		(.230)	(.288)		(.303)
Payoff matrix	MONEY	.194	.817**	.883***	.786**
		(.240)	(.347)	(.242)	(.364)
	GPLOSS	–.028	.166	.295*	.100
		(.226)	(.248)	(.158)	(.265)
	TEMPT	–.336***	–.452***	–.447***	–.449***
		(.118)	(.124)	(.090)	(.130)
Anonymity	VISUAL	–.205	.069		.079
		(.170)	(.208)		(.219)
	EXPOST	–.146	.172		.158
		(.170)	(.190)		(.202)
Group identity	LNSIZE	–.160*	–.040		–.046
		(.086)	(.094)		(.099)
	GPID	.177	.103		.015
		(.329)	(.319)		(.341)
	SUBGPID	–.475*	–.494*	–.603***	–.496*
		(.258)	(.250)	(.163)	(.265)
	SUBGPINC	.001	–.208		–.203
		(.649)	(.633)		(.662)
Communication	FREQDISC	1.207**	1.411***	1.641***	1.417***
		(.475)	(.484)	(.157)	(.508)
	FREQMESS	.437	.325	.408	.440
		(.358)	(.347)	(.315)	(.371)
	LNDISC	.148	.110		.108
		(.173)	(.176)		(.186)
	PROMISES	.504	.697**	.587**	.763**
		(.321)	(.337)	(.283)	(.376)

TABLE 4: Continued

Category	*Variable*	*Equation 5*	*Equation 6*	*Equation 7*	*Equation 8*
Communication	SUBGPDIS	–.004	.002		.002
		(.033)	(.032)		(.033)
Individual studies	SITTING		.069		–.082
			(.449)		(.535)
	NOTWORK		–.760		–.806
			(.855)		(.899)
	KELLEY72		–1.652***	–1.450***	–1.601***
			(.562)	(.334)	(.591)
	EDNEY78		–1.464*	–1.275**	–1.300
			(.802)	(.590)	(.868)
	BRECH77		–2.178**	–1.889**	
			(.974)	(.756)	
Other studies			n.s.		n.s.
Number of observations		130	130	130	110
Number of subjects		5,639	5,639	5,639	5,435
Buse R^2		.617	.678	.664	.699
Standard error of estimate		1.832	1.756	1.670	1.828

NOTE: Standard errors are in parentheses.
* Significant at a 10% level; ** significant at a 5% level; *** significant at a 1% level.

certainly be argued; however, even granting congruity in this instance leaves many more glaring contradictions to investigate.

All the other variables that should affect a selfish decider either are not meaningful or have the opposite sign. The size of the deciding group does not substantially affect the cooperation rate in six of the eight equations; only in Equations 1 and 5 does it hold to the prediction. Similarly, KNOWN is significant only in Equation 5, and here it is positive; in all other instances, it is not different from zero. Hence there is no evidence in the overall sample that backward induction is an important consideration. In addition, cooperation is not a result of self-enforcing agreements, implicit or not, because the ex post knowledge of other players' moves does not influence the observed probability.

If the subjects were rewarded with money, they were much more likely to cooperate: For the models with case variables, the range of improvement is 20%-25%. This is a striking contradiction of the orthodox interpretation of rationality: Instead of players being able to indulge in altruistic behavior when no money is at stake, the magnanimous choice is more likely when recompense is in cash. Finally, instead of providing a greater chance to establish a benevolent reputation, more numerous trials inhibit cooperation. Increasing the number of trials from 1 to 100 would diminish the average likelihood of cooperation by 13%-15%. Once again, this finding is firmly in opposition to the received notions of rational self-interest. Shortly, I will exploit this conclusion by dividing the sample into one-shot and repeated games and analyzing each separately.

A few of the factors that should not affect a participant guided by self-interest are, in fact, quite important. Of greatest consequence are the communication variables. The frequency of discussion is exceedingly meaningful in each equation, and its coefficient averages about .40 across the eight models. Hence, a 100 round prisoners' dilemma with discussion before each round would have 40% more cooperation than the same game with no discussion, and about 36% more cooperation than the same game with discussion every 10 trials. We can discern a hint that the effects of discussion have a varying half-life, perhaps depending on actions taken between conversations, or other factors affecting the social distance among participants.

