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The challenge of understanding decisions in experimental studies of common pool resource governance

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ABSTRACT

Common pool resource experiments in the laboratory and the field have provided insights that have contrasted to those derived from conventional non-cooperative game theory. Contrary to predictions from non-cooperative game theory, participants are sometimes willing to restrain voluntarily from over extracting resources and use costly punishment to sanction other participants. Something as simple as face-to-face communication has been shown to increase average earnings significantly. In the next generation of experiments, both in the laboratory and in the field, we need to extract more information that provides insight concerning why people make the decisions they make. More information is needed concerning attributes of individuals as well as the social and social–ecological context in which they interact that may give rise to such deviations from theoretical predictions. In the process of extracting more information from participants and the contexts in which they interact, we face several methodological and ethical challenges which we address in this paper.

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1. Introduction

Collective action problems facing groups who jointly harvest from a common-pool resource such as a fishing ground, pasture, forest, or water system are difficult to solve. In such common-pool resource dilemmas, the incentives are such that each individual would be better off if everyone else cooperated and they could “free ride” and obtain benefits from the resource without any sacrifice. The outcome predicted by non-cooperative game theory for such a situations is a Nash equilibrium in which no one cooperates. Hardin's (1968) influential article on the tragedy of the commons was widely accepted due both to its consistency with game theoretical predictions and because of well-known incidents of overharvesting of fishery and forest resources.

Perhaps because of the high profile of whaling and the collapse of some large fisheries in the 1970's (e.g. Peruvian anchovy fishery in 1972), the problem of commons dilemmas has been most extensively studied in the context of fisheries. Much of this work early on was theoretical and relied on the simple Gordon–Schaefer fishery model (Gordon, 1954). This work has since been extended in many directions but has often focused on the nature of institutional responses to the problem in terms of some sort of tax or definition of property rights, *in theory* (e.g. Smith, 1969; Clark, 1973, 1990; Clark et al., 1979). Although it generated many important general insights, it is not surprising that management efforts based on this work were often unsuccessful as the underlying models were stick-figures of real situations (Clark, 2006).

During the last 30 years, extensive field studies have uncovered many counter examples of long-lasting social–ecological systems where resource users have developed institutional arrangements without the external imposition of private or state ownership or the use of taxes as suggested by these simple models (e.g. NRC, 1986; Ostrom et al., 2002; Dietz et al., 2003). Many variables in the field potentially affect when and how resource users themselves overcome strong incentives to act in their short-term material interests and ignore the long-term benefits that they and others would obtain from

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¹ Hardin's work has been influential in recent decades, but various scholars have addressed the commons dilemma before such as Malthus (1798), and the study of the commons relate to the broader problem of externalities (Pigou, 1920; Coase, 1960).

cooperation. A robust finding across many studies, for example, is the importance of users monitoring one another (Gibson et al., 2005; Hayes, 2006; Ostrom and Nagendra, 2006; Coleman, 2009). Further, the mounting intensity with which humans are impacting many common-pool resources highlights the need to put some flesh on the stick figure models that have long dominated resource management policy and to reconcile the conflict between the simple theory and the complexity of empirical examples. This has led to the development and use of new methods to study the commons including a broad range of experimental techniques (Poteete et al., 2010).

One specific area of experimental enquiry surrounds understanding what individuals actually do in common-pool resource management situations: how they process information, how they make decisions, and how sensitive these activities are to subtle changes in context or in incentive structures. Experimental study of the commons started in social-psychology (e.g. Stern, 1976; Dawes et al., 1977), and in recent years has been a topic of investigation in behavioral economics (e.g. Ostrom et al., 1994). However, in order to meet rigorous requirements for experimental validity, these experiments typically have been extremely simple, designed to test very simple models of human behavior based on rational choice theory. After hundreds of economics experiments, some are beginning to call into question the value of such narrowly defined experiments that rely heavily on the presumption that participants think like economists in such experimental contexts (Smith, 2010). There is mixed evidence for the external validity of experimental studies: behavior in the experiments sometimes does not match observed behavior outside the experiment (Gurven and Winking, 2008), and sometimes it does (Rustagi et al., 2010).

Much of the work presented in this issue has to do with the importance of the micro-situational variables and the broader context based on the theoretical framework proposed by Poteete et al. (2010). Due to space limitations, here we provide only a brief description of the framework. For a more comprehensive discussion we refer the reader to chapter 9 in Poteete et al. (2010). At the broadest level, the framework includes learning and norm-adopting (in contrast to selfish rational) individuals. The decisions made by these individuals are affected by micro-situational variables and the broader context (Fig. 1). Examples of micro-situational variables include group size, communication, heterogeneity among participants, reputation, and time horizons. For example we know that an increase in group size typically makes collective action more difficult while the possibility of communication increases the potential for successful collective action. Knowledge is lacking regarding how these variables interact in different contexts. That is why experiments may provide the proper tool to test the impact of these micro-situational variables. Examples of broader context are policies at higher levels of organization, resource dynamics, and geography. Because of differences in broader contextual variables, field experiments are needed to test whether people in different contexts differ in the decisions they make.

To further the development of a broader framework for collective action and the commons we need to collect diverse sets of information

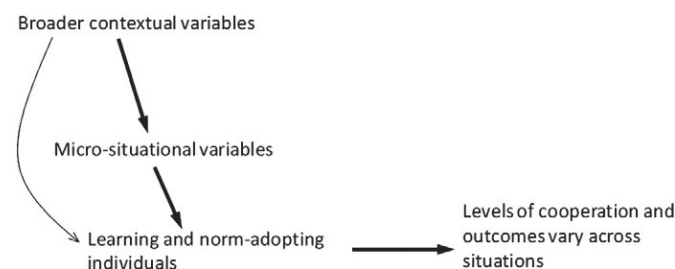


Fig. 1. Based on behavioral theory, cooperation in commons dilemmas is dependent on individual learning and norms, as well as the micro-situational variables and broader context.

Based on Poteete et al. (2010).

in addition to decisions made and basic demographic information. This article pulls together what we have learned through a series of experiments and the new challenges they have highlighted as we move into the future. Addressing the challenges of how to derive additional information such as social structure, mental models, beliefs, and trust relationships is the focus of the following sections.

In what follows, we first discuss different types of experiments that have been conducted as part of the work presented in this special issue and relate them to past experimental work. This is followed by a discussion of how to extract information concerning the individual behavior of participants and the decision-making context. Given the increasing use of these tools in the field, we also address the ethical issues involved. We conclude by synthesizing the insights derived from past work and challenges that lie ahead.

2. Types of Experiments

In this special issue various articles present results of studies that use a variety of experimental methods, from experiments with undergraduate students in a laboratory to rural villagers in Namibia, South Africa, Thailand, and Colombia. Each type of experiment has its own challenges, strengths and weaknesses. Harrison and List (2004) present a taxonomy of experiments by distinguishing six factors: the nature of the participant pool, the nature of the information that the participants bring to the task, the nature of the commodity, the nature of the task or trading rules applied, the nature of the stakes, and the nature of the environment in which the participant operates (Harrison and List, 2004; p. 1012). They define a *conventional laboratory experiment* as one that uses students as the participant pool and employs an abstract framing and an imposed set of rules. The *artefactual field experiment* differs from the conventional laboratory experiment in that it has a nonstandard participant pool, but still uses an abstract framing and an imposed set of rules. The *framed field experiment* differs from the artefactual field experiment by changing the nature of the commodity, say from monetary incentives to actual goods, or changing the information participants can use, for example, by doing trading experiments with experienced traders. In the *natural field experiment* participants do not know that they are in an experiment and participants naturally undertake the tasks of the experiment.

