SOCIAL SCIENCES

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Integrating simultaneous prosocial and antisocial behavior into theories of collective action

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Trust and cooperation constitute cornerstones of common-pool resource theory, showing that "prosocial" strategies among resource users can overcome collective action problems and lead to sustainable resource governance. Yet, antisocial behavior and especially the coexistence of prosocial and antisocial behaviors have received less attention. We broaden the analysis to include the effects of both "prosocial" and "antisocial" interactions. We do so in the context of marine protected areas (MPAs), the most prominent form of biodiversity conservation intervention worldwide. Our multimethod approach relied on lab-in-the-field economic experiments (n = 127) in two MPA and two non-MPA communities in Baja California, Mexico. In addition, we deployed a standardized fishers' survey (n = 544) to verify the external validity of our findings and expert informant interviews (n = 77) to develop potential explanatory mechanisms. In MPA sites, prosocial and antisocial behavior is significantly higher, and the presence of antisocial behavior does not seem to have a negative effect on prosocial behavior. We suggest that market integration, economic diversification, and strengthened group identity in MPAs are the main potential mechanisms for the simultaneity of prosocial and antisocial behavior we observed. This study constitutes a first step in better understanding the interaction between prosociality and antisociality as related to natural resources governance and conservation science, integrating literatures from social psychology, evolutionary anthropology, behavioral economics, and ecology.

INTRODUCTION

Trust and cooperation have been the cornerstones of the common-pool resource (CPR) theory's contributions to our understanding of local natural resources governance for more than 30 years (*1*, *2*). Previous research in this field has shown that cooperative strategies among resource users can increase the likelihood of sustainable and effective use of CPRs such as fisheries and forests (*3*–*5*). This result broadened the policy range for CPR governance, complementing dominant policy prescriptions favored during the second half of the 20th century (for example, command-and-control), which substantially disregarded the relevance of prosociality in resource governance under collective property regimes (*6*).

In contrast, the role of antisocial behavior in the prospects of collective action has only received attention in CPR theory when it relates to conflict among stakeholders (*7*–*9*). This is despite antisocial behavior being not limited to social interactions dominated by conflict. For example, Herrmann *et al.* (*10*) have shown that a large share of people punish not only norm violators but also norm compliers. This can result from a desire to punish subjects who deviate from "typical" group behavior (*11*). Such vengeful antisocial behavior has subsequently been related to a limited capacity to develop functional self-governance regimes (*12*). Other forms of potential antisocial behavior have been documented during laboratory-based contests and tournaments (*13*, *14*). This might lead to the implicit assumption that all types of antisocial behavior, that is, overbidding in tournaments, antisocial punishment, or spite, entail an obstacle to collective action. This paper explicitly examines whether extreme forms of antisocial attitudes (related to a desire to be ahead, spite, envy, or conflict) preclude collective action among resource users. In addition, we address whether prosocial and antisocial attitudes are mutually exclusive or can coexist at the community and individual level. The results of this study contribute to recent literature addressing community structure and dynamics in ecology (*15*–*18*), showing that the coexistence of antisocial and prosocial behavior is more common than previously thought, and are useful to improving our understanding of cooperation, conflict, and competition in conservation science and CPR governance (*19*). As we will see, it also furthers the integration of literatures in social psychology, evolutionary anthropology, and behavioral economics that, at present, are themselves incompletely linked.

We conducted field research in coastal communities within the Baja California region in northwest Mexico, a recognized area for its global marine biodiversity (*20*), including sites affected by the regulations of protected areas. Protected areas are globally prominent policy tools for the governance and conservation of a diversity of CPRs and public goods associated with forests, fisheries, and wildlife (*21*). In our study area, like elsewhere, ecotourism has been promoted as an economic activity compatible with protected areas' conservation goals while offering the potential of contributing to the development of local alternative livelihood opportunities (*22*). Yet, analyses of the literature have pointed out its unrealized potential and the need to view ecotourism within a wider political and cultural framework (*23*). In some cases, ecotourism can increase income inequality and social differentiation among some members of the community, which can lead to envy and loss of social cohesion, among other antisocial behavioral traits (*24*). The importance of concurrently analyzing the prosociality and antisociality effects that protected areas can have on communities' social interactions, as related to collective action, is based on the idea that if protected areas affect peoples' ability to organize for the provision or consumption of public goods and CPRs (*25*, *26*), then, we argue, protected areas affect the foundation of communities' ability to build viable local societies and economies that can sustain conservation in the long term.

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Within members of a local community, cooperative and competitive behaviors interweave through interactions with others and the environment through everyday activities (*27*, *28*), shaping communities and users' identities (*29*, *30*). We examine the need to "attend to the ways in which protected areas produce space, place, and peoples" (*31*, p. 251) by assessing whether and how marine protected areas (MPAs) contribute to the emergence of new patterns of social interactions. MPA establishment restricts access to fishing grounds and thus fosters competition among fishers, yet MPAs affect not only fishers but also a broader set of stakeholders, including tourism and industrial fishing sectors. Thus, we conceptualize MPAs as a governance intervention that modifies livelihood opportunities and incentives for collective action by creating new rules, norms, and practices that regulate stakeholders' interactions with the marine environment and with each other. The social effects of MPAs might be best understood by focusing on how fishers interact among themselves and with nonfishers.

