CHAPTER 7

Communication in the Commons

In chapters 5 and 6, we investigated behavior and outcomes in CPR dilemmas embedded in minimal institutional configurations. The behavior of subjects in these settings generates suboptimal, aggregate outcomes. In particular, outcomes closely approximate the aggregate predictions derived from noncooperative game theory applied to finitely repeated CPR dilemmas and are thus grossly inefficient from the perspective of maximizing group income. As we shall see in chapters 10–14, data from field settings suggest this type of outcome is not inevitable in settings with a richer set of institutional options for fostering communication and/or allowing sanctioning of noncooperative behavior. In this and the next chapter, we begin to examine simplified versions of more complete institutions. In this chapter, we explore the effects of face-to-face communication on appropriation behavior. In chapter 8, we examine behavioral properties of sanctioning as an independent mechanism and in conjunction with communication.¹

Communication: Theoretical Issues

The effect of communication in CPR situations, where individuals repeatedly decide on the number of resource units to withdraw from a common pool, is open to considerable theoretical and policy debate. Words alone are viewed by many as frail constraints when individuals make private, repetitive decisions between short-term, profit-maximizing strategies and strategies negotiated by a verbal agreement. Hobbes justified the necessity of a Leviathan on the frailty of mere words. For Hobbes, a contract that involves a promise by at least one of the parties to perform in the future is called a “covenant.” When both parties promise future performance, it is a “covenant of mutual trust” (Hobbes [1651] 1960, 87, 89). A covenant of mutual trust in a state of nature is void in Hobbes’s view if either has a reasonable suspicion that the other will not perform.

¹ This chapter relies extensively on E. Ostrom and Walker 1991.
For he that performeth first, has no assurance the other will perform after; because the bonds of words are too weak to bridle men’s ambition, avarice, anger, and other passions, without the fear of some coercive power, which in the condition of mere nature, where all men are equal, and judges of the justness of their own fears, cannot possibly be supposed. (Hobbes [1651] 1960, 89–90)

On the other hand, a covenant made “where there is a power set up to constrain those that would otherwise violate their faith” is likely to be fulfilled (Hobbes [1651] 1960, 90). Thus, Hobbes argued for the necessity of a “coercive power, to compel men equally to the performance of their covenants, by the terror of some punishment, greater than the benefit they expect by the breach of their covenant” (Hobbes [1651] 1960, 94).

The weakness of mere words and the necessity of external agents to enforce contracts is also a foundation upon which the powerful edifice of noncooperative game theory has been constructed. John Nash (1950, 1951) was among the first to distinguish between cooperative and noncooperative games. In cooperative games, players can communicate freely and make enforceable agreements; in noncooperative games, they can do neither. Some theorists particularly stress the inability to make enforceable agreements:

the decisive question is whether the players can make enforceable agreements, and it makes little difference whether they are allowed to talk to each other. Even if they are free to talk and to negotiate an agreement, this fact will be of no real help if the agreement has little chance of being kept. An ability to negotiate agreements is useful only if the rules of the game make such agreements binding and enforceable. (Harsanyi and Selten 1988, 3)\(^2\)

Thus, much of contemporary, noncooperative game theory treats one of Nash’s conditions as superfluous. In this view, the ability to communicate is inessential and unlikely to change results unless the individuals involved can

\(^2\) Harsanyi and Selten add that in real life, “agreements may be enforced externally by courts of law, government agencies, or pressure from public opinion; they may be enforced internally by the fact that the players are simply unwilling to violate agreements on moral grounds and know that this is the case” (1988, 3). To model self-commitment using noncooperative game theory, the ability to break the commitment is removed by trimming the branches that emanate from a self-commitment move to remove any alternative contrary to that which has been committed. In a lab setting, this would mean changing the structure of the alternatives made available to subjects after an agreement, which was not done.
call on external agents to enforce agreements.\textsuperscript{3} Verbal promises to keep agreements lack credibility when individuals know they will face future choices where sticking with an agreement would be costly. Theoretically, such promises are an insufficient basis for individuals to change strategies from a Nash equilibrium to something more cooperative.\textsuperscript{4} In the standard formulation of the theory, the key is that verbal commitments do not change the formal game structure. That is, if the games implemented in our laboratory setting accurately induce the valuations corresponding to the payoff function of the constituent game $X$, no strategic content is ascribed to nonbinding communication. More formally, when the symmetric constituent game $X$ has a unique symmetric equilibrium $x^*$, neither finite repetition nor communication creates new symmetric equilibrium outcomes. Let $c$ denote a communication strategy, in the communication phase $C$, available to any player. As long as saying one thing and doing another has no payoff consequences, then any strategy of the form $(c, x^*)$ is an equilibrium of the one-shot game $(C, X)$, and finitely repeated $x^*$ is a subgame perfect equilibrium outcome of one-shot communication $(C, X, X, \ldots, X)$ or repeated communication $(C, X, C, X, \ldots, C, X)$. In this situation, subgame perfection is deaf to covenants. However, as we show below, communication makes a big difference to behavior.

While the necessity of external enforcers is assumed necessary for cooperation in finitely repeatedly games, most theorists argue that stable and efficient equilibria can be achieved by participants in infinitely repeated games without the necessity of external enforcers.\textsuperscript{5} These arguments rely on trigger strategies (see chap. 3). Such strategies contain both a "stick and a carrot." The carrot (or benefit) is the gains that accrue to players from cooperation. The stick (or the punishment) is the credible threat to return to playing a one-shot noncooperative equilibrium strategy. A "grim trigger" strategy involves the threat to play the punishment strategy forever. Faced with the prospect of an infinitely long punishment, the argument is that no one would deviate from cooperative play. But, as we discussed in chapter 5, our games are not infi-

\begin{enumerate}
  \item Self-commitment is also possible, but whether the agreement is backed by external agents or self-commitment, the essential condition is that all branches of the game tree are removed that correspond to moves violating the agreement that has been made (Harsanyi and Selten 1988, 4). In the lab, this would mean that the experimenters would reprogram the experiment so that no more than the agreed upon number of tokens could be invested in the CPR. This condition was never imposed in the laboratory experiments. In the field, this would mean that some action was taken to remove the feasibility of certain types of activities. In a field setting, this is an almost impossible task.
  \item Considerable theoretical interest exists in various types of "cheap talk" options and their role in helping players achieve cooperative outcomes.
  \item This is based on the Folk Theorem of infinitely repeated games.
\end{enumerate}
nite, and as we discuss in chapter 9, there is some doubt whether trigger strategies organize observed behavior.