The laboratory experiment is a very controlled setting where outcomes of decisions can be measured precisely. But it is also an artificial context created by the experimenter which may affect the way participants make decisions. As Vernon Smith (2010) suggests, it is likely that participants do not make decisions in economic experiments the way economists do and therefore researchers need to be careful in interpreting the results of such experiments. This also calls into question what we expect to learn from such experiments. Is it an attempt to verify certain axioms about human behavior? If so, Smith suggests the prospects are slim. If we are happy to identify relationships between patterns of human behavior and potential biological, social, technological, and other contextual determinants of that behavior, then experiments provide fertile ground. When we relax experimental constraints and allow for different participant populations and more natural tasks, a better understanding of the background of the participants *vis à vis* the context of the experimental setting becomes very important for the interpretation of the results. By comparing the outcomes of experiments across such characteristics of the participants, we can begin to get at the complex interactions between participants and contextual variables in commons dilemmas. As such, experiments are increasingly combined with other methods to generate better information regarding the micro-situational variables that affect decision making and about the broader context in which the experimental task occurs.

Recently, we have seen an increasing use of artefactual and framed field experiments in combination with conventional laboratory

experiments. We are not aware of natural field experiments on common pool resource dilemmas. Before we discuss the challenges of combining different types of experiments, we present some lessons learned from the early years of commons experiments.

3. Common Pool Resource Experiments

In a typical experiment, the experimenter creates an environment in which a number of participants make decisions in a controlled setting. The rules (institutional arrangements) of the experiment define the payoff structure, the information participants have, and who belongs to which group. Participants voluntarily consent to take part in an experiment prior its initiation. They receive instructions on the possible actions about which they can make decisions and possible outcomes that depend on the decisions of all participants in the experiment. Decisions are made in private by writing information on a paper form or entering it on a computer. Salient incentives are provided in terms of monetary returns, or other relevant rewards, depending on the decisions made.²

Influential CPR experiments were performed by Ostrom et al. (1994)³ who started with a static, baseline situation that is as simple as could be specified without losing crucial aspects of the problems that real resource harvesters face. A quadratic production function was used for the resource itself—the payoff that one participant could obtain was similar to the theoretical function specified by Gordon (1954) for bionomic equilibrium. Much earlier experiments on cooperation and the voluntary provision of public goods had been conducted over the previous decades in the lab (Ledyard, 1995) but these were based on a pure public good problem whereas the CPR experiments mentioned here incorporate the non-linearity and rivalry or subtractability issues that are crucial to commons problems. The experiments were formulated in the following way. The initial resource endowment of each participant consisted of a given set of tokens that the participant allocates between two markets: Market 1, which had a fixed return; and Market 2, which functioned as a common-pool resource that was non-excludable and rival, and had a return determined in part by the actions of the other participants in the experiment. Each participant could choose to invest a portion of their endowment in the common-pool resource Market 2 (e.g. invest time in fishing), and the remaining portion was then invested in Market 1. The participants received aggregated information on the decisions of others.

Participants from student participant pools in baseline experiments substantially overinvested in Market 2 as predicted by theory. In a repeated game, at the aggregate level, the groups approach the Nash equilibrium or apply harvest efforts of even more than the Nash equilibrium. When participants are allowed to talk about the experiment face-to-face under a non-binding setting of open talk (cheap talk), the harvesting effort declines toward the cooperative equilibrium (see Ostrom and Walker, 1991; Sally, 1995; Balliet, 2010; Ahn et al. this volume). These findings hold even if there is heterogeneity among the participants in their initial endowment (Hackett et al., 1994).

In experiments where participants were allowed to reduce the earnings of others at a cost to themselves (costly punishment), Ostrom et al. (1992) found that participants use costly punishment but, as would be expected, this leads to lower net average returns. When groups could choose whether to use costly punishment or not, the earnings increased when costly punishment was chosen, but the number of actual punishment events was low. Cardenas (2000a) used

a hand-run variation of the original design of the CPR experiments, changed the choice variable in the instructions to the number of months a year spent in extraction from the common-pool resource (firewood), and ran the experiments in rural villages in Colombia with actual users of local forests. Although the basic results of Ostrom et al. (1994) were replicated, the results were more variable. For example, Cardenas found that “social distance and group inequality based on the economic wealth of the people in the group seemed to constrain the effectiveness of communication for this same sample of groups” (Cardenas, 2003). Cardenas et al. (2000) found that in these same experiments where the optimal rule was imposed and modestly enforced, the performance was lower than experiments where participants were allowed to have face-to-face communication. The phenomenon that people cooperate less in a situation with imposed regulation compared to one in which the same regulation was chosen by the group is called the crowding-out effect of voluntary behavior. This design was later tested by increasing the probability of being caught by the regulator and the possibility of voting on the enforcement of monitoring and sanctioning by an external regulator. This led to a finding that stricter enforcement could lead to results similar to those under self-governing through face-to-face communication (Rodríguez-Sickert et al., 2008). Vollan (2008) conducted a framed field experiment in Namibia and South Africa and found that the crowding-out effect depended on three factors: how controlling versus supportive was the external intervention, the level of trust within a social group, and the level of self-determination within the group.⁴ Other cases of crowding-out are reported by Barr (2001), Velez et al. (2010) and Lopez et al. (forthcoming). In all these papers there is a complementarity between different types of community enforcement systems which can reinforce one another. However, Castillo and Saisel (2005) report experimental results with fishermen on a Colombian Caribbean island where external regulation triggers better cooperation levels as compared to the baseline case without external regulation.

A more recent development is the focus on ecological dynamics. Traditional experiments use abstract resource dilemmas without dynamics and space. In fact, in each round participants experience the same commons dilemma. Based on insights from dynamic decision making (Brehmer, 1992), new experiments have been developed that explicitly include dynamics of ecological systems (Janssen et al., 2010). These experiments show that inclusion of temporal and spatial dynamics suggests that costly punishment has no positive effect if it is not combined with communication in contrast to earlier experiments with common pool resource and public good experiments (Ostrom et al., 1994; Fehr and Gächter, 2000). Field experiments with more relevant ecological dynamics provide mixed results (Cardenas et al., forthcoming). On the one hand, we find that participants make decisions that reflect their experience with the actual resource (Castillo et al. this volume). On the other hand, ecological dynamics can provide incentive structures that lead to similar results with students and rural villagers (Janssen et al. this volume).

Overall, these experiments on CPRs have shown that many predictions of the conventional theory of collective action do not hold; more cooperation occurs than predicted, “cheap talk” increases cooperation, and participants engage in sanctioning free riders (e.g. Ostrom et al., 1992). Experiments have also established that there is motivational heterogeneity in investment or contribution decisions as well as sanctioning decisions.

² The experiments discussed in the paper typically involve a sample of participants, use no deception, and provide monetary incentives. Commons experiments are also an area of investigation in social-psychology, but they use deception. Typically participants are told they are in a group experiment while they are experiencing a prescribed scenario, and they do often not derive rewards based on their actions. To avoid confusion we restrict our discussion to actual group experiments.

³ For resource experiments in psychology see Dawes (1980).

