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How Do Game Design, Gender, and Players' Backgrounds Affect Behavior in Framed Field Experiments? Evidence from Community Forestry in India

RESEARCH ARTICLE

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ABSTRACT

Framed field experiments (experimental games) are widely used to assess factors affecting cooperation in management of the commons. However, there is relatively little attention to how details of the games affect experimental results. This paper presents qualitative and quantitative results from a framed field experiment in which participants make decisions about extraction of a common-pool resource, a community forest. The experiment was conducted in 2017–2018 with 120 groups of resource users (split by gender) from 60 habitations in two Indian states, Andhra Pradesh and Rajasthan. We test whether within-subject treatments (non-communication, communication, and optional election of institutional arrangements (rules)), remuneration methods, and design of the game board affect harvest behavior and groups' tendency to cooperate. We also examine how characteristics of the community and players affect players' choices in the game, with special attention to gender differences. Results reveal participants harvested substantially less than the Nash prediction even in the absence of communication, with men extracting less than women in both states. For male groups in both states, both communication and optional rule election were associated with lower group harvest per round, as compared to the reference non-communication game. For female groups in both states communication itself did not significantly slow resource depletion; but introduction of optional rule election did reduce harvest amounts. For both men and women in Andhra Pradesh and men in Rajasthan, incentivized payments to individual participants significantly lowered group harvest, relative to community flat payment, suggesting such payments stimulated deliberation among game players. Findings have methodological and practical implications for designing behavioral intervention programs to improve common-pool resource governance.

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INTRODUCTION

Common-pool resources (CPR) like forests, pastures, water systems, fisheries and biodiversity play crucial roles in the livelihoods of local communities. However, limited understanding of resource dynamics and lack of cooperation amongst users often leads to over-extraction of resources, resulting in resource degradation. Experiences of practitioners engaging with the local communities to address challenges of natural resource governance indicate that overharvesting of resources is more common when communities are not able to perceive the impact of their decisions and actions on resource conditions or on their livelihoods in the long run. Even though communities may form rules regulating resource use, in the absence of strong monitoring and sanctioning mechanisms, they are not enforced, resulting in resource degradation (Anderies and Janssen 2013, Cox et al. 2010).

Experimental games (framed field experiments) provide a way for researchers and community members to see how different factors, including institutional arrangements, affect people's choices regarding resource use (Ostrom 2009a). Cardenas and Ostrom (2004) note that when deciding to cooperate, players draw on the material incentives and dynamics of the game as well as the characteristics of the group and individuals.

There has been considerable attention to designing games that simulate commons dilemmas, as well as different institutional structures to assess their effectiveness in overcoming the tendency for over-extraction. While previous experimental studies have shown that allowing participants to communicate and/or sanction others at a cost to themselves lead to more cooperative results for the CPR (Janssen et al. 2010, 2013, Ostrom 2006, Ostrom et al. 1992), rules imposed by the experimenter aimed at improving the performance of the group do not always lead to the desired outcome (Ostrom et al. 1992, Cárdenas et al. 2000, Vollan 2008, Janssen et al. 2013, DeCaro et al. 2015). One explanation for this is the crowding-out behavior of group-oriented decisions that are initially made because of intrinsic motivations, but due to external interventions, end up with behavior that is more self-oriented (Janssen et al. 2013). Another explanation is the perception of procedural justice is lower if rules are imposed rather than locally selected (DeCaro et al. 2015). To elicit support of the new regulation, which would then reduce the likelihood of crowding-out (Vollan 2008), Janssen et al. (2013) asked participants to choose from three commonly used options presented to them. The greater legitimacy arisen from internally driven decision-making can potentially lead to more pro-social outcome. As Narloch et al. (2012) note, the possibility to internally discuss collective strategies following the recommendations of an external agent can be a simple means to increase cooperation (Moreno-Sanchez and Maldonado, 2010), though the effectiveness of such internal mechanisms depends on group contexts (Cardenas 2003, Cardenas et al. 2011) and other factors such as social norms that also govern behavior and rule compliance as reported in Janssen et al. (2013). Focusing on the social learning role of games, Falk et al. (2021) emphasize that games are designed in a way that players have a chance to jointly invent, negotiate, and experiment with rule-making (Woodhill 2010, Hertzog et al. 2014, Speelman et al. 2017). From the perspective of effectiveness of social learning (Falk et al. 2021), internally determined institutional arrangement can help strengthen participants' confidence in the institutions as well as own capacity, willingness and feeling of responsibility to invest in the provision of institutional services (Pahl-Wostl et al. 2007, Wigboldus et al. 2016).

The use of individual (monetary) rewards has been standard practice in behavioral experiments to provide salient incentives for "serious" choices such that actions have motivational relevance (Smith 1982, Loomis 2014, Mørkbak et al. 2014). While economists usually assume that monetary incentives improve performance, Gneezy and Rustichini (2000) find that the effect of monetary compensation on performance was not monotonic. If participants perceive the rewards as a fair contribution for the effort, the results will not be affected by different levels of rewards (Gneezy and Rustichini 2000, Amir et al. 2012). However, if the monetary reward is perceived as very low, this can backfire and participants will put in less effort (Gneezy and Rustichini 2000). Some experimentalists – mainly in psychology – argue that intrinsic motivations are strong enough to reveal people's behavioral patterns (Smith and Walker 1993, Bartels et al. 2022, Falk et al. 2021) and it could be more effective to appeal to moral incentives (such as contributing to an important activity) rather than providing a monetary reward (Gneezy and Rustichini 2000).

Incentivized payments, in some cases, support a shift from a habitual (e.g., non-cooperative strategy) to a deliberative behavioral mode (e.g., cooperative strategy) (Falk et al. 2021), which may be of particular interest to efforts that use games to promote experiential learning about CPR governance and collective action. Empirical evidence of this, however, is lacking and when it does exist, results are mixed. In Madhya Pradesh, India, communities that played a surface water game with incentivized payments were significantly more likely to engage in dam maintenance activities after the game was played compared to a control group (Bartels et al. 2022, Falk et al. 2021). In a groundwater game in Andhra Pradesh, India,

Meinzen-Dick et al. (2018) found no effect of the payment methods on behavior.

Framing can affect the social component of games and resulting behavior of participants (Alekseev et al. 2017). For example, calling a Prisoner's Dilemma Game a "Community Game" was likely to elicit more cooperative choices than calling it a "Stock Market Game" (Ellingsen et al. 2013). Reviewing a wide range of experimental games, Croson and Gneezy (2009) find that women may be more susceptible than men to the effects of framing, particularly in risk-related games. Alekseev et al. (2017) find that framing that evokes real-life situations can increase the external validity of results. Little is known about what visual design elements in experimental games do to game behavior. Much of the literature related to visual design focuses on video game development whereby the visual design influences how players think and feel while playing (Milam 2013). Other studies look at the pedagogical effect of visual design (e.g., Javora et al. 2019, Strzalkowski and Symborski 2017).

