

# THE DRAMA OF THE COMMONS

Committee on the Human Dimensions of Global Change

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## Factors Influencing Cooperation in Commons Dilemmas: A Review of Experimental Psychological Research

*Shirli Kopelman, J. Mark Weber, and David M. Messick*

**T**his chapter reviews recent experiments on psychological factors that influence cooperation in commons dilemmas. Commons dilemmas are social dilemmas in which noncooperation between individual people leads to the deterioration and possible collapse of a resource (Hardin, 1968; Van Lange et al., 1992a). Hardin's parable about herdsmen who share a common pasture—each has an incentive to raise the number of sheep grazing, but if each herdsman does so they risk ruining the pasture—illustrates the prototypical commons dilemma. From an economic perspective, commons dilemmas are one class of social interactions in which equilibrium outcomes are (Pareto) inefficient. Such inefficient equilibria are not confined to resource and environmental situations, but arise in other domains as diverse as industrial organization, public finance, and macroeconomic policy.

Formally, all social dilemmas can be defined by three characteristics (Dawes, 1980; Messick and Brewer, 1983; Yamagishi, 1986): (1) a noncooperative choice is always more profitable to the individual than a cooperative choice, regardless

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of the choices made by others; (2) a noncooperative choice is always harmful to others compared to a cooperative choice; and (3) the aggregate amount of harm done to others by a noncooperative choice is greater than the profit to the individual. Commons dilemmas (also called resource dilemmas) are a subset of social dilemmas that have traditionally been defined as situations in which collective noncooperation leads to a serious threat of depletion of future resources (Hardin, 1968; Van Lange et al., 1992a). They can be categorized as "social traps" because behavior that is personally gratifying in the short term can lead to long-term collective costs (Cross and Guyer, 1980; Platt, 1973). Although we focus on commons dilemmas, we also draw on relevant research on other types of social dilemmas such as the prisoners' dilemma and the problem of public goods.

The first part of this chapter places recent research in a historical perspective lays out our framework and provides basic definitions. The second part provides a critical review of the recent literature within a categorical framework we developed. The third part concludes by linking the issues raised in our review to the other chapters in this volume.

## INTRODUCTION

### Historical Roots of Experimental Research on Commons Dilemmas

The modern history of social psychological research on common property management, commons dilemmas, resource dilemmas, or social dilemmas—as the field is variously labeled—began in the 1950s. In their path-breaking book, *Theory of Games and Economic Behavior* (1944), Von Neumann and Morgenstern introduced a specific class of models that outlined a theory of individual decision making (with the axiomatization of preferences and utilities) and proposed a theory of social interdependence for both zero-sum and nonzero-sum games. Although economists had been studying departures from competitive equilibrium since the turn of the century, this book spurred a flurry of empirical investigations that explored decision making and utility functions. By the late 1950s, the general ideas of game theory had been introduced to social psychologists in a formal manner by Luce and Raiffa (1957) and in terms of psychological theory by Thibaut and Kelley (1959).

The 1960s saw the proliferation of experiments on two-person games, largely prisoners' dilemma games, and, more importantly, on the generalization of the prisoners' dilemma idea to applied multiperson situations. Two of the important publications of this time, Olson's (1965) *The Logic of Collective Action* and Hardin's (1968) celebrated article "The Tragedy of the Commons," highlighted the issues for the scientific community. During this period, the interests of experimental psychologists and experimental economists diverged. Economists continued to focus on rules and institutions, as well as payoff structures (for an excellent account of the early development of experimental economics, see Davis and

Holt, 1993; Roth, 1995). Psychologists became interested in psychological factors such as individual differences (Kelley and Stahelski, 1970; Messick and McClintock, 1968), the effects on behavior of changing the payoffs (Kelley and Grezlak, 1972), and the effects of communication (Dawes, et al., 1977).

More generally, throughout the 1970s and 1980s, psychologists examined factors that influence cooperation across the range of social dilemmas, including commons dilemmas, prisoners' dilemmas, and public goods tasks (for a broader review of social dilemmas in the social psychological research, see Dawes, 1980; Komorita and Parks, 1994; Messick and Brewer, 1983). Much of the early work on prisoners' dilemmas was criticized on the grounds that it was atheoretical and that it had little to say about extra-laboratory affairs (Pruitt and Kimmel, 1977).

One interesting theme that has emerged from the more recent research we reviewed is the extent to which people are, or are not, other-regarding (how, if at all, people take others' welfare into account). The nature in which they are, or they become, other-regarding has become a central research question. Although the hypothesis that people have preferences for the welfare of others is at least as old as Adam Smith's *Theory of Moral Sentiments*,<sup>1</sup> psychologists have found this question pivotal for understanding choice behavior in interdependent situations. Early efforts in the latter half of the 20th century were made by Sawyer (1966), who tried to measure altruism, by Conrath and Deci (1969), who were estimating a "bivariate" utility function, and by Messick and McClintock (1968), who used a type of random utility model to assess social motives for allocating distributive outcomes in situations of social interdependence. In the Messick and McClintock model, each preference (maximize own outcome in absolute terms, maximize own outcome in relative terms, and maximize joint outcomes of both self and other) had sizable nonzero probabilities. In the 1970s researchers in economics (e.g., Scott, 1972) and in the behavioral sciences (e.g., MacCrimmon and Messick, 1976) began to explore preference structures that could produce behavior that appeared to be altruistic, selfish, and competitive at the same time.

In the 1980s, Messick and Sentis (1985) introduced the concept of a "social utility function" that was later expanded by Lowenstein et al., (1989). A social utility function posits additive preferences for one's own outcomes and preferences for the difference between one's outcome and that of others. Both studies found that the latter function takes its maximum when payoffs to self and other are equal, supporting the assumption made by Falk et al. (this volume:Chapter 5). Their economic model further generalizes the social utility component to comparisons with more than one other person.

### Our Framework

This chapter focuses on experimental work published in major peer-reviewed journals in psychology. In passing, we note experimental work in economics that bears on variables of interests to psychologists. We included studies that manipu-

lated factors that influence cooperation in commons dilemmas and sorted these factors according to the aspect of the type of manipulation involved.

We identified nine classes of independent variables that influence cooperation in commons dilemmas: social motives, gender, payoff structure, uncertainty, power and status, group size, communication, causes, and frames. We organized these classes to first distinguish between individual differences (stable personality traits) and situational factors (the environment). Situational factors were further differentiated into those related to the task structure itself (the decision structure and the social structure) and those related to the perception of the task (see Figure 4-1).

In the psychological literature, the main types of individual differences that have been studied are social motives and gender. The decision structure of the

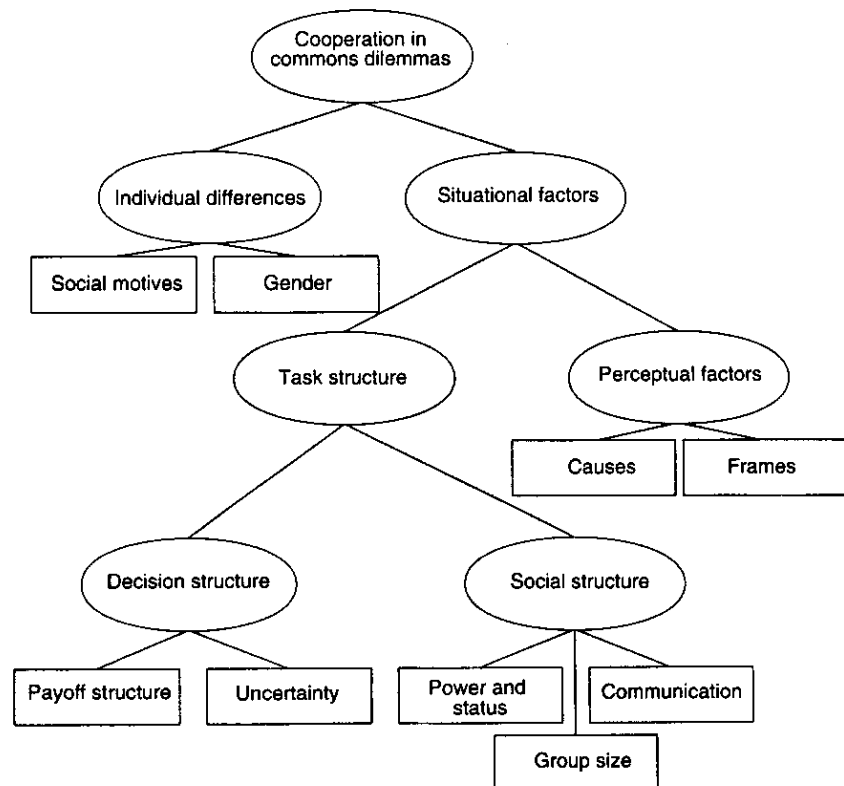


FIGURE 4-1 Elements influencing cooperation in commons dilemmas.

task includes factors like the payoff structure and the amount and type of uncertainty involved in the resource. The social structure includes factors such as the power and status of the individuals or organizations involved, the size of the group, and the ability of people to communicate with one another. Perceptual factors include perceived causes of shortages, or the way cooperation is framed.

### An Experimental Primer

Psychologists generally use an experimental approach to test hypotheses in a laboratory environment. They use scientific and statistical methods that control for extraneous influences and thereby reveal causal relationships between the variables studied. Some participants are assigned to perform a task in a control condition, while others are assigned to an experimental condition. The only difference between these two conditions is an experimental manipulation. As a result, if the two groups have statistically different outcomes (dependent variable[s]), these can be attributed to the experimental manipulation (independent variable[s]). Random assignment of participants to the experimental and control groups enables scientists to identify causal factors.

Imagine you just entered an experimental lab as a participant in a study. You are told that you will be participating in a decision-making task. You and several other people will be playing a game that simulates harvesting decisions by commercial fishermen over a period of 10 seasons. You receive some background information and are asked to make harvesting decisions over several rounds (each round representing a consecutive fishing season). You may be told that it is in your interest to maximize profits, but if the level of fish drops below a certain level, the reproduction rate will drop and there may be less fish to go around. You may or may not receive feedback about simultaneous decisions of other participants, about the size of the resource pool, about the replenishment rate, and other variables. As a participant you are not aware of the factors being studied, nor do you know whether you are in a control or experimental group.