⁴ Vollan (2008) tested the influence of penalties vs. rewards where the reward was framed as a supportive drought relief scheme but only penalty lead to the crowding-out effect. Participants could vote for their preferred rule (penalty, reward, and communication). The crowding-out effect for penalty only occurred when 2 out of 5 people voted for penalty and when it was played in the region where trust was about 50% higher (Namibia vs. Namaqualand). In Prediger et al. (this issue) the same cross country setup is further explored to highlight how underlying norms and ecological characteristics influence experimental results.

4. Measuring Micro-Situational Variables and the Broader Context Using Experimental Methods

4.1. Surveys and Individual Level Attributes

The actions of participants in experimental situations do not directly reveal personal characteristics or motivations. To avoid interpretations based on subjective assumptions, instruments that can be used to uncover determinants and processes that lead to observed actions are needed. Econometric analysis of observed behavior to measure social influence has analytical problems (Durlauf, 2002). The most common method of gathering data on an individual's attributes and beliefs is simply to ask them. Survey data are commonly used in social science research, the methodology is vigorously discussed (e.g., Hutchinson, 2004), and there is now a large literature regarding how to design and test questionnaires (e.g. Saris and Gallhofer, 2007; Sudman et al., 2004). Within common-pool resource experiments, one can (1) ask the participants about factors that might affect their decisions like socio-demographic information, experience with similar tasks, trust in others, perceived social pressure, a feeling of 'group identity', social status, etc. (2) ask the participants to articulate their goals or rules they follow or expect the others to follow in the experiment, (3) ask participants about their expectations concerning how other participants will act, how the resource will develop, or what the consequences of their decisions might look like, or (4) let the participants explain and evaluate their decisions. Such information helps researchers to better understand why experimental participants decide or act the way they are observed to act.

Questionnaire items are constructed starting with the answers, i.e. the information that shall be gathered. Different types of answers are common: (1) Open-ended questions allow any answer and minimize reactivity. However, answering open-ended questions is time-consuming and the information provided is often unsatisfying due to a lack of guidance. Thus, open-ended questions are typically avoided and are used only for explorative purposes; (2) While, in open-ended questions, the categories of the answers are determined after the data is gathered, in multiple-choice questions, these categories are defined beforehand. Thus, answering the questions and analyzing the results are both easier but designing such questionnaires is more difficult since all relevant response categories must be covered and the response options must give good guidance without biasing the data; (3) Numeric responses and psychometric scales are the most common form for items in psychological research. Scales allow the participants to mark a value between two extremes (e.g. 'do not trust at all' and 'trust completely'). Thus, for example, it can be assessed how much a person trusts others instead of only whether or not he or she trusts others; and (4) More complex response formats allow the gathering of comprehensive data structures such as strategies used to tackle a problem. However, such items are laborious to design, answer and analyze and require extensive introductions. For methodological reasons (test of reliability, to reduce noise and biases, etc.), the same information should be gathered with a number of items.

In experimental research, asking participants questions might also be criticized on three counts: (1) the quality of the data so gathered, (2) biasing effects of surveys on the experiment and vice versa, and (3) practical issues. The first issue has been investigated quite thoroughly (see e.g. Krosnick, 1999). Many studies have shown possible design flaws (e.g., suggestive questions or answering options) or certain response tendencies (e.g. a preference for positive answers). The biggest challenge is to make the respondent answer the same question the researcher has in mind without inducing a particular answer to that question. People often do not answer questions literally but, rather, try to fill the inferred knowledge gap of the inquirer, i.e. try to guess what the questioner really wants to know. This inference is made based on the question, the answering

options, other questionnaire items, and any other information available in the situation. If the respondent cannot determine what information is being asked for or does not have an opinion or knowledge of the subject in question, the quality of the data gathered will obviously be poor. Also, when sensitive subjects are touched upon, responses might be biased towards socially desirable answers. Although such problems limit what information can be gathered using questionnaires, a well-designed questionnaire allows the gathering of fairly accurate data and countless studies have generated valuable results from surveys.

The second issue, biasing effects of surveys on experiments and vice versa, has not, to our knowledge, been investigated explicitly. Research on priming and framing (e.g. Higgins, 1996) suggests that effects on actions should appear only if the questions are asked shortly (seconds or minutes) before the decisions are made. For example, questions on economic considerations and beliefs might lead to more 'rational' decisions. Causality may flow in the other direction as well: actions will have strong effects on answers if the consequences of the decisions are known. In this case, answers will be post-hoc interpretations that might be quite different from the actual states and processes that determined the decisions. These considerations suggest that the best time to ask questions is right after decisions have been made but before their consequences are known to the participants. Both of the above-mentioned effects can be controlled for by carefully designing the questionnaires and the experiment.

Finally, we turn to practical issues: designing questionnaires and integrating them into experimental designs requires considerable effort in order to avoid deleterious effects of the above-mentioned problems on data quality. Many additional tests are necessary to ensure that the experimental procedures and questionnaire instruments work well together (e.g. Presser et al., 2004). Beyond the efforts of scientists, data questionnaires require additional effort on the part of the participants: experiments get much longer which can be taxing and answering questionnaires is sometimes perceived as boring or difficult. On the other hand, well designed questionnaires can support the participants and spice up an experiment by introducing a form of communication. To conclude, gathering data on individual level attributes via questionnaires allows for better understanding of the determinants that lead to observed decisions and actions. Even though designing questionnaires and integrating them into experimental designs requires significant care and resources, a better understanding of the motivational and cognitive processes behind observed behaviors is well worth the effort.

4.2. Measuring Social Context in Experimental Settings

The social setting is often neglected or considered irrelevant in laboratory experiments because they are generally designed to control for and reproduce social settings exactly across repetitions of experimental treatments. It is also likely that the variation in social context across undergraduate students in most universities is sufficiently low as to not impede statistical explorations of experimental data. Field experiments are an exception to this rule, as they are often designed to understand behaviors within or across social contexts (Henrich et al., 2006; Marlowe et al., 2008; Benedikt et al., 2008). Field experiments designed with built-in cross-site comparisons appear to provide the best guidance on how to study and measure social context. However, studies that situate the field experiment within a specific social context also provide important guidance regarding how to study these issues.

Culture – an extremely complex multi-dimensional concept – is one of the most commonly studied aspects of broader context in economic experiments. The most prevalent class of such studies compare across cultural, national, or ethnic groups. Whitt and Wilson's (2007) comparison of Bosnjaks, Croats, and Serbs in Bosnia-Herzegovina and Takahashi et al.'s (2008) study in China,

Japan, and Taiwan are examples of such work. A drawback of this approach is that we often cannot determine what aspect of culture drives different experimental outcomes. More sophisticated approaches actually measure cultural traits within and across groups. An example of this type of research is Oosterbeek et al.'s (2004) meta-analysis of Hofstede (1991) and Inglehart's (2000) cultural classification systems across 75 cases which found that, in ultimatum games (UG), proposers with greater respect for authority make lower offers. An approach called "cultural framing" (Cronk, 2007), compares the results of classic economic experiments with those explicitly framed as a salient cultural institution. In her work with Ju/'hoan Bushmen, Wiessner (2009) compared the results of dictator and ultimatum games with real-life sharing behavior. In a study of Kenyan herders, Lesorogol (2007) compared the results of a classic dictator game with those of a dictator game modeled on a local meat-sharing institution. Both Wiessner and Lesorogol found that behavior in the classic dictator game differed substantially from behavior in real life. However, Lesorogol's findings also demonstrate that local norms and individual demographics were associated with game behavior when the dictator game was contextualized in a local institution.