Our study finds a high degree of coexistence of prosocial and antisocial behavior in small-scale fishing villages. As we will show, this result derives in part from single individuals displaying simultaneously high levels of prosociality and antisociality. Our study thus differs from previous research mainly from economics or psychology that implicitly or explicitly assumed that individuals' social values can be measured by means of mutually exclusive types (*32*–*35*), which also often suggests a long-term stability in behavior. Thus, this study unveils a coexistence of prosocial and antisocial behavior that has been previously neglected. Although antisocial behavior in general may be part of a broader set of cooperative strategies used as punishment to enforce social norms and secure egalitarian outcomes, our experimental design diverges from previous studies on antisocial punishment [for example, Herrmann *et al.* (*10*) and Irwin and Horne (*11*)] in that the participants could not make use of the information on individual play in the prosocial game to define their choices in the antisocial game. Thus, antisocial behavior in our design cannot be related to revenge. In addition, although we find substantial antisocial behavior, it is not necessarily related to conflict among community members. Rather, our evidence suggests that this behavior is based on a tendency to compete, generated by new income opportunities associated with the implementation of MPAs, such as the availability of new monetary grants distributed to local users by MPA managers. Most importantly, this antisocial behavior does not seem to hinder the capacity of members of the fishing community to cooperate, aiming to strengthen the broader social well-being.

Research on MPAs to date has relied on ethnographic tools to examine displacement and conflict [for example, West *et al.* (*31*)], semistructured household surveys to study food security [for example, Darling (*36*)], meta-analysis of case studies to examine human well-being [for example, Mascia *et al.* (*37*)] and the effectiveness of community-based conservation projects [for example, Brooks *et al.* (*38*)], or large-*n* standardized surveys to better understand the relationship between socioeconomic and governance characteristics with biophysical conditions [for example, Cinner *et al.* (*39*)]. To investigate the relationship between MPAs and the local communities in their adjacency, we incorporated lessons learned from our long-term engagement in the region since 1999 (*40*–*42*) to design and deploy lab-in-the-field economic experiments with fishers and nonfishers (n = 127) in two MPA and in two non-MPA communities.

We operationalize collective action experimentally by implementing a public goods game to measure the degree of prosocial behavior [see discussion by Ledyard (*43*)] and a modified joy-of-destruction game to measure antisocial behavior [as per Jensen (*44*)]. Section 1.1 in the Supplementary Materials provides a detailed description of these games. We determined the external validity of our findings through a large-*n* survey with 71% of all fishers (n = 544; 48% active) and interviews with expert informants (n = 77) in the four most important MPAs along the peninsula (Fig. 1).

We define cooperation in the public goods game as the prosocial ability to forgo immediate individual benefit in lieu of collective gain (*45*). The joy-of-destruction game measures an extreme, antisocial dimension of competition (hypercompetition), where individuals are willing to incur personal costs to destroy others' welfare. In the context of this study, we believe that Jensen's use of "hypercompetition" most closely matches our interpretation of people being motivated by a desire to be ahead, focusing on an own advantage in relative payoffs at a cost to absolute payoffs (*44*). Alternatively, the behavior in the game can be attributed to "spite" driven by envy, conflict, and schadenfreude. However, our multimethod approach grounds our interpretation to the local and historical context. Take, for instance, the response of a fisher in our study area to our question, "What is the most exciting part of fishing?":

> "…To be the *best* but also to be *a good friend* to everyone. I never fish by myself and I always try to beat the rest. When all of the boats arrive back on the beach we look to see who has caught the most fish. Sometimes we win by one kilo, sometimes we tie, but it is always exciting to see who won"
> (Fisher interview #4, January 2014).

Competition among local small-scale fishers interacting in the same community, as the above fisher illustrated, needs to be differentiated from competition among nonlocal (for example, industrial or small-scale) and local fishers, which can trigger open conflict through their perceived destructiveness or illegality. These conflicts have been extensively documented around the world (*46*–*51*), and our own work shows that our study area is no exception.

The track record and history of establishment and implementation of MPAs lead us to posit three hypotheses about the effects of MPAs on prosocial and antisocial behavior among members of a community. The null hypothesis states no differences in prosocial and antisocial behavior inside or outside MPAs. This can be expected when the MPA does not alter day-to-day activities as, for example, in contexts like Mexico where enforcement and monitoring of compliance to regulations are weak or nonexistent (*52*). We posit two mutually inclusive alternative hypotheses: The first posits to expect more antisocial behavior among community members inside MPAs than outside MPAs. Previous research shows that protected areas can contribute to poverty alleviation through alternative income sources associated mainly to tourism (*53*, *54*). Such additional income might lead to stronger social comparison, envy, and social stratification among stakeholders after the intervention. More generally, social comparison rises in competitive environments and often results in the desire to be ahead of others (*44*). This effect has been unexplored in the conservation science literature so far. The second alternative hypothesis posits more prosociality inside of MPAs than outside MPAs. This could arise, for instance, when the policy process related to the establishment and implementation of the MPA creates incentives for different local stakeholders to leave aside their internal differences