Broader social-ecological context variables (Ostrom 2007 and 2009b, Poteete et al. 2010) are important for understanding the rule crafting dynamics in CPR dilemmas (Castillo et al. 2011). As noted by Cardenas and Ostrom (2004), players' background and experiences with resource management as well as their individual characteristics are likely to affect their choices in the game. In particular, men and women tend to have different needs for natural resources (due to their different gender roles in households and communities, among other factors) and perceptions about the benefits of forests, as well as ways to sustainably manage CPR (Sunderland et al. 2014). Yet experiments specifically constructed to examine the gender differences in group dynamics, resource extraction strategies, voluntary election of rules, and response to treatments are limited (c.f. Meinzen-Dick et al. 2018). For instance, Ghate et al. (2013) purposely excluded women from their community forestry game in eight indigenous tribal communities in Maharashtra, India because women were reported to play a marginal role in forest management. Janssen et al. (2013) acknowledge an expected effect of gender bias in favor of males for most of the village sites due to its special effort made to recruit adults from households engaged in the resource extraction of that village. Yet women are major users of forest resources, and it is important to understand what affects their resource use patterns.

This paper presents results from a gender-balanced framed field experiment in which participants had to make decisions about extraction of a shared renewable resource, a forest. The experiment is a dynamic group game to simulate social dilemmas around CPR management, underlined by a tension between private earnings and collective resource sustainability. In 2017–2018 we implemented the experiment with 600 individuals in 120 groups of resource users from 60 habitations (named, distinct clusters of houses that constitute a local community), in Andhra Pradesh and Rajasthan states in India. This is part of a series of studies to examine whether games could provide a tool for social learning to improve management of the commons (Falk et al. 2021).

This paper addresses two sets of research questions related to players' behavior in the game:

1. How does the structure of the framed field experiment affect behavior? In particular:
   a. Do communication and internally determined institutional arrangements reduce overharvesting?
   b. Do individual monetary incentives based on how participants played in the game lead to more harvest than community flat payment?
   c. Does board structure with framing emphasizing ecosystem services reduce overharvesting?
2. How do characteristics of the community and of the players affect choices to cooperate in the game? In particular, what are the differences between how men and women behave in the game?

In this study, habitations vary in the effectiveness of existing governance of community forests (including, for example, institutional arrangements and collective action), households' dependence on forest, and forest conditions, among other demographic and socioeconomic factors. We give particular attention to gender differences in harvesting decisions in the game. Our experiment explicitly set up single-gender groups, both a necessity to respect the gender norms in some localities and a purposeful design that allows us to examine the gender differences.

In addition to quantitative data collected from the experiment and habitation and participant surveys, we took detailed notes during the experiment, focus group discussions (FGDs), and community debriefings (e.g., on local beliefs and norms regarding forest and its governance). This combination of quantitative and qualitative data allows us to examine and interpret how the structure of the game (including communication, election of rules, payment method) as well as characteristics of the group and gender of the players affect choices concerning whether to cooperate.

METHODS

EXPERIMENTAL DESIGN

We adapted the forestry experiment in Janssen et al. (2013). The basic structure of the game, first presented in Cardenas et al. (2013), is as follows. Participants can harvest trees from a shared forest in each round, and the stock will regenerate by adding one tree for every 10 trees remaining. The maximum number of trees that could be harvested in a given round depends on the size of the resource at the beginning of that round as shown in Table 1. Each tree harvested was worth INR 5 and earnings were recorded using tokens.

To address Research Question 1a, our experiment consists of three variations of the game as within-subject treatments (Charness et al. 2012) played in a fixed order designed for social learning:[1]

Set 1: "non-communication game" during which participants were asked to make individual decisions about tree harvesting without discussing with other players;

Set 2: "communication game" during which participants could discuss among themselves before making individual decisions; and

Set 3: "optional rule election game" with communication. This extends Janssen et al. (2013)'s design by inviting the participants to make decisions regarding monitoring and sanctioning rules. At the beginning of the set, participants were asked whether they would like to introduce monitoring rules based on their experience in Sets 1 and 2. If the group decided not to introduce monitoring, they continued as in Set 2. If they decided yes, the group spent up to 10 minutes discussing what kind of monitoring mechanisms they would like to have, and notes were taken of the suggested ideas. To ensure feasibility within the game context, the facilitator then suggested an example of monitoring mechanism, called monitoring and public announcement, for groups that opted for having one: The groups had the option to select someone from the habitation to act as the monitor. Just as the forest guard is paid a small sum as a wage (a mechanism that already existed in some communities), this monitor would also be paid a small fee by each player at the end of each round. At the end of the round, each participant would throw a dice. If anyone got a ONE or SIX, the monitor would check if that person violated the group's agreement and announce the extent of any violation. After three rounds, the groups were asked whether they wanted to introduce some form of penalty for the violators (i.e., sanctioning). If the groups declined, they continued for a further 4 rounds with monitoring. If they said yes, the groups discussed what kind of punishment they would like to introduce and then played a further 4 rounds incorporating their chosen sanctioning method.

The design of Set 3 is adapted from Janssen et al. (2013) in which participants were asked to elect from three pre-determined regulation options presented to them. It differs from Janssen et al. (2013) in that the groups decide whether and what kinds of rules they implement. This design element is motivated by the consideration that social learning is expected to be more effective when participants decide on the different rules on their own and try them out in a low-risk environment (Falk et al. 2021).

Whereas Janssen et al. (2013) began their game with a full board of 100 trees, our experiment was framed around a degraded forest with a starting stock of 50 trees. If allowed to regrow at the maximum rate (i.e., no harvest), it could reach the full capacity of 100 trees after 9 rounds. The adapted framing was relevant to the conditions of community forests in our study area and reduces the experiment duration while creating a sense of urgency to manage already degraded resources more sustainably.

For Research Question 1b and 1c, the experiment includes two other key design elements as between-subject treatments (Charness et al. 2012) to address methodological issues of interest to researchers (Meinzen-Dick et al. 2018, Falk et al. 2019 and 2021, Bousquet et al. 2002). To test the effect of remuneration methods, habitations in our sample were randomly assigned to receive either: 1) real money paid to individual participants based on how they played in the game, or 2) a flat payment of INR 2000 made to the community as a token of appreciation, regardless of how participants played. With individual payment, tokens earned from tree harvesting across all rounds played and all 3 sets of game were converted into rupees at the end of the experiment and paid in cash to each participant. Average earnings of participants under the individual payment method were around half the daily wage.

Resource level (Number of trees standing)	50–25	24–20	19–15	14–11	10–5	4–0
Maximum number of trees a player can harvest	5	4	3	2	1	0