Even though our games are finite, there are two alternative approaches for explaining observed patterns of cooperation. These approaches rely on notions of incomplete information. One source of incomplete information could surround the subjects’ perception of the termination point of the experiment. For example, suppose the players approach the game as if it were repeated, but with only a vague notion of how many repetitions. Assuming a very low termination probability, subjects may realize there is more than one sensible way of playing the game and that there are group gains to some of these possibilities. That is, not knowing exactly when it ends, they form their own continuation probability and act as though the game might last forever. In this case, there are many other equilibria available to them besides those associated with grim triggers. Some of these have efficiencies higher than that implied by the one-shot Nash equilibrium being played repeatedly, but less than 100 percent. A second source of incomplete information concerns other players’ types. For example, face-to-face communication (and resulting verbal commitments) may change subjects’ expectations of other players’ responses. In particular, if a subject believes that other subjects are of a cooperative type (that is, will cooperate in response to cooperative play) that subject may play cooperatively to induce cooperation from others. In this case, cooperating can be sustained as rational play in the framework of incomplete information regarding player types.6

Studies of repetitive CPR situations in field settings show that appropriators in many, but by no means all, settings adopt cooperative strategies that enhance their joint payoffs without the presence of external enforcers. Many situational factors appear to affect the capacity for resource users to arrive at and maintain agreed-upon limits to their appropriation activities.7 The ability to communicate appears to be a necessary but not a sufficient condition. The presence of external monitors and enforcers appears to be neither necessary nor sufficient (Wade 1988b; Siy 1982; McKean 1992). In many natural settings, monitoring and enforcement activities are undertaken by-participants themselves and often without external recognition and support. Rarely does

6. See McKelvey and Palfrey for a discussion of this argument for the case of the “centipede” game (1992, in particular pages 804–5).

7. Among the variables that have been identified as affecting the capacity of individuals to devise their own rules for limiting the use of a CPR are (1) net benefits from the restrictions; (2) discount rates of CPR users; (3) size of the appropriating group; (4) asymmetry of appropriations with regard to information, asset structure, leadership, and appropriation technologies; (5) the physical complexity of the resource; and (6) the institutional structure and incentives in place (see E. Ostrom 1990 and Libecap 1989).
one see behavior in field settings that would be consistent with the use of trigger strategies.\textsuperscript{8}

In prior laboratory investigations, communication has been shown to be a very effective mechanism for increasing the frequency with which players choose joint income-maximizing strategies, even when individual incentives conflict with the cooperative strategies.\textsuperscript{9} Hypotheses forwarded to explain why communication increases the selection of cooperative strategies identify a process that communication is posited to facilitate: (1) offering and extracting promises, (2) changing the expectations of others' behavior, (3) changing payoff structure, (4) the re-enforcement of prior normative orientations, and (5) the development of a group identity. Experimental examination of communication has demonstrated the independent effect of all five of these processes, but they also appear to re-enforce one another in an interactive manner.\textsuperscript{10} Prior research that relied on signals exchanged via computer terminals rather than face-to-face communication has not had the same impact on behavior. Sell and Wilson (1991, 1992), whose experimental design allowed participants in a public-good experiment to signal a promise to cooperate via their terminals, found much less sustained cooperation than we report below based on face-to-face communication.

A deeper examination of the role of communication in facilitating the selection and retention of efficient strategies is thus of considerable theoretical (as well as policy) interest.\textsuperscript{11} In this chapter, we focus primarily on the findings from a series of experiments in which we operationalize face-to-face communication (without the presence of external enforcement) in the CPR appropriation environment of chapter 5.\textsuperscript{12} The role of communication and its success in fostering outcomes more in line with social optimality is investi-

\textsuperscript{8} Slade (1987), for example, concludes from her study of price wars among gas stations in Vancouver that they used small punishments for small deviations rather than big punishments for big deviations.


\textsuperscript{10} Orbell, van de Kragt, and Dawes (1988) summarize the findings from ten years of research on one-shot public good experiments by stressing both the independent and interdependent nature of the posited explanatory factors for why communication has such a powerful effect on rates of cooperation.

\textsuperscript{11} See Banks and Calvert 1992a, 1992b for an important discussion of the theoretical significance of communication in incomplete information games.

\textsuperscript{12} See E. Ostrom and Walker 1991 for a more detailed discussion of the role of communication and the experimental evidence summarized here.
gated in settings in which (1) the communication mechanism is provided as a
costless one-shot opportunity, (2) the communication mechanism is provided
as a costless opportunity and on a repeated basis, and (3) the subjects face a
 provision dilemma of having to provide the communication mechanism in a
voluntary contribution decision environment.

One-Shot Costless Communication

We first turn to the simplest of all of our communication environments. The
structure of the experiments in this design is:

\[ X, X, \ldots, X, C, X, X, \ldots, X, X. \]

That is, subjects were given a one-time opportunity to communicate followed
by a series of repeated independent decisions. This environment allows for
several insights into the role of communication. Subjects have a one-time
opportunity to discuss the decision problem. If so desired, they can work at
determining a joint income-maximizing strategy and agreeing to such a strat-
egy. They have a one-time opportunity to impress on each other the impor-
tance of cooperation. But since the communication mechanism is not re-
peated, they have no opportunity to react jointly to ex post behavior.

Our first communication design paralleled that of the high-endowment
(25-token) baseline game for the first 10 repetitions of the constituent game.
The only difference was that subjects received information on all individual
decisions after each round. As discussed above, the anonymity of subjects
was retained since no subject knew the identity of the individuals identified as
player 1, 2, \ldots, 8 on their computer screen. Each subject was identified by a
tag with a letter from A to H when they communicated, but they were told
(and, this was actually the case) that there was no connection between the
order of the alphabetical tags and the order of the player numbers assigned in
the computer. This added information had no impact on observed yields.\(^\text{13}\) At
the end of the tenth round, the subjects were informed that they would have a
single opportunity of 10 minutes to discuss the decision problem. The instruc-
tions are summarized below.

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 10 minutes to hold such a discussion. You may discuss anything

\(^{13}\) This information condition is similar to the “reveal” condition of Palfrey and Rosenthal
(1992). They did not find that added information about individual contributions made a consistent
difference in strategies adopted in noncommunication, repeated-game experiments.
you wish during your 10-minute discussion period, with the following restrictions: (1) you are not allowed to discuss side payments (2) you are not allowed to make physical threats (3) you are not allowed to see the private information on anyone's monitor.

After this opportunity to communicate, the subjects returned to the constituent game, which was then repeated up to 22 more times.