In addition, the solicitation of promises by the experimenter raises cooperation by 12%-19% in the logistic models and by 30% in the linear equations. The promise of a self-interested player to cooperate should be neither believed nor followed, and yet, in real decision making, promises appear to be offered and trusted. Lastly, messages have no significance beyond their ability to convey promises, suggesting that the specific medium of language may be an essential factor in influencing behavior.

Other categories of variables also contain some surprises. The existence of a subgroup identity decreases the probability of cooperation by 12%-15% in the logistic equations. SUBGPID, SUBGPINC, and SUBGPDIS are highly correlated, and none is statistically significant in the linear equations. However, each is significant in the absence of the others, and if only one is dropped from the equation, one of the remaining two is meaningfully negative.[16] On the other hand, group identity theory is violated by the insignificance of GPID.

In a result surely not surprising to social psychologists, participants appear to follow instructions ordering them to cooperate or to compete. The range of coefficients on the former instruction represents a 34%-40% gain in cooperation, whereas the latter command increases defection by 20%-33% (with notably less significance). It must be emphasized that these figures are slightly bewildering to an economist, because the instruction to cooperate does not change the stated payoffs of the game or the seemingly obvious dominance of defection.[17]

The identity of the subjects as psychology students has a positive and meaningful effect on cooperation in three of the models. Although ECON is never significant, it is negative as feared by Frank and others, and it is certainly less than PSYCH, so there is some weak evidence of differences in educational training or preexisting philosophical proclivities.

TABLE 5: Correlation Matrix for Independent Variables (Single Trial Games)

	SS	*PSYCH*	*ECON*	*GIVE*	*COOP*	*MAX*	*COMP*	*MONEY*
SS	1.00							
PSYCH	0.01	1.00						
ECON	–0.10	–0.05	1.00					
GIVE	0.51	0.07	–0.07	1.00				
COOP	0.05	0.22	–0.04	0.12	1.00			
MAX	–0.09	0.63	–0.06	–0.17	–0.11	1.00		
COMP	–0.09	–0.07	–0.04	–0.10	–0.06	–0.08	1.00	
MONEY	0.09	–0.58	0.09	0.11	–0.50	–0.66	–0.40	1.00
GPLOSS	–0.04	–0.02	–0.08	–0.18	0.40	0.34	0.51	–0.76
TEMPT	0.17	–0.02	–0.04	–0.06	–0.09	–0.10	–0.12	0.19
VISUAL	–0.13	–0.01	–0.16	–0.21	–0.29	–0.08	–0.23	0.36
EXPOST	–0.09	0.58	–0.09	–0.11	0.50	0.66	0.40	–1.00
LNSIZE	0.11	–0.33	0.36	0.09	–0.33	–0.38	–0.27	0.63
GPID	–0.37	–0.16	–0.08	0.10	–0.14	–0.18	–0.11	0.28
SUBGPID	0.28	–0.24	–0.11	0.22	–0.20	–0.27	–0.16	0.41
SUBGPINC	0.36	–0.19	–0.09	0.09	–0.16	–0.22	–0.13	0.33
FREQDISC	0.32	–0.05	–0.11	0.11	–0.19	–0.09	–0.15	0.27
FREQMESS	–0.13	–0.09	–0.04	–0.13	0.28	0.18	0.37	–0.50
LNDISC	0.32	–0.00	–0.11	0.13	–0.19	–0.05	–0.15	0.23
PROMISES	0.07	–0.05	–0.03	–0.07	–0.04	–0.06	–0.04	0.09
SUBGPDIS	0.32	–0.13	–0.06	0.30	–0.11	–0.15	–0.09	0.23

(continued)

Lastly, the size of the loss to the group if strictly self-interested choices are made instead of altruistic ones (GPLOSS) is important and positive in Equations 2, 3, and 7. Because defection is dominant for any given number of cooperators, this relationship is an altruistic one. The players must perceive a lack of independence among their decisions: Either they believe that their own decision is representative and will somehow induce others to follow or they account for other people's payoffs when deciding what to do.