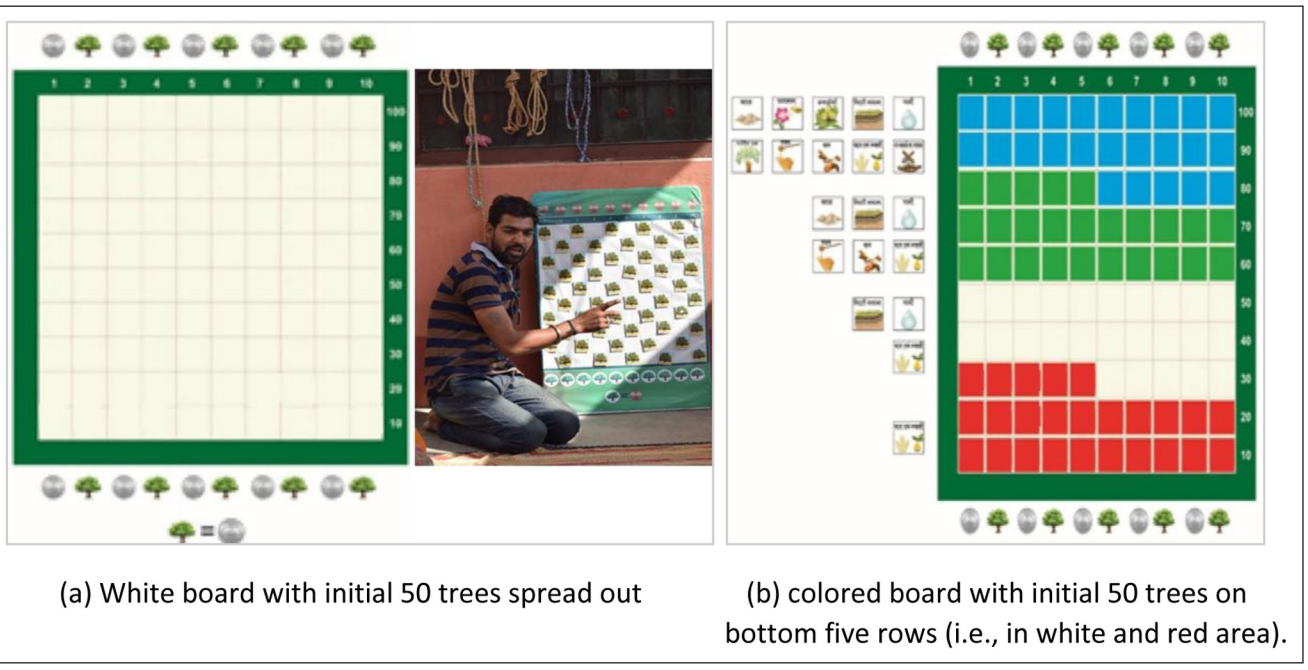
Table 1 Maximum number of trees that each participant can harvest in a round.

To test the effect of visual reminders of ecosystem services from forests, we randomly assigned habitations to one of two types of game board: 1) a simple white board that shows the spatial layout of the resource (trees) in each round (Figure 1a), and 2) a colored board with different colors linked to different resource sizes (i.e., forest conditions) with varying levels of ecosystem services provided by the forest (Figure 1b). Instead of having the initial stock of 50 trees spread across the board, the colored board started with all trees in the bottom half, covering the white and red squares. Additional trees beyond 50 would move into the green or blue area, and a loss of trees below 25 would expose the red area. Pictures of ecosystem services were placed on the board to indicate more services as one moved from red to white to green to blue areas. The colored board was as a reminder of higher ecosystem services associated with greater tree cover.

Participants' time constraint, especially that of women who have many household and farming responsibilities, could limit people's ability to complete or fully engage in field experiments (Meinzen-Dick et al. 2018). Therefore, we shortened the experiment in Janssen et al. (2013) by reducing the number of rounds. Instead of 10 rounds in each set, we played 6, 6, and 7 rounds in sets 1, 2 and 3, respectively. To mitigate the end-round effect, the number of rounds was not disclosed, though participants may anticipate the duration after the first set. Each set would end before the full number of rounds if there were less than 5 trees remaining, after regeneration.

To gather data on the habitations and characteristics of game participants to address Research Question 2, we conducted a FGD covering habitation characteristics, use and condition of community forest, and existing natural resource management (NRM) institutions. Immediately after the game, participants were interviewed about: 1) basic information about the participant and his/her household, and 2) brief mental model survey to understand the individual's perception about the resource and its management and whether he/she thinks differently after playing the game.

The experiment presented in this paper is part of a larger study that aims to understand the potential of experimental games as a social learning tool to improve collective action and CPR management institutions. Toward that end, following the game at each site, all members of the habitation were invited to participate in a community debriefing where basics of the game were described, and general game results were shared without specifics about individuals. The debriefing meetings engaged communities in discussions about how the exercise related to their own experiences and challenges, what lessons and insights the participants gained from the experience, and possible solutions identified by the communities. Detailed notes were taken at each experiment, FGD, and community debriefing to provide insight into what players were discussing among themselves regarding rules for harvesting, as well as local beliefs and norms about NRM in general and about the community forest specifically.



(a) White board with initial 50 trees spread out

(b) colored board with initial 50 trees on bottom five rows (i.e., in white and red area).

Figure 1 Two types of game board for displaying initial stock size, group choices and corresponding changes in resource size from round to round.

The effects of the intervention on community behavior are reported separately (Falk et al. 2021), but we draw on the qualitative data from the debriefings to complement the other data in this paper.

PROTOCOL

The field experiment was implemented during October 2017 to January 2018 by the Foundation for Ecological Security (FES), an Indian NGO working with communities on commons and livelihoods. Thirty habitations in Andhra Pradesh and Rajasthan each were randomly selected from FES's database of communities with which FES started engaging as part of its commons program during 2013–2016, giving a sample of 60 habitations (Figure 2).

In each state, each habitation was randomly assigned to one of 4 between-subject treatment bundles based on payment methods and game board types: 1) Individual payment + White board, 2) Individual payment + Colored board, 3) Community payment + White board, and 4) Community payment + Colored board (Figure 2). There is a minor imbalance between the "Individual payment + Colored board" and the "Individual payment + White board" bundles (Figure 2), due to imperfect coordination between the two states during splitting the 15 habitations per bundle target. In total, 120 groups or 600 forest users from 60 habitations participated in the experiment.

Sample balance check based on T-test and Kolmogorov–Smirnov test performed on selected key habitat characteristics variables for each state shows little evidence that the sub-samples selected for testing payment method and game board design effects, respectively, were systematically different (Table S1 and Table S2 in Appendix 1).

On the day of game intervention in each habitation, men and women from households that used the community forest were invited for a meeting, where the purpose of the game was briefly described. Five men and five women were then randomly selected to participate in two single-gender group games, as mixed gender group game would not have been acceptable by some local norms, and many women may not have felt comfortable speaking in front of men. Only one member of a household could be selected. The experiment began after playing three practice rounds and time for questions to ensure that participants understood the experiment. Following the practice rounds each group played the same 3 sets of games described above: non-communication, communication, and optional rule election games. The experimental design was pretested with resource users in rural communities before conducting the actual experiment reported here.

NONCOOPERATIVE AND COOPERATIVE HARVEST STRATEGIES

Based on the design of the experiment, a "Non-cooperative (Nash prediction)" harvest strategy and a "Cooperative (Economically optimal)" harvest strategy can be predicted. Figure 3 shows two illustrative paths of extraction for the two strategies (solid lines).[2] In the absence of communication and information on the number of rounds to be played, each player is assumed to maximize his/her payoff as fast as possible by harvesting the maximum allowed in each round. To do this, each player would harvest 5 trees per round in the first two rounds, depleting the resource after two rounds of decisions. This overharvesting, non-cooperative strategy results in a total of 50 harvested trees for the group, worth INR 250.

