Zapotec cooperative institutions: Exploring the psychological and social mechanisms

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Abstract

The cross-cultural variation in the scale and intensity of human cooperation poses a challenge to classic evolutionary explanations. Confronting popular explanations that eschew "culture", researchers propose that social norms and institutions culturally evolve to shape cooperation. Here, we examine how institutions shape cooperation by conducting a detailed comparative analysis of two cooperative institutions in a Zapotec community of Oaxaca, Mexico. The first, *gozona*, is a mutual aid institution that promotes cooperation in the contexts of agricultural labor and celebrations. The second, *usos y costumbres*, represents a set of traditional political institutions that facilitate the provisioning of public goods. Drawing on ethnography, vignettes, and surveys, we dissect the intertwined, cooperation-sustaining psychological and social mechanisms embodied in these institutions. We find that *gozona* and *usos y costumbres* are governed by different norms, which drive context-specific cooperation; they are not associated with generalized prosociality. Moreover, *gozona* and *usos y costumbres* norms harness distinct but overlapping sets of mechanisms, including reciprocity, interdependence, reputation, and punishment. These results support the view that institutions tap into and recombine diverse cooperation-sustaining mechanisms as they culturally evolve, challenging "culture-free" efforts to explain human cooperation. Indeed, even within a single, small community, different cooperative institutions work in different ways.

1. Introduction

In San Francisco Yateé, a Zapotec village in the mountains of Oaxaca, Mexico, people cooperate in many ways. In steep, hillside plots, friends and neighbors help each other harvest corn and coffee. When a family hosts a wedding, funeral, or saint's feast, villagers arrive early with contributions of corn, sugar, chocolate, and cash. Many stay all day to help with preparations,

making *tamales*, washing dishes, and carrying firewood. Yateé's men regularly work together to benefit the community– constructing a new school, clearing landslides, and putting out wildfires. Moreover, each year a rotating group of men set aside their subsistence or wage labor to fill unpaid civic roles, performing important functions like maintaining the drinking water system and organizing public works projects.

Such intense cooperation is not a given in human societies. Some small-scale societies, such as the Matsigenka of the Peruvian Amazon, struggle to mobilize cooperation beyond the extended family group (Johnson 2003). Meanwhile, while residents of large-scale, Western, Educated, Industrialized, Rich, and Democratic (WEIRD) societies readily cooperate with strangers in some domains (e.g., paying taxes, donating blood; Henrich 2020), many would balk at the idea of forgoing a year of salary to work *gratis* to benefit their hometown. Even among Zapotec villages in the same region as Yateé, anthropologists have recorded wide variation in cooperative tendencies (Nader 1964). Why do the people of Yateé cooperate so intensely, across so many domains?

Variation in the scale, intensity, and domains of cooperation represents a puzzle in human evolution (Henrich and Muthukrishna 2021). Although humans likely have genetically-evolved psychological capacities that support cooperation between, among others, close relatives (kin altruism; Hamilton 1964) and repeated interaction partners (direct reciprocity; Trivers 1971), these mechanisms fail to adequately explain the observed patterns of human cooperation (P. J. Richerson and Boyd 1998). A full explanation of human cooperation must explain not only our species' ultrasociality (we cooperate more intensely and at larger scales than most other mammals), but also the rapid scaling up of cooperation since the birth of agriculture, and the fact that many of the forces that support human cooperation can also sustain noncooperative or even maladaptive

behaviors, including some food taboos and rituals (Chudek and Henrich 2011; Henrich and Muthukrishna 2021; Boyd and Richerson 2022).

There is spirited debate among social scientists about the evolution of human cooperation and the roots of the observed global variation– particularly regarding the role of culture (Kurzban et al. 2015; Mesoudi 2020). On one hand, some evolutionary psychologists and evolutionary anthropologists contend that cooperation can be understood with little to no influence from culture. On the other hand, researchers in cultural evolution and many other social sciences argue that culture plays an *essential* role in cooperation. Here, we briefly review this longstanding debate.

