Computer Mediated Communication and the Emergence of "Electronic Opportunism"

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Abstract

An experiment on how communication affects cooperation in a social dilemma shows that computer mediated communication (CMC) and face to face communication have markedly different effects on patterns of collective behavior. While face to face communication sustains stable cooperation, CMC makes cooperative agreements in groups extremely fragile, giving rise to waves of opportunistic behavior. Further analysis of communication protocols highlights that the breakdown of ordinary communication rules plays an important role in explaining the fragility of cooperation in electronic contexts.[1]

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[1] We thank Lin Ostrom and James Walker for providing us information about their original experiments. Claudia Keser, Marino Pavanati, Alessandro Tonchia and Enrico Zaninotto helped us in different phases of our work. The research was supported by a grant of the Fondazione Rosselli, Italy.

1 - Introduction.

It has become a widely accepted hypothesis that, as computer mediated communication spreads in organizational life, the relevance of hierarchical relationships declines, leading towards the externalisation of activities out of organizational boundaries and, within such boundaries, to more networked, ad-hocratic configurations (Malone and Rockart 1991).

The argument is usually framed in terms of transaction costs (Williamson 1975): in particular, new technologies dramatically decrease coordination costs, i.e. costs related to the management of information in order to support the work of people and machines (Malone, Yates e Benjamin 1987) and their interactions in a world of increasing interdependencies. Moreover, it is assumed that computer technologies can reduce limits of human cognitive ability, thanks to their information storage and processing capacity (Keen 1991, Scott Morton1991). Altogether, these effects should drive towards non hierarchical relationships.

The move towards less hierarchy, however, stresses the need for self-organization and spontaneous cooperation among networked agents. Agents increasingly have to find autonomously norms, rules, common decision premises, and implement and enforce them through repeated interactions. Although computer mediated communication can facilitate coordination in many dimensions, cooperation still relies on basic aspects of social behavior such as trust, commitment or group identity, that by no means should be taken for granted in the new electronic context (Greif 1988).

Communication lies at the heart of spontaneous cooperation in many ways. It supports the understanding of collective tasks and provides the feedback necessary to their execution (Thompson 1967), but at the same time it structures social interactions and constructs group identity and the role of individuals within groups (Dawes et al. 1977, Dawes 1980). The way technological evolution affects communication is not neutral regards its social dimensions. It changes the rules of communication (e.g. conversational rules), the physical context within which communication happens (e.g. it doesn't necessarily imply the simultaneous physical presence of communicating agents), and the content itself of communication (e.g. it can exclude non-verbal messages).

Understanding the way computer mediated communication affects factors enabling social cohesion and cooperation is thus necessary both for analysing ongoing processes of change in social and organizational life and for orienting the design of computer network technologies. In this paper, we explore the impact on propensity to cooperate of a particular class of CMC technologies, those related to the use of electronic mail.

This is made through an experimental research strategy, that allows to insulate in a laboratory controlled environment the effects of the communication medium, comparing face to face communication with e-mail mediated one (Sproull and Kiesler 1991). We have created an experimental setting within which face to face and electronic groups deal with a task that tests their collective ability to find a solution and their capability of implementing such solution in a cooperative way.

The experiment reproduces a typical social dilemma situation, in which people have a collective interest to act cooperatively, but have individual incentives to act opportunistically. Social dilemmas are the paradigmatic frame within which cooperation can be studied. They are defined by two properties (Dawes 1980): whatever others do, individuals receive a higher payoff if they defect rather than cooperate; however, everyone is better off when everybody cooperates (the most well known example of social dilemmas is the prisoner's dilemma). Non cooperative game theoretical analysis of social dilemmas predicts that people will defect, trapping themselves in a deficient equilibrium[2]. However, experimental work has shown that face to face communication in social dilemmas has a strong positive impact on people's propensity to cooperate (Dawes 1980, Orbell et al. 1988, Sell and Wilson 1991, Ostrom et al. 1992). More specifically, the probability of success of cooperation increases as communication opportunities increase (Ostrom, Gardner and Walker 1992), as communication allows promise making (Orbell et al. 1988) and as it conveys feedback concerning individual behavior (Sell and Wilson 1991). These laboratory results have provided the ground for our effort to design an experiment that may help to discriminate the effects of different communication contexts on patterns of cooperation in an iterated social dilemma. Section 1 of this paper describes the experiment (and its antecedents). Section 2 reports the results, while section 3 explains the difference between face to face and electronic groups through the analysis of the experimental communication protocols. A final section discusses some implications of our experimental results.

2 - A laboratory social dilemma.

1.1 Communication and cooperation in a Common Pool Resources (CPR) game

Despite the pessimistic theoretical conclusions of the literature on social dilemmas (Olson 1965, Hardin G.1968), experience of the world shows that in many cases groups are able to achieve significant levels of cooperation even when individual incentives to defection are high (Ostrom and Walker 1991). Given the multiplicity of factors interacting in real world situations, a useful strategy for singling out the impact of specific causes is to explore group behavior in controlled laboratory experimental conditions. Ostrom, Walker and Gardner have attempted to explore in the laboratory the emergence of cooperation when there are no institutions or hierarchies that can embody the Hobbesian sword to discipline collective behavior.

Their experiment consists in a repeated social dilemma, where experimental subjects have to define individual strategies of investment in a situation in which there is a resource that, like a common or an irrigation system, can suffer from over-appropriation from individuals. In order to artificially reproduce such a situation, they have designed an experiment in which there are two markets in which each subject can allocate his resource endowment. Market 1 offers a riskless, constant rate of return. Market 2 offers a total return which is a function of how much all subjects have invested in it - and each participant receives a share of the total return which is directly proportional to the ratio of his investment in this market over the group one. The return offered by market 2 is represented by a parabolic function (see fig. 1a): beyond a certain level of investment, the group return decreases (as in the case of an over-appropriated land or water resource). The return function of market 2 generates a social dilemma, since if each subject tries to maximize "egoistically" his individual return, the resulting group investment level conduces to collective over-investment and thus to a global return which is by far inferior to the one attainable by limiting investments to the social optimum level.

Figure 1b plots the average and marginal returns generated by the payoff functions on market 1 and 2. It clearly shows the existence of three points of focal importance: the Nash

[2] Game theory concerns two different families of games: cooperative and non cooperative games. The main distinction lies on the presence only in the cooperative games of an "institution" able to enforce commitments that players define during the game.

("egoistic") equilibrium, the collective optimum (resulting from smart cooperation), and a naive social optimum, which derives from cooperating but forgetting the opportunity cost represented by market 1 returns.

The existence of a "naive equilibrium" reminds us that the Ostrom et al. experiment differs from a standard social dilemma in that it implies a much higher cognitive load for subjects: it not only implies problematic cooperation, but it requires that subjects are able to detect socially and individually optimal solutions. Thus, it blends collective problem solving with the logic of a social dilemma.

This constituent game is repeated for about 30 rounds[3]. In their original experiments, Ostrom et al. have focused on two factors that can explain the emergence of cooperation: communication and endogenous mechanisms of sanctioning. Here, we will report only the results related to communication.

Ostrom et al. have compared the group investment behavior in three versions of the experiment. The first version is represented by the "baseline game", where no communication is allowed among subjects before and during the experiment. A second version allows just one discussion period after the tenth round. A third version gives the opportunity to communicate each period after the tenth round.