With communication and guessing of the number of rounds the game would last (after playing the previous no-communication game), a cooperative group may choose a strategy to maximize payoff. Since we present an initially

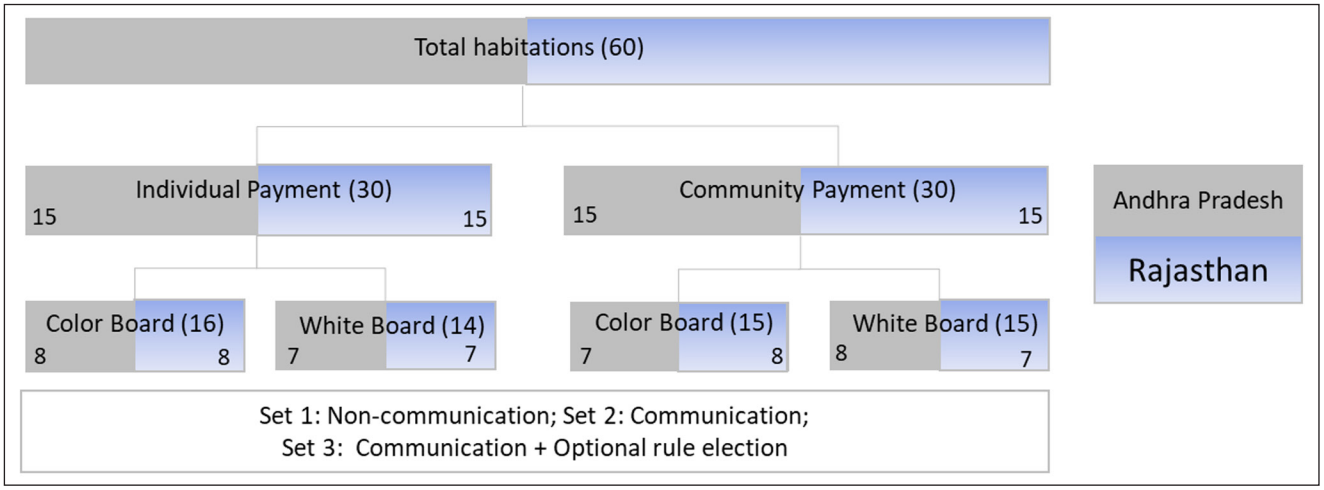


Figure 2 Sampling design and treatment assignment.

"degraded" resource, the economically optimal strategy is to refrain from harvesting, allowing the resource size to recover before extracting at the maximal levels over the anticipated duration (e.g., 75 trees over 7 rounds). Group cooperation leads to an economically optimal strategy if the limited time horizon is known.

These two paths are the same as those described in Janssen et al. (2013) and Ghate et al. (2013) with two exceptions: 1) more rapid depletion of resource in the Nash prediction, and 2) resource size allowed to exceed the initial stock of 50 trees before declining. These exceptions are due to our experiment presenting an initially "degraded" forest which would deplete much faster at the same maximum allowed harvest rates, and that it allows recovery of the forest stock toward its full capacity of 100 trees.

Ghate et al. (2013) propose a third strategy under which groups harvest at a rate that maintains the forest at its full capacity (100 trees). The resource size does not diminish at all because regeneration keeps the slightly extracted resource replenished. Because the strategy ensures the preservation of the resource over time, it is a sustainable solution to the CPR dilemma (Ghate et al. 2013). This strategy, named "Cooperative (Socially optimal/sustainable)" in Figure 3 (dashed line), is adapted to our experimental design by allowing the "degraded" forest to recover toward its full capacity. If actors have a long-term time horizon (or the total number of rounds is not known), they might refrain from harvesting to bring the stock up to its maximum, as indicated by the "Socially optimal/sustainable" path.

In line with theoretical predictions and findings of previous experiments of a Nash equilibrium strategy when participants cannot communicate or use costly sanctioning (Ostrom et al. 1992, Janssen et al. 2013), we might expect that in the absence of communication, participants overharvest in each round of the game and exhaust the renewable resource as rapidly as possible, but communication and "internally determined" institutional arrangements (e.g., monitoring and sanctioning rules) ease overharvesting. The framing of a "degraded" resource may affect the propensity to cooperate in either direction, adding uncertainty to the harvest strategy prediction.

ANALYSIS

We address the research questions using a combination of quantitative and qualitative data, including recorded harvest choices during the game, participant characteristics and mental models collected from individual surveys, habitation characteristics and local contextual information collected from the FGDs and community debriefing meetings.

For Research Question 1a–1c, to examine the effects of within-subject and between-subject treatments, we estimate a two-limit Tobit model for group harvest per round (censored data) and Poisson model for group congruence level (count data) by gender and state and control for group fixed effects. The congruence score, ranging from 1 (none of the 5 players chooses the same harvest level as other players) to 7 (all 5 players choose the same harvest level), measures the degree of consensus among the

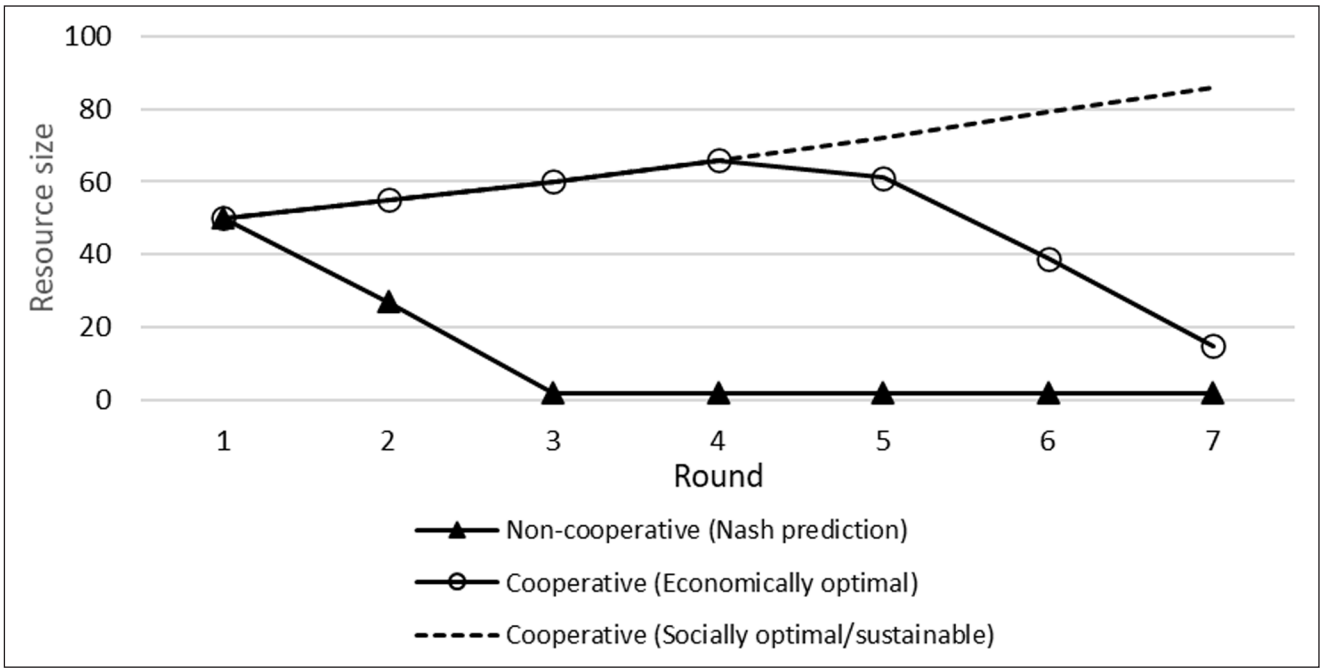


Figure 3 Illustrative theory-predicted harvest strategies.

group members, the lack of which may potentially cause resentment. Ordinary Least Squares (OLS) regressions are also performed as an approximation, reported in Table S3 and Table S4 in Appendix 1. We obtain standard errors that are robust to misspecification and intragroup (within-cluster) correlation in all models.