If a researcher wants to study the influence of communication on cooperation in a commons dilemma, then the information you and the other participants receive will be identical. However, in the experimental condition and not in the control condition, the fishermen may be allowed to communicate after five rounds (i.e., five seasons). Indeed, a well-documented finding reveals that experimental groups that are allowed to communicate consistently cooperate more than groups in which no communication is allowed (for a review see Dawes, 1980; Kerr and Kaufman-Gilliland, 1994; Messick and Brewer, 1983). Research described later in this chapter attempts to identify what aspects of communication are critical for developing cooperation.

The strength of the experimental method is its ability to test causal relationships between isolated variables in a controlled environment. Achieving such control over interacting variables is not generally possible in the field. However,

the degree of control has also, at times, been construed as a limitation. Despite the common assumption that lab research offers poor external validity (i.e., ability to generalize findings outside the lab), recent empirical work suggests that lab research reliably yields findings comparable in both nature and effect size to those of field research across multiple domains of inquiry (Anderson et al., 1999).

Although a lab environment is by design artificial in that it isolates behavior from many of the large number of simultaneous and interacting influences that affect behavior in the field, it need not ignore context. Often an experimental design simultaneously tests the influence of two independent variables (e.g., trust and communication) so that the influence of one on the other can be evaluated. For example, a recent study on the prisoners' dilemma suggests that in simple tasks, there is no difference between face-to-face communication and e-mail communication, while in complex settings, face-to-face communication elicits more cooperation than e-mail communication (Frohlich and Oppenheimer, 1998). The interaction between the type of communication and the type of task informs us that without examining both factors, it is difficult to predict cooperation.

### REVIEW OF RECENT FINDINGS IN THE EXPERIMENTAL LITERATURE

We begin this section by discussing the effects of differences among people, namely social motives and gender.

#### Individual Differences

##### *Social Motives*

Social motives have been conceptualized as stable individual characteristics. Based on experiments using the prisoners' dilemma, Kelley and Stahelski (1970:89) concluded that "two types of persons (cooperative versus competitive personalities) exist in the world whose dispositions are so stable and their interaction so 'programmed' by these dispositions that (a) they do not influence each other at the dispositional level, and (b) they do not influence each other's world views."

Although in theory, an infinite number of social motives (sometimes referred to as social value orientations) can be distinguished (McClintock, 1976, 1978), a common theoretical classification identifies four major motivational orientations (McClintock, 1972): (1) individualism—the motivation to maximize one's own gains; (2) competition—the motivation to maximize relative gains, the difference between one's outcome and that of the other; (3) cooperation—the motivation to maximize joint gain; and (4) altruism—the motivation to maximize other parties' gains. Individualism and competition motives often are referred to as "proself" motives, whereas cooperation and altruism are referred to as "prosocial" motives.

Social motives are measured using a series of decomposed games—each game requires a decision regarding points to be allocated to oneself and a contingent sum to be allocated to some other person—with fixed choices that represent the three most empirically frequent types: individualistic, competitive, and cooperative social motives (Kuhlman and Marshello, 1975). Because the task used to evaluate social motives is an internally consistent measure (Liebrand and Van Run, 1985) with high test-retest reliability (Kuhlman et al., 1986), it provides a dependable tool for measuring social motives.

In the context of resource dilemmas, consistent findings demonstrate that prosocial individuals harvest significantly more than people with prosocial motives (Kramer et al., 1986; Parks, 1994; Roch and Samuelson, 1997). Similarly, in scenarios that mirror "real-life" social dilemmas such as traffic congestion, prosocial individuals exhibit a greater preference to commute by public transportation rather than private car, and are more concerned with collective outcomes vis-à-vis the environment than proself individuals (Van Vugt et al., 1995; Van Vugt et al., 1996).

The "Might versus Morality Effect" provides a clear example of how social motives influence not only choice behavior but also the interpretation of behavior. Liebrand et al. (1986) examined the relationship between social motives and interpretations of cooperative and competitive behavior. They found that people with individualist social motives tend to interpret behavior along the might dimension (what works), whereas cooperators tend to view cooperation and competition as varying on the moral dimension (what is good or bad). Moreover, prosocials view rationality in social dilemmas from the perspective of the collective (community, group-level), whereas proself people may view it more from a perspective of individual rationality (egocentrically). Van Lange et al. (1990:36) argue that "if one accepts the idea that a perceiver's own goal or predisposition affects his/her choice and also indicates the perspective (collective or individualistic) taken on rationality, it follows that attributions to intelligence should be determined by the combination of the target's choice and the subject's own choice. Thus, social motives may relate not only to differences in choice behavior but also to different perceptions of rationality and intelligence.

Van Lange and colleagues (1990) confirmed that cooperators make larger distinctions between cooperative and noncooperative people than do competitors when making attributions about their behavior on a scale that measures "concern for others." Both cooperators and defectors (noncooperative people) agreed that cooperation is more related to concern for others than noncooperation. In three N-person prisoners' dilemma games (varying in the extent to which fear and greed could be the cause of noncooperation), they compared causal attributions made by cooperative versus noncooperative people. Following each game, participants were asked to make causal interpretations of cooperative and noncooperative choices performed by two imaginary target people (one was a cooperative person, the other was noncooperative). Their findings suggested that cooperators

(participants who made cooperative choices in the prisoners' dilemma) were more likely than defectors to attribute cooperation to intelligence, whereas defectors were more likely than cooperators to attribute noncooperation to intelligence.

Van Lange and Liebrand (1991) specifically tested whether individual differences in social motives influence perceptions of rationality in social dilemmas. They manipulated the perception of another person in terms of intelligence in a public goods dilemma. The findings supported their prediction that prosocial individuals expected more cooperation from an intelligent than an unintelligent person, while competitors expected significantly more cooperative behavior from an unintelligent other than an intelligent one.

Van Lange and Kuhlman (1994) evaluated whether social motives influence how information about others is interpreted. In this experiment, people with different social motives made different interpretations of a commons dilemma. Impressions of honesty or intelligence, as well as fairness and self-interest, fell in line with the might versus morality perspective. Cooperative individuals assigned greater weight to honesty than did individualist and competitive participants, while individualists and competitors placed greater weight on intelligence than prosocial participants. Similarly, Samuelson (1993) found systematic differences between cooperators and noncooperators in the importance they assign to dimensions of fairness and self-interest in resource dilemmas. Cooperators assigned greater weight to a fairness dimension, whereas noncooperators assigned greater weight to a self-interest dimension.

Another dimension that may relate to social motives is culture. People from collectivist cultures—cultures that view the self as interdependent with others—behave cooperatively with members of their own group and competitively with members of an out-group, whereas people from individualist cultures—cultures in which the self is perceived as an independent entity—focus less on the social environment and are more task oriented, focusing on their individual goals (Hofstede, 1980; Leung, 1997; Schwartz, 1994; Triandis, 1989). The relationship between culture and social motives is not as straightforward. In a study using an intergroup prisoners' dilemma, Probst and colleagues (1999) found that cultural values of individualism versus collectivism and social motives measured superficially similar constructs. However, the correlations between these measures were low and the authors caution against assuming overlap. Gaerling (1999) found that social motives are related to some cultural values but not to others. Prosocial individuals scored significantly higher on measures of universalism (a cultural value that relates to equality, social justice, and solidarity) but not on benevolence (a cultural value that relates to inner harmony, friendship, good relations, being liked, and security). Because culture is a complex group-level phenomenon, it may not map on directly to measures of individual differences such as social motives. Researchers are only now beginning to focus on the influence of culture on social dilemmas (Kopelman and Brett, *in press*).

The main conclusions that may be drawn from the research on social motives

is that prosocials who tend to view rationality in collective terms are more likely to cooperate in commons dilemmas than proselves who tend to view rationality in individual terms. Prosocials tend to think of cooperation as moral and of competition as immoral, while proselves tend to think of competition as effective and cooperation as less so. Both prosocials and proselves think that their own preferred strategy is more intelligent.

### *Gender*

Not much research has focused on gender in resource dilemmas. There seems to be a weak but reliable relationship between gender and social motives such that the percentage of prosocials (cooperators) is slightly higher among women than men, while that of proselves (individualists and competitors) is higher among men (e.g., Van Lange et al., 1997). A recent meta-analysis on gender and negotiator competitiveness also found a slight tendency for women to appear more cooperative than men in negotiations (Walters et al., 1998). Some experiments on gender differences and social dilemmas have been conducted using the public goods paradigm, but findings are contradictory.

Gender may influence cooperation because men and women respond differently to one another in group interactions and discussions (Stockard et al., 1988), because they differ in understanding and reacting to each other's actions (Cadsby and Maynes, 1998), or because they respond differently to certain types of resources (Sell et al., 1993). In one study, when participating in four-person same-sex groups, men contributed to a public good at higher rates than women (Brown Kruse and Hummels, 1993). In contrast, another study found all-female groups were more cooperative than either all-male groups or mixed-gender groups (Nowell and Tinkler, 1994). Similarly, Stockard et al. (1988) found that in mixed groups, women were more likely to cooperate than men, especially when discussion among group members was permitted. Yet another study found that women initially contributed significantly more than men, but that the difference disappeared with subsequent trials (Cadsby and Maynes, 1998). Sell and colleagues (1993) found no influence of group gender composition on contributions to a public good, nor did they find a gender effect when money was the resource; however, when the resource was changed to time with an expert, men cooperated significantly more than women.

These mixed findings suggest that gender may have an influence on cooperation in social dilemmas, but its effect may be small and variable. It may be that group diversity is more relevant than the specific gender composition. Research on minority opinions (Nemeth, 1986) and intragroup diversity (Gruenfeld et al., 1996; Williams and O'Reilly, 1998) in decision making suggests that divergence of opinion about the task—task conflict, in contrast to relationship conflict (Jehn, 1995)—leads to better decisions and thus also could influence the development of norms for cooperation in social dilemmas.