The experimental results strikingly support the hypothesis that communication plays a crucial role in enabling cooperation. While in the baseline game subjects confirm theoretical pessimism, defecting systematically and maintaining the group investment in the proximity of the Nash equilibrium, one-shot communication shows a peak of cooperation in the aftermath of the communication period, with a subsequent increasing wave of defection. Finally, repeated communication allows stable cooperation.

Why should communication alone push people to cooperate in a social dilemma? As Harsanyi and Selten (1988) have made clear, "an ability to negotiate agreements is useful only if the rules of the game make such agreement binding and enforceable", which is not the case here.

[3] In the original implementation of the experiment, participants know the total duration of the experiment in clock time, but do not know the exact number of rounds.

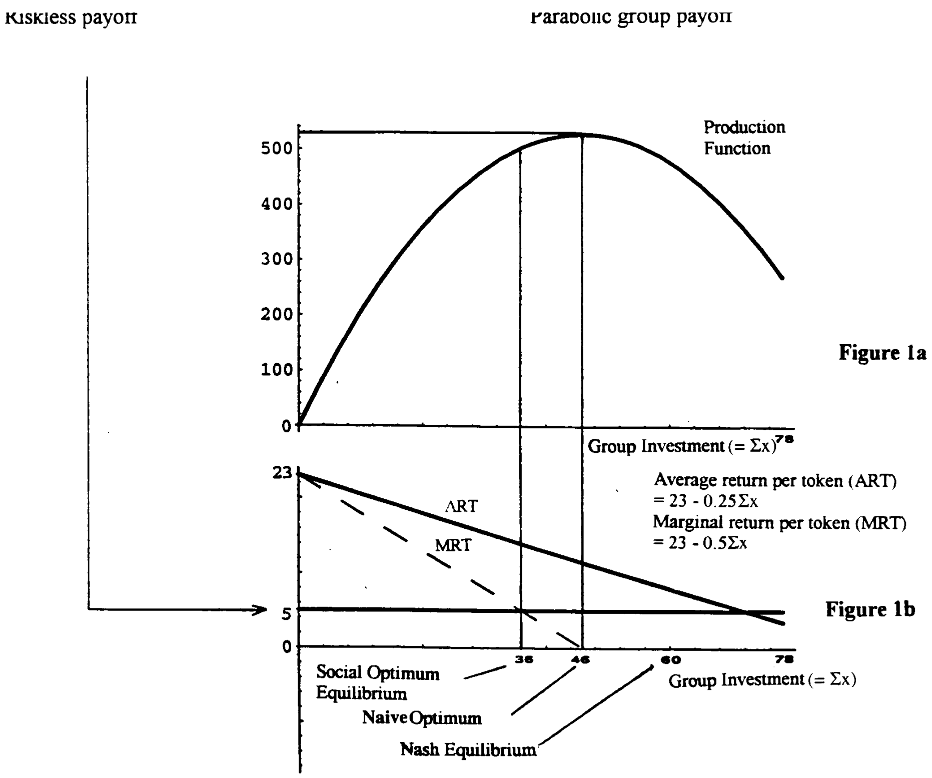

Figure 1 Group payoff of market 2 (1a) and average and marginal group payoff of market 1 and market 2 (1b)

1.2 The experimental design: face to face vs. electronic groups

The experiment of Ostrom et al. (1992) provides a natural background for a closer investigation of the effect of different modalities of communication on cooperation. Their experimental scheme has been slightly modified in order to be adaptable to a comparison of face to face communication with Computer Mediated Communication (CMC). First of all, we have defined two versions of the experiment, which are identical excepted for the way people can communicate. In one case, communication is face to face , in the other one it is computer mediated.

Second, we had to restrict the scope of our analysis to a specific kind of CMC. Our choice was dictated by two considerations. On one side, it had to be a largely diffused communication technology. E-mail was the most obvious candidate from this point of view. On the other side, it had to allow the reproduction of some relevant features of a group discussion. E-mail communication offers some good opportunities also from this point of view. In particular, we have considered the use of a mailing list; in mailing lists, a message sent to a virtual address is automatically sent to any list member. Senders are identifiable, and anybody can know what is said during a discussion. Better than other e-mail based communication systems, mailing lists can thus mime some basic aspects of a discussion around a table.

Once chosen the modality of electronic communication, it was possible to further define the details of the experimental scheme. Since CMC is more time consuming than face to face conversation, we limited to three the number of communication episodes during each experimental run. Communication time allowed in the CMC version was threefold the time given in the face to face one[4].

The basic structure of the experiment is thus summarized in fig. 2. The repeated game is played by six participants each time. There are 26 to 29 rounds[5]. Subjects face each round the same constituent game, which reproduces Ostrom et al. CPR game (see the appendix for more details). At the end of each round, all subjects were informed about their own payoff in both markets and the group investment level in market 2; at the same time, they could have no information about each single player's investment choices and payoff. At the end of the experiment, subjects were privately paid according to their cumulated payoff over all rounds.

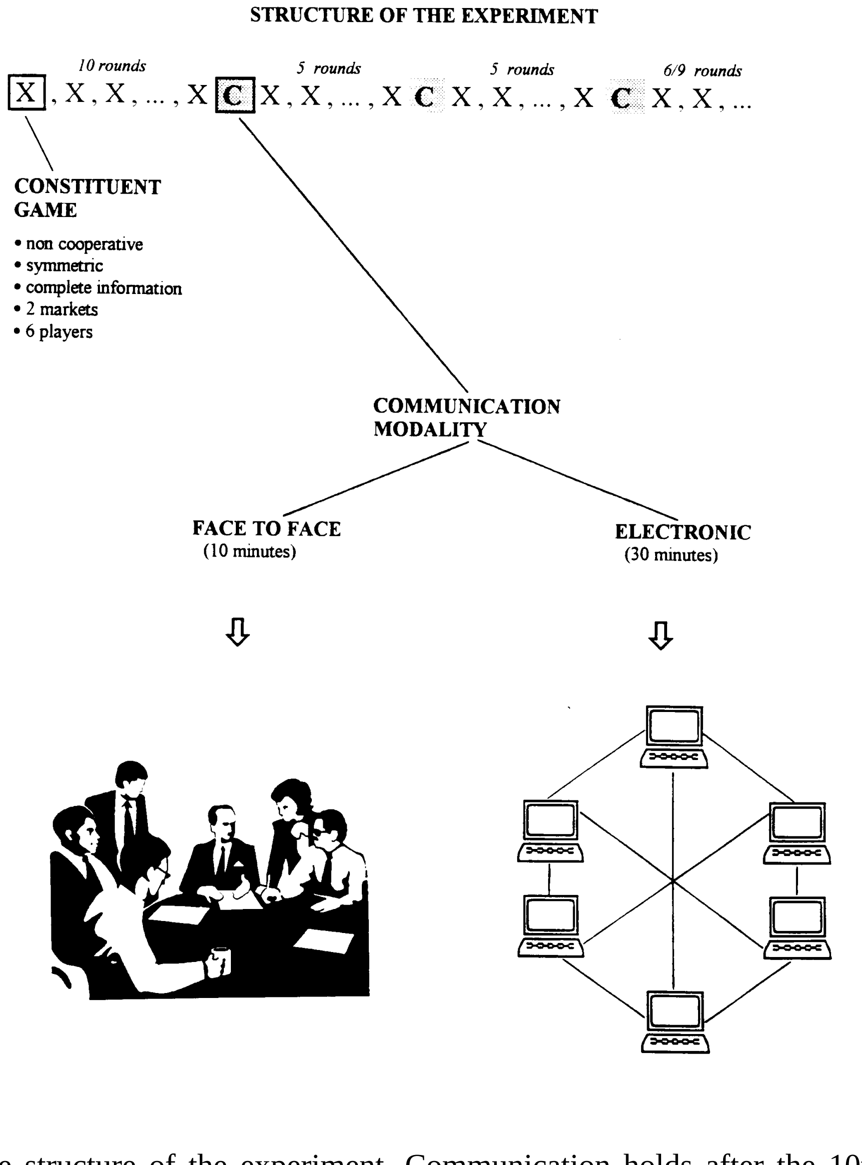

Figure 2. The structure of the experiment. Communication holds after the 10th, 15th, and 20th iteration.