The subgame consistent\(^{14}\) and subgame perfect equilibrium outcome for the one-shot communication game was for each individual to invest 8 tokens in the CPR, the same as in the baseline. The maximum yield was obtained if a total of 36 tokens were invested. Players were not allowed to invest fractional tokens and the symmetric strategy to obtain the maximum return is half way between everyone investing 4 tokens and investing 5 tokens. Thus, discovering and agreeing upon a joint strategy was a cognitive, as well as a strategic, challenge in this environment. If the players were to decide to invest either 4 or 5 tokens each, they would obtain 99 percent of maximum net yield in either case.

Experimental Results

The transcripts of the discussion during the communication round reveal that subjects perceived their problem as involving two tasks: (1) determining the maximal yield available and (2) agreeing upon a strategy to achieve that yield. The one-shot communication results are summarized in table 7.1. This table displays information regarding percentage of maximum net yield actually earned by subject groups.

The results of our three one-shot communication experiments are mixed. In experiment 19, the group achieved over 82 percent of maximum net yield in all but 2 of 22 rounds following communication. In experiment 20, communication had little efficiency-improving effects. Finally, in experiment 21, the group improved net yield significantly following communication but could not sustain such behavior.

Experiment 19

The players agreed to invest 6 tokens each in the CPR. While this investment level is somewhat higher than optimal, the players still obtained 89 percent of the maximal return in rounds in which they complied with the agreement. The group complied perfectly until round 21, at which point compliance began to break down. In round 21, one subject invested 7 tokens. In round 22, three

\(^{14}\) An equilibrium is subgame consistent if it prescribes identical play on identical subgames (Selten 1971).
TABLE 7.1. One-Shot Communication after Round 10, 25-Token Design
(Average Net Yield as a Percentage of Maximum)

<table>
<thead>
<tr>
<th>Round</th>
<th>1-5</th>
<th>6-10</th>
<th>11-15</th>
<th>16-20</th>
<th>21-25</th>
<th>26+</th>
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<tbody>
<tr>
<td>19</td>
<td>-48</td>
<td>-20</td>
<td>89</td>
<td>89</td>
<td>85</td>
<td>83</td>
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<tr>
<td>20</td>
<td>-73</td>
<td>-16</td>
<td>45</td>
<td>-0</td>
<td>12</td>
<td>32</td>
</tr>
<tr>
<td>21</td>
<td>-2</td>
<td>-2</td>
<td>88</td>
<td>48</td>
<td>31</td>
<td>61</td>
</tr>
<tr>
<td>Mean</td>
<td>-41</td>
<td>-13</td>
<td>74</td>
<td>45</td>
<td>43</td>
<td>59</td>
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</table>

Subjects invested 15, 7, and 7 tokens, respectively, producing a drop in yield to 59 percent. In round 23, one subject withdrew all tokens from the CPR, while the other 7 players returned to the agreed-upon 6 tokens. In all subsequent rounds, at least one player deviated from the agreement to invest 6 tokens. In round 28, the subject who had invested 15 tokens in round 22, invested 15 tokens again. Otherwise, all CPR investments ranged from 5 to 7 until termination in round 32.

Experiment 20

Communication had little effect on yields. In the communication period, the subjects immediately identified an investment strategy of 5 tokens each. The subjects noted that one of them had invested 25 tokens in each of the first 10 rounds. One subject surmised that this person could not be making too much, but little attention was paid to what they should do if this person persisted. Only one comment was made about their need to “stick to their agreement,” and that comment was made by the 25-token investor (who remained anonymous throughout the experiment). In rounds 11 and 12, seven of the players invested the agreed-upon 5 tokens, but the “heavy” investor from the first 10 rounds continued to invest 25 tokens. Thus, instead of earning 99 percent of maximal yield, the group earned only 56 percent. In round 13, one of these seven players doubled their investment in the CPR. This dropped the group yield to 35 percent. From round 14 to round 17, the group fluctuated between 20 percent and 55 percent. In round 18, several players increased CPR investment and yield plunged to -93 percent. When the experiment stopped after round 32, only two subjects were still investing 5 tokens in the CPR. No subject punished a defector by choosing to invest heavily in the CPR, as called for by trigger strategies employed in the Folk Theorem for infinitely repeated games. In fact, some subjects reduced their own investment levels in response to heavier investment by others. In 28 out of the 176 choices (or 16 percent), individuals invested less than the agreed-upon level of 5 tokens.
Experiment 21

Communication had a positive but not a sustained impact on yields. The subjects wanted to adopt a strategy that would maximize yield, but had considerable difficulty identifying such a strategy. They finally decided upon a complex strategy to invest 3 tokens each in round 11 and one additional token each in rounds 12, 13, and 14. Depending on the information they obtained from these four rounds, their plan was that each player would continue to invest the number of tokens that had produced the highest return. Round 11 went according to plan. In round 12, seven subjects stuck with the plan, but one invested 21 tokens. In round 13, six did follow the plan and in round 14 all players invested 6 as agreed upon. In round 15, two players reduced investments to 3 and the other six invested 6 tokens—achieving a 97 percent yield. From round 16 onward, at least one person invested more than 6 in each round and the percentage of maximal returns plummeted to as low as -49 percent.

What is obvious from these three experiments is that a single communication period enables participants to begin the process of adopting a joint strategy and to gain higher yields. However, the incapacity to communicate repeatedly limits the long-run durability of their agreements.

Repeated Costless Communication

Our second design involves repeated communication in both the low- and high-endowment settings. The structure of the experiments in this design is:

\[ X, X, \ldots, X, C, X, C, X, \ldots, C, X, C, X. \]

That is, at the outset, the constituent game was repeated for 10 rounds. After round 10, the players read an announcement, informing them they would have an opportunity for discussion after each subsequent round. The first opportunity to communicate lasted up to ten minutes. Each subsequent session lasted up to three minutes. During discussion sessions the subjects left their terminals and sat facing one another.\(^{15}\)

Experimental Results: Low Endowment

Summary data from the low-endowment 10-token series (experiments 22–25) is reported in table 7.2.\(^{16}\) These repeated communication experiments provide

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15. As in the one-shot communication setting, each person was identified with a badge that was unrelated to their player number. This facilitated player identification in our transcripts. If unanimous, players could forgo discussion.