### Decision Structure of the Task

#### *Payoff Structure*

Historically, experimental research on social dilemmas of all kinds has demonstrated significant effects attributable to changes in the “payoff structure” underlying a situation. What are the payoffs associated with cooperation or defection? What are the risks associated with different choices? The influence of payoff structures has been demonstrated not only in the laboratory, but also in the field (Van Lange et al., 1992b). Although emphasis most often has been placed on the monetary payoff structure in experimental games, the present review considers a broader array of structural factors that affect individuals’ choices. Central to popular and psychological understandings of behavior is the notion that behaviors generally are more likely to be exhibited when rewarded, and less likely to be exhibited when punished. The central question in any given situation is what combination or form of rewards and punishments (sanctions) will yield optimal or desirable results. A number of recent studies have offered new insights that may be applied productively to the development of better commons management techniques.

Gächter and Fehr (1999) moved beyond the familiar experimental manipulation of material economic rewards or punishments to examine the effect of social rewards on people’s willingness to contribute to public goods. They were specifically interested in whether social rewards alone could overcome free-rider problems. First, the investigators conducted a questionnaire study. The questionnaire results confirmed that participants “expect [to] receive more approval if they contribute more, and less approval if others contribute more. In addition, they expect higher marginal approval gains if others contribute more” (p. 346). In the main study, participants faced a public goods dilemma in one of four conditions: (1) an anonymous condition in which participants never knew who they were playing with; (2) a “social exchange” condition in which participants had an opportunity to interact after the game; (3) a “group identity” condition in which participants met one another before playing, but knew they would not see one another afterwards; and (4) a combination of conditions 2 and 3 in which participants met ahead of time, and had a chance to interact afterwards. Neither social familiarity (condition 3) nor the opportunity to receive social rewards in the form of expressions of appreciation after the fact (condition 2) improved the level of cooperation relative to the baseline anonymous condition. However, the combination of the two (condition 4) resulted in significantly higher levels of contribution.

Gächter and Fehr (1999:361-362) conclude that “social approval has a rather weak and insignificant positive effect on participation in collective actions if subjects are complete strangers. Yet, if the social distance between subjects is somewhat reduced by allowing the creation of a group identity and of forming weak social ties, approval incentives give rise to a large and significant reduction in

free-riding.” They go on to suggest that group identity effects may act as a facilitating “lubricant” for social exchange. It is important to note that there remained, even in the combined condition 4, a minority of participants who seemed unmotivated by social approval and willing to exploit the end-game round. A consistent finding in the gaming literature is that cooperation drops off as the end of the interaction draws near. Although many real-world commons dilemmas are related to resources that parties want to last indefinitely, a similar effect is likely to arise when a given party or parties sees an end to their interest in the commons, and therefore, the relationships that attend its management. Nonetheless, consistent with findings described elsewhere in this chapter, the effectiveness of social rewards in reducing free riding and increasing cooperation is enhanced by reductions in social distance and the facilitation of group identity.

Bell et al. (1989) offer a unique solution to the problem of overconsumption: Let consumers steal from one another. The investigators ran an experiment with a 3 (probability of punishment for stealing)  $\times$  3 (probability of punishment for overconsumption) design. The levels of probability for each factor were zero percent (control), 25 percent (low), and 75 percent (high). The punishment in both cases was a loss of points. In each round of play, participants could harvest from the common resource pool, or they could steal from the other players. The results suggest that increasing the probability of punishment for a behavior has a significant deterrence effect; there were main effects for punishment of both behaviors. However, “punishment of one behavior increased the occurrence of the selfish alternative” (p. 1483). If the probability of punishment for overconsumption increased, so did the likelihood of stealing from neighbors. If the probability of punishment for stealing from neighbors increased, so did the likelihood of overconsumption. “To summarize, in the commons simulation, punishment for overconsumption reduced overconsumption, helped preserve the commons, but increased stealing. Punishment of stealing deterred stealing, promoted depletion of the commons and increased overconsumption” (p. 1495).

Of course, in the real world more than one kind and level of reinforcer is operational at any given time. “Poaching wildlife, for example, may involve perceived rewards of food and hides, perceived thrill of the hunting experience, risk of being caught and punished, potential inconvenience, as well as depletion of the resource, among other consequences” (Bell et al., 1989:1491). Understanding the interplay of such factors is clearly a complex task that is, at least to some extent, unique to any given context.

The Bell et al. (1989) findings also should be read with an understanding that their experimental framework made stealing a highly public act. Although there are real-world analogues (e.g., parking in a handicapped parking spot), the majority of resource theft is done under the assumption that detection is improbable. Although their experiment fixed the probabilities of punishment regardless of an offense’s public nature, whether the potential for secret theft under the same probability conditions would yield different behaviors is an open empirical question. Cer-

tainly, given the findings reported earlier on the motivating influence of social approval or disapproval (Gächter and Fehr, 1999), one could reasonably anticipate greater willingness to offend if offered the opportunity to do so more discreetly.

In another interesting commons study, Martichuski and Bell (1991) crossed three levels of reinforcement (reward, punishment, or no reinforcement) with three different game structures (territoriality, "golden rule" moral suasion, and a basic structure). Rewards were affirmations for making commons-sustaining harvest choices (i.e., "Good choice, player X"), and punishments for commons-depleting harvest choices were simply the inverse (i.e., "Bad choice, player X"). The territorial structure involved splitting the larger pool so individuals essentially managed their own access to a personal resource pool. The golden rule moral suasion structure involved an initial suggestion that when participants made harvesting decisions, they could make "a lot of points" by making their decisions "exactly the way that [they] would want other people to make their choices." The basic structure was a straightforward commons dilemma (Edney and Harper, 1978).

Those in the privatization (i.e., "territorial") condition were more effective in preserving the commons than those in the moral suasion condition, who were in turn more effective than those in the basic structure condition. Reward and punishment improved the life of the commons in the moral suasion and basic structure conditions, but had no appreciable impact on the privatized condition. Furthermore, reward and punishment had equivalent effects. Martichuski and Bell (1991:1367) suggest that "it seems that a privatized resource maximizes individual harvests while preserving the slowly regenerating resource, and that rewards and punishments do not add to these maxima." This raises a number of interesting questions. For example, would an elaborate system of metering and rationing (with limits or tiered pricing) be a simpler and more effective mechanism for managing certain resources (e.g., water) than elaborate reward and punishment systems? Where it is difficult to effect a system akin to privatization, moral suasion combined with a reinforcement system seems to be a strategy worthy of consideration.

This final point is particularly interesting in light of the rather weak manipulations of this study. The statement "Good move" flashing on one's computer screen is hardly a powerful reward. There is, however, at least one problem from our perspective with the moral suasion condition: It appears to confound what the morally right thing to do is (golden rule) with maximizing personal utility ("Here is a way to make a lot of points..."). This is problematic given that, unlike the typical understanding of social dilemmas, the manipulation seems to suggest that participants' short-term gains can be improved by considering community issues. Further testing of these findings in a context where moral suasion is less confounded, and in which more powerful and realistic rewards and punishments are utilized, could be both interesting and worthwhile.

The value, necessity, and effectiveness of sanctioning systems can vary across cultures. Yamagishi (1988:271) found that American participants in a pub-

lic goods experiment "cooperated more strongly than Japanese subjects when no sanctioning existed." The sanctions were monetary and were double the amount a person contributed to a "punishment fund." Yamagishi (1988:271) explains his finding in terms of Taylor's (1976) argument that the existence of "a strong external system of sanctioning destroys the basis for voluntary cooperation." Therefore, the existence of such a system "exacerbates the conditions which are claimed to provide its justification and for which it is supposed to be the remedy." He suggests that Japan's more collectivist culture and the culture's tendency toward mutual monitoring and sanctioning result in a decrease of trust in the absence of such control mechanisms relative to America's more individualistic society. This was further supported by questionnaire findings that indicated a lower level of interpersonal trust among Japanese participants than their American counterparts. This finding poses at least two challenges for those interested in commons management. The first is to give careful consideration to cultural factors when making statements about commons dilemma strategies. The second is to consider the long-term consequences of sanctioning systems and authorities on trust and general cooperative tendencies in communities. This is a difficult balance.

Although we focus on experimental and not on applied commons dilemma research, it is important to note that there have been numerous studies on the effects of reward/punishment strategies outside the lab. In this vein, Van Vugt and Samuelson (1999) conducted a field experiment on structural solutions that promote water conservation. They made explicit use of the social dilemma framework to test the effect of personal metering during a naturally occurring resource crisis—a water shortage. They found that conservation efforts were greater among metered (versus unmetered) households when people perceived the water shortage as severe. They suggest "it is time to move beyond the simplified taxonomy (of individual versus structural solutions) to investigate the dynamic interrelationship between structural changes and individuals' psychological and behavioral responses within their new interdependence structure" (p. 743).

In conclusion, sanctioning systems offer potential benefits to the management of common resources. On the other hand, sanctioning systems may undermine intrinsic motivations for cooperation and other generally helpful factors for community life such as interpersonal trust.

### *Uncertainty*

Environmental uncertainty increases the difficulty of solving social dilemmas. For example, in many environmental problems the size of the resource pool and its replenishment rate may not be known, or estimates may be contested. For a discussion of the institutional response to uncertainty in complex adaptive systems such as commons dilemmas see Wilson (this volume:Chapter 10). Other authors in this volume confirm that uncertainty of one kind or another can complicate both the exercise of sustaining a common resource (Agrawal, this vol-

ume:Chapter 2) and the possibility of one emerging (McCay, this volume:Chapter 11). In the experimental literature, too, the influence of environmental uncertainty on cooperation has emerged as a focal issue.

Ignorance of crucial parameters tends to reduce cooperation in commons dilemmas. In the face of increasing levels of environmental uncertainty about the pool size, people request more for themselves, expect others also will request more, overestimate the size of the resource pool, and display more variability in their harvesting efforts (Budescu et al., 1990, 1992, 1995). These experiments establish that pool size uncertainty affects behavior in both symmetric and asymmetric payoff structures. The effects of pool size uncertainty were corroborated by Hine and Gifford (1996) in an experiment that extended the experimental manipulation of uncertainty to situations of regeneration rate uncertainty; both types of environmental uncertainty led to greater probability of overharvesting. These findings were also supported by Gustafsson et al. (1999a; 1999b).