Further insight into the level of self-interest displayed in these many experiments can be gained by dividing the sample into one-trial games and repeated games. There were nine experiments testing behavior in one-round dilemmas under 41 separate experimental conditions. Because of the small sample size, there is a high degree of correlation among some of the independent variables, as shown in Table 5. These two relationships also hold with respect to this subsample: MONEY = 1 – EXPOST = 1 – (COOP + MAX + COMP). Based on the results from the entire sample, I assume that the coefficients on EXPOST and MAX are zero in order to make a weighted least squares analysis possible. Of these treatments, 31 rewarded subjects

TABLE 5: Continued

	GPLOSS	*TEMPT*	*VISUAL*	*EXPOST*	*LNSIZE*	*GPID*	*SUBGPID*
SS							
PSYCH							
ECON							
GIVE							
COOP							
MAX							
COMP							
MONEY							
GPLOSS	1.00						
TEMPT	0.06	1.00					
VISUAL	–0.41	0.31	1.00				
EXPOST	0.76	–0.19	–0.36	1.00			
LNSIZE	–0.47	0.06	–0.14	–0.63	1.00		
GPID	–0.22	–0.10	–0.01	–0.28	0.17	1.00	
SUBGPID	–0.43	–0.14	0.29	–0.41	0.06	–0.36	1.00
SUBGPINC	–0.38	–0.26	0.30	–0.33	0.02	–0.29	0.81
FREQDISC	–0.19	0.30	0.46	–0.27	0.00	–0.07	0.28
FREQMESS	0.64	–0.15	–0.29	0.50	–0.33	–0.14	–0.20
LNDISC	–0.15	0.34	0.44	–0.23	0.00	–0.05	0.22
PROMISES	0.06	0.47	0.15	–0.09	0.02	–0.08	–0.11
SUBGPDIS	–0.24	–0.15	0.03	–0.23	0.08	–0.20	0.55

with money, and the variables PSYCH, COOP, MAX, COMP, FREQMESS, and BRECH77 are zero in all of these trials.

Table 6 contains the results of the analysis. Equation 9 is a linear probability function, Equation 10 is logistic, Equation 11 is logistic with LNDISC substituting for FREQDISC, and Equation 12 is a logistic function on only those observations involving money. Once again, the presence of discussion is highly significant and raises the cooperation rate by more than 45 points. The length of discussion is slightly less powerful than the simple presence of conversation. Verbal directions to cooperate (the experiment using an additional incentive to cooperate consisted of multiple rounds) also significantly dampened defection. Both instructions to compete and the presence of a recognized subgroup decrease cooperation significantly in a couple of equations. The signs and significance of other variables are obscured by the degree of multicollinearity. Nevertheless, it is safe to say that one-trial games reveal very little rationally self-interested behavior: A single round game offers participants protection from punishment and shelter from social pressures; it allows no chance to enforce any agreement, and yet conversation enhances an already robust rate of cooperation![18]

TABLE 5: Continued

SUBGPINC	*FREQDISC*	*FREQMESS*	*LNDISC*	*PROMISES*	*SUBGPDIS*
1.00					
0.33	1.00				
–0.16	–0.19	1.00			
0.27	0.99	–0.19	1.00		
–0.09	0.23	–0.04	0.25	1.00	
0.48	0.06	–0.11	0.06	–0.06	1.00

Given the negative coefficient on LNITER in Tables 3 and 4, we know that, in violation of received theory, the repeated games have a lower rate of cooperation than one-shot games, but are there other differences between the two subsamples? With the understandable exception of LNITER, the correlation matrix for the repeated games subsample greatly resembles that for the entire sample. Because there are 89 different experimental conditions, the concern about multicollinearity is greatly reduced.[19]