16. These low-endowment communication experiments were conducted very early in our
TABLE 7.2. Repeated Communication after Round 10, 10-Token Design
(Average Net Yield as a Percentage of Maximum)

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<td>22</td>
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<td>96</td>
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<td>23</td>
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<td>25</td>
<td>37</td>
<td>39</td>
<td>94</td>
<td>98</td>
<td>100</td>
</tr>
<tr>
<td>Mean</td>
<td>33</td>
<td>27</td>
<td>97</td>
<td>98</td>
<td>100</td>
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strong evidence for the power of face-to-face communication. Players successfully use the opportunity to (a) calculate coordinated yield-improving strategies, (b) devise verbal agreements to implement these strategies, and (c) deal with nonconforming players through verbal statements. When allowed to communicate repeatedly, subjects greatly enhanced their joint yield and sustained this enhancement. For analytical purposes, we define a defection as a Market 2 investment larger than agreed upon. In the low-endowment environment, we identified only 19 defections from agreements out of 368 total decisions (a 5 percent defection rate).

Experimental Results: High Endowment
The high-endowment CPR game is a more challenging decision environment than the low-endowment game. While the equilibrium of the two games is identical, the disequilibrium implications of the 25-token game change considerably. With 25 tokens, as few as three subjects investing all of their tokens can essentially ruin the CPR (bring returns below w), while with 10 tokens it takes seven out of eight subjects to accomplish this much damage. In this sense, the 25-token environment is much more fragile than the 10-token environment. We were interested in exploring whether subjects could cope with this more delicate situation through communication alone. In the field, this type of fragility is manifest in fisheries (all small boats versus all trawlers) and in forestry (individuals with chain saws versus bulldozers).

Further, we were interested whether varying the information players received about past actions of all players and joint outcomes affected patterns

research and used a modified 10-token payoff function for Market 2 \((15\bar{x}_t) - .15(\bar{x}_t)^2\). Yields as a percentage of maximum from experiments without communication using this payoff function closely parallel the yields observed in our 10-token low-endowment baseline design. Across 20 decision rounds, the difference in mean yields between experiments using these two alternative payoff functions for market 2 was only 6.4 percent, slightly higher in the low-endowment baseline design presented in the text.
of behavior. In experiments 26–28, subjects received only aggregate information on actions and outcomes between rounds. This level of information was identical to that of the 10-token repeated information discussed above. In experiments 29–31, subjects received additional information on individual Market 2 investments between rounds. This information was by subject numbers only. Unless the subjects successfully used the discussion rounds to ascertain actual subject identity, this information treatment left subject identity anonymous.

Table 7.3 summarizes the data for the 25-token repeated-communication experiments under both information conditions. In all six experiments (numbers 26–31), joint yield increased dramatically over that achieved in the first 10 rounds. In experiments 26, 28, and 30, however, the fragile nature of nonbinding agreements in this high-endowment environment became especially apparent, particularly near the end of the experiment.

**Experiment 26**

The subjects disagreed about the best strategy—some arguing for investing 7 or 8 in the CPR and others arguing for 4 or 5. As the end of their first discussion period was announced, they rushed into a rapid agreement to “try 6 each and see what happens.” All but one person kept to the agreement, with two extra tokens invested. After further discussion of whether 6 was the right amount, they again agreed upon this level of investment. One player ended the discussion by saying, “Let’s not get greedy. We just got to start trusting.”

Fourteen extra tokens were invested in round 12, which produced a drop in their yield from 85 percent to 48 percent of maximum. When they next communicated, player B announced

This should be our last meeting—if we can’t get some trust, we might as well go back and screw each other over. We could all make more

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<th>TABLE 7.3. Repeated Communication after Round 10, 25-Token Design (Average Net Yield as a Percentage of Maximum)</th>
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<td>29</td>
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<tr>
<td>31</td>
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<td>Mean</td>
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</table>
money if we could stick together, but if some are going to do the others in, then, we just should go.

Rounds 13, 14, and 15 were close to the agreed-upon levels and yields were above 80 percent of maximum for each of these rounds. After round 15, the discussion period started off with:

Player H: Not everyone is investing 6.
Player B: Evidently not.
Player C: Unless everyone keeps to it, it starts to get away from us.
Player H: Let’s say we invest 6 again. Obviously, somebody is cheating, but what can we do? But the rest of us can just continue to invest 6.

The players refused to talk after round 16. After yield dropped to 56 percent of maximum in round 17, the discussion started off with:

Player E: Someone is getting a free ride, so I say that we should just dump whatever we want into 2.\textsuperscript{17}
Player H: But we screw ourselves too.
Player B: I think we should just turn it loose.
Player H: I am happy with continuing to invest 6. Yeah, someone is cheating, but that is the best we can do. Is it worth a dime or five cents?
Player E: [Obviously upset, shakes head and does not say anymore.]

The group in this experiment never again had perfect compliance.\textsuperscript{18} But the threats to dump all the tokens into the CPR—a trigger strategy—were not carried out either. For 5 rounds, yields wavered between 72 percent and 80 percent of maximum. On the other hand, on the (unannounced) final round 23, their net yield plummeted to 11 percent of maximum.

\textit{Experiment 27}

The subjects mistook the optimal strategy. They adopted a group strategy of investing 50 tokens in the CPR (two subjects invest 7, six invest 6). They devised a complex rotation scheme and kept to it with only one exception throughout rounds 11 to 23. When one subject invested 11 rather than the

\textsuperscript{17} The player is referring to Market 2 (the CPR).

\textsuperscript{18} Players H and E had followed the agreement through round 17; player B had followed through round 16, but was one of the four individuals who invested more than the agreed-upon level in round 17. Player E invested 8 in round 18, but then returned to follow the agreement throughout the remaining rounds. Player H never deviated from the agreement. Player B alternated between 6 and 7 tokens in Market 2 after this discussion.
agreed-upon 6 tokens, no one knew who the errant person was or whether the additional investment came from a single player (because subjects had information only about total investments). In the communication round following this defection, the dialogue went like this:

Player A: Who did it?
Player C: Did someone get a little greedy?
Player E: We ended up with more tokens in Market 2.
Player C: But still the person who did put in the extra, they would not have made anymore, would they have?
Player E: Just a few darn cents above the rest of us.
Player A: Let’s go back and try it the old way.

After further discussion, player A urged, “We should be able to keep this going a little longer,” and player F wondered whether the person who put in the extra tokens was “greedy or was it just an error.” Player D responded that perhaps the person was not thinking about the consequences. Player A urged everyone to “go back to the way we were doing it.” The subjects then returned to their terminals for 3 more rounds of perfect compliance with their rotation agreement.

The transcript reflects individuals who are puzzling why someone would break their agreement and their resolve to return to the rotation scheme they had devised. They achieved 84 percent of the potential yield rather than a higher percentage because they had miscalculated the optimum and not because they had difficulty keeping to their agreement.