Why does increased variability about the potential size of the resource or uncertainty regarding the replenishment lead to increased overuse? One explanation is that increased variability of the pool size makes people think that others' requests also will be more variable. Budescu et al. (1990) suggest that, depending on whether an individual is risk seeking or risk averse, environmental uncertainty may respectively lead to either increased or decreased requests from the commons. They found that risk-seeking people requested more from the resource pool than risk-averse people.

Work by Roch and Samuelson (1997) supports the hypothesis that different types of people perceive environmental uncertainty differently. Specifically, social motives moderated the effect of environmental uncertainty on harvesting behavior. These authors found that individualists and competitors (proselves) increased their harvesting under situations of uncertainty. In contrast, prosocial individuals (cooperators and altruists) held their harvest constant, or harvested less.

Another possible explanation for increased harvesting in the face of environmental uncertainty relates to the finding that in situations of uncertainty, people overestimate the size of the pool. As uncertainty about the common resource increases, both the mean estimate and their associated standard deviations increase (Budescu et al., 1990). On one hand, people may believe that the pool is larger because it potentially can be larger. However, this may be a justification for their overharvesting behavior. Uncertainty about pool size may provide a stable external justification for greed: "It's not my greed, I simply assumed the pool was larger - who knew?" Like the diffusion of social responsibility in large groups (Darley and Latané, 1968; Fleishman, 1980),<sup>2</sup> uncertainty also may act to diffuse personal accountability.

Increased harvesting from a common resource under circumstances of uncertainty occurs both in situations of simultaneous protocol of play (Budescu et al.,

1990) and sequential protocol of play (Budescu et al., 1992; Rapoport et al., 1993). The "protocol of play" refers to the temporal order in which people harvest from a shared resource pool (Budescu et al., 1997). Using a simultaneous protocol, people make their harvesting decisions simultaneously and often anonymously. Under a sequential protocol, there is a prespecified order and each person knows his or her position in the sequence and the sum of previous harvests (i.e., current size of resource). In the sequential protocol of play, an additional effect results such that an inverse relationship characterizes the player's position and the size of the request—the first player is likely to make the largest harvest.

An interesting variant of the sequential protocol is the positional protocol, where there is uncertainty about the resource size for subsequent players. In this case, first movers cannot depend on those who come later to adapt to larger initial harvests because the magnitude of the early harvests will not be known. The positional protocol permits three hypotheses about decision making. First, because sequential pool size information is unavailable, there should be no position effect—the results should look like the simultaneous protocol. Alternatively, if players all expect the position effect to exist, then they will act in accordance with it and create the effect and the results should look like the sequential protocol. Finally, the ambiguity and uncertainty about how to approach harvesting, even for the early players, will result in some harvesters thinking the appropriate model is the simultaneous protocol and others thinking the appropriate model is the sequential protocol. If this were to occur, the results should fall somewhere between the two "pure" benchmarks of simultaneous versus sequential protocols. Budescu et al. (1995), Budescu et al. (1997), and others have confirmed this latter hypothesis.

Van Dijk et al. (1999) have questioned the dominant view that environmental uncertainty leads to defection. They have found that environmental uncertainty is not necessarily detrimental to collective interest. In a complex experimental setting, they show that cooperation in social dilemmas depends on the type of dilemma (public goods or common resource dilemma), the asymmetry of position in the group (e.g., high-position members have more resources in a public goods dilemma and are allowed to harvest more in a common resource dilemma), and the type of uncertainty faced by a group. The authors found that groups dismiss uncertain information and base their decisions on environmental information that is certain.

In conclusion, uncertainty tends to reduce cooperation in commons dilemmas, although not always. Although uncertainty is not easily resolved by facts because scientific findings about the size of the resource and its replenishment rate are often controversial, it is important to note the potentially negative influences that uncertainty has on cooperation in commons dilemmas.

### Social Structure of the Task

In the past 10 years, research on various elements of the social context of commons-related decisions has yielded a number of important clarifications to earlier findings and charted worthwhile new territory. Although there is still some debate, it is fairly clear today that groups that interact repeatedly have higher cooperation rates in social dilemmas than groups that are rebuilt every time (Keser and van Winden, 2000). This line of research highlights a potential difference in cooperation between interactions with “strangers” and interactions in familiar social contexts. There is an array of research on issues relating to social structure. In this section, we will focus on three broad categories of research: (1) power, status, and leadership; (2) group size; and (3) understanding the role of communication and communication-related factors in commons settings.

#### *Power and Status*

Issues of power and status have long been a subject of focal interest for social scientists (e.g., Weber, 1924). In recent years, work by Pfeffer (1981) and others has reinvigorated efforts to better understand the ubiquitous role of power in governing and influencing human behavior. This lens now is being focused on social dilemma settings.

It is not uncommon for individuals to violate the expectations of others in ways that hurt other members of their group. Social dilemmas in general, and commons dilemmas in particular, offer a fertile context for this kind of betrayal of expectations. Someone is expected to contribute to a public good, or exercise restraint in harvesting a common resource, and fails to do so—causing negative outcomes for everyone else. In such circumstances, it is typical for the offending party to offer a justification for offending behavior. (A justification is defined as accepting responsibility for an act, but denying that it was wrong. It is distinct from an excuse, in which the offending party agrees that an act was wrong, but denies responsibility for it.)

A group of researchers examined the impact of power and status on the judgments people make about justifications that are offered in a common resource dilemma setting (Massey et al., 1997). Justifications are significant in common resource dilemmas; they are assertions that behaviors that seem a violation of the rules or norms that govern a resource—or the spirit behind them—are not violations at all. Broad acceptance of a justification can redefine fundamental understandings and rules of behavior.

A series of three experiments yielded four interesting findings (Massey et al., 1997). First, and perhaps least surprising, an offending act was judged to be less proper if the justification was invalid than if it was valid. (The validity of justifications was determined through extensive pretesting with a random sample of a similar population.) Second, when an offending individual had higher status than

other group members (i.e., a Ph.D. in resource management), it positively impacted others' judgments of the offending act's propriety if the individual's justification was also valid or at least ambiguous in terms of validity. The augmenting effect was greatest when the justification was ambiguous in terms of its validity. Strikingly, however, an offending individual's higher status was a liability if the justification was invalid. Third, an offending individual's greater level of power had a positive impact on others' public judgments of the offending act's propriety, but not on their private judgments. Finally, if an offending individual had both high status and greater power, the combination resulted in a positive impact on even others' private judgments about the act's propriety.

Clearly, the power and status of actors in a commons dilemma context can have a significant effect on how both individuals and their actions are perceived. Further study of such variables is certainly merited. Because a justification constitutes a denial that an act was wrong, one of the interesting implications of these findings is that those with status and power may be in a privileged position when it comes to defining propriety concerning a common resource and its management.

Mannix (1991) compared the resource distribution strategies of organizational groups as a function of discount rate—of what the value of resources would be over time. Her high discount rate condition was assigned a value of 12 percent, while the low discount rate condition was assigned a value of 2 percent. Groups in the high discount rate condition were more likely to adopt coalition strategies that involved fewer group members than groups in the low discount rate condition. This strategy resulted in lower individual and group outcomes. The low discount rate groups, by contrast, actually achieved growth in their resource pool over time. Why the increased competitiveness and destructive behavior among those facing a high discount rate? Mannix offers a few hypotheses. First, she suggests that the rapid devaluation of the resource pool might have led group members to treat every round “as if it were the last” (1991:388). Second, she suggests that the rapid discounting of resource value might have seemed startling relative to anchoring on initial harvesting values, and that group members quickly shifted to short-term strategies to compensate. Finally, she suggests that deep discounting also could affect the value of relationships: “one defector in a high discount condition may generate more fear and defensive behavior than the same defector in a more stable environment” (1991:389). This study raises a number of largely unresolved questions regarding the effects of participants' valuations of future resources on their harvesting decisions. Nonetheless, Mannix's finding that perceived rapid devaluation can lead to increased competition and the formation of excluding coalitions is a noteworthy and instructive caution to those who manage resources.

In addition to the discounting of resource value, and perhaps uncertainty, power imbalances within groups that draw on a common resource can increase

the likelihood of coalition formation (Mannix, 1993:2). Mannix argues that when imbalances exist, individual group members have a harder time focusing on mutual gains, and instead focus on protecting their own interests. Coalitions can have significant negative effects on a group's overall outcomes because they can deprive individuals and subgroups of access to the resources they require to succeed or survive. Consistent with her hypotheses, Mannix found that, relative to groups with equalized power relations, groups with power imbalances: (1) made less efficient use of available resources; (2) were more likely to begin the exercise distributing resources to a subset of the group; (3) included fewer people in resource utilization across multiple rounds; and (4) took more effort to reach agreements on resource distributions. Power imbalance was manipulated by assigning different profit percentages to divisions in a decentralized organization (equal versus unequal). In addition, members of groups with power imbalances were more likely to see the group as competitive, be motivated by individual gains, and retaliate against those who omitted them from a coalition. Evidently it also was easier for groups with power imbalances to form small coalitions rather than large ones.

Mannix (1993:16) concludes that power imbalance can be detrimental to group outcomes, noting that "power imbalance appears to encourage competition and a focus on individual outcomes resulting in less integrative agreements." She does, however, offer a possible prescription for better functioning groups: "One of the ways to balance power is to assemble group members from the same position in the hierarchy who have various sources of expertise that are all necessary to the functioning of the group. This way, although the group members would still have their own interests and goals, they might not be as threatened by the positions of other group members" (pp. 18-19).

Wade-Benzoni et al. (1996) offer some important insight into both asymmetric power distributions between people in a commons dilemma and the role of egocentrism (the tendency to see the world only from one's own point of view) in commons management. In an elaborate study that simulated a real-world fish-stock dilemma, they found that levels of egocentrism affect individuals' and groups' perceptions of fairness in asymmetric dilemmas. Next, and more importantly, they found that overharvesting behavior was positively correlated with levels of egocentrism. These two findings naturally lead to the question of whether anything can be done to decrease egocentric biases in dilemma settings. By examining egocentrism before and after discussion, the investigators learned that discussion appeared to decrease egocentric biases. This suggests that the reduction of egocentrism may be one of the reasons why communication has a positive effect on cooperation in social dilemmas in general (see section on communication later in this review). In keeping with Mannix's (1993) conclusions, the study's results suggest that overharvesting tendencies are greater in asymmetric than in symmetric dilemmas. Finally, overharvesting behavior also is related to participants' beliefs about what other participants are likely to do.