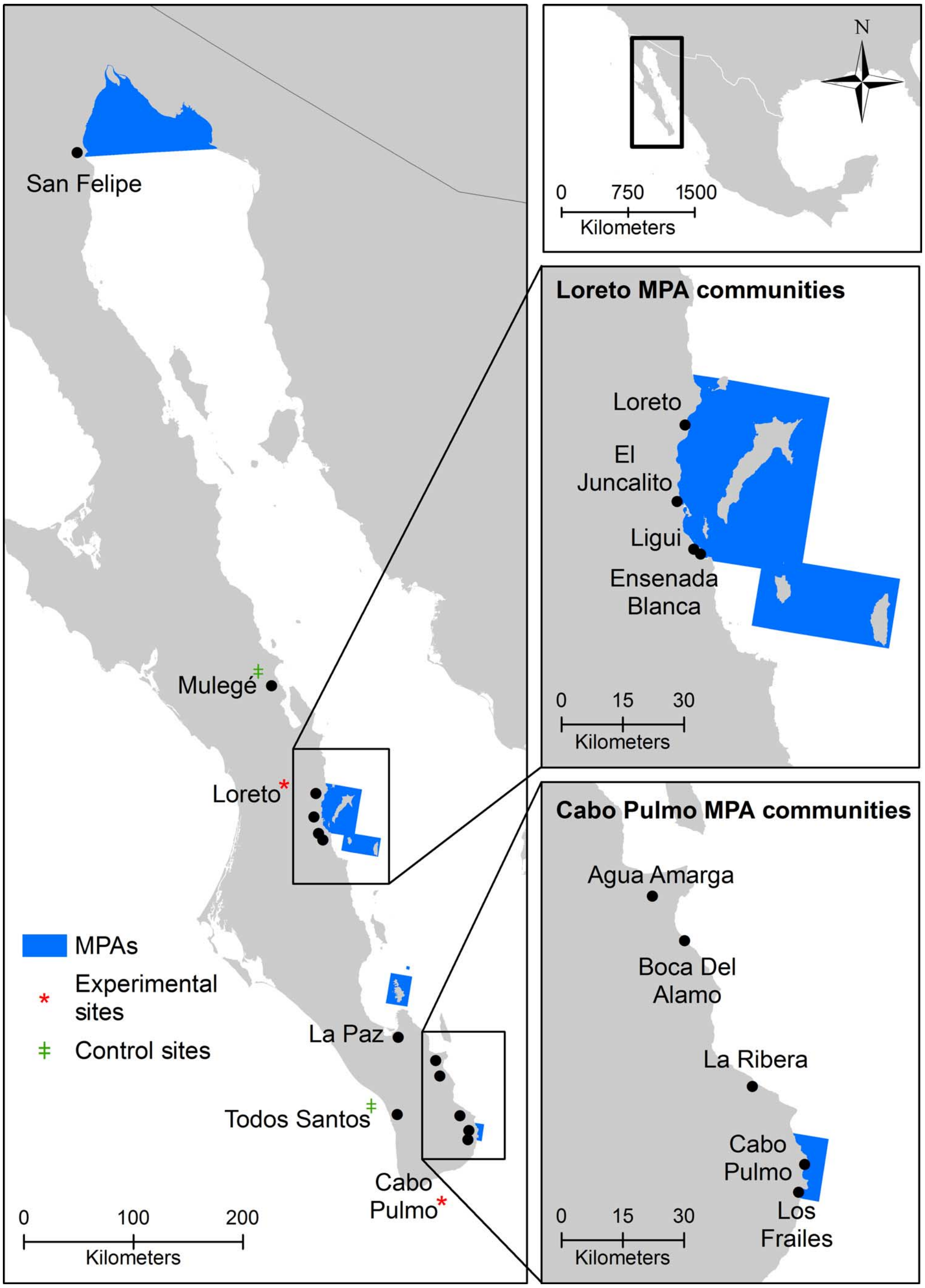

Fig. 1. Study area showing location of MPAs, associated fishing communities, and control sites.

and work together to establish new rules to deal with a common enemy or threat such as industrial fishers, or to confront the government in its attempt to restrict marine space uses. Such antisocial behavior has been shown to be important for the evolution of human cooperation (*55–57*).

RESULTS

Fifteen years after the establishment of the MPAs, there is, on average, higher prosociality and antisociality in MPAs than in non-MPAs. This result holds for all combinations of pairings between fishers and nonfishers (Fig. 2). Subjects made decisions in the experiment being aware of whether the person they interacted with was a fisher or a nonfisher. We observed that fishers making decisions toward others (irrespective of whether those others are fishers or not fishers) are more prosocial and antisocial in MPAs and that the same result holds for the behavior of nonfishers. For the decisions made by fishers versus nonfishers, see the insignificance of the "fisher" dummy in the ordinary least squares (OLS) regressions for model 2 in tables S4 to S7; for results where fishers are the "other," see models 1 and 2 in tables S4 and S6; and

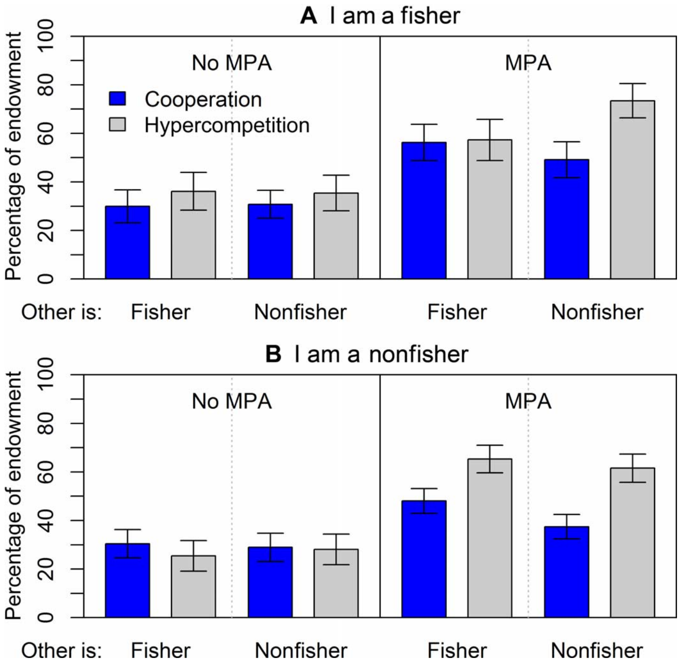

Fig. 2. Higher average cooperation and hypercompetition in MPA than in no-MPA sites. (**A** and **B**) The percentage of endowment used for cooperation and hypercompetition in no-MPA and MPA sites when the individual making a choice to cooperate and/or hypercompete is a fisher (A) and a nonfisher (B). Cooperation is defined as the percentage of endowment allocated to a group fund, and hypercompetition is defined as the percentage of endowment allocated to reduction of others' payoff.

for results where nonfishers are the "other," see models 1 and 2 in tables S5 and S7. Results for the effect of MPA remain highly significant to a stepwise inclusion of a rich set of individual control variables obtained from the postexperimental survey (models 3 to 7 in tables S4 to S7) and are robust to a collection of other robustness checks (tables S9 and S10).