**Experiment 28**

The participants again mistook the optimum strategy. They initially adopted a group strategy of investing 50 tokens (two subjects investing 25 each, six investing 0) together with a rotation scheme. Several subjects articulated concerns about whether the experiment would continue long enough for them to complete the rotation, but they did agree on the system. When one subject put in 25 tokens for 2 rounds in a row, the information that 75 tokens had been invested in the CPR went without comment for 1 round. Once the rotation had been completed, the subjects discussed what to do now and whether the extra 25 tokens had been placed in error. They adopted a symmetric strategy of all investing 7 tokens in the CPR (20 tokens greater than optimum) that they held

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19. This defection occurred in round 20. Since the baseline experiment was 20 rounds, defections were more likely on the twentieth round. That some defections come in the twentieth round points to the bounded nature of the experimental setting. That more defections do not come at this point or soon thereafter in the communication experiments is hard to explain using backward induction.
to with two small exceptions. When discussing these defections, one player asked, "Why mess it up?" The implication was that small defections could lead to a worse outcome for all if they continued. The implied threats worked relatively well in sustaining this suboptimal but yield-improving strategy.

As noted above, in experiments 29, 30, and 31, we modified the information provided subjects after each round so that in addition to learning about the total tokens invested, group yield and individual yield, each subject also received information about the individual decisions of other subjects in previous rounds. Information was given by subject number, thereby preserving anonymity. The major difference between experiments 26–28, on the one hand, and 29–31, on the other, was that subjects could know whether excess tokens above their agreements had been invested by one or two individuals or by most of the subjects.

**Experiment 29**
The subjects first agreed to one rotation system for 4 rounds and a second rotation system for 2 rounds. They settled on a pattern of all investing 4 tokens in the CPR and obtained 99 percent of the yield for the rest of the experiment. During the repeated communication portion of their experiment, there was no defection from their agreement.

**Experiment 30**
Player F suggested that they all put in 1 or 2 tokens in the CPR. Surprisingly, the group agreed to invest 1 token in Market 2 (the CPR). Not only did they agree but they kept to their agreement for 7 rounds. During this time they received only 40 percent of the achievable net yield. In the eighteenth round, player F put in 25 tokens, while everyone else continued with their investment of 1 token. Needless to say, the discussion after round 18 was heated. Player F eventually "confessed" and indicated that "I had wanted to do that forever. . . . I thought I had to do it." She was asked how much she made and the amount of the payoff ($3.75) was a shock to everyone. She had, in fact, captured most of the feasible yield. During that round, total yield rose to 99 percent! But, the distrust that was engendered meant that the group could not achieve an agreed-upon level of investment. In the subsequent round, the total yield dropped from 98 percent to 80 percent, to 78 percent, to 52 percent, to −117 percent, finally pulsing back to 21 percent at the end of the experiment. It is somewhat perplexing to know how to count "infractions" in this case. The agreement basically broke down. After round 18, only one subject continued to invest 1 token. Thus, 39 decisions out of 104 opportunities (or 38 percent) of the decisions were not in conformance with their original decision. In summary tables we develop in chapter 9, we will not count these decisions as defections since the agreement broke down.
**Experiment 31**

The subjects had experienced group yields in the first 10 rounds that varied from $-216$ percent all the way to $96$ percent. In their first discussion round (after the tenth round of play), they agreed to invest 6 tokens in the CPR. In the eleventh round, six subjects invested at the agreed level or below while one subject (player E) invested 10 and another invested 7. When the group sat down for a discussion, several participants urged the individuals who had gone over their agreement to put in 6. This seemed to work in round 12, as everyone complied with the agreement. Round 13 produced almost complete compliance with one player putting in 1 token more than agreed. But in round 14, player E put in 10 tokens and player A put in 7. This produced a bit of an explosion. Several players searchingly asked who was the person putting in 10. One player remarked, “Someone is sitting here thinking—those idiots—they are so gullible.” After lots of stressful discussion, they returned to their terminals with a plea to “try it again. If it doesn’t work, we need to try to find out who 4 and 5 are [the two overinvestors].”

In round 15, players E and A again invested one more token than agreed upon and everyone else conformed to the agreement. At this point, one subject suggested that they “go around the circle and tell our numbers.” Several subjects indicated that they were perfectly willing to tell who they were, but no further efforts were made to identify the individuals who had invested more than their agreement. Round 16 produced perfect compliance, and the subjects clapped when the result was announced on the screen. But, in round 17, players E and A again put in 7 while the others put in 6. The subjects who had earlier indicated that they wanted to know who the individual was started to reveal their own player numbers and asked the others to do so. Player A correctly revealed his identity as number 5 on their screens, but player E told the group (falsely) that she was player 7 (someone who had consistently held to their agreement). Since the real player 7 was also claiming to be player 7, this act by player 4 was quite “problematic” for the group.

From then on, player E consistently overinvested 1 or 2 tokens, while several others began to join her. The group always achieved far more than they had prior to communication (never below 78 percent), but the minor overinvestment by one, and eventually by a few, players, was a source of considerable annoyance to the others.

At several points, they discussed initiating a trigger strategy. One player asked: “Now what are we going to do, are we going to go for a free-for-all?” Another replied: “Go for a free-for-all? Shucks no, we all lose.” The first proposed the idea again: “I am just saying that if we all go for a free-for-all, the person with the highest amount in there may well lose the most.” The response this time was: “Yeah, it is not worth it, if somehow we could all put in 6, we gain a lot. Some people are preying on us, poor, honest souls here.”
The possibility of adopting a trigger strategy—throwing a free-for-all—was discussed several more times during the remainder of the experiment but never tried. The infraction rate for this experiment was 19 incidents out of a total of 104, or 18 percent.

In these repeated communication experiments, subjects were able to obtain consistently higher payoffs than in the one-shot communication design, particularly after round 15. As shown in table 7.3, subjects in the repeated, communication experiments obtained an average yield of 78 percent of maximum in rounds 16 to 20 as contrasted to 45 percent in the one-shot communication design. In the rounds after round 20, the yields were 62 percent and 43 percent, respectively.