Also related to the study of coalitions and power distribution is research on voting institutions. Walker et al. (2000) found that voting substantially increases the efficiency of the outcomes in commons dilemma games. Voting can act as a communication signal when no communication is possible. "The very act of making a proposal and voting on a set of proposals signals limited information to all involved. In particular, it appears to generate information that enables a learning process to occur" (p. 231). This learning extends to subsequent situations and enables people to coordinate their activities even in rounds where no proposals are made.

In 1991, the California water shortage offered Tyler and Degoey (1995) a natural commons dilemma to study. With complete survey data from 400 people directly affected by the shortage, they were able to pose a number of interesting questions about authorities and leadership in relation to the management of a common resource dilemma. Their results replicated earlier experimental findings that people confronted with a severe resource shortage willingly endow authorities with additional control over the resource (e.g., Messick et al., 1983). They also found that the legitimacy of such authorities was determined in large part by the authorities' commitment to fair allocation and decision-making procedures (procedural justice). Perhaps most interesting was their finding that respondents' social identifications with their community moderated the relationship between authorities' use of fair procedures and the support of the authorities. Those who felt pride in their community and perceived procedures to be fair expressed particularly strong support for the regulating authorities. In fact, people who took pride in their community cared even less about their personal outcomes. Taken as a whole, Tyler and Degoey (1995:482) suggest that authorities' effectiveness is "primarily linked to the nature of their social bonds with community members." Social identification with community is an important variable that should not be overlooked in future studies of resource dilemmas.

A number of recent findings speak to contingency issues related to leadership and administration in social dilemma settings. Wit and Wilke (1990), for example, examined the role of who presented rewards and punishments in a social dilemma, and to whom they were presented. The experimental procedures placed participants in the role of chemical company managers concerned with making waste storage versus waste treatment decisions. The former choice was in participants' short-term financial interests, while the latter choice was better for the community and promised greater long-term value. For 124 undergraduates they found no difference between the effectiveness of rewards or punishments on their choices, regardless of whether they were presented by the government or by their parent companies. In contrast, for 239 managers, rewards supplied by the parent company were highly effective, while those supplied by government were actually counterproductive. This finding suggests an interesting consideration for those attempting to manage dilemmas in the real world: What source of sanction-

ing is most likely to be embraced and respected by the people who make the important decisions?

A large existing literature has explored the conditions under which group members opt to appoint a leader to aid them in achieving their goals in a commons dilemma (e.g., Messick et al., 1983; Samuelson and Messick, 1986). It indicates that groups will opt for a leader when they have failed to manage a resource efficiently and inequalities in harvesting outcomes emerge and that followers will endorse leaders when they are successful in maintaining the common resource (Wilke et al., 1986; Wit and Wilke, 1988; Wit et al., 1989). Studies on public goods also point out that leaders are not autocratic decision makers but rather need some form of legitimacy in order to be effective in persuading members to cooperate (Van Vugt and De Cremer, 1999).

Wit and Wilke (1988) examined the role of leaders' allocation decisions in determining whether or not their leadership is endorsed. Their experiment varied both the outcomes the leader allocated to himself or herself (leader overpayment, leader equal payment, leader underpayment) and his or her allocation to subordinates (participant overpayment, participant equal payment, participant underpayment). They found that leader "endorsement was weakest when the leader overpaid himself or herself" (p. 151) and when the participant making the evaluation had been underpaid relative to other group members. Three more specific findings are also worth noting. First, the leader received his or her greatest endorsement when all allocations were equal. Second, when the leader paid himself or herself less than his or her fair share, participants seemed to take little notice of differences between themselves and other subordinates. Third, when participants were overpaid, they took little notice of how the leader and the other subordinates were paid.

### Group Size

Earlier research established the much-replicated tendency of small groups to achieve more cooperative outcomes than larger groups (e.g., Dawes, 1980). One recent study offers an interesting insight into a mechanism that may partly explain this tendency: self-efficacy. Self-efficacy is an individual's belief that he or she is competent and capable of taking effective action to achieve a given outcome (Bandura, 1986). In a series of experiments, Kerr (1989) demonstrated that even when group size was objectively irrelevant to the impact a participant could have on an outcome, members of small groups felt more "self-efficacious" than members of larger groups. In the last experiment in this series, the effect of group size on assessments of "collective" efficacy—the perception that one's group can succeed at a given task—was measured. A largely parallel effect to the self-efficacy results was found. When the provision point (proportion of group members demonstrating contributing behavior necessary to achieve the public good) was high (67 percent), group size had no significant impact on assessments of collec-

tive efficacy. However, when the provision point was low (33 percent), smaller groups were perceived to be more efficacious than large groups. Kerr (1989:307) observes that "The striking thing is that this belief persisted even when exactly the opposite was objectively true."

Despite Kerr's consistent finding across three studies that smaller group size resulted in judgments of greater self- and collective efficacy to attain a public good, only in the last study were there significant group size effects on actual cooperative behavior. Kerr hypothesized that reductions in group size may increase assessments of the efficacy of others' cooperative behaviors, and therefore encourage free riding. Kerr's experimental paradigm may have encouraged free riding relative to other settings "by minimizing interaction and identifiability" (p. 310).

Kerr refers to his findings as "illusions of efficacy," which he attributes to "familiar judgmental heuristics, involving an overgeneralization of experience in groups of varying sizes" (p. 287). It would be interesting to test whether segmenting an affected population and highlighting subgroup goals or restraints encourages cooperative behaviors in commons dilemmas. For example, one might highlight water consumption behavior in a given apartment building or neighborhood rather than simply highlighting a statewide need for restraint. Other work suggests that small groups are more motivated to divide resources equally than are members of large groups (Allison et al., 1992). This tendency might make it easier for members of smaller groups to make appropriate harvesting decisions.

In contrast, recent studies in economics contradict the widely held view that a group's ability to provide an optimal level of a pure public good is inversely related to group size. Isaac et al. (1994) investigated free-riding behavior in public goods provision and found that groups of sizes 40 and 100 actually provided the public good more efficiently than groups of sizes 4 and 10. To overcome methodological problems that may be associated with studying large groups, they make two methodological modifications: (1) decision-making rounds last several days rather than a few minutes, and (2) rewards are based on extra-credit points rather than cash. The high level of cooperation in large groups is inconsistent with the standard Nash model, but can be explained by alternative approaches such as that of Ledyard (1993), who proposed an equilibrium model in which individuals get some satisfaction (a warm glow) from participating in a cooperative group.

An experiment that introduced a market mechanism for managing the commons provides a somewhat different perspective on group size (Blount White, 1994). Each participant played the role of a corporation that drew on a finite water supply. As it became apparent that the common resource was dwindling at a dangerous pace, half of the participant groups were given the option of buying out other participants. In the "transfer payment" condition, each participant could set a price for his or her right to consume water from the supply, and the other participants could make contributions to buy a seller out. Once a participant was

bought out by the others, that participant closed up shop. Therefore, the buyouts could reduce the number of participants drawing on the water supply—effectively reducing group size. Note that participants were not buying a right to a fixed quota of consumption, but simply a reduction in the number of enterprises drawing on the common resource.

Blount White (1994) initially hypothesized that the act of paying compensation to remove a participant from the commons would make the true costs of overconsumption more salient for the remaining participants, and thereby reduce the speed with which they exhausted the remaining water supply. Interestingly, not only did the water supply of groups with the transfer payment option last no longer than the water supply of groups without the transfer payment option, but those with the option consumed significantly more in later rounds than those without the option. Thus, “the market-based intervention hastened depletion” (p. 443). The transfer payment option actually motivated greater self-interest, rather than greater attention to conservation. Why? In debriefing, participants commonly “cited the strategy of trying to take out as much as possible for oneself and then trying to get bought out” (p. 443). Blount White suggested that “when participants pay compensation they may not cognitively interpret it as a cost of consumption but as the purchase of the right to consume more” (p. 453). She concluded, “a self-regulated, market-based approach is not necessarily effective at controlling detrimental social choice patterns” (p. 454). Of course, any number of additional tests of this conclusion would be merited, but the finding is nonetheless interesting and relevant to real-world commons management.

### *Communication*

Among the most consistent findings in the experimental social dilemma literature is that a period of discussion among participants yields positive cooperative effects. In the face of an impressive and systematic research program on the effect of communication on cooperation, all but two explanations of this phenomenon had been dismissed as insufficient explanations of the communication effect (Dawes et al., 1990). Those two explanations were: (1) Group discussion enhances group identity or solidarity, and (2) group discussion elicits commitments to cooperate. Still greater clarity regarding the causal mechanism at work was necessary to move forward and more effectively develop optimizing strategies for real-world dilemmas. It is precisely this kind of research enterprise—teasing apart the mechanisms driving an effect—for which experimental laboratory methods seem uniquely well suited.

Kerr and Kaufman-Gilliland (1994) competitively tested the group identity versus commitment explanations in a step-level public goods task. In an elegant  $8 \times 2 \times 2$  factorial design, they manipulated the self-efficacy of participants' cooperation, the presence or absence of discussion, and the anonymity or public nature of cooperation decisions after discussion. They found a clear pattern of results

consistent with the “elicitation of commitments” explanation. “Regardless of how inefficacious a cooperative act was for providing the public good, those who had previously discussed the public-good cooperated at a rate about 30 percent higher than those who had not participated in such a group discussion” (p. 521). While groups that engaged in discussion demonstrated a stronger, more positive sense of group identification, and group identification accounted for some variance beyond that accounted for by discussion condition, it clearly was not a sufficient explanation for the communication effect. Discussion resulted in commitments, and, on average, people followed through with their commitments. These results are also consistent with the finding that, in a public goods dilemma, “a pledge with a certain degree of commitment may facilitate cooperative behavior” (Chen and Komorita, 1994).