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4 Research has suggested that the time required to reach a consensual agreement among agents with CMC is three to four times the one needed in face to face discussion (Sproull and Kiesler 1991)..

5 Subjects were only informed about the time duration of the experiment, but couldn't know of how many rounds it would consist.

3 - Experimental results.

We have performed for each version of the experiment three runs, each time with different subjects. Although three runs for each version are too few to produce significant statistics, nevertheless they generate two times three "artificial case studies" from which important lessons can be learned. As shall be subsequently seen, behavior in the two versions is different enough to justify their use as preliminary explorations into a realm that will require more systematic enquiry[6].

2.1 Version A: face to face groups

The dynamics of group performance in the face to face version of the experiments is summarized by fig. 3.

In general, there is a striking regularity in group behavior in all three runs. From a first glance at the figure, there are three relevant features that come immediately to the eye.

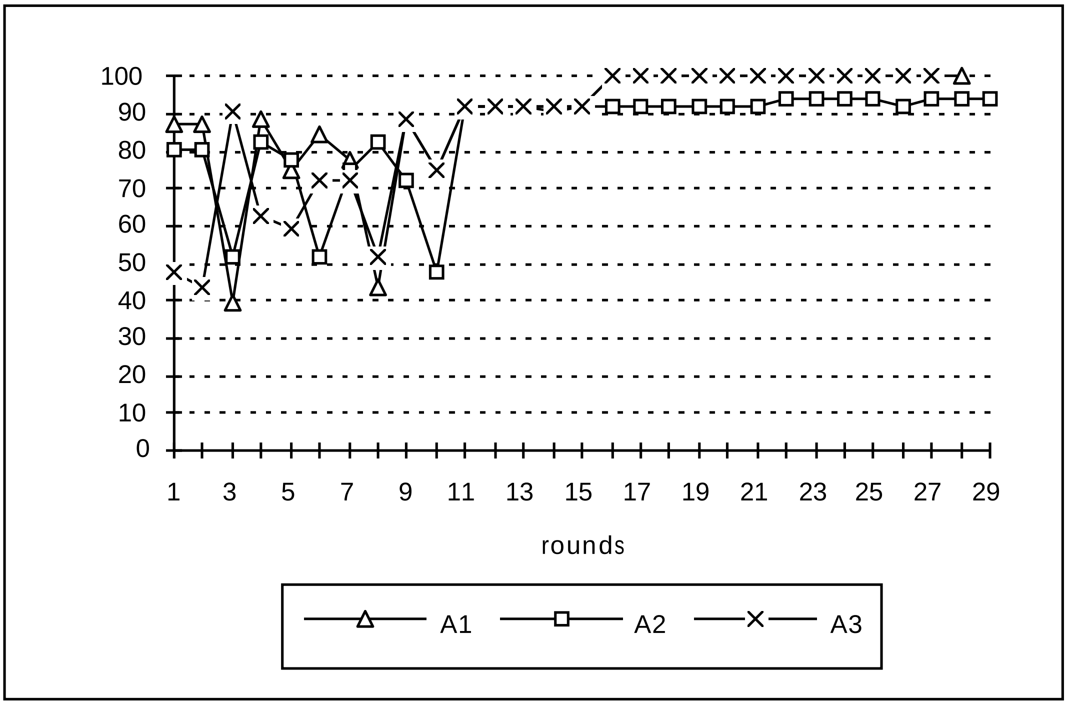

Figure 3. Group payoff in percent in market 2 recorded in three experiments. Vertical lines correspond to communication episodes. A1, A2 and A3 are the three different experimental runs.

Before communication, investment fluctuates

In the first ten periods, subjects cannot communicate. The aggregate level of their investments shows sharp fluctuations. These fluctuations reflect a still unstable characterization of individual behaviors. While part of the subjects do not change their initial altruistic or free riding strategy during these

[6] As usual, budget considerations have limited our ability to replicate the experiments. Further replications and extensions of the experiments are currently under study at the Trento Laboratory of Experimental Economics.

early periods, a substantial fraction of the subjects seems to follow a trial and error process, shifting from defection to cooperation and vice versa. Thus, there seems to be a variable mix of cooperative efforts and free riding that inhibits the emergence of the social optimum and generates unstable patterns of collective investment (see Ostrom et al. 1992, p. 409 for similar considerations).

After communication, stable cooperation emerges

The first communication incident radically modifies the patterns of collective behavior. During the group discussion, subjects find a mutual agreement over a common investment policy, and implement it since the first period following communication. Subjects faithfully implement agreed policies until the end of the game, although the agreements are sometimes redefined in subsequent communication incidents. It is worth noting that although some subjects perceive that the agreement may be sub optimal, they do not betray their former commitments, but rather wait next communication opportunity to propose a better policy. Furthermore, cooperation seems to be robust in front of minor defection events. In one single experimental run, two different subjects over invest by mistake in one period, without triggering a wave of retaliation by other subjects.

Groups get first stuck in the naive optimum

A relevant feature of face to face groups is that after the first communication episode, they all get stuck in sub optimal investment policies, that correspond to what we have called "naive optimum". In other words, they forget to consider the opportunity cost represented by market 1 return rates, and simply look at the highest point of the return parable of market 2. In two cases they are able to improve their performance after further communication, while in a case they are locked in the naive optimum until the end. Thus, face to face groups appear better at cooperating than at collective problem solving, at least in the first shot.

2.2 Version B: electronic groups

The dynamics of group performance in the CMC version of the experiments is summarized by fig. 4.