For Research Question 2, to explore which group characteristics (averaged from individual participant characteristics) and habitation factors are significant predictors of group harvest in each round, we run pooled Tobit regressions on gender, Scheduled Tribe membership, presence of commons-related institutions, as well as characteristics such as age, education, dependence on agriculture and forests, and indicators of confidence in village-level cooperation (game participant's confidence that people in the village are willing to help others and contribute to community public goods) without group or habitation fixed effects. All regressions are performed on Andhra Pradesh and Rajasthan separately to control for state fixed effects.

RESULTS

RESEARCH QUESTION 1

Overall extraction patterns and relatability of the game

We did not find evidence that, even in the absence of communication, participants overharvested in each round of the game and exhausted the renewable resource as rapidly as possible. Overall, results on resource size in each round by gender and state (Figure 4) cannot be characterized as "Non-cooperative (Nash prediction)" as depicted in Figure 3, nor did the groups in our experiment reveal "Cooperative (Economically optimal)" behavior. Instead, we observe participants harvested substantially less than the Nash prediction even in the absence of communication (Set 1). This phenomenon is stronger for male than for female participants in both states.

One possible factor to explain that participants harvested less than the Nash prediction may come from our framing of the resource as a "degraded" forest. While this may

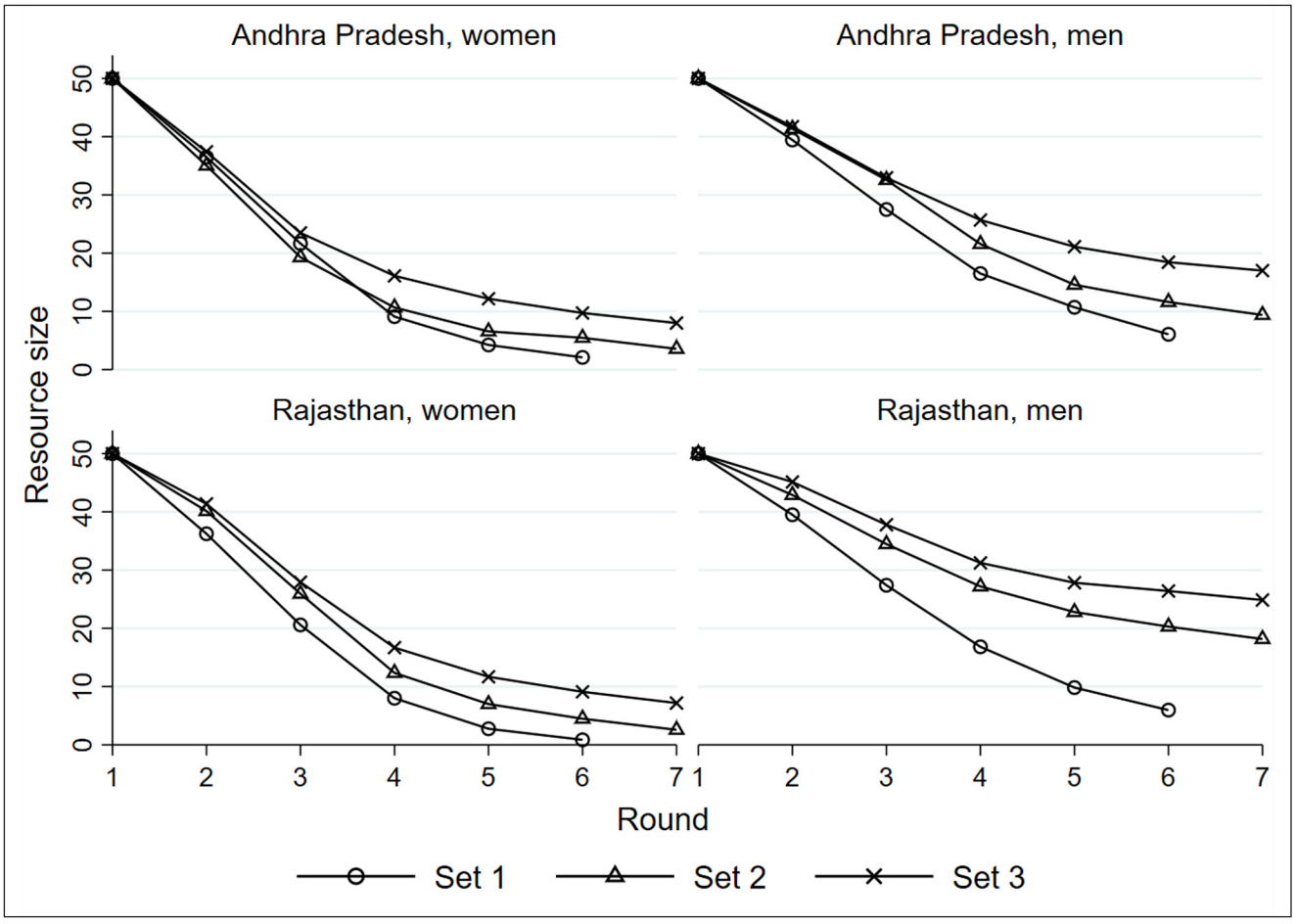


Figure 4 Average resource size over the rounds by state and gender.

Note: See Table S5 in Appendix 1 for descriptive summary.

have contributed to a less aggressive harvest strategy, it is unlikely to be the only reason. Qualitative information indicated that many participants were uncomfortable with the idea of cutting down trees in the game, as both local norms and community or state regulations prohibit cutting down trees without explicit permission. Although households frequently extract forest products, harvesting practices are limited to cutting branches or collecting fallen wood. Conversations at community debriefing meetings indicate that many communities view forests not only as the source of provisioning ecosystem services (mainly forest products that meet the consumptive, domestic, and productive needs of local people), but also an important source of regulating and supporting ecosystem services (such as water purification, rainfall regulation, and soil erosion control) and cultural services (such as spiritual connection and cultural heritage).

We measure relatability (*How relatable is the game to your forest experience in the habitation?*) with three categories: 1 = Not very much or slightly relatable, 2 = Somewhat relatable, and 3 = Relatable a lot. The level of relatability is very high in Andhra Pradesh (2.591) and significantly higher than in Rajasthan (1.893). Within each state, men found the game more relatable than women did, with men in Andhra Pradesh reported the highest relatability (2.685) and women in Rajasthan the lowest (1.775) (Table S6 in Appendix 1).