Bouas and Komorita (1996) further confirmed Kerr and his colleague's finding that group identity enhancement is an insufficient explanation for the effect of group discussion. However, the structure of their study led them to a somewhat different conclusion about what constituted a sufficient explanation. Whereas Kerr and Kaufman-Gilliland's (1994) study tested the effects of a universal consensus (commitment), Bouas and Komorita (1996) found that a more generalized perception of a degree of consensus was also sufficient to elicit the communication effect. For those managing real-world resources, this stream of research suggests that finding ways to elicit commitments and maximize perceptions of cooperative consensus might be worthwhile.

A natural follow-up question flows from these studies: Why do people follow through on their commitments? Do they fear social sanctions (social norm), or are they internally motivated (internalized or personal norm)? One of the interesting findings of Kerr and Kaufman-Gilliland's original study (1994) was that the anonymity of actual contribution decisions had no effect on the decisions. People honored their commitments even if there was no chance of getting caught cheating. Kerr and his colleagues (Kerr et al., 1997) followed up with a more rigorous test of whether anonymity would moderate the effects of group discussion. Although it was possible for participants in the original study to believe the experimenter might know whether they cheated or not, this follow-up study made it seem impossible for the experimenter to determine whether or not participants honored the commitments they made. In the anonymous condition, the videotape of each session was purportedly mangled and dangled in its damaged state before participants' eyes before they had to make their decisions. The results of this study suggest that the functioning norm in such situations is governed predominantly by self-monitoring. It appears that for most people, the norm against violating their stated commitments is an “internal personal one” as opposed to a social one. This suggests that, paired with dialogue, a society's ability to instill well-internalized personal commitment norms among its citizens may be more effective in managing resource dilemmas in the long run than sanctioning systems. However, as Kerr and his colleagues make sure to point out, not everyone

strictly adheres to such an internalized norm. Thirty-two percent of their participants failed to do so. This may simply underscore the value of developing better paradigms for moral education. However, it perhaps further reinforces the importance of finding the right kind of sanctioning system to deal with those inclined to act selfishly and imprudently. This stream of research implies that further empirical study of promising and committing in groups and ways to encourage trustworthiness in those inclined to renege on commitments would be worthwhile pursuits.

Our increasingly electronic age is changing the kinds of communication that may occur in commons settings. Commons dilemmas often involve actors from a variety of institutions who are dispersed geographically, and thus e-mail communication may be commonly used to discuss and negotiate the use of a common resource. Comparing the efficacy of e-mail versus face-to-face communications is of both theoretical and practical interest. As mentioned earlier, research on the prisoners' dilemma suggests that in simple tasks there is no difference between face-to-face communication and e-mail communication, while in complex settings, face-to-face communication elicits more cooperation than e-mail communication (Frohlich and Oppenheimer, 1998). The investigators also examined whether one form of communication had better outcomes for cooperation in later rounds when no further communication was allowed. They found no differences in the "staying power" of the communication effect on cooperation as a function of communication channel. These results raise important issues that are just as relevant in commons resource management. They suggest that there are subtleties worth exploring in the communication effect as a function of communication channel. Furthermore, the study may have implications for researchers. For pragmatic and economic reasons, many researchers have adopted experimental techniques that offer e-mail (usually to a fictitious other) as the communication channel open to participants in lab experiments. The reported study raises a caution for such researchers regarding the generalizability of effect sizes as a function of computer-based versus "live" methods.

Communication can vary not only in terms of the medium that is used but also with respect to directionality. One question that has been raised is whether the unidirectional flow of information can also yield a positive effect on cooperation. Using prisoners' dilemma game and dictator game paradigms, Bohnet and Frey (1999) concluded that two-way communication is not always required to yield "solidarity" (cooperation). They found that one-way identification alone was sufficient for participants to personalize an anonymous stranger, reduce social distance, and positively affect participants' behavior. (Mutual identification and two-way communication generally still had more powerful effects.) The authors cite their study as supportive of Schelling's (1968) claim that "the more we know, the more we care." For the management of resource dilemmas, these findings suggest that actions diminishing social distance between "harvesters" and

those who stand to suffer first or most from the depletion of a resource may have advantageous consequences.

### Perceptual Factors

In this section we review recent studies that have questioned the effects of manipulating perceived causes and cognitive frames on cooperation in resource dilemmas. The general methodological structure of these studies is to hold constant the basic economic structure of the decision problem (or to manipulate it systematically) and to systematically change the reasons why things are as they are—the framing, verbal description, or context of the problem. The goal is to determine if these noneconomic and noninstitutional variations influence cooperation in the social dilemmas and if so, how.

### Causes

Hoffman and Spitzer (1985) were perhaps the first researchers to show that the reason given for people's priority position with regard to access to a shared resource made a difference in how much of the resource they claimed for themselves. When the researchers told their participants that they had "earned the right" to go first, to be the "controller," people took more of the resource than when they were told they had been "designated" as the controller by the experimenter. This study was followed by Samuelson and Allison (1994), who systematically varied, among other things, the reasons participants were given for having been assigned a priority position with regard to a resource presumably shared with five other participants. All participants were told they had been assigned to be the first of the six-member group to extract resources from a common pool. However, four groups of participants were given different descriptions about how they achieved this position. The underlying idea of the experiment was that a legitimate method for assigning a privileged position would lead the people to believe they were justified to take more than an equal share of the resources, whereas an illegitimate or questionable procedure would not support such justification. The better the "fit" between the means of getting the privilege and the justification, the more likely it is that people will depart from a "share equally" rule that allocation tasks evoke (Messick, 1993).

According to Samuelson and Allison (1994), this fit is maximal when the process resulting in the first position is a good example of a fair mechanism, which is to say when it is a good prototype of a selection process that leads to a "first come, first served" rule. Two such mechanisms, they propose, are flipping a coin and excelling on an achievement test. Roughly a quarter of their participants were told that they got first position by means of a coin toss, and a quarter were told that they got first position because they answered the most questions

correctly on a test of general knowledge. Two other equally random, but less prototypical ways were used to putatively assign the first position for the other participants. One quarter were told they had gotten the most answers correct on an achievement test, but they had seen that one of the six tests was much easier than the other five. The lucky person would get first place, not the person who knew the most. As a test this was unfair, but as a random device it was fair because tests were assigned randomly (subjects were told). In any case, it was not a prototypical process. Neither was the fourth mechanism, which involved calculating the distance of a participant's birthday from a randomly selected day of the year. Although participants rated this process as fair, they also rated it as unprototypical.

The study results showed that participants given the two prototypical justifications for their privileged position took nearly 50 percent more of the shared resource than those given the less prototypical justifications. Moreover, the importance of the justification depended on the details of the decision problem. When overuse resulted in zero payoffs for everyone, the effect of the justification was nonexistent; when people were allowed to keep whatever they had taken, the participants with prototypical justifications took nearly twice as much as those with unusual justifications.

Causal attributions are also important with regard to scarcity or abundance of the resource pool. Why there is a lot or a little has been shown to make a difference in how people treat the resource. In a field study of water use during the 1976-77 drought in California, Talarowski (1982) found that people who stayed within their water allocation limits tended to believe the drought was caused by a natural shortage. Those who exceeded their allocation, however, expressed the view that the shortage was people-induced. In this type of study, it is impossible to say whether the beliefs cause the behavior or the behavior causes the beliefs, or whether both are being caused by some other factor.

Rutte et al. (1987) tried to provide an experimental answer to this question. In their study, participants were told that they would be the fifth person of a six-person group to harvest from a shared pool. All subjects saw the harvests of the previous four (bogus) group members. Collectively, these first four members took 20 points (Dutch guilders—the experiment was conducted in the Netherlands). Half of the subjects were told that the pool initially contained 35 points (leaving 15 for the last two members to share) and half were told that it contained 25 (leaving just 5 for the last two members to share). Half of the people in these two conditions were told that all group members knew the size of the pool from the beginning, and the other half were told that the first four were ignorant of the pool size. When everyone knew the pool size, the shortage or abundance would be attributable to the others, whereas it would be attributable to luck when the first four did not know.

When all group members knew the pool size, the behavior of the first four

tends to establish a norm, either a norm of generosity (when there are 35 points) or a norm of greed (when there are 25). Thus the prediction was that when the group was seen as the cause, the participants would be more greedy (when the pool had 25 points), and less greedy (when it had 35) than the participants in groups whose first four members did not know the pool size. The data confirmed this pattern. People-caused shortages reflect a lack of restraint, whereas nature-caused shortages need not.

Samuelson (1991) showed that causal attributions were important in preferences for structural solutions to commons crises. Groups were given a chance to collectively manage an experimental resource pool and were given feedback that they had not done well in maintaining the pool. Roughly half of the people were told that most groups did well and that the task was rather easy, inducing an attribution that the people in the group were greedy. The other half were told that the task was a difficult one and that most groups did not do well, inducing the attribution that poor performance was due to the difficult environment. They were then told that they would be given a chance to do the task for a second time. At this point the subjects were told that they could do the task in the same way they had done it in the past or, if they wished, they could elect a leader who would make a group harvest on each trial and allocate the resources to the members. Samuelson (1991) found that nearly twice as many subjects favored having a leader when they thought that the reason for the prior failure was task difficulty (57 percent favored having a leader) than when they thought it was personal greed (30 percent favored the leader), suggesting that preferences for "solutions" depend on perceptions of causes.

There is one other point about causes that needs to be made in this section, which is that people will only try to solve social dilemmas if they think it is their responsibility to do so, and if they place causal agency on themselves. A study by Guagnano et al. (1994) showed that the ascription of personal responsibility was highly correlated with reported willingness to pay for a variety of environmental goods. This work suggests that people need to see themselves as appropriate causal agents in order to contribute at a higher level to the solution of environmental dilemmas.

In comparison with individual differences and both the decision and social task structure variables, perceptual factors may be easier to manipulate in real-world dilemmas. The scope of causal attribution and cognitive frames, however, goes beyond the "spin" given to the dilemma by the media or by another social institution. Causal attributions—how people explain a certain situation—influence how much of a resource people claim for themselves. This is evident with respect to the priority position regarding access to a shared resource, scarcity or abundance of the resource pool, and preferences for structural solutions to commons crises.