Another way of examining social context is via language and discourse. Following the finding that conversation increases cooperation (Balliet, 2010), researchers have developed increasingly complex and innovative ways of studying communication in economic experiments. Beyond the manipulation of communication under experimental conditions, some scholars examine free-flowing text provided by study participants using qualitative methods (Pavitt et al., 2005; Janssen, 2010). In a different vein of research, scholars have become interested in understanding how linguistic knowledge provides access for group members to different sets of indigenous knowledge and norms, which then shapes their behavior in economic experiments. For example, Henrich et al. (2004) collected data on indigenous language use in their study of fifteen small-scale societies. In a variation on this approach, Gurven (2004a,b) examined competence in a national language (Spanish) via interviewer-administered tests of written and spoken competence in experiments with the multilingual Tsimane of Bolivia.

A third set of methods for studying social context focuses on social interactions and relations. One simple approach categorizes societies according to their kinship organization (Gneezy et al., 2009), residence patterns (e.g., Henrich et al., 2004), or the density of kinship ties (Barr, 2004). At the individual level, researchers have also surveyed experimental participants regarding their household structure or the local presence of kin (e.g., Macfarlan and Quinlan, 2008). Additionally, experimentalists have used observational methods such as time blocks or focal follows (e.g., Hill and Gurven, 2004) and social network studies based on recall interviews (e.g., D'Exelle, 2008; Attanasio et al., 2009) to collect data on social interactions at the individual and community level. This work on social interactions and relations has provided a rich set of insights including Croson and Gneezy's (2009) review of gender differences in experiments, which shows that women are reliably more risk averse, less competitive, and sensitive to social cues than men. Because collecting interactional data is generally very costly (for observations) or unreliable (for interviews), people have sought other ways to capture data on social connectedness. Another set of techniques examines social capital using structured protocols to survey experiment participants. Different protocols focus on aspects of social capital such as trust (Danielson and Holm, 2007), trustworthiness (Wilson et al., 2009), or fairness (Karlan, 2005), and past trusting behavior (Glaeser et al., 2000). Studying social capital in this way has shown that trust attitudes are related to some aspects of game behavior (Glaeser et al., 2000). Bouma et al. (2008), for example, measure individual and village trust levels and correlate this with caste heterogeneity at village scale. They find that non-agricultural dependent participants trust other participants less.

A fourth and final approach to characterizing social context involves political and economic data. At the group level, experimentalists have characterized population size (Marlowe et al., 2008) and settlement size (Henrich et al., 2004) based on published or self-collected census data. An alternative, used by Henrich et al. (2004), is a *a priori* classification of groups' political complexity, market integration, or payoff to cooperation. At lower levels of analysis, scholars have collected survey data on individuals' village affiliation (Gurven et al., 2008) and pile sort data on political coalitions (Patton, 2004). To date, few scholars have sought to use experimental economics with migratory, refugee, or resettled populations (but see Fong and Luttmmer, 2009 for a study with refugees from Hurricane Katrina). In a handful of cases, scholars have relied on simple techniques, such as categorizing communities as sedentary/nomadic (e.g., McElreath, 2004) or resettled/non-resettled (Barr, 2004), to study population-level mobility. Future studies may utilize more sophisticated survey and qualitative techniques to study these mobile populations. Another important set of measures collects data characterizing local economies and individuals' participation in them. Henrich et al. (2004) demonstrated the importance of studying payoffs to cooperation and market integration for explaining prosociality in small-scale societies. At the community level, this may involve ranking societies based on their reliance on cooperative production (Alvard, 2004) or measuring the distance between villages and their nearest marketplace (Gurven, 2004a). At the individual level, a number of scholars have also studied market integration based on self-reports of wage labor participation (Ensminger, 2004), income earned from cash-cropping (Tracer, 2004), or number of visits to markets (Gurven, 2004a,b). For the particular case of commons users, Cardenas (2000b) found a strong correlation between actual experience of the participants with extraction of resources and their capacity to solve the commons dilemma in the experiment.

The work discussed in this section illustrates a number of efforts to measure social context so that we can investigate its effect on experimental outcomes. Most of this research has used ultimatum and dictator games to explore basic questions about human prosociality and was not designed to understand commons dilemmas. Nevertheless, these studies demonstrate the value of studying the relationship between social context and cooperative behavior. We believe these approaches have the potential to help address the challenge posed in the introduction: to reconcile the conflict between simple theory and the complexity of empirical examples.

4.3. Tools for Measuring Broader Social–Ecological Context

Participants in field experiments make decisions that provide insight into particular aspects of human behavior that are difficult to obtain from classic ethnographic tools and surveys. In essence, participants are placed in a relatively simple, simulated action situation (Ostrom, 2005) in which there is a higher degree of control over several variables than in the system in which they live. For an assessment of broader social–ecological context, one can associate field experiments with other methodologies. Classical sources of information very commonly used with the experiments are socio-economic surveys. The information gathered with surveys helps researchers to understand how individual characteristics affect behavior during the experiment. We consider here two specific methods: participatory rural appraisal (PRA) and role-playing games (RPGs).

Participatory rural appraisal tools (PRA) were originally designed to assist local development processes and have been modified to also address research questions (Chambers, 1994). Cardenas et al. (2003) and Lopez (2010) have used them in combination with field experiments in order to understand broader context and micro situational variables (Ostrom, 2007; Poteete et al., 2010). The authors explained that after running all the experimental sections in locations

with users of natural resources, they conducted a one day workshop with some of the participants of the experiments. The aim of this workshop was to better understand the local reality in order to analyze the information gathered during the experiments and to construct, together with the participants, bridges between the experiment and reality. In order to do that, they used a set of participatory rural appraisal tools to collect valuable information about the natural resources, the rules and norms existing in the area used to manage those resources, and the level of economic dependence on resources, among other variables. This information allowed the research team to form a general “picture” of the community and their reality. Immediately after this, the experiment and the different institutions used during the experiment are explained in detail. From there, community members started to make connections and see resemblances between the experiment and the use of the natural resources.

Approaches such as role-playing games (RPG) attempt to address questions about broader context and micro-situational variables while at the same time “facilitate dialogue, shared learning, and collective decision making through interdisciplinary and “implicated” research to strengthen the adaptive management capacity of local communities” (Gurung et al., 2006 [p. 2]). This is the definition of companion modeling (ComMod)⁵ that includes RPGs along with computer modeling and participatory simulations. If the researcher combines experimental methods with RPGs, she is putting the participants in an action situation that is not only more complex, but also simulated and, as a result, with much less control. Experiments and RPGs are devices that share the idea that people will express their behavior through actions, revealing facts that hardly would be expressed orally or in a written form (Vieira Pak and Castillo, 2009). These authors suggest that the tools become “talking objects that address local actors and researchers” (p. 24). The use of RPGs in combination with field experiments provides the opportunity to use the insights and findings from role games for reevaluating both the research problem and the questions, as well as to design new experiments. Castillo et al. (this issue) use RPGs after the experiments. They ask the participants to modify the experimental settings to make them more realistic. In other words, they ask the participants to include the necessary context. In this process, participants are modifying the action situation according to their mental model about the social and ecological attributes of the problem being addressed. The process of RPG construction itself produces a discussion space where participants use the broader context and micro situational variables of their social-ecological system to criticize and modify the experiment. This exercise has been carried out in order to observe players' own representations of their SES, rule crafting processes, and CPR problem perception (Castillo et al., this issue).