Effects of communication and internally determined rules

We find qualitative and quantitative evidence that both communication and "internally determined" institutional arrangements (e.g., monitoring and sanctioning rules) ease overharvesting. Compared to the non-communication rounds (Set 1), resource depletion on average slowed down in the communication rounds (Set 2), even though this was "cheap talk" (Ostrom 2009a) without enforcement of agreements that might be reached. Optional rule election (Set 3) was associated with even more limits on harvest. As Figure 4 shows, this pattern is present for both gender groups in both states. In Set 3, all groups in Andhra Pradesh and 88% of the groups in Rajasthan introduced monitoring fees paid by individual participants, with groups paying between INR 5 to 25 per group in monitoring fee in Andhra Pradesh and INR 5 in Rajasthan. While rules for monetary sanctioning were only adopted in 11% of all groups across two states, public announcement, as a form of social sanctioning, was commonly used, whether or not groups had introduced a monitoring fee.

Group level fixed effect regression analysis, conducted separately for men and women in Andhra Pradesh (Table 2) and Rajasthan (Table 3), shows that, for male groups in both states, both communication (Set 2) and optional rule election (Set 3) were associated with lower group harvest per round, as compared to the reference non-communication game (Set 1) (column 1 in Tables 2 and 3). OLS regression results (Tables S3 and S4 in Appendix 1) are highly consistent with the Tobit regression results. For female groups in both states, communication (Set 2) itself did not significantly slow down resource depletion but the introduction of optional rule election (Set 3) did make a difference in reducing harvest.

Group level fixed effect regression analysis shows that communication (Set 2) had a positive effect on the degree of congruence (agreement in harvest decisions among group members) for female groups in both states (column 4 in Tables 2 and 3) and optional rule election (Set 3) was positively associated with congruence for male groups in Andhra Pradesh and both male and female groups in Rajasthan. This is consistent with our expectation that communication and rules tend to improve consensus. Again, OLS regression results (Tables S3 and S4 in Appendix 1) are highly consistent with the Poisson regression results.

Effects of payment type

We find evidence that individual payments to participants based on how they played in the game led to more harvest than community flat payment, but only for female groups in Rajasthan (column 2, Table 3). For both men and women in Andhra Pradesh (Table 2) and men in Rajasthan (column 1, Table 3), incentivized payments to individual participants significantly lowered group harvest, relative to community flat payment. That is, individual payments resulted in more pro-social behavior in three out of four gender groups across the two states. These results are consistent with those estimated with OLS model (Tables S3 and S4 in Appendix 1). One possible explanation is that, with individual payments, participants have incentives to maximize "long-term" earnings, not knowing with certainty how many rounds they would play. Another possible explanation is that individual payments may have triggered a deliberative behavioral mode which favors cooperative strategies over non-cooperative strategies that maximize individual earnings, as Falk et al. (2021) argue. Narloch et al. (2012) show that individual rewards can increase conservation levels through a crowding-in effect that stabilizes collective action. In our experiment, it renders a possible explanation that the internal self-regulating mechanisms responded to individual payments, given that there is pre-existence of pro-social norms around community forest within the communities.

Similarly, individual payments were is also associated with greater congruence among group members, with the exception of one group: women in Andhra Pradesh.

	GROUP HARVEST		CONGRUENCE	
	MEN	WOMEN	MEN	WOMEN
	(1)	(2)	(3)	(4)
Round into set	−0.942***	−1.064**	0.063***	0.078***
	(0.321)	(0.488)	(0.017)	(0.024)
Payment type (Individual = 1, Community = 0)	−9.042***	−2.131***	0.597***	−0.376***
	(0.517)	(0.324)	(0.041)	(0.021)
Game board type (Color = 1, White = 0)	12.827***	4.562***	−0.224***	0.458***
	(1.009)	(0.418)	(0.068)	(0.024)
Trees at round start	0.101***	0.159***	−0.007***	−0.004**
	(0.028)	(0.049)	(0.002)	(0.002)
Dummy variable for Set 2	−1.555***	−0.018	0.021	0.123***
	(0.515)	(0.733)	(0.060)	(0.047)
Dummy variable for Set 3	−2.916***	−2.681***	0.116*	0.063
	(0.668)	(0.886)	(0.061)	(0.049)
Constant	11.193***	13.567***	1.108***	1.549***
	(1.971)	(2.570)	(0.114)	(0.110)
Regression	Tobit	tobit	Poisson	Poisson
N	459	387	459	387

Table 2 Group fixed effect regression results for group harvest per round and congruence among group member in harvest choice per round, by men and women in Andhra Pradesh.

* p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in paratheses. Results on dummy variables for groups not reported here.

	GROUP HARVEST		CONGRUENCE	
	MEN	WOMEN	MEN	WOMEN
	(1)	(2)	(3)	(4)
Round into set	−0.900***	−1.333***	0.053***	0.072***
	(0.169)	(0.342)	(0.010)	(0.011)
Payment type (Individual = 1, Community = 0)	−2.993***	2.639***	0.339***	0.128***
	(0.245)	(0.242)	(0.019)	(0.010)
Game board type (Color = 1, White = 0)	−1.751***	3.298***	0.181***	0.586***
	(0.291)	(0.335)	(0.026)	(0.014)
Trees at round start	0.078***	0.105***	−0.005***	−0.004***
	(0.024)	(0.037)	(0.002)	(0.001)
Dummy variable for Set 2	−2.364***	−0.564	0.064	0.105**
	(0.552)	(0.457)	(0.053)	(0.046)
Dummy variable for Set 3	−3.712***	−2.054***	0.209***	0.146**
	(0.794)	(0.515)	(0.055)	(0.059)
Constant	13.218***	8.920***	0.812***	0.769***
	(1.017)	(2.536)	(0.065)	(0.083)
Regression	Tobit	Tobit	poisson	poisson
N	521	412	521	412

Table 3 Group fixed effect regression results for group harvest per round and congruence among group member in harvest choice per round, by men and women in Rajasthan.

* p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in paratheses. Results on dummy variables for groups not reported here.

For the two male groups, the results reveal that the effect of individual payments on pro-social behavior likely had a high degree of agreement within groups.

Effects of game board structure

Our results on the framing effect of board structure on group harvest were surprising. We expected that the colored board, which emphasized ecosystem services associated with better forest conditions, would reduce overharvesting. While the colored board was associated with significantly less harvesting among men in Rajasthan, it was associated with significantly more harvesting among men in Andhra Pradesh, and among women in both states. It may be that the complexity of the board caused confusion, or was not interpreted as the designers intended.

Follow-up visit to 16 habitations (8 habitations in each state) about 18 months after the games were played revealed that some visual factors such as the color and distributions of trees on the boards may have caused different reactions that are difficult to interpret. Simple cognitive testing in FGDs revealed that, while the majority of FGD participants found the colored board informational and conveying the message about links between forest condition and benefits as we expected, some participants related the red color to fire, whereas others associated the white board with ideas such as "fully barren", "destruction caused by deforestation", "complete degraded ecology", or "unmanaged" and the colored board with "protected forests" or "complete vegetative cover".

RESEARCH QUESTION 2

Table 4 presents regression results on which group characteristics (averaged from individual participant characteristics) and local contextual factors are associated with harvesting choices. Overall, men harvested significantly less than women—perhaps related to women's roles in providing fuelwood for cooking. As noted above, allowing communication did not reduce how much women harvested (as communication did with men). The field teams noted that men generally participated in the discussions more actively when communication was allowed, whereas many women did not speak during group discussions and their discussions were brief when they did talk (though the field teams did observe nonverbal communication among women). Men may have been more comfortable speaking because CPR governance has historically been a male domain in India and women generally lack experience with exercising agency in collective resource management issues. Men also found the game to be more relatable to their experience with forests than women did in each state.