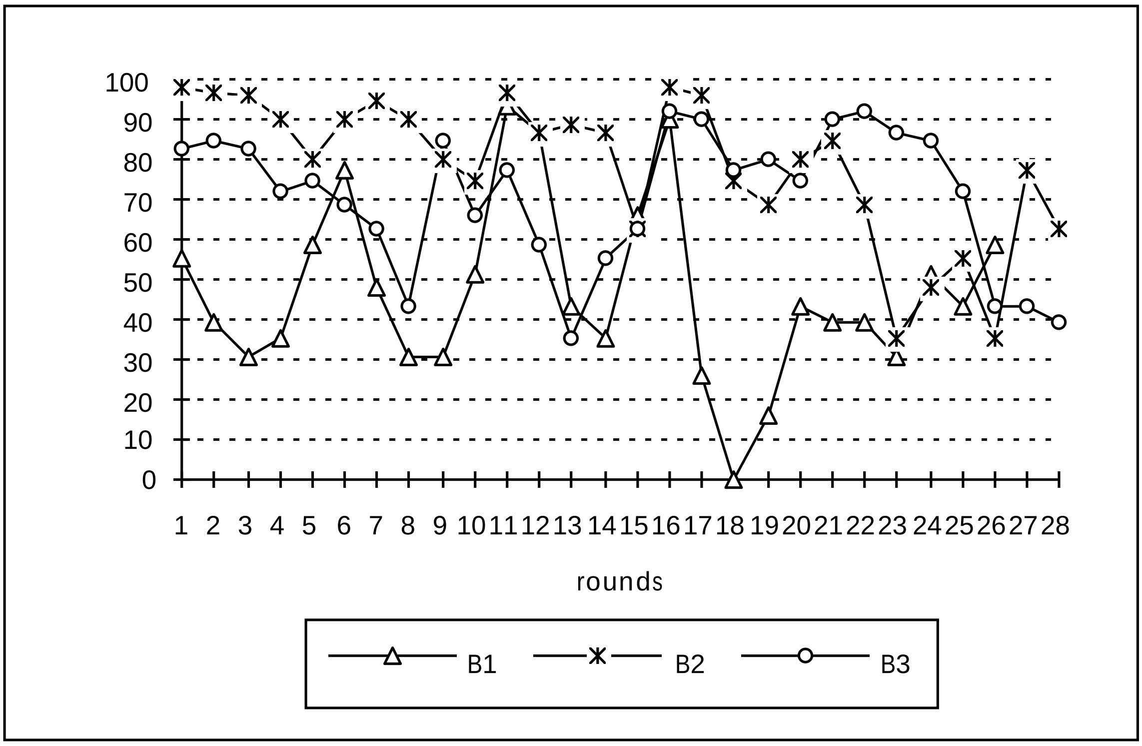

Fig. 4 Group payoff in percent in market 2 recorded in three experiments. Vertical lines correspond to communication episodes. B1, B2 and B3 are the three different experimental runs.

Before communication, investment fluctuates

The behavior of electronic groups before communication is quite similar to that of face to face groups, with the exception of one experimental run, in which there seems to be a stronger inclination to free riding (this suggests that accidentally, anticipation of different kinds of communication by subjects may affect behavior before communication itself). Investment levels fluctuates in ways similar to those commented above, although with minor intensity[7].

After communication, opportunism breaks out cooperation

Although computer mediated communication also enables the emergence of cooperative agreements among subjects, cooperation turns out to be extremely fragile in electronic groups. Overall, six communication incidents over nine generate a cooperative agreement (although in five cases only a majority of subjects commits itself to a group investment policy). However, commitments are systematically disregarded: immediately after the agreement, a few subjects start defecting, triggering an avalanche of free riding. It is interesting to remark that new communication opportunities allow new agreements to be made after the first wave of

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[7] Lack of more observations makes it hard to explain the nature of this slight difference, that might be the effect of random factors.

defections; nevertheless, the impact of subsequent communication on cooperation seems to be neatly decreasing, reflecting growing collective disenchantment. In two experimental runs, agents explicitly give up in the last communication round, stating the failure of collective spontaneous agreements without the "sword" of authority. A third run is somehow different, since agents fail to reach an agreement in the first communication episode, but do agree on a sub optimal policy in the two subsequent ones, defecting immediately after. Finally, all groups converge in the last phase of the game towards an aggregate investment level that approximates the corresponding Nash equilibrium aggregate investment[8].

Electronic groups are smarter problem solvers than face to face ones

Despite their modest cooperative performance, if one looks at the group ability to find out optimal collective solutions, electronic groups appear to be smarter than face to face ones in at least two cases over three. While face to face groups have shown to be extremely prone to be trapped in the naive optimum in the early phases, two electronic groups immediately find the correct social optimum since the first communication round.

2.3 Some comparative statistics

Following tables provide some comparative statistical information concerning the experimental results with the two communication modalities. Experimental runs have been subdivided in four phases, the first one including the first ten periods before communication, and the other ones including the periods following each communication incident. Table 1 reports the average aggregate group investments and the average group payoffs (in percent)[9].

	Face to Face Groups							Electronic Groups					
round	**A1**		**A2**		**A3**			**B1**		**B2**		**B3**	
	inv	**r.%**	inv	**r.%**	inv	**r.%**		inv	**r.%**	inv	**r.%**	inv	**r.%**
1-10	53.2	**77.7**	55.2	**71**	56.2	**69**		62.2	**47**	46.9	**90**	54.5	**74**
11-15	46	**92.3**	46.2	**91**	46	**92.3**		55.8	**72**	49.2	**86.2**	59	**59.2**
16-20	36	**100**	46	**92.3**	36	**100**		63.6	**40**	49.2	**86.2**	50.4	**82.6**
21-...	36	**100**	45.2	**93**	36	**100**		62.8	**45**	58.7	**60**	54.6	**73**

Table 1 Aggregate average group investment (inv) and related average group payoff (%) in the four blocks of each experimental run.

8 This is in analogy with what happens both in the no communication and in the one-shot only communication versions of the Ostrom et al. (1992) experiment. Notice that the analysis of individual investment policies indicates that what is approximated ia an asymmetric Nash equilibrium, rather than the symmetric one. For a discussion, see Keser and Gardner 1994.

9 Net yield accrued as a percentage of maximum = (return from Market 2 - opportunity costs of tokens invested therein)/(return from Market 2 at the social optimum - opportunity costs of tokens invested therein) . Opportunity costs equal the potential return that could have been earned by investing the tokens in Market 1.

More interesting is to look at the intensity of defection in the two versions (Table 2): defections in electronic groups increase as one moves from each phase to the following, and as one goes away from the last communication episode (Figure 5).

Fig. 5 Number of players that defect after each computer mediated communication phase (CP) even if a commitment has been defined. Each of the three lines represents an experimental run

A more subtle feature is how the distribution of individual investments evolve through time. Figure 6a shows the distribution of individual investments in tokens during the initial rounds of the electronic version of the game. Figure 6b gives the same information referred to the last rounds of it. It is possible to evidence a convergence to higher individual investment levels, which, on the average, confirm the game theoretic prediction (the Nash equilibrium).

Finally, table 2 provides more precise information about the content of agreements in each experimental run. For each communication incident, we report the existence or not of an agreement, its distance from the social optimum, and how many subjects declare to agree.

	Face to Face Experiments						**Electronic Experiments**					
runs	**A1**		**A2**		**A3**		**B1**		**B2**		**B3**	
	r. %	**n.**	**r. %**	**n.**	**r. %**	**n.**	**r. %**	**n.**	**r. %**	**n.**	**r. %**	**n.**
1st CP	92.2	6	92.2	6	92.2	6	97.2	5	100	4		
2nd CP	100	6	92.2	6	100	6	97.2	6	100	5	92.2	5
3rd CP	100	6	93.6	6	100	6					92.2	5

Table 2. Content of agreements: group payoff in percent of the social optimum (r.%) and number of players who subscribe to the agreement (n), emerging in each communication phase (CP). Empty cell means that no agreement was reached.