Subjects in the repeated communication setting were also able to keep their defection rates lower than in the one-shot setting. In the one-shot design, players invested more tokens in the CPR than agreed upon in 133 out of 528 opportunities (a defection rate of 25 percent), while the defection rate was 13 percent (42 out of 312) with repeated communication. Repeated communication enabled subjects to discuss defections and to cut the defection rate in half. In all communication experiments, subjects offered and extracted promises of cooperation, thereby increasing their joint yield significantly above that obtained prior to communication. Only in repeated communication did subjects develop verbal sanctioning mechanisms that enabled them to sustain consistently higher yields. Communication discussions went well beyond discovering what investments would generate maximum yields. A striking aspect of the discussion rounds was how rapidly subjects, who had not had an opportunity to establish a well-defined community with strong internal norms, were able to devise their own agreements and verbal punishments for those who broke those agreements. These verbal sanctions had to be directed at unknown defectors, since subjects' decisions were anonymous. Subjects detected defection solely through aggregate investments. In many cases, statements like "some scumbucket is investing more than we agreed upon" were a sufficient reproach to change defectors' behavior. However, verbal sanctions were less effective in the 25-token environment. These results are similar to those obtained in previous research in different but broadly similar environments.

**Costly Communication**

In this series of experiments, subjects faced the joint task of providing the opportunity to communicate and, if provided, using the mechanism productively. The structure of the experiments in this design is

\[ X, X, \ldots, X, PC, X, PC, X, \ldots PC, X, PC, X, \]
where $P$ denotes the opportunity to provide the communication mechanism, but at a cost. Specifically, in each decision round after the tenth round of the constituent game with no communication, subjects faced a decision of whether to invest toward the provision of the communication mechanism. The subjects were placed in a decision situation parallel to the provision point experiments discussed in the appendix to chapter 5. The provision mechanism imposed on the right to communicate placed subjects in a second-order public-good dilemma situation (with a provision point). Second-order dilemma games exist whenever individuals must expend resources to provide a mechanism that may alter the strategic nature of a first-order dilemma game (Oliver 1980; Taylor 1987). The opportunity to communicate in a CPR dilemma situation can be viewed as a mechanism that enables individuals to coordinate strategies to solve the first-order CPR dilemma. In our other designs, the opportunity was presented to the players at no cost.

In this design, however, we increased the realism of the experimental setting by imposing a cost for communicating. In field settings, communication is not free. Some individuals have to bear the cost of organization. If communication is going to continue, these costs must be borne repeatedly. Without continuing provision of a mechanism for communication, the communication effort may collapse and with it the possibility of avoiding the suboptimal outcomes of the first-order social dilemma.

These communication experiments were conducted to investigate the properties of a mechanism in which provision of the right to communicate was costly. Since our goal was to examine the "pure" effects of the costly provision structure, we wanted to control for subjects' awareness of the impact (success) of communication itself. This design feature was captured by using subjects who had participated in our previous communication experiments. Thus, these subjects had experienced the efficiency enhancing characteristics of communication. No subject group was drawn intact from a previous experiment. To utilize this design feature, however, we had to ensure that subjects did not enter the decision environment with prior "implicit bargain" agreements. That is, we needed a decision environment parallel in structure to our previous design, but with a different cooperative equilibrium. The equilibrium properties of this design capture this characteristic.

Parallel to other designs, we conducted this investigation with a set of noncommunication baseline experiments and a set of parallel experiments where communication was allowed if the costs were provided by the participants. In the three baseline noncommunication experiments, subjects participated in a series of at least 20 rounds in which no form of oral or visual communication was allowed. The first 10 rounds of the "costly communication" experiments were conducted in a manner identical to the noncom-
munications experiments. Prior to round 11, however, the subjects received an announcement that can be summarized as follows.

Subjects were informed they would be given the opportunity to purchase the right to discuss (as a group) their investment decisions. The rules on discussion were exactly the same as in the discussion sessions in which they participated in previous experiments, except now the subjects were informed that they must purchase the right to communicate with each other. Each round they were asked to privately decide whether they would contribute $.20 toward the opportunity. If at least five agreed to contribute, the entire group was to be allowed to meet in a discussion session.20

There are several key differences in the parameterizations of this design relative to our previous designs. In these experiments (1) the payoff function for Market 2 was increased (shifted upward) relative to that of our other designs, (2) the payoff from Market 1 was reduced to zero, (3) individual token endowments were equal to 15 tokens, and (4) subjects started the experiment with an initial capital endowment of $5.00. The reasons for the increased token endowments and the use of an up-front capital endowment will be made clear after we investigate the theoretical properties of this design.

Theoretical Predictions

Consider the specific parameterizations for Market 1 and Market 2. The strategy set for each player is \( x_i \in \{0, 1, 2, \ldots, 15\} \), where \( x_i \) denotes the number of tokens player \( i \) invests in Market 2. The payoff for player \( i \) \( h_i(x) \), in cents, is:

\[
h_i(x) = \begin{cases} 
0 & \text{if } x_i = 0 \\
0(15 - x_i) + (x_i/\Sigma x_i)(25\Sigma x_i - .30(\Sigma x_i)^2) & \text{if } x_i > 0 
\end{cases}
\]

---

20. It was explained verbally to the subjects that all contributions were final. If the group was not successful in funding the communication session, contributions were not refunded. The particular cost of $.20 per individual and the requirement that five of eight individuals must contribute to provide the mechanism were chosen to make the provision a nontrivial problem and yet not to make the provision so costly that provision would have been virtually impossible. One would like to be able to calculate the expected costs and benefits from provision. These are not well-defined terms, however, in this context. Some groups may require only one round of communication to coordinate a strategy that stays in place for the entire experiment. Other groups may require repeated rounds of face-to-face discussion. The fact that our groups struggled with the provision problem, but did eventually succeed, suggests that our parameterizations were reasonable.
where \( \mathbf{x} = (x_1, \ldots, x_9) \) is the vector of strategies of all players. This symmetric game has multiple Nash equilibria in pure strategies, with \( \Sigma x_i = 74 \) (approximately 40 percent of maximum net yield possible from Market 2). These are generated by having six players play \( x_i = 9 \) and two players play \( x_i = 10 \). The game also has a symmetric Nash equilibrium in mixed strategies, with \( E(\Sigma x_i) = 74 \). This equilibrium is generated by each player playing \( x_i = 9 \) with probability \( .74 \) and \( x_i = 10 \) with probability \( .26 \).

Note that the decision of whether to contribute in the provision stage (providing the opportunity to communicate) does not affect the Nash equilibrium prediction of the appropriation stage. Whether one contributed or not in the provision stage is a sunk cost once one moves to the appropriation stage.

A group investment of 42 tokens yields a level of investment at which \( \text{MRP} = \text{MC} \) and thus maximum net yield. Conversely, a group investment of 83.3 tokens yields a level of investment at which \( \text{ARP} = \text{MC} \) and thus 0 net yield from Market 2. For this design, note that this result would yield a 0 total return from investments in Market 2.