A second main finding shows that a substantial portion of subjects in MPA sites (42%) were simultaneously highly antisocial (using more than 50% of endowment in the joy-of-destruction game) and highly prosocial (contributing more than 50% of endowment in the public goods game) toward fishers. Those "hypercompetitive cooperators" include both fishers (40%) and nonfishers (43%). In non-MPAs, we only found hypercompetitive cooperators in 8% of the sample. Figure 3 presents, within and outside MPAs, disaggregated percentages of hypercompetitive cooperators for decisions made by fishers and nonfishers ("I am") toward another player that is a fisher or a nonfisher ("other is"). Regression analyses on covariates for hypercompetitive cooperators show a high tendency to agree with the statement "competition is important in a functioning society" (table S8 variable "society2"). This statement was not associated with prosocial or antisocial behaviors separately (tables S4 to S7). In addition, older people were more likely to be hypercompetitive cooperators. This may be explained by people being most competitive around the age of 50 (*58*) and by them being key actors for transmission of social norms like cooperation and competition in fishing communities (*59*).

Addressing potential selection bias

Why were the MPAs set up in these specific locations? Was it because people were especially environmentally friendly or cooperative in the

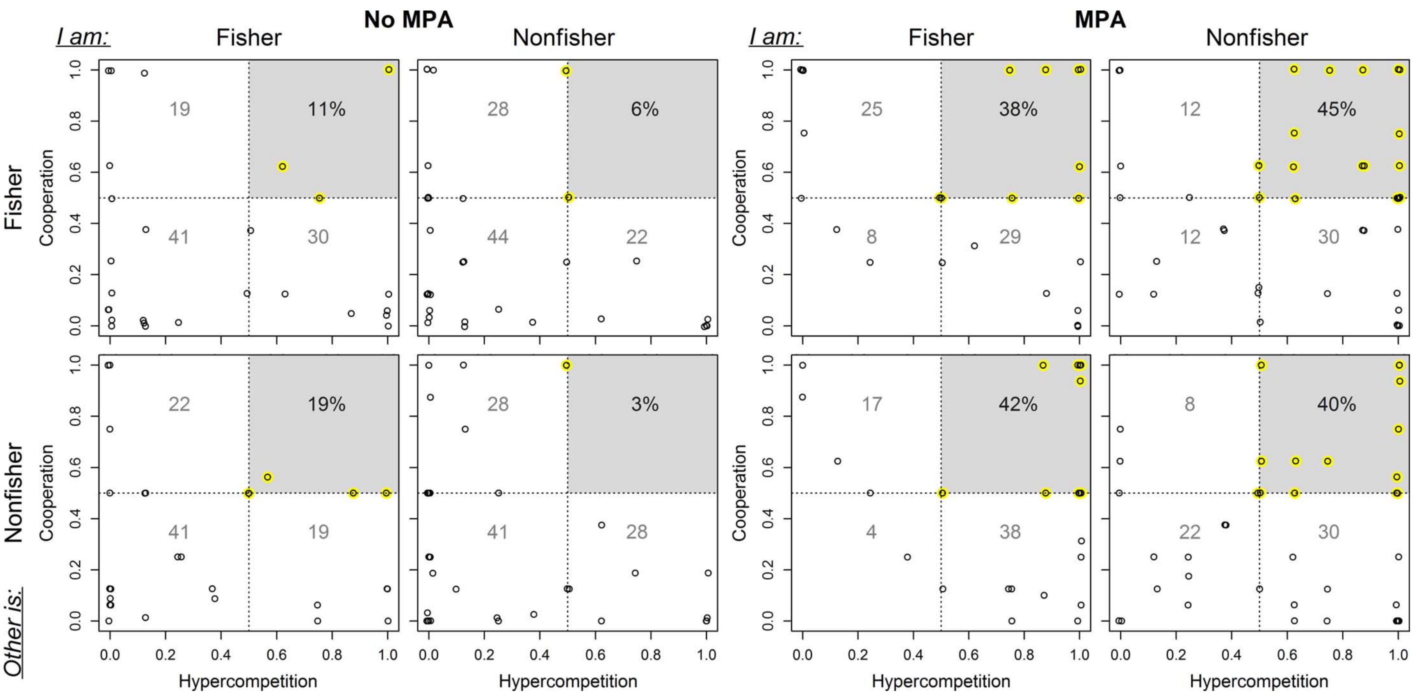

Fig. 3. A much higher proportion of hypercompetitive cooperators are found in MPA sites than in no-MPA sites. Percentage of hypercompetitive cooperators (also highlighted in yellow) are found in the upper right quadrant at no-MPA and MPA sites, and they are defined as those individuals allocating at least 50% of their endowment to the group fund and 50% of their endowment to reducing others' payoff. "I am" refers to the participant making the choice depicted and "other is" refers to the participant the "I am" is paired with.

affected communities? Or rather the opposite (because they were extremely destructive in fishing)? Both examples would imply that our reported results do not stem from the creation of the MPA but measure preexisting differences in behavior.