### Frames

Framing, in the study of decision making, concerns the ways in which outcomes, options, and actions are described. Interest in framing can be traced to "prospect theory," the seminal work of Kahneman and Tversky (1979), which showed that people respond differently to decision problems in which the same outcomes are described either as gains or as losses. These authors introduced the concept of loss aversion, which refers to the empirical observation that people evaluate the loss of a given amount more seriously than they evaluate a gain of the same (absolute) amount in risky choices. Moreover, risk attitudes may change as a function of outcome framing. Kahneman and Tversky (1979) proposed that people tend to be risk averse with gains and risk seeking with respect to losses. Monetary outcomes can be framed by changing the reference point from which they are evaluated. A salary of \$60,000 could be described as \$10,000 more than the average for an industry (a positive frame), or \$10,000 less than the mean salary of people with a comparable education (a negative frame).

In the study of social dilemmas, the idea of outcome framing seemed to correspond to the distinction between public goods dilemmas and common-pool dilemmas. In public goods problems, people must make a contribution or give money and hence experience a loss; in common-pool problems, people will make harvests from a resource and hence experience a gain (e.g., Brewer and Kramer, 1986). Thus there seemed to be a one-to-one correspondence between social dilemmas and outcome framing, and many of the early experiments on framing were based on this correspondence. These early studies found inconsistent and puzzling results (see Aquino et al., 1992; Brewer and Kramer, 1986; De Dreu et al., 1992; Fleishman, 1988; McDaniel and Sistrunk, 1991). In these early studies, it was not always clear whether the predictions being made were based on the loss aversion concept or on the assumed difference in risk attitudes for gains and losses.

A recent study of this type (Sonnemans et al., 1998) makes it clear that there is no simple way to apply prospect theory to social dilemmas. Prospect theory requires the specification of a clear reference point for the evaluation of prospects, and social dilemmas are complicated decision situations with a multitude of potential reference points. Moreover, these authors found that although there were no initial differences in cooperation between two versions of a game—one in which people gave money to create a public good and one in which people restrained themselves from taking to create the good—differences did emerge as the participants gained experience with the task. The authors argue that these results require a dynamic theory that can highlight the learning that takes place in the two different environments as participants explore the consequences of their choices.

Although there is little doubt that framing effects occur, there is no consensus on the underlying cause or causes. Indeed, there may be many ways to frame

social dilemmas and to influence rates of cooperation, and that fact may be the most important result of this line of experimentation. The following experiments illustrate some of these framing manipulations and their consequences.

De Dreu and McCusker (1997) pursued the loss aversion concept by creating payoff matrices for a two-person prisoners' dilemma game that expressed payoffs either in terms of gains or in terms of losses. They then argued that framing outcomes as gains or losses changes the relative utility or preference between cooperating and defecting in different ways depending on the person's social value orientation. On the assumption that choice frequencies are a direct function of the difference in payoff magnitudes, these authors argued that the incentive to cooperate should be greater in a loss frame than in a gain frame for cooperatively oriented people (who are trying to maximize the sum of the payoffs for the two parties). However, for individualists (trying to maximize their own payoff) and for competitors (trying to maximize the difference between what they get and the other's payoff), the incentive to defect is stronger in loss frames than in gain frames. Thus, they argue, framing can make some people more cooperative and others less so, depending on their utilities. These authors report a series of three experiments that provide impressive support for their hypothesis. Cooperative subjects cooperated more in loss-framed games than in gain-framed ones, while the reverse tended to be true for individualists and competitors. De Dreu and McCusker (1997) also reviewed more than a dozen previously conducted experiments to marshal suggestive evidence that the instructions in these studies determined if loss frames influenced cooperation and, if so, how.

Not all framing has to do with losses and gains. Batson and Moran (1999) conducted a prisoners' dilemma experiment in which the game was described as either a "Business Transaction Study" or a "Social Exchange Study." The instructions for the former consisted of business examples, while the instructions for the latter referred to noneconomic social exchange. The idea was that the description of the task could trigger different means of evaluating strategies for interacting in it. As expected, people made more cooperative choices when the task was framed as a social exchange study than as a business transaction study. These authors also demonstrated that when empathy was created for the other participant in the experiment, the level of cooperation was increased regardless of the frame.

Frames also can be implied by institutions, as has been shown by Elliot et al. (1998). In this experiment, subjects read a series of news briefs, either about entrepreneurial business strategies or about cooperative business strategies. They were also asked to generate examples of successful business strategies that were, respectively, entrepreneurial or cooperative. Then, in the context of doing another experiment, they were given the chance to engage in a public goods social dilemma for a series of six trials. Unlike the Batson and Moran (1999) experiment, here there was no direct labeling of the game, but the labels had been primed in the first part of the study. The entrepreneur-framed people cooperated

in about 39 percent of the trials, whereas the cooperative-framed people cooperated in 75 percent of the trials.

Larrick and Blount (1997) have reported a related finding. They noted that the underlying structure of an ultimatum bargaining game and a sequential social dilemma were identical. Yet typically, social dilemma studies produce more cooperation than is reported with ultimatum bargaining games. In a clever series of studies, Larrick and Blount (1997) were able to show that the differences in cooperation rates were attributable to procedural frames: differences in the ways the actions were described. Specifically, second movers in ultimatum bargaining games are told they may "accept or reject" the offer left by the first mover, while in sequential social dilemmas, the second movers are told they can "claim" what is left by the first mover. It is of interest that the connotations of the verb "to claim" not only affect the second mover, who is more likely to accept whatever is left, but also the first mover, who is more likely to leave more than in the accept or reject frame.

Van Dijk and Wilke (1997) have argued that the framing of property rights or the implied ownership of common or personal resources can influence cooperation. These authors contrasted a commons dilemma framework with a public goods dilemma framework. In the resource dilemma, participants were told either that they could harvest up to 20 units from a common pool of 80 (there were four people in a group) or that they could harvest as many units as they wished from their own pool of 20. In the public goods version, they were told either that they could contribute up to 20 units of their own property, or that they could contribute up to 20 units from a common pool of 80. In this experiment, the framing of the pool as one's own or as a common pool had an impact in the resource dilemma. People took more when taking from their own pool than when taking from the common pool. In the latter case, the authors speculate people were concerned about the others' fate; in the former there was less need to think about the others. However, in the public goods context, the authors argue, because the goal of the contribution is to create a shared result, people will think about the others regardless of whether the contributions come from a private or public pool. Thus the authors did not expect nor did they find a framing difference in the public goods situation.

Van Dijk and Wilke (2000) took this a step further than their previous article and suggested that what is really happening with framing manipulations is that the decisions people are being asked to make induce the people to focus on one aspect or variable of the decision problem. For instance, one difference between cooperation in resource dilemmas and public goods dilemmas is that the decision in the former is how much to take, while the decision in the latter is how much to give. The correspondence between the two dilemmas, however, in terms of measures of cooperation, is how much one leaves and how much one gives. The choice of the verb, either giving or keeping in public goods games, and taking or

leaving in resource games, may frame the decision independently of the consequences of the choice. Taking and keeping refer to what one will have oneself, and leaving and giving refer to the collective component.

It may be that the actual decision (take, keep, leave, or give) causes one to focus on a quantity that determines one's strategy. For instance, in giving in public goods dilemmas, there is a tendency for people with different endowments to give equal proportions of their endowments. Perhaps this is not the result of the public goods dilemmas but rather because people are focusing on what is necessary to meet the criterion rather than what they have left. Likewise, in resource dilemmas, people typically focus on achieving equal final outcomes. Perhaps this is because they are induced to focus on what they get, rather than what they leave. To test this hypothesis, resource and public goods dilemmas were created in which the participants were either focused on what they ended up with (take and keep) or on what they contributed (give and leave). Van Dijk and Wilke (2000) then calculated whether the person seemed more to be trying to achieve proportionality or equal final outcomes. The results indicated that a large part of the difference between the two types of games could be accounted for by decision-induced focusing, by the quantity on which one was induced to focus.

Most of the studies we have discussed in this section directly manipulated the decision frame in one way or another. One study that indirectly manipulated the frame was reported by Tenbrunsel and Messick (1999). This investigation into the effects of economic sanctions on cooperation in a hypothetical pollution decision suggested that economic sanctions, the possibility of being fined for violating an agreement to reduce emissions, had at least two effects on decision makers. First, they may transform what previously had been considered an ethical issue, whether we have a duty to reduce emissions or not, into a business issue, whether it pays to reduce emissions or not. Second, they change the cost/benefit calculation to make cheating less profitable. However, the authors argued that the cost/benefit analysis would be done only for those people who saw the problem as a business problem. If the decision is seen as an ethical one, then the right thing to do is clear—do not cheat.

So if economic sanctions are introduced that are weak, if the fines are small and the probability of detection is remote, the result may be an increase in cheating. The sanctions will induce more people to think of the problem as a business problem and to find, as a result of the cost/benefit analysis, that cheating is profitable. However, if the sanctions are strong, they should have a deterrent effect on cheating, but only for people who frame the decision as a business decision. Cheating should remain rare among people who frame the decision as an ethical one. The results of the experiments reported by Tenbrunsel and Messick (1999) supported these expectations. Cheating was more likely with weak sanctions than with no sanctions, and the sanctions made more people think of the decision as a business decision than an ethical decision. However, when the sanctions were

strong, cheating was reduced, but only for people who viewed the decision as a business problem.

It is clear that cooperation in social dilemmas can be influenced strongly by framing effects, and it seems equally clear that these effects can be of a variety of types—such as framing outcomes as gains or losses, framing games as entrepreneurial or social exchange, or framing choices as taking, keeping, leaving, or giving. Outside a lab environment, however, one must contend with intervening variables such as the challenges of alternative frames of reference advocated by people with competing interests.

## CONCLUSIONS AND SYNTHESIS

The research reviewed in this chapter demonstrates the breadth of experimental work done on commons dilemmas and the advances that have been made in this area over the past decade. Relative to earlier research in psychology, recent work has been more theoretically grounded and more sensitive to field implementation. In this section we link theoretical and empirical findings from the disciplines discussed in other chapters of this volume with the topics we have surveyed.