One output of the combined use of experiments, RPGs and participatory approaches is to formalize mental models. The decisions participants make are the result of internal simulations of participants' mental models *sensu* Sterman and Booth Sweeney (2007 [p. 215]): “the

⁵ Companion modeling (ComMod) is methodological an approach developed by CIRAD's researchers (Bousquet et al., 1999, 2002; Barreteau et al., 2003), in which “a combination of pragmatic and theoretical questions regarding the management of renewable resources and the environment” (Barreteau et al., 2003, p. 2) are addressed. In the ComMod framework interaction between actors and researchers is the principal source of knowledge. Among the fundamental assumptions of the approach are that: a) the research objects are complex, highly dynamic and characterized by uncertainty, b) “the existence of multiple and legitimate points of view, including the ones produced by scientific expertise”, and that c) “these different viewpoints deserve to be taken into account in an iterative process of understanding, confrontation, and analysis” (Barreteau et al., 2003, p. 2). The intended objectives of the approach are twofold: a) the understanding of complex environments and b) to support collective decision-making processes in complex situations. Multi-agent systems (MAS) is the simulation tool privileged by the approach in combination with others such as role playing games.

term ‘mental model’ includes a person's (often implicit) beliefs about the networks of causes and effects that describe how a system operates, along with the boundary of the model (which factors are considered endogenous, exogenous, or immaterial) and the time horizon considered relevant.” Mental models are fed by culture, information about the action situation, perception of this situation, and information about actual outcomes of prior action (Ostrom, 2005). The design of a field experiment is affected by the researcher's mental model of the problem addressed. Eliciting mental models in order to understand decision making and behavior patterns in field experiments imply a methodological choice, which can include a combination of tools such as RPGs, interviews, and rapid rural appraisal (RRA). Regarding the use of interviews, the type of questions that have proved efficient are those that elicit mental models indirectly. Such questions induce storytelling, general descriptions of activities, and informal conversations. The content analysis of these stories can provide insights into the structure of mental models (Bécu, 2006).

In summary, identification of the broader social-ecological context is important in the design of empirical research through the use of methods which complement experiments. The scheduling of the different methods depends on the objective of the research. When the experiments test decision models through de-contextualized settings, these complementary methods can be used after the experiments to give an assessment of how much players take their context into account in their decisions in the experiment. When the objective is to design contextualized field experiments, the complementary methods will precede experiments.

5. Ethical Challenges and Data Integrity

Any social research that includes the application of participatory workshops, focal groups, surveys, or interviews entails an intervention in the local social dynamics in the same way as do experiments and RPGs discussed in previous sections. Ethical concerns with the methodologies just listed should increase when used in conjunction with field experiments due to additional positive and negative impacts that researchers may impose while working in rural communities. In random interventions such as field experiments, a number of questions arise: What are the effects (positive and negative) of conducting experiments in local communities? Does feedback need to be given to the communities? Do the monetary payoffs of the experiments generate local perturbations? And, will the field experiments generate meaningful policy and/or management recommendations?

Ethical concerns can arise in every step of the process from the recruitment to the interpretation of results as discussed below. Following ethical principles will most likely also increase the quality and integrity of the data. The following discussion is based on our experience.

5.1. The Recruitment Process

The types of experiments discussed here typically lack a meticulous sampling process aimed at obtaining a representative sample of the population.⁶ In the field, recruitment is often done by word of mouth among the population of interest. How can the researchers invite participants from all the different segments of society they are working with in order to spread the benefits equally within the communities? Unfortunately, in many of the cases the researchers conducting experiments are not able to stay for a long

⁶ Bahry et al. (2005) conducted an experiment in Russia that is an exception to that statement. The recruitment process was done through a stratified random sample. Further exceptions are experiments in India, and Vietnam where participants are recruited from households who have been surveyed before. Another example of a stratified sampling process is reported in Cardenas et al. (2009) and for a study with more than 3000 participants in six Latin American cities.

period of time in the communities to comprehend the logic of their organization, perform a complete census, and invite people based on a random sample. Very often the recruitment process is done in conjunction with leaders and NGOs working in the communities in order to respect local institutions. Since earnings in the experiments are relatively high, this recruitment process can bring some problems when leaders' political motivations could mislead and bias the sampling in favor of their supporters. This exclusion of certain segments of the population is ethically problematic and biases the data at the same time. Even the researchers themselves could be manipulated by local forces. Experimenters should try to use as much as possible other sources of recruitment once in the site to avoid concentrating the recruitment through a single channel. An *a priori* investigation about local power and political relations is a recommended practice. Once engaged in the experimental sessions, a major challenge for the experimenter will be to maintain their distance from local context so that participants do not associate her with the particular forces or biases that these local leaders and agendas may bring during the recruitment process.

5.2. The Payment

In some regions local institutions and organizations could claim that payment in workshops, experiments or even surveys can be seen as a payment for participation, and it could become a perverse incentive for future participation of local people in development projects. It would be useful to understand the local institutional context in advance, and make attempts to link the objectives of the research to local organizations' programs. Thus, it is extremely important to justify with the communities the use of monetary incentives, by including explicit explanations for their use. The best justification encompassing several types of instruments for collecting data is that, with a payment, the researcher intends to compensate the participant for the opportunity cost of his time devoted to the study, and for the case of experiments in particular, payments create an environment of incentives that shifts decisions from the hypothetical to real economic consequences.

Related with the payment is the question of confidentiality. Even when the researchers claim the contrary, it is clear that community members may communicate about their earnings. Voluntary information sharing is beyond researchers' control. A problem arises when people are forced (by other participants or external agents) to reveal their earnings or their strategy during the experiment. These issues of confidentiality about decisions and outcomes become critical when the experimental design involves games and decision settings with conflicts regarding bargaining, fairness or social dilemmas such as in the case of commons problems. Games with non-interdependent payoffs (e.g. risk and time preferences and competitive markets) do not bring up as many ethical issues. When payoffs involve conflicts of interests or fairness issues, it is crucial that the researcher keep decisions and payments as confidential as possible using a clear consent form and procedure.

5.3. Results Analysis

The ethical responsibilities of the researcher include being clear and transparent with the community about the fact that the resulting data from any field experiment are valid for the simulated action arena, not necessarily for the real one in which the community lives every day.

One method to be clear about experiments and research is to conduct a workshop with the community's members to debrief them regarding experimental results. In this way, community members have the opportunity to expose any question they have about the experiments and research. When funding is available, it is recommended that a report be written and distributed among the participants in the experiments.

The pedagogical effects of field experiments have only been partially explored (Cardenas and Carpenter, 2008; Cardenas, 2009; Lopez, 2010). In the latter paper, the author collected information through a survey and interviews regarding changes in the fishery activity months after the experiment. The information is still very descriptive, but it suggests that the experiments are a very useful tool for increasing the natural resources users' awareness about the importance of collective action.

Results of experiments can be used to generate insights for policy makers, and at a minimum they can create a space for dialog between policy makers, regulators, and communities. Any policy recommendation should be addressed with knowledge about the limitations of the experiments, because reality is always more complex than an experimental setting. That is the reason why the combination of experiments with other methodologies is so important.