In the study area, biological considerations played a decisive role in the designation of MPAs (*60–63*) as part of international commitments made by Mexico in the 1990s to increase overall area of conserved seascapes (that is, San Felipe was established in 1993, Cabo Pulmo in 1995, Loreto in 1996, and La Paz in 2007). More specifically, the General Law of Ecological Equilibrium and Environmental Protection of Mexico (promulgated in 1988 and amended in 1996 and in 2007) lists the protection of "original environment [that] has not been significantly modified by human activities or where the environment needs to be preserved and restored" (*64*) as a criterion for MPA establishment. Fraga and Jesus (*65*, p. 10) note the lack of reference to social factors such as "improving the livelihood of local communities through such aims as poverty alleviation." Peterson (*63*), Rife *et al.* (*62*), and our informal interviews (section 2.1 in the Supplementary Materials) describe that the main criterion for Cabo Pulmo and Loreto MPAs' establishment was biological protection of valuable ecosystems. Informal interviews also suggest that by framing these goals as attainable through the exclusion of industrial fishers like shrimp trawlers—widely seen as fishing competitors and environmentally destructive—governmental authorities gained the support of local stakeholders for MPAs' establishment. Furthermore, our ex-post survey data do not reveal any significant differences between participants from MPA and non-MPA sites in observable characteristics (table S3). The use of biological values as the guiding criterion for the designation of MPAs sites—currently including more than 15,200 sites according to the MPA Atlas Web site (www.mpatlas.org)—is common practice around the world (*66*, *67*).

External validity

Can the experimental results be extrapolated to other MPAs in the study area? The MPAs we studied are typical examples of the most common type of coastal MPAs globally, designated as multiple use areas with no-take core areas outside of which artisanal fishing is permitted (www.mpatlas.org). These MPAs exhibit similar coastal and marine degradation trends as elsewhere (*68*).

Using in-person survey responses by fishers in four MPAs in Baja California (n = 544), we verified that there were no systematic variations between the two experimental MPA sites and the two nonexperimental MPAs. All MPAs had a considerable impact on the day-to-day activities of fishers (Fig. 4A), there is strong polarization on the view of the impact of conservation on catch in all of them (Fig. 4B), and, most interestingly, 80% of fishers in each of the four MPA stated that they are able to solve their problems jointly (Fig. 4C). In sum, albeit the MPAs entailed tangible impacts on fishers, prosociality is high in all four MPAs, which is in line with our experimental results. We also have some suggestive evidence that all four MPAs likewise created both winners and losers through differences in catch rates (Fig. 4B) and through an increase in income opportunities outside of fishing for some families but not others: either through a direct increase of tourism-related jobs (for example, diving tourism and sport fishing in Cabo Pulmo) or through seasonal programs sponsored by MPAs to provide alternative sources of income. An overtime assessment of the Conservation Program for Sustainable Development in La Paz MPAs suggests that some fishers are more likely than others

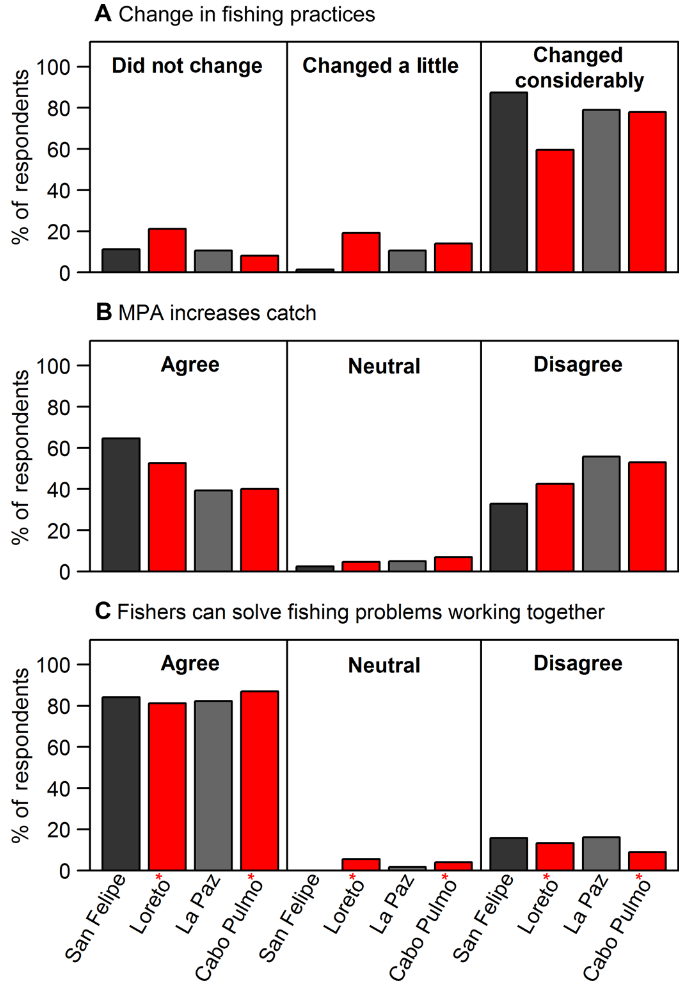

Fig. 4. Fishers' self-reported responses on the experimental and nonexperimental MPAs in our study area. (**A** to **C**) Fishers' self-reported responses (n = 544) on how MPAs have affected their fishing practices (A), catch (B), and their own capacity to work together to solve fishing problems (C). Experimental MPA sites are marked with an asterisk.

to successfully renew their grants (*69*). Together, these evidences suggest an increased social stratification in MPAs, which we argue is a precursor for strengthening social competition.

DISCUSSION

Our experimental results support higher levels of prosociality and antisociality (alternative hypotheses 1 and 2) in MPA than in non-MPA fishing communities. Previous experiments among users of natural resources, including fishers, consistently found high levels of prosociality [for example, Cardenas (*70*)]. Our results contribute to this literature by showing that prosociality is even higher in MPA sites. Our survey results show that this result does not derive from higher fish abundance and catch in MPAs (Fig. 4B). Furthermore, we also find that not only fishers but also nonfishers become more prosocial. Thus, because MPAs also affect nonfishers, the impact of MPAs should not be underestimated. Potential mechanisms need to explain a general pattern of social norms at the community level.