### Emergence of Other-Regarding Behavior

Many of the experimental findings that we have reviewed are consistent with the general economic model proposed by Falk et al. (this volume:Chapter 5). Their theory suggests that people evaluate their outcomes, at least in part, by comparing them to the outcomes of others with a general preference, all else equal, for equality. The research we reviewed suggests that differences in other-regarding behavior are sometimes viewed as individual differences and other times as situational attributes.

The individual differences approach assumes that people have stable preferences for what they consider fair distributions of outcomes irrespective of the specific person involved. For example, social motives in the social psychological literature are found to be stable individual differences that persist over time (Kuhlman et al., 1986). Other-regarding behavior by cooperative individuals has, until recently, been considered by economists as “anomalous” and “sub optimal” in that it departs from the assumption of rational, self-interested behavior that underlies economic theory (Thaler, 1992). However, a recent experiment by Clark (1998) finds that people who choose such “sub optimal” strategies do not depart from economically rational behavior because of heuristic errors in their decision-making process. Indeed, research surveyed in this chapter suggests that they follow a “collective” versus an “individual” level of rationality.

Situations matter too. In athletic situations the important outcome is usually the score difference—who wins and who loses. In some judicial matters the court

decides in favor of one party. Both are competitive situations and all types of people understand this and change their motives and objectives accordingly. One situational or social factor that may influence people's preferences is the extent to which others are seen as cooperative. People evaluate the behavior of others before deciding on their own preferences for a given situation. If others are willing to exercise self-restraint, then so am I. In this case, social mechanisms, such as the norm of reciprocity (Cialdini, 1993; Gouldner, 1960) or social history between people, may come into play and influence interpersonal exchange behavior (e.g., Gallucci and Perugini, 2000; Ortmann et al., 2000).

Conditional preferences can, as Falk and colleagues (this volume:Chapter 5) perceptively note, convert common-pool resource problems into coordination problems. They have shown that their model may provide a sufficient explanation for some communication effects, sanctioning effects, willingness to do what others did, and other departures from strict, self-interested rationality. The model they offer has the powerful virtue of parsimony at the level of “stylized” facts and there is nothing that we reviewed that would constitute a refutation of their ideas. What our review suggests is that preferences may be more complex than just the “inequity aversion” process that Falk et al. propose. For instance, the perception of the causal texture of problems may influence willingness to cooperate or the way that choices are framed or described. We believe the model offered by Falk and colleagues is a valuable first step in the direction of creating a theory of individual human choice that is sufficiently rich to accommodate the wide variety of results that we have described.

The experimental research we have reviewed also confirms the conclusions of Richerson and colleagues (this volume:Chapter 12) in that we find that people do cooperate with strangers, that cooperation is contingent on many things, and that institutions, and cues that imply institutions, do matter. There is little doubt that important aspects of human sociability are part of our evolutionary nature. Most trivially, although it may not be in a woman's best interest to assume the risks of bearing children, we are not the offspring of women who chose not to take this risk. And, just as we have evolved rules for cooperation, institutions that govern the form and pattern of the cooperation also need to evolve. Furthermore, there must be a “fit” between the individual psychology of cooperation and the institutions that foster and regulate it. We may be “wired” to cooperate in small egalitarian family and communal groups, but we must also find ways in large hierarchical groups of strangers to “work around” our evolutionary tendencies to make stable, efficient, and sustainable shared resources.

McCay (this volume:Chapter 11) offers a thoughtful model for the emergence of self-organized cooperation. When do people mobilize themselves to coordinate a common resource? McCay proposes that people must recognize a serious problem, determine the attendant cause and effect relations, and answer the question “is the problem too far gone?” Parts of her model are supported by research reviewed in this chapter. For example, “is the problem too far gone?”

relates directly to the question of efficacy: Can we make a difference? The literature on self-efficacy that we have reviewed indicates that McCay is absolutely correct to see an affirmative answer to her question as an important determinant of whether or not people mobilize.

McCay also argues that communication and persuasion are important for mobilizing people. We would add that experimental lab research on communication suggests that the elicitation of commitments from the parties involved is likely to have the greatest impact. Similarly, experimental work on the nature of decision structures and power may be of use in further specifying what parts of the macro-institutional structures identified are of greatest interest in understanding mobilization. It may be complemented by a model of "structural change in resource dilemmas" that was proposed based on earlier studies in the experimental literature (Samuelson and Messick, 1995).

### Social Heterogeneity

A question that has sparked opposing theoretical perspectives in the broader literature on commons dilemmas is whether socioeconomic heterogeneity leads to cooperation or hinders it. Bardhan and Dayton-Johnson (this volume:Chapter 3), who focus on economic heterogeneity in large-scale studies of locally managed irrigation systems, find support for the latter—heterogeneity hinders cooperation. As Bardhan and Dayton-Johnson note, other types of heterogeneity (social, ethnic, and cultural) may also play an important role. Some research we surveyed on gender composition of groups points out that such group heterogeneity can influence cooperation, although the direction of influence demands further specification of relevant contingencies.

One way to narrow the gap between laboratory and local common-pool resource dilemmas is by actually conducting experiments in the field. An excellent example is an experiment conducted by Cardenas (2000:4) that focused on the influence of economic heterogeneity: "[I]nstead of introducing these effects [economic heterogeneity] artificially through experimental institutions or incentives, and instead of attempting to avoid these factors to enter the experimental design as noise, we accounted for such information that people may bring into the field lab, and analyzed it against the experimental behavior and outcomes." Rather than bringing participants to an experimental lab, this study took the experimental lab to a community (several villages in Colombia). Similar to other findings reported by Bardhan and Dayton-Johnson (this volume:Chapter 3), economic heterogeneity decreased cooperation.

### The Scale of the Dilemma

Social heterogeneity may be especially salient in cross-national dilemmas where members of different cultures come together to solve commons dilemmas.

These may translate not only into differences in cultural values and norms at the group level, but as Young (this volume:Chapter 8) points out, international regimes also operate in social settings that feature a substantial amount of institutional heterogeneity. Decisions at this international level are complicated further by the tensions involved in shifting vertically to national levels of authority. Young describes how implementation of such agreements may vary due to differences in competence, compatibility, and capacity of national governments. The experimental literature would point out another hurdle: The chore of implementing international agreements often becomes fragmented among different subgroups, potentially turning the resource dilemma structurally from an intragroup to an intergroup conflict. Changing the paradigm to an intergroup dilemma changes the incentives and behavior of people in social dilemmas (Bornstein, 1992). Changes along levels of analysis become especially relevant when designing experiments because variables influencing cooperation may not have the same effect when evaluated in small-scale versus large-scale commons situations.

A recent chapter by Biel (2000) discusses similarities and differences between factors promoting cooperation when evaluated (1) in a laboratory environment; (2) in small-scale communal property regimes; and (3) in large-scale societal dilemmas. For example, social norms of reciprocity and commitment may not play as key a role in large-scale dilemmas where the social group is intangible and face-to-face communication is unlikely. On the other hand, environmental uncertainty is likely to play a much larger role because the resources involved in large-scale dilemmas are often less visible (e.g., air pollution) and less quantifiable (e.g., oceans). When evaluating differences across scales, it is important to note whether the characteristics of the resource and/or the complexity of institutional arrangements may account for these differences.

Rose (this volume:Chapter 7) offers a significant real-world example that fleshes out the different structural solutions that may be effective in large-scale dilemmas versus smaller scale common property regimes. As she points out, real-world commons dilemmas occur in complex, dynamic systems in which disagreement over the truth of "facts" must be expected. Some level of uncertainty is the norm. Small communities have developed complex rules and norms that protect the resource as well as the interests of the local community by providing barriers of entry. Developing similar mechanisms in large-scale market regimes is challenging in that instituting a system of tradable environmental allowances that create a level of certainty around the rights that such allowances convey is not a trivial task. Will they be durable rights? Will the volume of entitlement associated with each allowance remain constant? In facing this challenge it is both valuable to understand the predictable ways uncertainty affects individual actors, and to appreciate the positive impact reductions in uncertainty can have on cooperation in commons dilemmas.

### Environmental Uncertainty

Both lab and field studies have pointed to the importance of reducing uncertainty to promote cooperation on both individual and organizational levels. Research we reviewed highlights how environmental uncertainty increases harvesting behavior by individual decision makers. Wilson (this volume:Chapter 10) points out that better institutions for managing the commons can be designed, but that this requires a paradigmatic shift in the way that environmental uncertainty is approached. From the perspective of institutional design, the goal is to create the circumstances under which the average user views restraint as rational. Wilson suggests that the reductionist scientific approach, which has dominated the field, needs to incorporate complex, dynamic, and adaptive processes (like oceans and weather patterns). In such "complex adaptive systems," cause and effect relationships are weakened and predictability decreases.

### A Final Word

A dynamic dialogue between experimentalists and field researchers can yield fruitful results for both. Qualitative research is key to developing rich models that can be subjected to experimental testing and controlled decomposition, which can in turn offer insight for future theoretical model development and field-based interventions. Agrawal's review (this volume:Chapter 2) of the traditional, largely case-based literature on common-pool resources points at a substantial overlap between lab and field studies both in terms of the choice of variables studied and their implications. Readers of his review should find striking parallels with the findings reported in this chapter on issues ranging from group size to sanctions and the significance of communication and a sense of efficacy. Agrawal (this volume:Chapter 2) identifies the importance of employing a "careful research design that controls for factors that are not the subject of investigation" (p. 65). This is exactly what the experimental approach has to offer. The strength of the experimental method is that by isolating variables, it enables social scientists to pit theoretical concepts against one another and establish causal linkages.

### NOTES

1 In this first book (published in the middle of the 18th century, a decade before his more famous book on the wealth of nations, his hypothesis is made clear early on: "However selfish man may be supposed, there are evidently some principles of his nature, which interest him in the fortune of others, and render their happiness necessary to him, though he derives nothing from it..." (Werhane, 1991:25).

2 A person is less likely to respond to an emergency situation when there are many bystanders than when that person thinks he or she is the only witness.

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