Given the possible payoffs for this design, one can see why we modified certain features of this design relation to our original 10-token baseline design. We increased individual token endowments to 15 (from 10) so that full dissipation of net yield would not be inhibited by a binding constraint on resource endowments. Further, with this design, it is possible for subjects to actually have negative returns for a decision period. For this reason, and to increase the likelihood of subjects earning some minimal experimental earnings, we added the up-front cash endowment.

Experimental Results

We begin our interpretation of the results with a summary of the level of inefficiency generated in the noncommunication baseline experiments (32–34). As with our other baseline experiments with the 15-token design (experiments 32–34), the resource allocations between the two markets are at very low levels of efficiency. From table 7.4, we see that (pooling across all experiments and the first 20 rounds) average net yield equaled only 39 percent of optimum. Further, as noted with other experiments, there was a tendency for net yield to decrease with repetition of the decision process. Again, it was the Nash prediction that most accurately describes the aggregate data.

In table 7.4, we also present summary information on net yield accrued across experimental decision periods for the three “costly communication”
TABLE 7.4. Baseline Zero Marginal Cost and Costly Communication after Round 10 (Average Net Yield as a Percentage of Maximum)

<table>
<thead>
<tr>
<th></th>
<th>1–5</th>
<th>6–10</th>
<th>11–15</th>
<th>16–20</th>
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<tbody>
<tr>
<td>Baseline Zero Marginal Cost</td>
<td></td>
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<tr>
<td>Mean, experiments 32–34</td>
<td>42</td>
<td>45</td>
<td>36</td>
<td>35</td>
<td>—</td>
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<tr>
<td>Costly Communication</td>
<td></td>
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<tr>
<td>Experiment 35</td>
<td>67</td>
<td>54</td>
<td>60</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Experiment 36</td>
<td>41</td>
<td>35</td>
<td>83</td>
<td>56</td>
<td>47</td>
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<tr>
<td>Experiment 37</td>
<td>32</td>
<td>26</td>
<td>85</td>
<td>97</td>
<td>83</td>
</tr>
<tr>
<td>Mean, experiments 35–37</td>
<td>47</td>
<td>38</td>
<td>76</td>
<td>84</td>
<td>76</td>
</tr>
</tbody>
</table>

experiments (35–37). Recall that the ability to fund the communication mechanism was allowed only in rounds 11–20. From table 7.4, we see the aggregate effect of the communication opportunity. In the first 10 rounds of the communication experiments, the mean level of net yield is nearly identical to that observed in our baseline experiments (42 percent compared to 43 percent). In rounds 11–20, net yields shift significantly to an average of 80 percent. This compares to 35 percent in rounds 11–20 of the baseline experiments. Clearly the ability to communicate has translated into a shift in efficiency. Unlike the 14 experiments in which the right to communicate was provided without cost on a repeated basis, however, these subjects struggled to provide the communication mechanism and to coordinate strategies.

We turn now to a detailed account of the decision process in each of the 3 costly communication experiments.

**Experiment 35**

In the first 2 rounds of this experiment, the players did not achieve sufficient contributions to fund the right to communicate. Three players contributed 20 cents after round 10 and again after round 11, but they failed to gain the five contributions needed to provide a communication period. After round 12, the group was successful when six players made contributions. Player D (who was the only player not to make a contribution in any of the prior rounds) led the discussion with a suggestion that the group develop a rotation scheme for investments in Market 2. Player D was the major "verbal organizer" in both communication experiments in which he participated. Players D and G spent a minute or so calculating the optimal strategy. Player G then proposed that "we all put in 5, and that we rotate two people putting in 6. That looks pretty good, shall we do that?" It took some time to figure out how to coordinate the rotation system, but eventually a scheme was agreed upon. In this discussion,
no reference was made to the problem of cheating or to the need to hold firm to the agreement so as to avoid paying the cost of communicating again.

After this single communication period, the players implemented the agreement perfectly for 4 rounds. When this first "rotation" was accomplished, Player A cast a solitary vote for a second communication period. Only minor deviations occurred during the next 5 rounds, and no further effort was made to communicate. Overall, the players in this group conformed to their agreed-upon strategies in 92 percent of their actual investment decisions.

**Experiment 36**
In this second costly communication experiment, five subjects contributed 20 cents at their first opportunity. Player G started the session with this statement:

> The reason we are here is to make a profit, so we need to lower the group investment down from 66 and 70, which we have been doing, down to say 42 or 40. And if we all agree to invest 5, then we would have 40 invested as a group. Ten in Market 1 and 5 in Market 2. We would get maximum profit out of this. Is that a reasonable decision?

Some further effort was made to calculate whether or not this was optimal. Relative to other groups, these subjects focused on calculations with very little discussion. Only seven statements were made during the communication period. Player G ended this period with the statement: "Everybody needs to do it—if you remember from last time, if everyone does not do it then someone sucks it."

Round 11 involved perfect coordination. In round 12, player A (who had said nothing in the discussion period) invested 15 tokens in Market 2, while the others held to their agreement to invest 5. In round 13, players E and D increased their investment in Market 2 by 1 token, and thus joined player A as defectors, even though their rate of defection was low. By round 14, there were five defectors and only three players holding to the agreement. Three players contributed 20 cents each after the fourteenth round in an unsuccessful attempt to regain the right to communicate. After round 15, a solitary player contributed 20 cents toward communication; that was the last contribution toward communication made in this experiment. Several of the players continued their low contribution rates while most of the players did not.

The players in this group conformed to their agreed-upon strategies in 45 percent of their actual investment decisions—the lowest percentage of any of the communication experiments. Although the players had achieved over 90 percent of the available net yield in the first 4 rounds after communication, the percentage fell steadily to 47 percent in the last 3 rounds of the experiment.
Experiment 37
In this experiment, four subjects contributed toward communication after the tenth round, falling one vote shy of the provision level. After the eleventh round, six individuals made the necessary contribution to obtain the right to communicate. Two of the players, who had been among the most active communicators in the earlier experiments, took the lead (as well as financially contributing toward the achievement of a communication period). After some hurried calculations, the group decided to invest 6 tokens in Market 2 and 9 in Market 1. They obtained 98 percent of the available net yield with this strategy. The players seemed concerned about making a quick decision and avoiding the need for further communication. As player E argued during the communication period: “Let’s decide something so that we all know what we are doing so that we don’t have to confer each time.” On his debriefing form, player E indicated: “Instead of a complicated maximizing scheme, we chose a simple, easy-to-follow method to set relatively maximized profits.”