The statistics on repeated games in Table 7 present a fascinating mix: More factors emerge that both support and refute a view of weak self-interest. Fitting the model of weakly selfish decision making are the following: TEMPT, significant as in Equations 1 to 8, but of twice the magnitude; LNSIZE, which has not differed from zero to this point, indicating that a doubling in the size of the group will increase defection by about 7%; and KNOWN, which signifies the presence of backward induction in Equation 13, but not in the logistic equations.[20]

On the other hand, in addition to the usual cooperative variables of discussion, promises, monetary rewards, instructions, and participant back-

TABLE 6: Regressions on COOPRATE for Experiments with a Single Trial

Category	*Variable*	*Linear Equation 9*	*Logistic Equation 10*	*Logistic Equation 11*	*Logistic Equation 12*
	Intercept	.642	1.071	2.913	1.328
		(.907)	(3.669)	(3.992)	(1.485)
Subjects	PSYCH	–.094	–1.015	–2.312	
		(.669)	(2.714)	(2.888)	
	ECON	–.302	–1.417	–1.438	–1.413
		(.211)	(.949)	(.977)	(1.025)
Instructions	GIVE	–.150*	–.451	–.507	–.342
		(.084)	(.365)	(.378)	(.416)
	COOP	.430***	1.975***	2.015***	
		(.118)	(.586)	(.604)	
	MAX	—	—	—	—
	COMP	–.282*	–1.700**	–1.694**	
		(.156)	(.750)	(.773)	
Repetition	LNITER	—	—	—	—
	KNOWN	—	—	—	—
Payoff matrix	MONEY	.219	.239	–1.055	
		(.649)	(2.660)	(2.883)	
	GPLOSS	–.086	–.663	–1.590	–.781
		(.448)	(1.820)	(1.947)	(1.979)
	TEMPT	–.093	–.231	–.091	–.206
		(.093)	(.387)	(.404)	(.419)
Anonymity	VISUAL	–.236	–.761	–.859	–.723
		(.138)	(.524)	(.546)	(.568)
	EXPOST	—	—	—	—
Group identity	LNSIZE	–.064	–.191	–.207	–.184
		(.059)	(.209)	(.215)	(.226)
	GPID	.020	.084	.083	.026
		(.110)	(.461)	(.475)	(.504)
	SUBGPID	–.149	–.910*	–.953*	–.953*
		(.128)	(.492)	(.508)	(.535)
	SUBGPINC	–.116	.302	.602	.352
		(.214)	(.993)	(1.012)	(1.075)
Communication	FREQDISC	.537***	1.868***		1.839***
		(.072)	(.332)		(.363)
	FREQMESS	.148	1.287*	1.289*	
		(.110)	(.699)	(.720)	
	LNDISC			.864***	
				(.162)	
	PROMISES	.063	.276	.220	.275
		(.173)	(.645)	(.667)	(.698)
	SUBGPDIS	–.009	–.003	–.008	–.006
		(.009)	(.038)	(.039)	(.041)

(continued)

TABLE 6: Continued

Category	Variable	Linear Equation 9	Logistic Equation 10	Logistic Equation 11	Logistic Equation 12
Individual studies	SITTING	—	—	—	—
	NOTWORK	—	—	—	—
	KELLEY72	—	—	—	—
	EDNEY78	—	—	—	—
	BRECH77	–.100	–.606	–.651	
		(.303)	(1.358)	(1.399)	
Other studies		—	—	—	—
Number of observations		41	41	41	31
Number of subjects		2,245	2,245	2,245	1,752
Buse R^2		.887	.775	.761	.722
Standard error of estimate		2.666	2.035	2.096	2.200

NOTE: Standard errors are in parentheses.
* Significant at a 10% level; ** significant at a 5% level; *** significant at a 1% level.

ground in psychology, a number of factors are freshly emergent. Although the coefficients of PSYCH, COMP, MONEY, FREQDISC, and PROMISES are similar to those seen in the regression equations for the entire sample, that of COOP is smaller (and less significant) and that of GPLOSS is larger. Therefore, with respect to the incentive structure of a repeated game, the growing impact of the temptation to defect on the level of cooperation is balanced by the continuing positive influence of monetary stakes and by the loss to the group from not achieving uniform cooperation through reciprocal altruism.