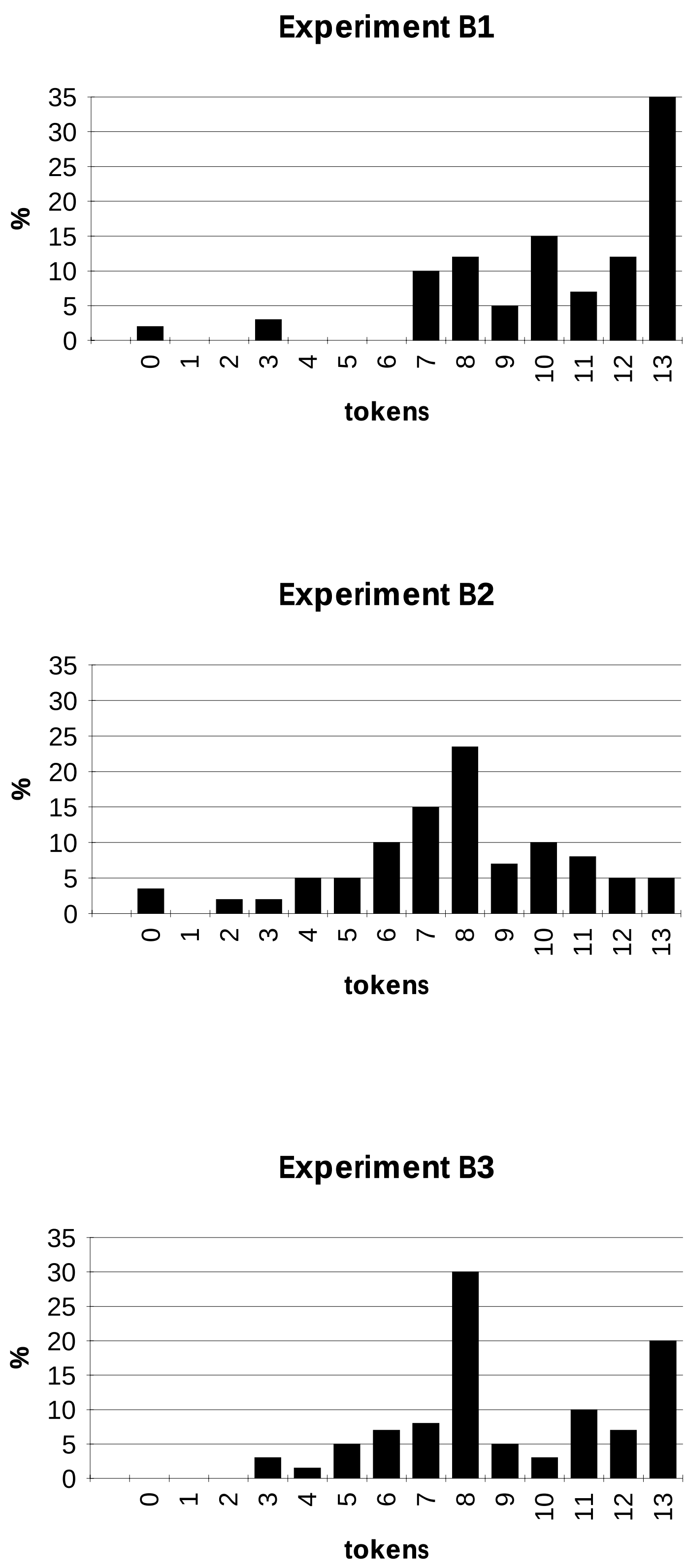

Figure 6a Distribution of individual investments in market 2 during the first ten iterations of the game (version B).

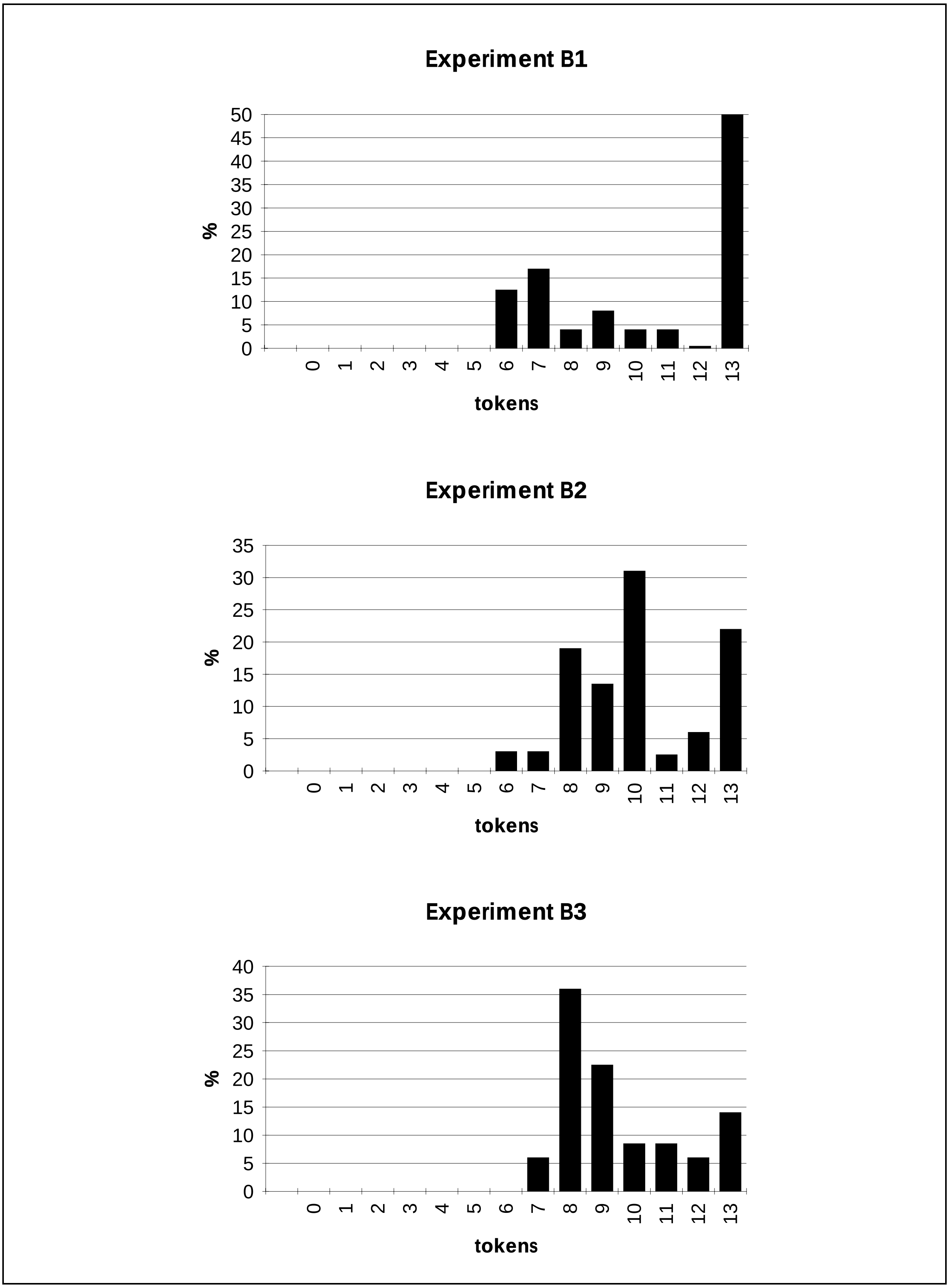

Figure 6b Distribution of individual investments in market 2 during iterations 23 to the last of the game (version B).

4 - Explaining electronic opportunism: communication and the structuring of groups.

The former report of experimental results leaves us with two key questions. Why does face to face communication facilitate cooperation, while e-mail based communication leads to growing waves of opportunistic behavior? And why do electronic groups, on the converse, better perform at collective problem-solving tasks? Furthermore, are these two phenomena independent or interrelated?