For 10 rounds, the players observed perfect compliance to their agreement with no further discussion. In round 20, player A invested 9 instead of 6 tokens in Market 2. In round 21—the unannounced final round—player A continued the investment of 9 tokens while player D invested all 15 tokens in Market 2. Player D had invested 15 tokens throughout the noncommunication rounds, had not voted at any time to hold a communication period, did not say anything during their discussion, and had conformed to the agreement for 9 rounds. On his debriefing form he commented on his actions in the following way:

I never purchased because I felt like the others would purchase it, consequently, I wouldn’t lose $.20. I didn’t feel like I was taking advantage of the group in this respect. I also felt like since I didn’t purchase the opportunity, I did not have to abide by the group’s decision because I really didn’t want to meet.

The players in this group conformed to their agreed-upon strategies in 96 percent of their actual investment decisions. In the 10 rounds following successful provision of the opportunity to communicate, this group averaged 96 percent of optimal net yield from the CPR.

These experiments demonstrate the strength as well as the fragile nature of costly communication. Since it was costly to communicate, each group met only once. Two of the groups had to go several rounds before sufficient contributions enabled them to meet. What is striking, however, is that two of the groups achieved almost perfect compliance to their joint strategy after only a single opportunity to discuss the problem. The other group experienced
cascading defections once it was clear that they could not mount the level of voluntary contributions needed to achieve a second or third “pep talk.”

Conclusions

These experiments provide strong evidence for the power of face-to-face communication in a repeated CPR dilemma where decisions are made privately. When communication was provided as a costless institution that could be drawn upon on a systematic basis, players successfully used the opportunity (1) to calculate coordinated yield-improving strategies, (2) to devise verbal agreements to implement these strategies, and (3) to deal with nonconforming players. Considerable time and effort was expended during the communication periods simply trying to ascertain the optimal, joint strategy, since these experiments afforded considerably more choice than a dichotomy between a “cooperative” and a “noncooperative” strategy. On the other hand, our design in which communication was a one-shot institution and our high-endowment design, which allowed for greater appropriation power in the hands of individuals, demonstrated that words alone can be quite fragile.

In those experiments where players received only aggregate information about outcomes, the problem of dealing with cheating was potentially even more difficult to cope with than the problem of discovering the optimum. How subjects dealt with this problem is revealing, both in terms of what they did and did not do. Verbal criticism was a common ploy used against anonymous defectors. Evocative terms, such as scumbucket and pimp, were used as negative persuasion. At no time did they agree to adopt a trigger strategy. Several groups overtly faced the problem of small levels of nonconformance, discussed trigger strategies, and decided to keep as close to their agreement as possible as long as the level of deviation did not get too large. The potential threat of everything unraveling was clearly in view.

In field settings, it is rare that the opportunity to communicate is costless. Someone has to invest time and effort to create and maintain arenas for face-to-face communication. The costly communication experiments investigated the effort of costly provision of the communication mechanisms on (1) the ability of players to provide the mechanism and (2) the impact of the second-order dilemma in solving the first-order dilemma posed by the CPR experiment itself. The provision problems that players faced in the costly communication experiments were not trivial and did, in fact, create a barrier. In all three experiments, the problem of providing the institution for communication reduced the speed with which an agreement could be reached and the efficacy of dealing with players who broke an agreement. On the other hand, all groups eventually succeeded in providing the communication mechanisms
(but only once) and in dealing (to some degree) with the CPR dilemma. On average, efficiency in these groups increased from 42 to 80 percent.

In general, these results are consistent with closely related research. Isaac and Walker (1988a, 1991) found similar results for costless and costly communication in a public-good environment with symmetric payoffs. In experiments similar to those discussed above for costly communication, they found that increasing the complexity of the environment reduced the success of face-to-face communication, but that, even with this reduction, the institution remained a successful mechanism for improving market efficiency. Further, in recent research Hackett, Schlager, and Walker (1993) examine the robustness of communication as an efficiency-enhancing mechanism in settings where appropriators differ in size, as measured in appropriation capacity. This heterogeneity creates a distributional conflict over the allocation of access to common-pool resources. They present findings from a series of experiments where heterogeneous endowments are assigned (1) randomly, and appropriators have complete information; (2) through an auction, and appropriators have complete information; and (3) randomly, and appropriators have incomplete and asymmetric information. In summary, their study demonstrated the robustness of this institution in situations of endowment heterogeneity. Heterogeneous appropriators, when allowed to engage in face-to-face communication, substantially increased the level of rents earned from the common-pool resource. In addition, yield enhancement remained substantial (although reduced) under relatively severe conditions of four endowment types with incomplete and asymmetric information.

Of the five hypotheses forwarded by others to explain the impact of communication (see the first section of this chapter), the evidence from our experiments clearly supports two:

1. Communication did provide an opportunity for individuals to offer and extract promises of cooperation for nonenforceable contracts.
2. Communication did facilitate the boosting of prior normative orientations.

Our experiments, however, cannot clearly differentiate between the various normative orientations that are evoked in such situations. We tend to agree with Orbell, van de Kragt, and Dawes (1988) that keeping promises appears to be a more fundamental, shared norm than "cooperation per se." It is, of course, difficult to sort these out. When a defector is called a "scumbucket," is the reproach being used because someone is breaking a promise, is being uncooperative, or is taking advantage of others who are keeping a promise? The strength of the reproaches used probably reflects the multiple offenses committed by those who did not keep to their prior agreements.
The evidence from these experiments demonstrates that external agents are not necessary to achieve high levels of conformance to verbal promises even when

1. players make repeated anonymous and private decisions and breaking the verbal agreement strongly dominates keeping the verbal agreement; and
2. players do not have an opportunity to establish a well-defined community with strong internal norms and established ways to enforce these norms.

On the other hand, the evidence from these experiments should not be interpreted as supporting arguments that communication alone is sufficient to overcome repeated dilemma problems in general. While many endogenous arrangements appear to evolve in experimental and field settings to overcome CPR dilemmas, many endogenous efforts have failed as well. The evidence from the high-endowment and one-shot communication experiments suggests why individuals in some natural settings do not rely solely on face-to-face communication. When the actions of one or a few individuals can be a strong disequilibrating force or frequent opportunities for communication are not feasible, individuals who have the capacity to agree to sanction one another as well as communicate with one another might well want to add the sword to a covenant. While the theoretical predictions are that individuals in such settings would not sanction one another, endogenous sanctioning is frequently observed in field settings. In the next chapter, we explore a range of questions involving the development of endogenous institutions, including the effects of various types of internal and external sanctioning mechanisms.