The new factors are GIVE and VISUAL, and they speak to the importance of normative considerations and social connections when people make decisions within a relationship, even a transient one formed in a laboratory. Remember that GIVE reflects the labeling of the dominated choice with an affective name, and VISUAL denotes whether the subjects could see each other when deciding. Because both of these factors are present in every round if they are extant at all, they can serve as a counterbalance to selfish behavior, by being constant reminders of the payoff of other subjects.

Discussion has the most significant influence on the average rate of cooperation in repeated games. Equation 14 uses DISC10, a dummy variable equal to 1 if any discussion took place among the subjects at any point in the experiment. Clearly, as seen in the greater significance of LNDISC in Equation 15 and FREQDISC in Equation 16, the amount or frequency of conversation is an important additional factor in determining the overall level of cooperation. I propose that the relative power of the frequency of discus-

TABLE 7: Regressions on COOPRATE for Experiments with Repeated Trials

Category	*Variable*	*Linear Equation 13*	*Logistic Equation 14*	*Logistic Equation 15*	*Logistic Equation 16*
	Intercept	.294	–.041	–.374	–.413
		(.143)	(.566)	(.546)	(.530)
Subjects	PSYCH	.169**	.294	.421	.550**
		(.071)	(.294)	(.274)	(.266)
	ECON	–.052	–.231	–.243	–.275
		(.071)	(.313)	(.297)	(.289)
Instructions	GIVE	.220**	1.084**	.817*	.973**
		(.109)	(.446)	(.435)	(.412)
	COOP	.224	.754	1.104*	1.169*
		(.141)	(.667)	(.643)	(.625)
	MAX	.063	–.045	.194	.241
		(.076)	(.272)	(.268)	(.261)
	COMP	–.187	–1.240*	–.873	–.804
		(.168)	(.693)	(.668)	(.650)
Repetition	LNITER	–.021	–.071	–.074	–.116
		(.031)	(.121)	(.114)	(.109)
	KNOWN	–.160*	–.302	–.420	–.499
		(.093)	(.369)	(.347)	(.336)
Payoff matrix	MONEY	.232***	.329	.667**	.809**
		(.087)	(.336)	(.325)	(.321)
	GPLOSS	.200**	.480	.470	.566*
		(.076)	(.323)	(.306)	(.295)
	TEMPT	–.246*	–1.092*	–1.206**	–1.010*
		(.128)	(.567)	(.541)	(.523)
Anonymity	VISUAL	.204**	.697*	.732**	.717**
		(.090)	(.380)	(.353)	(.342)
	EXPOST	.060	.132	.255	.217
		(.061)	(.243)	(.229)	(.223)
Group identity	LNSIZE	–.107**	–.429**	–.427**	–.470**
		(.053)	(.214)	(.204)	(.198)
	GPID	.256	1.476	1.297	1.184
		(.216)	(.983)	(.935)	(.909)
	SUBGPID	–.143	–.582	–.632	–.731
		(.197)	(.746)	(.709)	(.688)
	SUBGPINC	—	—	—	—
Communication	FREQDISC	.319***			1.270***
		(.072)			(.268)
	FREQMESS	–.104	.011	–.049	–.042
		(.168)	(.638)	(.607)	(.589)
	LNDISC			.351***	
				(.083)	
	DISC10		.780***		
			(.244)		

(continued)

TABLE 7: Continued

Category	Variable	Linear Equation 13	Logistic Equation 14	Logistic Equation 15	Logistic Equation 16
	PROMISES	.315***	.757*	.876**	.896**
		(.082)	(.448)	(.426)	(.414)
	SUBGPDIS	.049	.194	.206	.219
		(.073)	(.274)	(.260)	(.253)
Individual studies	SITTING	.230*	.603	.701	.776*
		(.132)	(.482)	(.458)	(.445)
	NOTWORK	–.647***	–2.221**	–2.184**	–2.318***
		(.218)	(.891)	(.846)	(.818)
	KELLEY72	–.535***	–1.425**	–1.929***	–1.960***
		(.153)	(.616)	(.562)	(.546)
	EDNEY78	–.381	–.587	–.730	–1.433
		(.268)	(1.145)	(1.090)	(1.077)
	BRECH77	—	—	—	—
Other studies		n.s.	n.s.	n.s.	n.s.
Number of observations		89	89	89	89
Number of subjects		3,394	3,394	3,394	3,394
Buse R^2		.864	.711	.739	.753
Standard error of estimate		1.792	1.492	1.419	1.378