Experiments are also becoming popular tools to evaluate the performance of development projects. Experiments have been conducted in the context of two different government development projects⁷ in Colombia to measure changes in social capital and the willingness to contribute to public goods (Coleman and Lopez, 2009; Attanasio and Phillips, 2008; Attanasio et al., 2009).

6. Conclusions

Common-pool resource management experience over the last four decades has made it clear that institutional responses based on theoretical models alone are insufficient. Formal representation of decision making in such models is typically very simple and context independent. As such, the outcomes from such models can only be general and context independent. Experiments have been used to fill the gaps. In early, simple experiments in the lab, context and micro-situational variables were controlled for as researchers attempted to isolate particular responses and behaviors that supported the homo-economic model of human behavior. As this work has progressed, it has become clear that homo-economic appears only in a very narrow range of conditions and for a small fraction of the population (Smith, 2010). Most of the time, especially in common-pool resource management contexts, these conditions are not met since people pursue a wider range of aims than just profit maximization. Micro-situational variables and broader context matter. To better understand the relationship between these factors and human decision making, numerous of experiments have been conducted in the lab and in the field that have moved beyond traditional protocols. We are just beginning to scratch the surface of what we can learn from well-designed experiments with virtual worlds in the lab and with cartoons of real world situations in the field, but we must act with caution. This paper has attempted to summarize some of this exciting work and highlight some warning signs for future work.

In the same manner that the long experience of conducting experiments in the lab has created an implicit and explicit set of rules regarding protocol design, recruitment strategies, incentives, confidentiality, and management of ethical issues, experience in the field should also bring a set of minimum standards about using experiments to interact with communities that use common-pool natural resources. Experience has also taught us that a minimum set of standards should also be accompanied with enough creativity and adaptability on the part of researchers as they approach their research in each local context, with no significant losses of replicability across sites. We have mentioned the importance of incorporating local context into the design and the collection of data to better interpret the data from the choices made by participants in the experiment. In this article we have identified field studies where a systematic collection of such data has enriched the researchers' work. It seems, however, that the experimental studies have been more successful in incorporating the

⁷ The two government led projects are "Familias en Acción" and "Programas de Desarrollo y Paz".

social context than the ecological context (e.g. how degraded or conserved the surrounding ecosystem is at the time of the experiment, and if this has an effect in the observed behavior). The level of dependence on the resources by the communities and the state of natural stocks has been identified as two crucial factors for the emergence of successful local institutional arrangements in the commons (Ostrom, 2005). Future experiments in the field could be enriched by collecting such information about the micro-situational variables and the local social–ecological context of the commons action arena. This could be achieved in a more systematic manner by designing samples of several sites or locations with variation in the conditions of the ecological system and in the levels of dependence on the resources by the local users.