While prompting groups to think about monitoring and sanctioning mechanism in the optional rule election game (Set 3) was useful for both male and female groups in this experiment, it may be particularly helpful for female participants to experiment with rules. Because women are responsible for getting fuelwood for cooking, they may feel a stronger need to harvest wood, but when rules are imposed, women are restricted from getting wood from the forest—both in the game and in real life.

Other than gender, most demographic characteristics are not significant. Relatability was negatively associated with harvesting in Andhra Pradesh, suggesting that players tended to make pro-social choices when they resonated with the game. Groups with greater kutcha housing (made from local materials, as opposed to pukka houses of brick or cement) had lower harvest levels in both states, perhaps indicating that those with greater wealth were more oriented to profits than to sustaining the forest. Greater dependance on forest by habitations was associated with higher group harvest levels in both states. Groups with greater level of cookstove modernization chose lower harvesting levels in Andhra Pradesh, perhaps because they were less dependent on the forest for firewood. Groups in Rajasthan with higher proportion of households in habitations whose members have migrated in the last 12 months tended to harvest more, perhaps indicating that they were less vested in the local community over the long term. In Andhra Pradesh, groups with greater trust, indicated by perceived willingness of people in the village to make contribution to community public goods, tended to harvest less. Finally, groups in Andhra Pradesh with lower market access (captured by *Distance to nearest town*) also tended to harvest more.

Due to differences in model specifications and estimation methods, it is not entirely surprising that some estimated effects, in particular, those of the two treatment variables (payment method and game board type) are not always consistent between Table 4 (gender group-pooled Tobit regressions by state and no group or habitation fixed effect) and Tables 2 and 3 (group fixed effect models by gender and state). Qualitatively, Table 4 is consistent with Tables 2 and 3 in the effects of Set 2 and Set 3.

	ANDHRA PRADESH	RAJASTHAN
Round into set	−1.947***	−1.718***
	(0.219)	(0.192)
Gender of group (Male = 1; Female = 0)	−3.412***	−2.959***
	(1.033)	(0.783)
Payment type (Individual = 1, Community = 0)	0.621	0.475
	(0.941)	(0.724)
Game board type (Color = 1, White = 0)	0.701	1.125
	(1.034)	(0.908)
Trees at start of round	0.025	0.024
	(0.020)	(0.016)
Dummy variable for Set 2	−0.434	−1.154***
	(0.359)	(0.352)
Dummy variable for Set 3	−1.972***	−2.174***
	(0.456)	(0.442)
How relatable is the game to your forest experience in the habitation?	−2.526***	0.609
	(0.838)	(0.898)
Age of participant	0.045	0.023
	(0.060)	(0.039)
Highest grade of education completed	0.952*	0.674
	(0.495)	(0.423)
Scheduled tribe	0.326	−0.472
	(1.540)	(1.188)
Household size	0.167	−0.315
	(0.451)	(0.203)
Agriculture (Farming, animal husbandry or forestry) is primary source of household livelihood	−2.02	0.026
	(2.164)	(1.322)
Total land under cultivation (in local units)	0.254	0.118
	(0.244)	(0.218)
Distance from house to nearest forest (km)	0.457	−0.053
	(0.366)	(0.151)
Kutcha house	−16.427***	−3.093***
	(3.849)	(1.002)
Level of modernization of cookstove	−2.714***	0.146
	(0.816)	(0.851)
Easy to find help in the village to search for lost livestock	0.666	0.581
	(0.829)	(0.548)
People in the village willing to make contribution to community public goods	−3.609***	0.109
	(1.070)	(0.729)

(Contd.)

	ANDHRA PRADESH	RAJASTHAN
Dependence on forest	1.716**	0.718*
	(0.744)	(0.385)
Forest condition	0.086	–0.42
	(0.670)	(0.608)
Number of households in habitation	–0.004	–0.004
	(0.009)	(0.003)
Proportion of households in habitation whose members have migrated in the last 12 months	0.01	0.023**
	(0.037)	(0.010)
Distance to nearest town (km)	0.180**	0.018
	(0.079)	(0.020)
Single caste in the habitation	0.088	–0.837
	(0.991)	(1.014)
Proportion of landless households in habitation	1.377	0
	(5.080)	(.)
Forest or common land related institutions in habitation	1.598	–0.704
	(1.911)	(0.695)
Number of livestock in habitation	0	0.001
	(0.001)	(0.002)
Constant	16.320***	17.799***
	(5.544)	(3.588)
Regression	Tobit	tobit
N	834	913

Table 4 Regression results for group harvest in each round by state.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in paratheses.

DISCUSSION

The result that in general, our groups of resource user game participants exhibited extraction behavior along the continuum of "Non-cooperative (Nash prediction)" and "Cooperative (Economically optimal)" is not surprising. As Narloch et al. (2012) argue, individuals are normally driven by a combination of self-interest and endogenously shaped social preferences (Carpenter and Seki 2010, Castillo and Saysel 2005, Henrich 2000), such as conditional as well as unconditional cooperativeness, inequity aversion, and risk aversion, which in turn reflect social norms such as altruism, reciprocity, fairness, and safety-first (Cardenas and Carpenter 2008, Velez et al. 2009).

Participants in our study did not behave as cooperatively as those in Ghate et al. (2013), where participants in eight indigenous (tribal) communities in Maharashtra, India, maintained the resource size at the initial stock level (100 trees) by harvesting below what the regenerative capacity allowed. Ghate et al. (2013) credited the highly cooperative behavior, even in the absence of communication, to the deeply embedded shared norms of behavior and mutual trust. Since forests play an important role in the lives of many tribes, their traditions in general exhibit pro-social behavior (Gurven and Winking 2008), and their relationship with forests is commonly reflected in their religion and social norms that make them protective of the forests unless prevented by governmental policies (Gadgil and Guha 1992). Our sample had fewer tribal participants, but the discussions showed that to many, forest embodies mother nature and holds sacred value, important for the identity of the community, the future of the people, and way of life. As one of the male players in Andhra Pradesh stated: "If the forests are in good condition, we will also

be healthy, the livestock will be in good condition, there will be rainfall and everyone will be trouble-free." One of the women players in Andhra Pradesh extended this beyond benefits to humans: "All living organisms should be benefitted from the forests. Let the birds and animals take some and let us take some. Let us leave some trees for the benefit of birds and animals."

Qualitative findings indicate that many communities also have rules against cutting down trees. Based on these norms and rules, participants may have exercised some degrees of self-regulating in the experiment, avoiding cutting down trees, even without communication (Set 1). Communication in Set 2 then allowed participants to check in with others and confirm their pro-social norms around forests, further discouraging non-cooperative harvest behavior. As Narloch et al. (2012) argue, internal, self-regulating mechanisms in the form of peer sanctions and rewards, as well as improved communication can enhance collective action and may, therefore, enable communities to solve social dilemmas (Cardenas 2003, Cardenas et al. 2000, 2011, Carpenter et al. 2004).