NOTE: Standard errors are in parentheses.
* Significant at a 10% level; ** significant at a 5% level; *** significant at a 1% level.

sion reflects the half-life inherent in communication: Time mutes the interpersonal consequences of words. The difference between the one-shot and repeated game samples with regard to the significance of the instructions variables is consistent with a waning response to language.

5. FURTHER DISCUSSION

At times it is easy to dismiss the results of a single experiment. A critical reader can find fault in an experimental procedure for introducing various biases and not establishing certain controls, and then he or she can stress the unique features that prevent general application of the findings. Pooling many different experiments submerges most of these biases and unique elements under a tide of large numbers. The only dry ground left for the critic is condemnation of the methodology of experimentation itself, and this would be, to my mind, an unwarranted dismissal, because true decision making has clearly taken place in these laboratories. Thousands of participants, albeit in a very controlled setting, have confronted each other in games, the visible payoffs of which embodied real social dilemmas.

TABLE 8: Summary of Predictive Performance of Rational Self-Interest Model

Category	*Variable*	*Significant Same Sign*	*Zero*	*Significant Opposite Sign*
Payoff matrix	TEMPT	12	4	0
Group identity	LNSIZE	6	10	0
Repetition	KNOWN	1	10	1
Anonymity	EXPOST	0	12	0
Repetition	LNITER	0	5	7
Payoff matrix	MONEY	0	5	10
		Zero	*Significant*	
Group identity	GPID	16	0	
Subjects	ECON	16	0	
Communication	SUBGPDIS	16	0	
Group identity	SUBGPINC	12	0	
Instructions	MAX	12	0	
Communication	FREQMESS	13	2	
Instructions	GIVE	11	5 (1 neg.)	
Anonymity	VISUAL	12	4	
Payoff matrix	GPLOSS	11	5	
Subjects	PSYCH	9	6	
Group identity	SUBGPID	9	7	
Instructions	COMP	5	10	
Communication	PROMISES	5	11	
Instructions	COOP	2	13	
Communication	FREQDISC	0	13	

One rather crude way to summarize my results is to count the number of equations in which each variable held to the prediction of the model of rational self-interest. Table 8 contains this rough summary with the top half showing the factors that should have influenced a self-interested subject, and the bottom displaying those experimental elements that should have been ignored by such an individual. The variables in each subtable are ordered according to the support they lend the theory of weak self-interest, and a glance at the table reconfirms the degree to which the experimental record contradicts this theory.

I believe we must take the results of these experiments quite seriously and begin to reformulate our notions of self-interest and rationality, and our evaluation of conversation. Rational behavior may not always be self-interested. If the temptation to defect is great, the group size is large, or no money is at stake, people will be more likely to act in their own self-interest. Yet, their consciences are triggered and they seem to account for the utility of others if the group has a lot to gain when everyone cooperates, if they are instructed to cooperate, if they can look at their partners when deciding, if they can select an affectively named choice, and, most importantly, if they can engage their partners in conversation.

Economists have tended to view language as simply a large, commonly recognized message space: A set of words, the vocabulary, serves as input for a grammar function that produces a sentence, and this sentence is mapped by a language back into the vocabulary to derive an overall meaning from the adjunction of the individually expressive words. Because a language consists only of this reflective mapping, it can be represented by a static set of meanings or messages. Hence, one economist claims, "A common language consists of (1) a meaningful vocabulary, and (2) a common understanding among agents that it is appropriate to interpret statements according to their literal meaning" (Rabin 1990, 145).