1.1 The cultural evolutionary view of human cooperation

Researchers in cultural evolution argue that culture– especially social norms and institutions– is the key to solving the puzzles of human cooperation. According to cultural evolutionary theory, human minds have evolved to acquire and retransmit culture, including tools, beliefs, rituals, and– crucially– social norms (Henrich 2015; Chudek and Henrich 2011). We define *social norms* as culturally-transmitted standards of behavior that are shared and enforced within a community (e.g. "people should pay their taxes"; "newlyweds should live with the groom's family"). Social norms are packaged together into *institutions*, which govern domains such as kinship and religion. Scholars have argued that the emergence of norms and institutions in early human groups created selection pressures favoring the genetic evolution of cognitive mechanisms that facilitate life in social groups, equipping humans with some innate prosocial tendencies (P. J. Richerson and Boyd 1998; P. J. Richerson et al. 2016).

Moreover, theory suggests that norms and institutions play a critical role in shaping cooperation within individuals' lifetimes, pulling psychological and social levers to stabilize cooperation. Psychologically, cooperative institutions foster prosociality as the component norms

are internalized (transformed into internal preferences, biases, and heuristics), a process which is facilitated by evolved norm psychology (Chudek and Henrich 2011, see S1.1). Institutions can likewise tap aspects of human psychology that evolved to support cooperation between close relatives (kin altruism), repeated interaction partners (direct reciprocity), and individuals whose fitnesses are otherwise intertwined (interdependence psychology) (Henrich and Muthukrishna 2021; Richerson and Henrich 2012; see S1.3). Socially, institutions can leverage mechanisms that sustain costly behaviors within groups, including reputation (indirect reciprocity) (Bhui et al. 2019; Panchanathan and Boyd 2004; Nowak and Sigmund 2005) and punishment (J. Henrich and Boyd 2001; Jordan et al. 2016; Boyd et al. 2010; Fehr and Gächter 2002; Fehr and Fischbacher 2004) (see S1.2). Theorists suggest that as institutions culturally evolve, they stitch together different cooperation-sustaining mechanisms. Because each institution travels a distinct cultural evolutionary path— shaped by local social, ecological, and perhaps even domain-specific forces— this process is hypothesized to result in rich institutional diversity, both within and between societies (Henrich and Muthukrishna 2021; Richerson and Henrich 2012). Thus, within this framework, norms and institutions explain the broad variation in the scale, intensity, and domains of human cooperation.

Research from across the social sciences supports this view of human cooperation. Ethnographers have documented how cooperative norms are enforced (Wiessner 2005; Kajanus and Stafford 2023), while political scientist Ostrom's (1990, 2005) foundational work identified institutional design features that facilitate effective common-pool resource management. Cross-cultural studies using anonymous, one-shot behavioral economic games reveal relationships between institutions and prosociality (Henrich et al. 2010; Rustagi 2023; Purzycki et al. 2016). Because these games preclude punishment and reputational damage, behavior in this context likely

reflects intrinsic motivation—internalized norms (Henrich and Ensminger 2014). Moreover, although children across diverse societies show similar patterns of prosociality early in development, they diverge towards local adult behavior during middle childhood, around the same time that they become responsive to novel prosocial norms (House et al. 2020). This suggests an important role for norms in generating cross-cultural variation in prosociality. Finally, studies have revealed that cooperation is shaped by institutions that govern mutual support (Cronk, Berbesque, et al. 2019), kinship (Schulz et al. 2019), collective ritual (Whitehouse and Lanman 2014; Watson-Jones and Legare 2016), warfare (Mathew and Boyd 2011), common-pool resource management (Ostrom 1990; Lansing 1991), market exchange (Henrich et al. 2010, 2001; Rustagi 2023), and religion (Purzycki et al. 2016). This body of research strongly suggests that norms and institutions lie at the root of cross-cultural variation in cooperation.