Trying to approach an answer to such questions requires a closer analysis of the form and the content of communication within the experimental groups.

In the case of electronic groups, we have recorded every message exchanged among subjects, thus providing complete information about communication contents. In the case of face to face groups, on the other side, communication is not filtered by any artificial support, and thus we had to record it through a sort of "candid camera", providing not only verbal protocols of discussions but also information about other aspects of communication (tones of voices, facial expressions, gestures) (Goodwin and Heritage 1990).

We must recall that the choice of subjects was guided by a concern to have experimental groups with the minimal amount of prior mutual personal knowledge (see appendix). Thus, it was reasonable to assume that there were no significant prior group dynamics before the start of the experiment. The experiment consequently shows the genesis of group interactions from an initial collection of disconnected individuals in a controlled laboratory setting. The examination of communication protocols suggests that the face to face communication allows a much stronger structuring of the group than e-mail based communication.

The distribution of communication activity

A first, rough indicator of the group structuring may be the distribution of communication activity among group members (Sproull and Kiesler 1991), that points out to a sort of "structural entropy" of interventions. As table 3 shows, face to face groups exhibit much stronger variance in individual resort to communication. In other words, in face to face groups, there is a more unequal participation of individuals to discussions.

	Face to Face Experiments				**Electronic Experiments**		
runs	**A1**	**A2**	**A3**		**B1**	**B2**	**B3**
average	23.5	22.8	33.2		14.2	24.0	18.3
variance	89.6	95.1	68.1		25.1	33.0	23.5

Table 3 Individual interventions during each experimental run: average number and variance.

This phenomenon has already been observed in similar settings, as summarized in Sproull and Kiesler (1991). Although Sproull and Kiesler emphasize differences in status as an explanation of this effect, our data point out to an explanation which is more linked to the way e-mail based communication affects patterns of conversation in the group. Face to face conversation is typically structured by two main set of rules (Suchman 1987): sequentiality rules and alternance rules. Sequentiality puts constraints on conversational coherence, implying that each individual expression acts as a premise of subsequent ones and helps to interpret them. Thus those that subsequently intervene are constrained by former ones.

Alternance rules discipline the way individuals take their turn in a conversation. Again, alternance rules inhibit parallel talk and constrain the individual ability to enter a discussion and contribute to it. Altogether, these rules imply a high degree of order in a conversation, which appears as a paradigmatic form of social cooperative interaction (Schegloff 1972, Sacks, Schegloff and Jefferson 1978).

E-mail communication affects discussions by altering both rules, loosening their effect. Alternance rules obviously break down, since many subjects at a same time can send messages without disrupting the flow of the discussion (e.g. by interrupting another intervenant). Thus, there is no alternance, but (potential) simultaneity. Sequentiality is loosened by the fact that, having no direct feedback on his/her interventions, one can lose coherence with the conversation without being stopped by others; moreover, one can avoid answering to some messages, or ignore them, or refer to any other moment of the conversation, or enter some monologue going on regardless of what others think and say. Consequently, there is a very loose social control over the conversational order. Second, there is a potential overflow of messages, due to the break down of alternance rules, that makes it so that while one responds to some message, there are new messages arriving he cannot read while writing, such that when he sends his reply sequentiality with the development of the conversation is lost (McGrath 1990).

Summarizing, the more equal access to communication in electronic conversation is not necessarily the consequence of less status concerns (and more conversational democracy) but can be the result of lesser order induced by the technical nature of communication and by its effects on conversational rules. If there is communicational democracy, it can easily be a democracy of monologists.

First advocacy effects

This argument can also help to understand the presence of "first advocacy effects" in face to face groups and its absence in electronic ones. The "first advocacy effect" is another well-known phenomenon in group discussions (Weisband 1992, Dubrovsky et al. 1991). It consists in the prevalence of the first solution proposed in collective problem solving activities. Coherently with former laboratory observations (Weisband 1992), our experiment shows that in all face to face communication incidents, the first proposed solution is the one enacted by the group. This doesn't happen in the electronic version of the experiment. This is a major cause of the better problem solving performance of the electronic discussions, since electronic groups do not get stuck on initial naive solutions but go on exploring a larger set of possible solutions.

Conversational rules again can play a major role in causing the divergence of outcomes in face to face and electronic discussions. In particular, sequentiality rules appear to be tightly connected to first advocacy effects, since they immediately focus group attention on the development of the first proposal, that acts as the premise of the subsequent discussion and structures the subsequent flow of information. In the electronic setting, sequentiality rules are looser, and thus there is much less focusing on first proposals (and there can be more than one "first proposals", as a consequence of the absence of alternance rules).

Structural differentiation

An important effect of first advocacy on group structuring is the emergence of leadership phenomena. The first advocate gains leadership attribution by group members, creating elementary forms of differentiation in the face to face group structure that do not appear in the electronic ones.

The differentiation of social structure is further enhanced by the shaping of subgroups and by simple forms of task decomposition, that in our experiment are again peculiar to face to face groups only. For example, during a discussion, a group has split in three subgroups: one group was calculating the individual payoffs deriving from the last proposal, another one was exploring alternative strategies, and in a third group one subject was trying to convince reluctants to adhere to a given policy. Furthermore, within subgroups there was an elementary division of labor (e.g. one subject was suggesting how to compute payoffs, while the other one was making actual computations). The decomposition in subgroups tends to be a spontaneous process that self-reinforces during discussions rather than being intentionally planned: division of labor emerges by evolution rather than by design (Hutchins 1991).

Once more, the process of differentiation of social structure in face to face groups seems to exploit the more flexible resources offered by face to face communication. For example, organizing an elementary division of labor such as the one referred above in an electronic context would imply too high communication load and time as compared to what is required in face to face interaction. Consequently, in electronic groups, people that propose a strategy usually make by themselves all the related computations. Monitoring among subgroups would also be more complex in the electronic context, making it difficult to keep them coordinated. An important implication is that the elaboration of investment strategies in face to face groups involves more persons (is more a collective achievement) than in electronic ones. It is reasonable to assume that this may have a relevant impact on people's propensity to keep to agreements and cooperate.

The emergence of collective norms

A crucial aspect of group life is the emergence of norms and conventions. Norms can play an especially relevant role in social dilemmas, favoring cooperation in absence of hierarchies or institutions (Lewis 1969, Hardin 1982). Our experiment exhibits the emergence of simple norms and conventions in a laboratory environment. However, those rules of behavior happen to be radically different in the two kinds of group. Face to face groups engage very early in discussions about rules of behavior in case of agreement violations. They stress the need to keep the group cohesion even face to defections, countering the benefits of cooperation to the costs of everybody defection. Electronic groups are initially less prone to discuss norms of collective behavior, and when doing it follow the opposite path, engaging in menaces of general defection as a deterrent for individual opportunistic temptations. Thus, norms in electronic groups are more fragile than those in face to face groups, since they imply the end of cooperation even in presence of minor defections. While the face to face convention elicits the promise that, in front of a defection, other will keep on cooperating, the electronic group norms imply the expectation that a single defection will break out cooperation. Face to face groups stress the carrot, while electronic groups only see the stick.