This perspective restricts the role of language within economics in two ways. First, talk is cheap: The act of communicating provides information to a game without affecting anything else, in particular the translation of payoffs into utility (Farrell 1987, 35). Second, the medium of the message is irrelevant: Speaking is not different from writing or semaphore, as long as the message is commonly understood (Rabin 1990, 150). Yet, in one of the very few articles by an economist on language, Marschak (1965) discusses the failure of the attempt to replace phones in jet fighters with buttons or switches each dedicated to one of the few necessary messages: "without the relief of verbal, voiced exchange, tension might become intolerable" for the pilots (p. 135). A simple signaling system carrying the same informational content could not provide the coordination and interconnection required by the pilots.

Philosophers and psychologists have long held a more complex view of language. Communicating is an act in and of itself; speech has an impact beyond that arising from its content. In one view, meaning arises from the mutual consideration of the utterer and the addressee, and this common identification may spill over into actions other than speaking and listening. Thus language may elicit an involuntary commitment to act nonselfishly. My current research blends the notions of sympathy and the impartial spectator propounded by Adam Smith in *The Theory of Moral Sentiments*, with the theory of language developed by George Mead, in order to characterize more fully the relationship between language and rationality (Sally 1993). I hope other researchers find my summary of the unorthodox results consistently found in these decision-making experiments over the last 35 years useful in understanding the connection between observable payoffs and the choices of rational individuals.

APPENDIX

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NOTES

1. Assume that the police can prevent future interactions between the prisoners through an effective witness protection program, so that threats would be impotent and reciprocation would be unavailable.

2. All cites that are italicized will be found in the appendix, which is a list of the experiments used to compile a database. Nonitalicized cites are located in the reference section.

3. I wish to be explicit about the meanings I attach to certain descriptive words with normative implications. I will assume that people are "rational" in the sense of choosing that action which gives them the best results. An individual, i, who is motivated by "self-interest," will pursue the objective Maxπ_i, where π_i is his personal payoff. However, if he is "altruistic," his goal will be Max U(π_i, π_j), where j is his partner and U is a function of payoffs such that ($\frac{\partial U}{\partial \pi_j} > 0$). "Selfish" is synonymous with "self-interested," and "sympathetic," with "altruistic." Accordingly, cooperation in a nonrepeated prisoners' dilemma is altruistic, whereas defection may indicate self-interest. "Rational self-interest" will refer to the theory, especially prominent in economics, which confounds rationality and the maximization of one's personal payoff. It is this theory that is confuted by the experimental evidence.

4. I will use the term "social dilemma" to refer to an *n*-person prisoners' dilemma, with $n \geq 3$.

5. Two questions about the composition of the sample immediately arise: Does the reported cooperation rate differ between these two journals? Have subjects become more or less cooperative over these 35 years? The answer to both questions, when controlling for all other factors, is No. The *Journal of Conflict Resolution* did not feature only experiments with a great deal of conflict, and the *Journal of Personality and Social Psychology* did not publish only evidence of cooperation. Furthermore, for better or worse, there is no indication that human nature with respect to the proportions of self-interest and altruism has changed over the last 3 decades.

6. A referee has objected correctly that game theory applies only to the actual utilities perceived by the players and that there is nothing in the theory per se that identifies stated payoffs with utility. However, self-interest is usually implicitly assumed by game theorists, so that if player i maximizes U(π_i, π_j, E) where j is his partner and E represents the environment surrounding a decision, then U has the following qualities: $\frac{\partial U}{\partial \pi_i} > 0$, $\frac{\partial U}{\partial \pi_j} = 0$, and $\frac{\partial U}{\partial E} = 0$. The experimental evidence does not support this narrow formulation of the player's utility. The rejoining of theory and experience I am advocating must take place along these lines: How are stated payoffs translated into utility, and what factors ignored by game theory are critical to this translation?

7. The specific exceptions are the following: *Evans (1964)* and *Wichman (1970)* reported only the median number of cooperators, and *Bixenstine, Levitt, and Wilson (1966)* and *Goehring and Kahan (1976)* gave mean cooperation rates for the latter part of their total trials.