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References

- Alvard, M., 2004. The ultimatum game, fairness, and cooperation among big game hunters. In: Henrich, J.P., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H. (Eds.), *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies*. Oxford University Press, UK, pp. 413–435.
- Attanasio, O., Phillips, D., 2008. Peace and Godwill? Using an experimental game to analyze Paz and Desarrollo. The Institute for Fiscal Studies EWP08/03.
- Attanasio, O., Barr, A., Cardenas, J.C., Genicot, G., Meghir, C., 2009. Risk Pooling, Risk Preferences, and Social Networks. Working paper.
- Bahry, D., Kosolapov, M., Kozyreva, P., Wilson, R.K., 2005. Ethnicity and trust: evidence from Russia. *American Political Science Review* 99 (4), 521–532.
- Balliet, D., 2010. Communication and cooperation in social dilemmas: a meta-analytic review. *Journal of Conflict Resolution* 54 (1), 39–57.
- Barr, A., 2001. Social dilemmas, shame-based sanctions, and shamelessness: experimental results from rural Zimbabwe. Centre for the Study of African Economies Working Paper WPS/2001.11: Oxford University.
- Barr, A., 2004. Kinship, familiarity, and trust: an experimental investigation. In: Henrich, J.P., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H. (Eds.), *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies*. Oxford University Press, UK, pp. 305–334.
- Barreateau, et al., 2003. Our companion modelling approach. *Journal of Artificial Societies and Social Simulation* 6 (1) Retrieved from <http://jasss.soc.surrey.ac.uk/6/2/1.html>.
- Bécu, N., 2006. Identification et modélisation des représentations des acteurs locaux pour la gestion des bassins versants. PhD thesis, Montpellier, University of Montpellier 2.
- Benedikt, H., Gächter, S., Thöni, C., 2008. Antisocial punishment across societies. *Science* 319, 1362–1367.
- Bouma, J.A., Bulte, E.H., van Soest, D.P., 2008. Trust and cooperation—social capital and community resource management. *Journal of Environmental Economics and Management* 56, 155–166.
- Bousquet, F., Barreateau, O., Le Page, C., Mullan, C., Weber, J., 1999. An environmental modelling approach. The use of multi-agent simulations. In: Blasco, F., Weill, A. (Eds.), *Advances in Environmental and Ecological Modelling*. Elsevier, pp. 113–122.
- Bousquet, F., Barreateau, O., d'Aquino, P., Etienne, M., Boissau, S., Aubert, S., Le Page, C., Babin, D., Castilla, J.-C., 2002. Multi-agent systems and role games: collective learning processes for ecosystem management. In: Janssen, M.A. (Ed.), *Complexity and Ecosystem Management: The Theory and Practice of Multi-Agent Systems*. Edward Elgar, Cheltenham, UK, pp. 248–285.
- Brehmer, B., 1992. Dynamic decision making: human control of complex systems. *Acta Psychologica* 81, 211–241.
- Cardenas, J.C., 2000a. Rural Institutions, Poverty and Cooperation: Learning from Experiments and Conjoint Analysis in the Field, Doctoral Dissertation, Department of Resource Economics, University of Massachusetts Amherst.
- Cardenas, J.C., 2000a. How do groups solve local commons dilemmas? Lessons from experimental economics in the field. *Environment, Development and Sustainability* 2 (3–4), 305–322.
- Cardenas, J.C., 2003. Real wealth and experimental cooperation: evidence from field experiments. *Journal of Development Economics* 70 (2), 263–289.
- Cardenas, J.C., 2009. Experiments in environment and development. *Annual Review Resource Economics* 1:24.1–24.27.
- Cardenas, J.C., Carpenter, J., 2008. Behavioural development economics: lessons from the field in the developing world. *Journal of Development Studies* 44 (3), 337–364.
- Cardenas, J.C., Stranlund, J.K., Willis, C.E., 2000. Local environmental control and institutional crowding-out. *World Development* 28 (10), 1719–1733.
- Cardenas, J.C., Chong, A., Nopo, H., 2009. To what extent do Latin Americans trust and cooperate? Field experiments on social exclusion in six Latin American countries. *Economia* 9 (2), 103–146.
- Cardenas, J.C., Janssen, M., Bousquet, F. forthcoming. Dynamics of rules and resources: three new field experiments on water, forests and fisheries. In J. List, and M. Price (Eds.), *Handbook on Experimental Economics and the Environment*. Edward Elgar Publishing.
- Cárdenas, J.C., Maya, D.L., López, M.C., 2003. Métodos experimentales y participativos para el análisis de la acción colectiva y la cooperación en el uso de recursos naturales por parte de comunidades rurales. *Cuadernos de Desarrollo Rural* 50, 63–96.
- Castillo, D., Saisel, A.K., 2005. Simulation of common pool resource field experiments: a behavioral model of collective action. *Ecological Economics* 55 (3), 420–436.
- Chambers, R., 1994. Participatory rural appraisal (PRA): analysis of experience. *World Development* 22 (9), 1253–1268.
- Clark, C.W., 1973. The economics of overexploitation. *Science* 189, 630–634.
- Clark, C.W., 1990. *Mathematical Bioeconomics: The Optimal Management of Renewable Resources*. Wiley, New York.
- Clark, C.W., 2006. *The Worldwide Crisis in Fisheries: Economic Models and Human Behavior*. Cambridge University Press.
- Clark, C.W., Clarke, F.H., Munro, G.R., 1979. The optimal exploitation of renewable resource stocks: problems of irreversible investment. *Econometrica* 47, 25–47.
- Coase, R., 1960. The problem of social costs. *Journal of Law and Economics* 3 (1), 1–44.
- Coleman, E.A., 2009. Institutional factors affecting biophysical outcomes in forest management. *Journal of Policy Analysis and Management* 28 (1), 122–146.
- Coleman, E.A., Lopez, M.C., 2009. Reconstructing Cooperation from Civil Conflict: Experimental Evidence from Colombian Development Policy. Working paper.
- Cronk, L., 2007. The influence of cultural framing on play in the trust game: a Maasai example. *Evolution and Human Behavior* 28, 352–358.
- Crosen, R., Gneezy, U., 2009. Gender differences in preferences. *Journal of Economic Literature* 47 (2), 448–474.
- D'Exelle, B., 2008. *Inequality, Networks, and Exclusion Distributive Decision Making in Small-Scale Societies*. Maastricht University, The Netherlands.
- Danielson, A.J., Holm, H.J., 2007. Do you trust your brethren? Eliciting trust attitudes and trust behavior in a Tanzanian congregation. *Journal of Economic Behavior & Organization* 62, 255–271.
- Dawes, R.M., 1980. Social dilemmas. *Annual Review of Psychology* 31, 169–193.
- Dawes, R., McTavish, J., Shaklee, H., 1977. Behavior, communication, and assumptions about other people's in a commons dilemma situation. *Journal of Personality and Social Psychology* 35, 1–11.
- Dietz, T., Ostrom, E., Stern, P., 2003. The struggle to govern the commons. *Science* 302 (5652), 1907–1912.
- Durlauf, S., 2002. On the empirics of social capital. *Economic Journal* 112, F459–F479.
- Ensminger, J., 2004. Market integration and fairness: evidence from ultimatum, dictator, and public goods experiments in East Africa. In: Henrich, J.P., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H. (Eds.), *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies*. Oxford University Press, UK, pp. 356–381.
- Fehr, E., Gächter, S., 2000. Cooperation and punishment in public goods games. *American Economic Review* 90, 980–994.
- Fong, C., Luttmer, E., 2009. What determines giving to Hurricane Katrina victims? Experimental evidence on racial group loyalty. *American Economic Journal—Applied Economics* 1 (2), 64–87.
- Gibson, C.C., Williams, J.T., Ostrom, E., 2005. Local enforcement and better forests. *World Development* 33 (2), 273–284.
- Glaeser, E.L., Laibson, D.I., Scheinkman, J.A., Souther, C.L., 2000. Measuring trust. *Quarterly Journal of Economics* 115 (3), 811–846.
- Gneezy, U., Leonard, K.L., List, J.A., 2009. Gender differences in competition: evidence from a matrilineal and a patriarchal society. *Econometrica* 77 (5), 1637–1664.
- Gordon, H., 1954. The economic theory of a common property resource: the fishery. *Journal of Political Economy* 62, 124–142.
- Gurung, T., Bousquet, F., Trebil, G., 2006. Companion modeling, conflict resolution and institution building: sharing irrigation water in the Lingmuteychu Watershed, Bhutan. *Ecology and Society* 11 (2): 36.
- Gurven, M., 2004a. Economic games among the Amazonian Tsimane: exploring the roles of market access, costs of giving, and cooperation on pro-social game behavior. *Experimental Economics* 7, 5–24.
- Gurven, M., 2004b. Does market exposure affect economic game behavior? The ultimatum game and the public goods game among the Tsimane' of Bolivia. In: Henrich, J.P., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H. (Eds.), *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies*. Oxford University Press, UK, pp. 194–231.
- Gurven, M., Winking, J., 2008. Collective action in action: pro-social behavior in and out of the laboratory. *American Anthropologist* 110 (2), 179–190.
- Gurven, M., Zanolini, A., Schniter, E., 2008. Culture sometimes matters: intra-cultural variation in pro-social behavior among Tsimane Amerindians. *Journal of Economic Behavior & Organization* 67, 587–607.
- Hackett, S., Schlager, E., Walker, J., 1994. The role of communication in resolving commons dilemmas: experimental evidence with heterogeneous appropriators. *Journal of Environmental Economics and Management* 27, 99–126.
- Hardin, G., 1968. The tragedy of the commons. *Science* 162, 1243–1248.
- Harrison, G.W., List, J.A., 2004. Field experiments. *Journal of Economic Literature* 42 (4), 1009–1055.
- Hayes, T.M., 2006. Parks, people and forest protection: an institutional assessment of the effectiveness of protected areas. *World Development* 34 (12), 2064–2075.
- Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H. (Eds.), 2004. *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies*. Oxford University Press, Oxford.