Once cooperative norms are interiorized in face to face groups, they do not need to be reasserted even when there have been minor defection episodes (as it happens twice, as recalled above). On the other side, after defection waves have arisen, electronic groups reaffirm their norms in increasingly aggressive terms, finally degenerating in insulting menaces and expressions - a variant of the well-known "flaming" effect in electronic communication (Sproull and Kiesler 1991). Cooperative agreements are not the only norms that collapse in electronic groups. Other examples include the violation of the social obligations to answer to questions or to tell the truth: both norms have been heavily and repeatedly violated in the electronic version of the experiment, while they have been respected in face to face groups.

The weakening of social norms in electronic contexts has been repeatedly described (Sproull and Kiesler 1991). Explanations of this phenomenon have much emphasized the de-individuation and insulation generated by computer mediated communication. The technological filter lets people's body disappear, with its context of status signs, emotional expressions, symbolic attributes, respect, identity etc. However, this explanation doesn't capture completely our evidence: the problem is not that people do not respect norms because they feel anonymous, but that subjects are unable to generate cooperative group norms, and this affects their perception of not being part of a group. Group identity rather than personal identity is the missing factor. Even extreme behaviors as insulting others in "flaming" episodes do not reflect only de-individuation but also come from increasingly frustrated expectations about the shaping of a cooperative group.

All these observations point out to a general theme: a discussion is a cooperative achievement in itself that sustains the ability to interpret other people's actions, intentions or beliefs. This cooperative achievement is allowed by the rules that organize a conversation described above and that make its contents intelligible. Mutual intelligibility is based on one side on the systematic organization of the speech prosody, gesture, facial expression of the speaker, on the other on head nods and shakes produced by the participant who is in the role of listener (Krauss and Fussell 1990).

Furthermore the success of communication as joint task enable *speech act* as a mean to engage oneself or the others in future actions (Searle 1972). In our specific experiment this action consists in respecting a cooperative behavior through promises. E-mail based communication loosens or disrupts communication rules, and hence makes it much harder to create an order in a discussion. This fact is reflected in the general dissatisfaction that subjects have expressed about their experience with electronic communication at the end of the experiment. What makes our subjects unhappy with computer mediated communication? Interestingly, they cannot be unsatisfied with the ability of CMC to sustain problem solving, since we have seen that electronic groups have been better problem solvers than face to face ones. Furthermore, the vast majority of subjects interviewed after the experiment do not complain about lack of time in communication. They rather emphasize the intrinsic disorderliness of the discussion and the chaotic flow of messages. Subjects complain that they have often lost the thread of what others were saying; it was often unclear to whom a message was responding; information was often redundant, since many subjects were simultaneously writing the same things; and there was a permanent unbalance between reading and writing - most of the time subjects were writing, losing important exchanges of information. Thus, although e-mail based communication is effective in supporting collective problem solving efforts, it makes people helpless in organizing the conversation, thus failing in creating the social order of the discussion.

Problem solving performance and communication

The previous observation s suggest an explanation of why electronic groups are more effective at finding optimal solutions, even if they are subsequently unable to implement them.

Electronic groups have generated a flow of proposals that, in absence of the sequentiality rule, have been able to stay alive until the end of the communication phase. The electronic storage of messages has obviously supported individual memory to keep track of the flow of proposals. Furthermore, the flow of proposals has been much wider than in face to face communication for a series of reasons, including the lower influence of the first proposal, the more concise and task oriented nature of messages exchanged, and the lack of temporary freezing of the discussion around secondary issues. At the end of the electronic discussion, subjects have in facts voted on most interesting solutions. The lack of leadership factors has clearly affected both the proposal generation and selection processes, since there has been no subject able to manage the communication flow thanks to a superiority role recognized by all participants.

Communication phases in face to face experiments have been radically diverse. Proposals have been expressed, explained and evaluated one by one, respecting the sequentiality rule

Each phase has ended with an endorsement by all members of the group of the best looking proposal. The first advocacy effect and leadership have thus deeply affected the number and the quality of proposals and the final selection process. This explains why it took more communication phases to find out the optimal solution and why the choice process has been initially locked in the naive optimum, which is the easiest solution to find and thus has a high probability of being the first one generated.

5 - Concluding remarks.

In this paper, we have explored how different communication modalities affect the ability of experimental groups to find and implement cooperative solutions in an iterated social dilemma. By comparing the effects of face to face discussions with those of computer mediated communication, we have found that in "electronic groups" cooperation is extremely fragile, exposed to the arousal of waves of opportunistic behavior, despite the positive effects of computer mediated communication on collective problem solving ability. This result might be explained by the de-individualising, isolating effects of electronic communication (Diener 1980, Sproull and Kiesler 1991). However, a closer analysis of communication protocols brings us to emphasize how in electronic contexts the loosening of the basic organizing rules of face to face conversation may play a major role in explaining the fragility of cooperation. The inability of subjects to cooperatively construct an ordered conversation may inhibit the emergence of group structure and identity, causing the final break-down of cooperation. Of course, the two explanations appear to be more complementary than competing (in fact, recent research in the theory of social identity underlines that personal and group components of social identity do converge: Reicher 1984, Spears et al. 1990).

As most laboratory work , our experiment has tried to answer highly general questions by exploring collective behavior in very specific conditions. Thus, one has to be extremely cautious in extrapolating the experimental results to ecological conditions in which computer network technologies are actually used. However, the relevance of the social dilemma metaphor for understanding collective behavior in electronic contexts is unquestionable. Computer networks are common pool resources in themselves, just like irrigation channels or commons. They are exposed to dramatic risks of over exploitation, which are multiplied by the irrelevance of variable costs to their usage. Once people are connected to networks, they have an incentive to exploit them to a maximum level, leading to well-known phenomena of overload and "electronic traffic jams". Moreover, there are multiple opportunities for free riding in the networked society. For example, people in organizations can access information stored in databases by others without contributing in turn to information storage, thus creating informational asymmetries they can exploit (or simply avoiding the costs of storing information without losing the advantages of accessing it). In the long run, as database free-riding diffuses, this may generate useless databases. Kollock and Smith (1995) have been studying Usenet communities in the Internet, and have shown how social dilemmas arise in such "virtual commons" (notice that Usenet groups are in facts large mailing lists). Several free riding behaviors have been singled out in their analysis, ranging from bandwidth overuse to lurking (reading ongoing discussion without contributing to them) to breaking cultural and social rules like decency. Those free riding behaviors can disband entire Usenet groups or paralize them in conflict, showing all the disruptive power of electronic opportunism.

A relevant question concerns the fact that in our experiment we have intentionally avoided to have a prior history of interactions among group members (see appendix). One may hypothesize that CMC wouldn't affect cooperation if subjects had previously developed group experiences. The problem branches in two sub-questions. The first one is: what is the impact of prior face to face group experience on subsequent cooperation in an electronic context? Here, the problem is that of the transferability of group identity and norms in new, electronic contexts. The second question is: would electronic groups learn to cooperate after a first failure if they could reiterate the experience (or a similar one)? In this case, the problem is that of the evolution of cooperation within electronic contexts: do groups learn from their former failures, and how? We are currently planning to explore both questions by new experiments. A first attempt to analize the impact of prior face to face social interaction on subsequent electronic group behavior has shown that groups with prior experience of face to face interaction in non related tasks show higher levels of cooperation while preserving the problem solving effectiveness of CMC (Rocco, in preparation).