Our interviews and observations suggest that higher prosocial behavior in MPAs could result from at least three sources inducing higher group strength: (i) our interviews suggest that the establishment of MPAs might have created opportunities for cooperation among different stakeholders to confront a common enemy/threat (section 2.1 in the Supplementary Materials), and higher prosocial behavior could also be attributed to the emergence of norms for cooperation among stakeholders (ii) through exposure to trust-building exercises or (iii) through being subject to government regulations promoting cooperative interactions (*71*). In Loreto, Cabo Pulmo, and La Paz, local and international nongovernmental organizations have engaged stakeholders in trust-building exercises through meetings and activities encouraging participants to work together after the creation of the MPA (*72*). For instance, in Loreto, conflict resolution experts engaged stakeholders through trust-building exercises described as "a democratic experience in the community [that was] very satisfactory for most stakeholders because it was a very inclusive and transparent process where most stakeholders felt represented" (*73*, p. 31). Moreover, in MPAs, fishers were mandated to organize into fishing cooperatives to gain fishing permits to fish within MPA boundaries (see in-depth interview data in section 3.1 in the Supplementary Materials). Membership of fishing cooperatives in the region is decidedly kinship-based, and kinship is thought to be the social basis of cooperation (*45*). Our interview data show that 80% of all cooperatives were created after the establishment of the MPAs and approximately 70% of their members are related by kin.

Although experimental lab and, even more so, field applications of joy-of-destruction games remain uncommon, our study corroborates the findings of Prediger *et al.* (*19*) with Namibian farmers, showing that a substantial proportion of subjects will choose to destroy another person's money when provided with complete anonymity. Our study also suggests that the willingness to destroy part of the other person's payoff in the experiment is associated with an increase in social competition. When subjects were asked for their motives to reduce another subject's income, they often stated that they wanted to earn more money than the other person (30%), whereas motives like vengeance (5%), deriving pleasure from harming others (7%), or disliking people (7%) were not named as often. In the same vein, very few respondents in MPAs (5%) and outside MPAs (3%) stated that they had conflicts with other participants in the session, whereas 62% of participants in MPAs and 55% in non-MPAs had at least one family member in the session. Finally, there is a large and significant difference in agreement to the statement "winning is most important to me." Within MPAs, 48% of respondents agreed, compared to only 29% in non-MPAs (Fisher exact test; $P = 0.03$). Thus, it seems that preference for being mean or conflictive toward others did not play a major role, whereas being ahead of others in a competition did. Jensen (*44*) attributes this behavior to strong social comparisons, resulting in gains and losses not being reckoned in absolute terms, but in relative terms. MPAs might be increasing social comparisons in class-based societies like Mexico because of the higher number of stakeholders (for example, tourism operators and recreational fishers) interacting than in non-MPA sites, where fishers mostly interact only with other fishers. There is significant support in the MPA literature for MPAs' role in promoting economic diversification (that is, mostly related to tourism) in diverse locations around the world (*74*–*77*). However, income diversification and, to a greater extent, income disparity among culturally cohesive rural fishing communities have also been shown to result in envy and group differentiation (*74*, *78*). As Brondo and Bown (*74*) observed among small-scale fishing communities in Honduras, income diversification as a result of MPA establishment created social divisions and tensions. Some of the anthropological work from Mexico and elsewhere suggests that market integration or expansion within historically isolated communities may disrupt societal norms and thus trigger envy and even witchcraft (that is, the evil eye) toward those that become economically more prosperous (*79*, *80*). From this perspective, social differentiation in regard to the economic and occupational status could have been exacerbated by the implementation of the MPA, leading to higher levels of antisocial behavior when compared to non-MPA sites. Such a dynamic might have been captured when we asked fishers and nonfishers about their perception on the political influence of fishers in their community compared to individuals who did not fish. Respondents perceived fishers to have less political power in MPAs (28%) than in non-MPAs (56%) ($\chi^2 = 3.6313$, $P = 0.01$). In addition, the availability of temporary grants to fishers and nonfishers inside of MPAs and the evidence suggesting some individuals are funded repeatedly more often than others might also be driving this social differentiation dynamic (*69*).

Studies from evolutionary anthropology and human behavioral ecology suggest that the relationship between market integration and prosociality and antisociality is a complex one: When Tanzanian Mpimbwe communities entered market economies, increasing wealth inequalities had the potential both to change the way individuals managed risk and to alter their cooperative relationships with kin (*81*). Henrich *et al.*'s (*82*) study of 15 societies found that the higher the degree of market integration and the higher the payoffs to cooperation, the greater the level of prosociality expressed through experimental games. Yet, when market integration was highly stratified within and among villages of the Machiguenga forager-horticulturalists of lowland Peru, it led to incipient class division and greater social distance among households (*83*). Among the Tsimane of Ecuador, increasing market integration over the past half-century has not substantially displaced more traditional social cooperative networks that help buffer against a variety of risks that can affect food security (*84*). Yet, those with more novel economic opportunities shared food and labor with less households (*85*).