- Henrich, J., McElreath, R., Barr, A., Ensminger, J., Barrett, C., Bolyanatz, A., Cardenas, J.C., Gurven, M., Gwako, E., Henrich, N., Lesorogol, C., Marlowe, F., Tracer, D., Ziker, J., 2006. Costly punishment across human societies. *Science* 312, 1767–1770.
- Higgins, E.T., 1996. Knowledge activation: accessibility, applicability, and salience. In: Higgins, E.T., Kruglanski, A.W. (Eds.), *Social Psychology: Handbook of Basic Principles*. Guilford, New York, NY, US, pp. 133–168.
- Hill, K., Gurven, M., 2004. Economic experiments to examine fairness and cooperation among the Ache Indians of Paraguay. In: Henrich, J.P., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H. (Eds.), *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies*. Oxford University Press, UK, pp. 382–412.
- Hofstede, G., 1991. *Cultures and Organizations: Software of the Mind*. McGraw-Hill, New York.
- Hutchinson, S.R., 2004. Survey methods. In: DeMarrais, K.B., Lapan, S.D. (Eds.), *Research Methods in the Social Sciences: Frameworks for Knowing and Doing*. Hillsdale, N.J., Lawrence Erlbaum Associates, Publishers, pp. 283–301.
- Inglehart, R., 2000. Culture and democracy. In: Harrison, L.E., Huntington, S.P. (Eds.), *Culture Matters: How Values Shape Human Progress*. Basic Books, New York.
- Janssen, M.A., 2010. Introducing ecological dynamics into common pool resources experiments. *Ecology and Society* 15 (2), 7.
- Janssen, M.A., Holahan, R., Lee, A., Ostrom, E., 2010. Lab experiments for the study of social-ecological systems. *Science* 328, 613–617.
- Karlan, D.S., 2005. Using experimental economics to measure social capital and predict financial decisions. *American Economic Review* 95 (5), 1688–1699.
- Krosnick, J.A., 1999. Survey research. *Annual Review of Psychology* 50, 537–567.
- Ledyard, J., 1995. Public goods: a survey of experimental research. In: Kagel, J., Roth, A. (Eds.), *Handbook of Experimental Economics*. Princeton University Press, Princeton, pp. 111–194.
- Lesorogol, C.K., 2007. Bringing norms in the role of context in experimental dictator games. *Current Anthropology* 48 (6), 920–926.
- Lopez, M.C., 2010. Combining experiments and participatory rural appraisal tools in the field: exploring new techniques to study the management of the commons in Colombia. Working paper.
- Lopez, M.C., Murphy, J., Spraggon, J., Stranlund, J.K. forthcoming. Does government regulation complement existing community efforts to support cooperation? Evidence from field experiments in Colombia. In: J. List, and M. Price (Eds.), *Handbook on Experimental Economics and the Environment*. Edward Elgar Publishing.
- Macfarlan, S.J., Quinlan, R.Q., 2008. Kinship, family, and gender effects in the ultimatum game. *Human Nature* 19, 294–309.
- Malthus, R.T., 1798. *An Essay on the Principle of Population*, London.
- Marlowe, F.W., Berbesque, J.C., Barr, A., Ensminger, J., Barrett, C., Bolyanatz, A., Cardenas, J.C., Gurven, M., Gwako, E.L., Henrich, J., Henrich, N., Lesorogol, C., Tracer, D., 2008. More 'altruistic' punishment in larger societies. *Proceedings of the Royal Academy*. 275, 587–590.
- McElreath, R., 2004. Community structure, mobility, and the strength of norms in an Africa society: the Sangu of Tanzania. In: Henrich, J.P., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H. (Eds.), *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies*. Oxford University Press, UK, pp. 335–355.
- NRC (National Research Council), 1986. *Proceedings of the Conference on Common Property Resource Management*. National Academies Press, Washington, DC.
- Ostrom, E., Dietz, T., Dolsak, N., Stern, P., Stonich, S., Weber, E. (Eds.), 2002. *The Drama of the Commons*. Committee on the Human Dimensions of Global Change. National Academies Press, Washington, DC.
- Oosterbeek, H., Sloof, R., Van Kuilen, G., 2004. Cultural differences in ultimatum game experiments: evidence from a meta-analysis. *Experimental Economics* 7, 171–188.
- Ostrom, E., 2005. *Understanding Institutional Diversity*. Princeton University Press, Princeton, New Jersey.
- Ostrom, E., 2007. A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences*. 104 (39), 15181–15187.
- Ostrom, E., Nagendra, H., 2006. Insights on linking forests, trees, and people from the air, on the ground, and in the laboratory. *Proceedings of the National Academy of Sciences* 13 (51), 19224–19231.
- Ostrom, E., Walker, J.M., 1991. Communication in a commons: cooperation without external enforcement. In: Palfrey, T.R. (Ed.), *Laboratory Research in Political Economy*. University of Michigan Press, Ann Arbor, pp. 287–322.
- Ostrom, E., Walker, J.M., Gardner, R., 1992. Covenants with and without a sword: self-governance is possible. *American Political Science Review* 86 (2), 404–417.
- Ostrom, E., Gardner, R., Walker, J., 1994. *Rules, Games, and Common-Pool Resources*. University of Michigan Press, Ann Arbor.
- Patton, J., 2004. Coalitional effects on reciprocal fairness in the ultimatum game: a case from the Ecuadorian Amazon. In: Henrich, J.P., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H. (Eds.), *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies*. Oxford University Press, UK, pp. 96–124.
- Pavitt, C., McFeeters, C., Towey, E., Zingerman, V., 2005. Communication during resource dilemmas: 1. Effects of different replenishment rates. *Communication Monographs* 72 (3), 345–363.
- Pigou, A.C., 1920. *The Economics of Welfare*. Macmillan and Co., London.
- Poteete, A.R., Janssen, M.A., Ostrom, E., 2010. *Working Together: Collective Action, the Commons and Multiple Methods in Practice*. Princeton University Press.
- Presser, S., Rothgeb, J.M., Couper, M.P., Lessler, J.T., Martin, E., Martin, J., Singer, E. (Eds.), 2004. *Methods for Testing and Evaluating Survey Questionnaires*. John Wiley & Sons, Hoboken, NJ.
- Rodríguez-Sickert, C., Guzmán, R., Cárdenas, J.C., 2008. Institutions influence preferences: evidence from a common pool resource experiment. *Journal of Economic Behavior and Organization*. 67 (1), 215–227.
- Rustagi, D., Engel, S., Kosfeld, M., 2010. Conditional Cooperation and Costly Monitoring Explain Success in Forest Commons Management. *Science* 330, 961–965.
- Sally, D., 1995. Conservation and cooperation in social dilemmas: a meta-analysis of experiments from 1958 to 1992. *Rationality and Society* 7, 58–92.
- Saris, W.E., Gallhofer, I.N., 2007. *Design, Evaluation, and Analysis of Questionnaires for Survey Research*. Wiley-Interscience, Hoboken, NJ.
- Smith, V.L., 1969. On models of commercial fishing. *The Journal of Political Economy* 77, 181–198.
- Smith, V.L., 2010. Theory and experiments: what are the questions? *Journal of Economic Behavior and Organization*. 73 (1), 3–15.
- Sterman, J.D., Booth Sweeney, L., 2007. Understanding public complacency about climate change: adults' mental models of climate change violate conservation of matter. *Climatic Change* 80, 213–238.
- Stern, P.C., 1976. Effect of incentives and education on resource conservation decisions in a simulated commons dilemma. *Journal of Personality and Social Psychology* 34, 1285–1292.
- Sudman, S., Bradburn, N.M., Wansink, B., 2004. *Asking Questions: The Definitive Guide to Questionnaire Design — For Market Research, Political Polls, and Social and Health Questionnaires*. Jossey-Bass, San Francisco, CA.
- Takahashi, C., Yamagishi, T., Liu, J.H., Wang, F., Lin, Y., Yu, S., 2008. The intercultural trust paradigm: studying joint cultural interaction and social exchange in real time over the Internet. *International Journal of Intercultural Relations* 32, 215–228.
- Tracer, D., 2004. Market integration, reciprocity, and fairness in rural Papua New Guinea: results from a two-village ultimatum game experiment. In: Henrich, J.P., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H. (Eds.), *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies*. Oxford University Press, UK, pp. 232–259.
- Velez, M.A., Murphy, J.J., Stranlund, J.K., 2010. Centralized and decentralized management of local common resources in the developing world: experimental evidence from fishing communities in Colombia. *Economic Inquiry* 48 (2), 254–265.
- Vieira Pak, M., Castillo, D., 2009. Designing and implementing a role-playing game in the Colombian Amazonian Frontier: a tool to explain factors, colonos' decision making and landscape transformation, Working paper.
- Vollan, B., 2008. Socio-ecological explanations for crowding-out effects from economic field experiments in southern Africa. *Ecological Economics* 67 (4), 560–573.
- Whitt, S., Wilson, R.K., 2007. The dictator game, fairness and ethnicity in postwar Bosnia. *American Journal of Political Science* 51 (3), 655–668.
- Wiessner, P., 2009. Experimental games and games of life among the Ju/'hoan Bushmen. *Current Anthropology* 50 (1), 133–138.
- Wilson, D.S., Tuminelli O'Brien, D., Sesma, A., 2009. Human prosociality from an evolutionary perspective: variation and correlations at a city-wide scale. *Evolution and Human Behavior* 30, 190–200.