The theoretical and empirical support of the positive effect of communication on cooperative behavior in multi-player experiment has been relatively well established (e.g., Cardenas 2001, Falk et al. 2019 and 2021, Janssen et al. 2010 and 2013, Ostrom, 2006, Ostrom et al. 1992, Van Dijk and De Dreu 2021). In addition to the benefit of offering a pathway to cooperation (Van Dijk and De Dreu 2021) and helping people to coordinate their actions (He et al. 2019), the games' potential to facilitate institutional change through social learning is strongest when they are combined with communication (Balliet 2010, Falk et al. 2019 and 2021, Hertzog et al. 2014, Speelman et al. 2017).

Moving from communication alone ("cheap talk" without enforcement) to groups adopting rules for monitoring further increased cooperation to conserve the resource. The fact that all groups in Andhra Pradesh and most (88%) in Rajasthan chose some form of monitoring rules—even though there was a cost to monitoring—indicates that they saw the value of monitoring. Monetary sanctions were not as common, but public announcements as a social sanction were also used. Our game allowed groups to discuss and form their own rules, rather than imposing them externally. Communities appreciated the opportunity to discuss resource degradation issues and develop solutions together. In the experiment, participants experienced first-hand how group dynamics (such as leadership, peer-pressure, trust) and decision-making processes (e.g., participatory discussion, voting to determine rules, external facilitation) can lead to changes in behavior and group outcomes. Particularly, the sequential progression from non-communication, communication, to optional rule election game allowed the participants to see how cooperation led to more desired outcome and to test how the rules they chose worked.

Our results demonstrate that design features, such as individual payments or framing about resource conditions, can affect participants' behavior in the experiment. Methodical cognitive testing of design features is paramount to ensuring positive and effective social learning (and avoiding negative or counter-productive learning). Usual pre-testing of instruments for empirical research may be insufficient to understand the possible diverse reactions to design features. Starting with a "degraded forest" with only half the number of trees (compared to previous forest games) was relatable to these communities, where existing forests are sparse, and also helped the game to go faster (which helped accommodate women's time constraints). However, framing the game decision to be about cutting down trees was problematic, as that is prohibited in many villages. Alternative layout of the game board to indicate ecosystem services was also not understood consistently. Cognitive testing of game design can help determine how different types of player understand the game, and see whether they are responding to the same factors that game designers intended to test.

Ours is one of the few studies to test whether individual payments—a standard procedure in experimental games in economics, but not psychology—affect players' behavior (Falk et al. 2021). Incentivized payments were associated with lower harvests for men in both states and women in Andhra Pradesh (but not Rajasthan), suggesting a possible reinforcing effect on pro-social behavior. However, if collective action games are to be part of the interventions for CPR management, there are legitimate concerns not only about the cost of making payments, but also that individual payments may cause resentment by those who lose out or are not invited to play (Meinzen-Dick et al. 2018).

Our result on the effect of individual payments does not necessarily contradict Meinzen-Dick et al. (2018)'s viewpoint regarding the suitability of using individual payments in interventions implemented by NGOs. If indeed individual payments amplified the social pressure for the good, an important future research question is how this effect would play out in experiential or social learning. Importantly, providing monetary rewards to individual participants in behavioral experiments as an activity or intervention could pose concerns as NGOs and other development agencies are sometimes reluctant to distribute unequal or differential monetary rewards which could be in contrast to their common practices (Meinzen-Dick et al. 2018; Falk et al. 2021).

Conducting the game separately with women and men not only allowed more space for women to participate, but also revealed gender differences in how men and women understood and responded to the game. Not only did women harvest more in the game (perhaps related to their responsibility for household fuelwood provision), but the effects of game structure differed for men and women. Men responded more to communication ("cheap talk") than women, but both responded to rules that they themselves selected.

As Janssen et al. (2013) note, there is mixed evidence on the external validity of experimental games, even those carried out in the field with real resource users. Although a full analysis of how players' choices in the games relates to their actual behavior under different conditions is beyond the scope of this paper, responses of participants on how they felt the game related to their own situation provides a pointer to external validity. Relatability was relatively high in Andhra Pradesh (between "somewhat relatable" and "relatable a lot"), but the mean response for men in Rajasthan was only "somewhat relatable" and for women in Rajasthan even less than that. This suggests work is needed to adapt the game in Rajasthan, and to be sure that women can understand and identify with the game. For example, instead of cutting trees (which is prohibited or against social norms in many communities) other harvesting mechanisms might be used.

CONCLUSION

Framed field experiments can provide insights to researchers, policymakers, practitioners, and community members about what affects cooperation to manage the commons. This study provides evidence of how the structure of games and background of the players can affect responses regarding forest use in two states in India. We find that communication reduced the likelihood of overharvesting for men (but not women), but when groups were allowed to choose monitoring and sanctioning rules, both men and women were more likely to reduce harvesting. The use of such games may provide a tool for experimentation and social learning to develop rules to improve NRM (Cardenas and Carpenter 2008, Falk et al. 2021). By facilitating communities to experiment with their own rules, such games could help create a buzz around forest conservation issues, identifying challenges and gaps in existing governance practices and having a catalytic effect on efforts to institutionalize forest management rules.

Paying individuals based on their earnings in the game (as opposed to a flat contribution to the community) had a mixed outcome: increasing the likely harvest levels for women in Rajasthan, but reducing them for women in Andhra Pradesh and men in both states. While such incentive-based payments may stimulate deliberation among game players, resulting in more or less pro-social behavior depending on how social norms interact with the game incentive, further research is needed on the mechanisms through which individual cash payments influence participants' behavior.

The unexpected outcome of our colored game board, which was designed to emphasize the ecosystem services of forests, increasing harvests among women in both states and men in Andhra Pradesh points to the need for careful attention to visual design of games. Although we had pretested our game, more extensive cognitive testing of the framing could be helpful also in increasing the relatability of the game, and its external validity.

The role of gender needs to be understood, both in games and in actual resource use. Because the sustainable management of CPR requires meaningful participation of men and women resource users, it is important to examine both men's and women's choices. But women are too often underrepresented in experimental games, and if they are included in mixed groups, women may not be comfortable expressing themselves. By running separate groups for women and men, our study found important gender differences in choices in the game, including how players responded to the payment method treatment. These need to be understood in context, where women have primary responsibility for household firewood supply, but also where women (who generally have lower education levels) took longer to understand the game. We recommend that, rather than assuming that all-male or mixed gender games represent real resource users' responses, researchers should run separate groups of men and women unless they can establish that men and women are equally comfortable in understanding the games and in discussing resource management issues in mixed groups.

NOTES

1 While laboratory experiments might randomize the order treatment to separate out the effect of communication and rules from an overall learning effect, testing of prior games showed that this was too confusing to the players (many of whom had very little education and no prior experience with such an activity), and undermined the NGO's objectives of using this as a learning experience for the communities.

2 To simplify the calculation, we assume same harvest levels for all players in a group in each round. In addition, multiple paths can lead to the same "Cooperative (Economically optimal)" outcome (i.e., total group harvest of 75 trees after 7 rounds) but only one such path is shown in Figure 3.

ADDITIONAL FILES

The additional files for this article can be found as follows:

- **Appendix 1.** Table S1–S6. DOI: https://doi.org/10.5334/ijc.1179.s1
- **Appendix 2.** Experiment protocol. DOI: https://doi.org/10.5334/ijc.1179.s2

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COMPETING INTERESTS

The authors have no competing interests to declare.

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