The fisher quoted in the Introduction reminds us that cooperation and competition coexist in everyday life (that is, "coopetition"). However, from a strict rational choice perspective, it is challenging to explain the coexistence of extreme opposite behaviors (welfare-enhancing cooperation and welfare-reducing destruction) at a substantially large proportion of respondents. A person pursuing only his self-interest to maximize his payments at the end of the session would neither cooperate with a partner nor pay money to destroy another person's money. Similarly, an altruist would cooperate with a partner but would not pay money in the joy-of-destruction game. Previous experimental literature often restricted the choice set of individuals precluding the concurrent emergence of the two opposing behaviors. This becomes most apparent in psychological (*34*, *35*) and economic (*32*, *33*) decomposed games measuring social value orientation. The logic behind the decomposed games is to classify people into mutually exclusive categories, such as either selfish, altruist, conditional cooperator, caring for group efficiency, inequality averse, or caring for the least well-off player. In most of these measures, spite is not considered to play a role [see, however, Levine (*86*)]. Our study shows that by conducting a sequence of two very simple games, we derive that a large share of the population are what can be referred to as "spiteful cooperators." This is a behavior that has not been considered before because of its theoretical contradictions. Thus, our finding suggests that players might not have fixed types and that preferences might not be universal, but rather an individual's inclination toward others may vary across different experimental environments. The study by Brañas-Garza and colleagues (*87*) also points in this direction. Results show that a relevant share of individuals reject "unfair" offers in an ultimatum game (less than 50% of the sender's endowment) when being a recipient and prefer to end the game with nothing, while these subjects simultaneously send unfair offers in a dictator game where the recipient has no possibility of rejecting the offer. In that study, a selfish subject would accept any offer and send unfair splits, whereas a fairness-driven subject would reject unfair offers and send fair splits. Similarly, Savikhin and Sheremeta (*13*) and Prediger *et al.* (*19*) show a coexistence of cooperation and competition in an experimental setting. For example, in Prediger *et al.* (*19*), 30% of individuals could be classified as being both cooperative and spiteful. Clearly, more research is needed to explain the emergence and evolutionary stability of the coexistence of prosocial and antisocial behavior.

An open question is why the MPA similarly affects fishers and nonfishers. One might speculate about several possible explanations: Fishing might be so important that norms of behavior spill over to the general population, the general population is also directly affected by the MPA creation, or the behavior of fishers and nonfishers is unrelated and there are different mechanisms explaining high antisociality and high prosociality among these two subpopulations. Our preferred explanation on the basis of our long-term engagement in the area is that MPAs lead to the development of a market-oriented society that increases trust and cooperation (*88*) at the same time that market integration may lead to social stratification and sentiments of inequity aversion and envy. When previously cohesive fishing communities start to diversify economically and depend less on fishing, they are no longer affected by the same types of economic circumstances and thus might spur feelings of inequity or envy among those that do, manifesting in the hypercompetition behavior we observed.

Overall, our findings suggest that MPAs seem to be producing particular types of peoples [recall West *et al.* (*31*)], enhancing coupled cooperative and competitive behavior (*89*), through the creation of hypercompetitive cooperators within MPAs. This view is substantiated by people who stated "competition is important for society," and who are more likely to be identified as hypercompetitive cooperators. Changing the balance of winners and losers in redefining when, how, and who will be permitted or forbidden to use particular areas within the MPA (*63*) alters the relationships stakeholders have with each other and with the ocean fundamentally. This might, in turn, influence issues of identity, social structure, and work organization (*30*).

In summary, a number of suitable mechanisms might be in play to explain our findings, and disentangling them is the next step of research. Yet, given our findings, the question to ponder is whether emerging populations of hypercompetitive cooperators in MPAs will enable MPAs' effectiveness as a long-term conservation tool. As Jensen (*44*) argues, in the long term, hypercompetition might not necessarily be detrimental to cooperation. In particular, hypercompetitive acts might not be maladaptive; reckoning gains relative to others rather than in absolute terms can be an important part of human cooperation, rather than just an ugly by-product. More generally, our results add to previous literature [for example, Axelrod (*90*)] suggesting a positive effect of antisocial behavior. Yet, our main contribution consists in illustrating, through a multimethod approach, that interweaving the role of prosociality and antisociality constitutes a key step into future CPR theory development and better integration with and among literatures in social psychology, evolutionary anthropology, behavioral economics, conservation science, and ecology.

To our knowledge, this is the first study to use this approach to describe the impacts of protected areas in communities of users and the possible mechanisms behind them. Yet, it is not without limitations. To corroborate the robustness of our experimental results, future work would need to increase the number and type of protected areas assessed and ideally collect experimental data before and after the creation of protected areas, more explicitly considering differences in the designation process for protected areas to see how that affects prosociality and antisociality. The nonrandom placement of protected areas may pose challenges to the interpretation of results as causal effects. This reemphasizes the role that multiple methods will continue to play toward investigating the effects of protected areas in communities and their potential for long-lasting conservation and human well-being.

MATERIALS AND METHODS

Experimental design

Economic experiments are controlled interactions among individuals based on game theoretic predictions. The use of pecuniary or other material incentives and anonymity make experiments less prone to hypothetical bias or social desirability biases than surveys (*91*, *92*).

We conducted nine experimental sessions in six locations: Five sessions were held at locations that lie adjacent to two MPAs (Loreto and Cabo Pulmo), and four sessions were carried out in hometowns of fishers that operate outside of the influence of MPAs (Fig. 1 and table S1). In all locations, participants included fishers and nonfishers (representing other stakeholders, for example, tourism operators, recreational fishers, shop owners, and teachers) living in the community, and each of them made decisions toward a fisher and toward a nonfisher in their session.

Each session consisted of the following:

(i) A standard linear public goods game (*93*) as a straightforward workhorse to study cooperation. In the two-player version that we implemented, each subject has an initial monetary endowment (equal for all players) and can make voluntary contributions to a common fund. For every peso contributed to the common fund by either player, we added 50 cents, and the total was afterward evenly divided between the two players, irrespective of the amounts invested by each player. The social optimum for a pair of players is to invest all their endowment in the common fund; however, each of them has incentives to free-ride in the investments of the other and not contribute.