A related question concerns the impact of subjects' expertise with e-mail based communication in collective problem-solving tasks[10]. If the constraints e-mail imposes on the syntax of conversation are critical, subjects with enough experience in problem solving though CMC might have developed a stronger communicational competence in the electronic context. This might significantly facilitate the emergence of conversational organization and thus of cooperation tout court.

Finally, it should be stressed that we have chosen to use in our experiment a groupware tool based on e-mail, since this is the most diffused electronic communication system. Unfortunately, it is not also the most flexible one. It wouldn't be generous to extrapolate our results to electronic communication per se. Different communication systems will differently affect the rules of discussion and thus the self-organizing abilities of groups. For example, other technologies might be more able to reproduce alternance and sequentiality rules or to bring in the body of participants. Despite its limitations, our experiment may suggest from this point of view relevant directions in which CMC tools can be developed, stressing the need for more conversation-oriented technologies (Winograd and Flores 1986).

[10] Our subjects were experienced e-mail users, but had no relevant prior exposure to collective problem solving tasks through e-mail.

Appendix

The experiment

The CPR game

The CPR game consists in the repetition of a constituent game by a group in a given number of rounds. The main four constituent game's features are so summarized: it is a *static*, *symmetric, non cooperative*, *complete information game*. This means that: first, all decisions are simultaneously taken by each player in each round; second, each player has the same endowment, the same set of feasible strategies and the same payoff function; third, commitments are in no ways made enforceable relying on external authorities; fourth, every player exactly knows each individual payoff corresponding to any individual strategies' combination.

At the start of a round each player is endowed with e (e=13) tokens and he has to divide the whole sum in two markets, without fractionating any token or keeping any token apart. The markets are named Market 1 and Market 2.

Market 1 represents the safe alternative: it yields a payoff of 5 cents (w = 5 cents) per token invested and there are no limits to the individual investment in it. Market 2 represents instead the common pool resource (CPR) as it is conceptualized as a collective good suffering over- appropriation by the investors' group. Supposing to calculate market 2 payoff in commodities, let Sxi denote the total investment in the CPR by the group and v = 1 cent the value of each commodity produced in this market. The group payoff (in cents) in market 2 is given by the following production function:

$$F(Sx_i) = 23\, Sx_i - 0.25\, (Sx_i)^2$$

It is a concave parabolic function with parameters a = 23 and b = 0.25. A low level of group investment pays better off than the investment in market 1 (F'(0) > w), but, as the investment level grows up, the marginal return decreases and becomes negative above a 46 tokens group investment (F'(46)=0).

Each participant receives an individual payoff from market 2 proportional to the ratio of his own investment to group total investment in this market. This implies that everyone has an incentive to increase his own investment (xi) in market 2 to maximize an individual payoff function; nevertheless, as every player adopts this strategy, everybody gets a payoff inferior to the one that can be achieved if every player limits the investment in market 2. This situation clearly depicts a social dilemma, where an individual payoff function conflicts with a collective payoff function.

Formally, the individual payoff function is given by :

$$u_i(x) = \begin{cases} w \cdot e & \text{, if } x_i = 0 \\ w(e - x_i) + x_i / Sx_i\, F(Sx_i) & \text{, if } 0 < x_i <= e. \end{cases} \qquad (1)$$

The collective payoff function consists in the sum of all individual payoffs ui(x):

$$u(x) = nwe - w\, Sx_i + F(Sx_i) \qquad (2)$$

Both functions can be optimized by applying first order conditions. The "egoistic" group investment level resulting from maximization of function (1) is given by:

$$Sx_i^* = (n/n+1)\ (a - w)/b \qquad (3)$$

Let equation 1 represent the payoff function in a symmetric, non cooperative game. This implies that there is a unique symmetric Nash equilibrium, with each subject investing

$$x_i^* = (1 /n+1)\ (a - w)/b \qquad (4)$$

It is important to emphasize that other Nash equilibria are represented by the whole set of asymmetric Nash equilibria, where players invest different amounts of tokens in market 2, but the total amount respects condition (3).

The optimization of function (2) leads to a collective optimum or social optimum, consisting in an individual investment about half the amount of former "egoistic" level. First order conditions of equation (2) are:

$$- w + F' (Sx_i) = 0 \qquad (5)$$

It means that the social optimum is achieved when the marginal return from market 2 equals market 1' s riskless return rate (see fig. 1). Thus, the group optimal investment level is given by :

$$Sx_i^{**} = (a - w)/2b \qquad (6)$$

Hence, the maxima of functions (1) (and (2) correspond respectively to the two focal behaviors in a social dilemma: the dominant choice of defection (no one would like to move away from this choice) and the more profitable but fragile one of cooperation. Cooperation can also correspond to a sub optimal commitment, if players maximize only $F(Sx_i)$ as a collective payoff function, ignoring the opportunity cost represented by market 1. Following Keser (1994) we call this equilibrium naive optimum.

Table 1 summarizes the former exposition of the game

market 2 production function	$23\ Sx_i - 0.25\ (Sx_i)^2$
market 1 return rate	5 cent
market 2 return rate	1 cent
number of individuals	6
individual endowment	13 tokens
Nash equilibrium individual investment	10 tokens
Social optimum individual investment	6 tokens
Naive equilibrium individual investment	8 tokens

Total individual payoff at Nash Equilibrium	95 cents (= 52%)
Total individual payoff at social optimum equilibrium	119 cents (=100%)
Total individual payoff at naive equilibrium	95 cents (= 92%)

Table 1 Some quantitative characteristics of the experiment

The implementation of the experiment

The experiment iterates the constituent game over 26 to 29 times. Everybody receives complete information about the constituent game (payoff functions in both markets, average and marginal returns) and a table with all payoffs deriving from any combination of investment in both markets. At the beginning of the experiment, players are told that they are going to make a series of investment decisions, under the following restrictions: 1. all individual investments are anonymous to the group; 2. the length of this series is only temporally known. Thus each player sits in front of a networked computer on which he makes investment decisions and receive, after each iteration, information about the outcome of the last choice, and the record of past outcomes. Specifically, the player has the following information about the last iteration: how much himself individually invested in market 1 and 2, and the corresponding payoffs; and what was the level of group investment in market 2 (thus, he can't have information about others' individual choices).

After the tenth, fifteenth and twentieth iteration, subjects receive a message interrupting the game and allowing them to start a communication phase. There are two versions of the experiment, that only differ for the communication modalities allowed to subjects. In one case, communication happens around a table, and has a 10 minutes duration, in the other participants communicate by a mailing list, a particular e-mail communication protocol, for 30 minutes.

The message all players receive tells : "*Some participants in experiments like this have found it useful to have the opportunity to discuss the decision problem you face. You will be given ten (or thirty*, in the electronic version*) minutes to hold such a discussion. You may discuss anything you wish, respecting the following conditions: 1. you are not allowed to discuss side payments; 2. you cannot make physical threats; 3. you cannot see the private information on anyone's monitor*."

The selection of experimental subjects

Participants to the experiment were recruited according to two criteria. 1) The target was represented by undergraduate students in Economics, Environmental Sciences and Information Sciences of the University of Venice; subjects of the electronic version of the experiment had to be experienced users of electronic networks. Thus, these subjects were recruited directly through e-mail messages; other subjects were recruited through ordinary announcements in the University locals. 2) We tried to have minimal mutual knowledge of subjects prior to the experiments. Although this was not perfectly possible, we arranged groups in such a way that more than 80% of participants knew only one other participant in the same group.

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