8. For the experiments with three options, only those choices benefiting the entire group are counted as cooperative. For the public goods experiments of *Isaac, Walker, and Thomas (1984)* and *Sell and Wilson (1991)*, the average share of endowment contributed to the group is used as the cooperation rate. For the common resource dilemmas of *Edney and Harper (1978)* and *Brechner (1977)*, cooperation is calculated as the ratio of actual points harvested or replenished to the points generated under a perfectly cooperative strategy.

9. I have included incentives as well as words in the definitions of COOP and MAX. Although the latter variable is not significant in the forthcoming analysis, the former is, and I shall demonstrate that the effect of words alone was the same as that of words and a group incentive.

10. The role of discussion in potentially creating a positive group identity is not coded for by this variable, that is, the presence of discussion alone does not cause GPID to be equal to 1.

11. A positive group identity was engendered by using patients from the same neuropsychiatric ward (*Wallace and Rothaus 1969*), by translating players' earned points into cash at different rates (*Marwell and Ames 1981*) and by dividing a larger group of subjects into two groups based on the color of a poker chip pulled from a hat (*Orbell, Dawes, and van de Kragt 1988*).

12. Specific examples from my sample are as follows: payoff matrices based on subgroup performance (*Bornstein 1992; Bornstein et al. 1989; Komorita and Lapworth 1982*), patients

from different neuropsychiatric wards playing each other (*Wallace and Rothaus 1969*), cooperative contributions going to members of a different group (*Orbell, Dawes, and van de Kragt 1988*), more extensive knowledge of game structure for one player (*Swensson 1967*), and a discussion of local income distributions by the participants (*Dawes, McTavish, and Shaklee 1977*).

13. Promises were required through the following methods: The subjects could choose only from notes prewritten by the experimenter (*Voissen and Sistrunk 1971; Gahagan and Tedeschi 1968; Radlow and Weidner 1966; Evans 1964; Swensson 1967*); the subjects were seated around a table with confederates of the experimenter who promised in turn to cooperate or defect (*Oskamp and Perlman 1965*); the experimenter took a roll call vote after the discussion ended (*Dawes, McTavish, and Shaklee 1977*).

14. The studies with more than two choices were the resource dilemmas of *Edney and Harper (1978)* and *Brechner (1977)*, and the public goods dilemmas of *Isaac, Walker, and Thomas (1984)* and *Sell and Wilson (1991)*.

15. Most of the zeros are due to the variable not being included in game theory or rational self-interest. Again, it seems essential to me to understand how these examinable factors might influence the translation of observable payoffs into unobservable utility.

16. With respect to Equation 2, the regression coefficients (standard errors) are as follows: SUBGPID –.164*** (.052); SUBGPINC –.367*** (.112); SUBGPDIS –.019*** (.007); SUBGPID –.122** (.058) and SUBGPDIS –.012 (.008); SUBGPINC –.276** (.129) and SUBGPDIS –.011 (.008); SUBGPID –.098 (.064) and SUBGPINC –.241* (.139). Clearly, the subgroup identity variables are not collectively insignificant. (See Table 3; * significant at a 10% level; ** significant at a 5% level; *** significant at a 1% level.)

17. As I mentioned earlier, one observation in the sample included an additional reward for the pair of subjects who cooperated most successfully. If this observation is excluded, the regression coefficients (standard errors) for COOP do not change noticeably: for Equation 2, .442*** (.117); for Equation 6, 1.545*** (.456). I conclude that the words of the instructions themselves are affecting the decisions of many subjects.

18. The extent of cooperation in one-trial games brings to mind the anecdote frequently mentioned in order to criticize the theory of rational self-interest: Many of us travel to places where we will never go again. During our visit we will eat in a restaurant in which we will certainly never dine again. As is the custom, our tip will not be revealed to the waiter until after the meal is completed and we have left the restaurant. Nevertheless, almost all of us will leave him a tip, and if we have had a pleasant social interaction and friendly conversation with him, we will probably be quite generous.

19. There are no positive observations for SUBGPINC so it is not included in the analysis.

20. Because I use the average rate of cooperation over all trials as the dependent variable, KNOWN might well have a strong effect on cooperation in the last few rounds while being of marginal significance in the general regression.

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