(ii) A modified joy-of-destruction game (*94*) designed to capture antisocial behavior. In this game, players can use part of an initial monetary endowment (equal for all players) to reduce money from the other player at a personal cost. The money of the other player is not "stolen" but simply destroyed. By design, the antisocial behavior cannot be associated with antisocial punishment of specific individuals. Despite subjects having played the public goods game first and the joy-of-destruction game next, they did not receive any feedback on the behavior in the public goods game of their counterpart before moving on to the second game and were not necessarily paired in the second game with the same person in the room (pairs were randomly and independently defined). Thus, reciprocity, inequity aversion, and envy directed toward a particular individual in the experimental setting are removed as potential motives for reducing money. Two of the motivations for reducing the other person's money are spite and the desire to be ahead of the other player (see section 1.1 and appendix 1 in the Supplementary Materials for an in-depth description of the experimental procedure and for the experimental instructions and script for recruitment, respectively).

(iii) An ex-post socioeconomic survey including personal demographic characteristics, social norms, opinion regarding MPAs in the past and present, and opinion about local authorities and social organizations (see table S2 for the description of variables and appendix 2 in the Supplementary Materials for the questionnaire). The original sample was n = 140, but because we excluded subjects who did not pass a minimum number of test questions about the procedure of the experimental games, the final n = 127. Results did not change when the full sample was used (see section 2.2 in the Supplementary Materials for robustness check tests).

Standardized survey, semistructured interviews, and participant observation

We documented fishers' perceptions of MPA effects on their fishing activities and catch, as well as their ability to work with each other to solve collective action problems through a standardized survey (n = 544; 48% active), which encompassed 11 localities within the influence of the four MPAs in Baja California (Fig. 1 and table S1) (see section 1.2 in the Supplementary Materials for in-depth description). We only included in our analysis (Fig. 4) data from fishers who self-reported to be actively participating in fishing activities at the time the survey was conducted (n = 371). Archival research, 77 semistructured interviews to key informants (that is, fisheries leaders, government MPA officials, and nongovernment organization personnel), and participant observation generated information about the public participation process and history related to the creation and implementation of all four MPAs (see section 1.3 in the Supplementary Materials for in-depth description). Authors' long-term engagement through participant observation in fishing communities in the study area and broader region (*40–42*, *95–97*) provided intuition and in-depth contextual knowledge that cannot be attained through experiments or surveys alone.

Statistical analysis

In table S3, we provide mean differences between MPA and non-MPA sites showing that all outcome variables are significantly different between MPA and non-MPA sites. Besides this, there are no differences in observable characteristics (age, gender, education, and length of stay in village) or session composition (number of fishermen and conflict with others or family members). The only statistical difference is in the attitude toward "winning." Within MPA, 48% agreed to the statement that winning is the most important thing. This underlines our discussion in the main text where we argue that the presence of MPA increased the competition among fishermen.

Concerning the real-life applicability of our experiment, our ex-post survey showed 43% of participants stating that the joy-of-destruction game reminded them of a real-life situation they had encountered in their community, and slightly more people stated that the public goods game reminded them of something that happened in their community (61%). Thus, although we used abstract and unframed experiments, both behaviors seem relevant measures of community-level interactions.

The main statistical analyses are based on OLS regressions with robust SEs (to correct for potential heteroscedasticity) for two main dependent variables, namely, cooperation in the public goods game and hypercompetitiveness in the joy-of-destruction game. We included blocks of relevant explanatory variables stepwise to check for stability of coefficients in models 1 to 6 in tables S4 to S8. Note that we are deliberately not using an automatic, stepwise regression approach to increase goodness of fit. Rather, we are interested in the sign and strength of the different coefficients per se. Some categorical variables were recoded from a four-point Likert scale to dummy variables to ease interpretation. These variables end with 2 (for example, winning2 and society2).

Table S4 presents the results for cooperation decisions in the public goods game when the recipient is a fisher, and table S5 presents the corresponding results when the recipient is a nonfisher. In addition, table S6 presents the results for the joy-of-destruction game (that is, hypercompetitiveness) when the recipient is a fisher, and table S7 presents the corresponding results when the recipient is a nonfisher. All results presented in tables S4 to S7 remain robust to probit and tobit analyses.

In addition, we present in table S8 a binary probit to identify the attributes that increase the likelihood of an individual to be classified as a hypercompetitive cooperator. In this analysis, we also followed a stepwise approach in the introduction of additional covariates. All the analyses were restricted to subjects who were correctly answering at least four of the quiz questions for each experiment when checking for a correct understanding of the game.

We conducted two different robustness tests for each of the four dependent variables, namely, cooperation to fishers, cooperation to nonfishers, hypercompetitiveness to fishers, and hypercompetitiveness to nonfishers. The first robustness test excluded the two high-stake sessions (table S9). This was to control whether the main results were mainly driven by the presence of high stakes. Second, we included in the analysis all subjects who participated in the experiment, including those who did not achieve the minimum threshold of correct quiz questions (table S10). All results remained robust.

SUPPLEMENTARY MATERIALS

Supplementary material for this article is available at http://advances.sciencemag.org/cgi/content/full/2/3/e1501220/DC1
Materials and Methods
Additional results
Table S1. Characteristics of our study site and our surveying effort.
Table S2. Description of variables.
Table S3. Mean differences (or frequencies) between MPA and non-MPA sites.
Table S4. Cooperation to fishers.
Table S5. Cooperation to nonfishers.
Table S6. Hypercompetitiveness to fishers.
Table S7. Hypercompetitiveness to nonfishers.
Table S8. Hypercompetitive cooperator to fishers.
Table S9. Robustness test: exclude high-stake sessions.
Table S10. Robustness test: include all participants.
Appendix 1. Experimental instructions.
Appendix 2. Ex-post questionnaire.
References (*98–107*)

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