1.2 Culture-free hypotheses of human cooperation

On the other side of the debate, researchers argue that human cooperation can be explained largely without culture. Many evolutionary psychologists contend that cooperation is best understood as the product of specialized cognitive adaptations that evolved to support cooperation in small-scale groups of the human past (Tooby and Cosmides 2016). Proposed adaptations include the ability to detect cheaters, moral emotions, and a motivation to punish free-riders (Tooby et al. 2006; Pinker 2010; Price et al. 2002; Cosmides and Tooby 1992). In this framework, variation in cooperation is explained not by cultural traits like norms and institutions but by "evoked culture", wherein these evolved cognitive mechanisms are differentially activated by local environmental cues (Cosmides and Tooby 1992). To explain the large-scale cooperation that we observe today, some evolutionary psychologists argue that cognitive adaptations for small-scale cooperation are sufficient (e.g. direct reciprocity, Krasnow et al. 2013; Delton et al. 2011), while others posit that

it reflects maladaptive "misfiring" of those adaptations (Burnham and Johnson 2005). Similarly, human behavioral ecologists have suggested that contemporary variation in cooperation is best explained by non-cultural factors, such as ecology (Lamba and Mace 2011, 2013). Meanwhile, Boyer and Petersen (2012) theorize that institutions reflect, rather than shape, human psychology, suggesting that humans tend to create or acquire institutions that fit their genetically-evolved intuitions. The role of cultural evolution in cooperation– and indeed, the broader power of culture to explain human behavior– is an area of lively debate (Kurzban et al. 2015; Mesoudi 2020; Baumard and André 2025).

1.3 The current paper

To contribute to our understanding of the role of norms and institutions in human cooperation, this paper presents a detailed case study of two cooperative institutions in a Zapotec village of Oaxaca, Mexico. *Gozona* is a mutual aid institution that supports cooperation in the contexts of celebrations and agricultural labor. Meanwhile, *usos y costumbres* facilitates the provisioning of public goods that benefit the entire community.

Drawing on ethnographic, vignette, survey, and behavioral economic game data, we use this case study to test predictions from cultural evolutionary theory about how institutions shape cooperation. First, we hypothesized that cooperation in the contexts of *gozona* and *usos y costumbres* is driven by context-specific social norms rather than general prosocial inclinations (generalized altruism). Our results support this hypothesis. Second, testing the prediction that cooperative institutions stitch together different mechanisms as they culturally evolve, we hypothesized that *gozona* and *usos y costumbres* tap different social and psychological mechanisms to stabilize cooperation. Considering the roles of reputation, punishment, reciprocity, and interdependence, we find that these institutions rely on overlapping but distinct sets of

mechanisms to sustain cooperation. This highlights the diverse ways that cultural evolution can build cooperative institutions. In addition to elucidating how institutions shape cooperation, this paper brings a cultural evolutionary perspective to bear on institutions that have long interested sociocultural anthropologists studying Mesoamerica (Mulhare 2000; Monaghan and Cohen 2000).

2. Ethnographic background

San Francisco Yateé, known colloquially as Yateé, is a Zapotec community (population 430) in the mountainous Sierra Norte region of Oaxaca (Figure S5, see S2.1 for more detail). A rich mosaic of cooperative institutions structure social life in Yateé, including *compadrazgo* (ritual kinship institution) and *barrios* (voluntary associations that sponsor Catholic celebrations). Here, we focus on *gozona*– a mutual aid institution– and *usos y costumbres*– a set of traditional political institutions.

2.1 *Usos y costumbres* (traditional political institutions)

Yateé is politically semi-autonomous, run under what is formally known as "indigenous regulatory systems" (*sistemas normativos indígenas*). Locally called *usos y costumbres* ("customs and traditions", hereafter *UyC*), the system represents a web of institutions governing citizenship, community service, collective decision-making, and ingroup justice. The contemporary *UyC* system is the product of centuries of transformation. While political organization in Oaxacan Pre-Columbian civilizations was stratified– with authority and land tenure concentrated in the hands of ruling kin groups– 20th century anthropologists encountered small, egalitarian communities with collective land rights and strong, place-based identities (Chance 1989; Chassen-López 2004). Scholars argue that this fundamental shift in social organization was spurred by Spain's "divide and conquer" approach to dealing with the indigenous population of Mexico. The Spanish Crown intentionally broke up larger civilizations and lineages into small, place-based units, granting them

rights, legal identities, and some autonomy, while also extracting tributes and forced labor(Chance 1989; Chassen-López 2004). Today, there is broad institutional variation across Oaxacan indigenous communities (Curtin et al. 2024), likely generated over the centuries as each community traveled a unique cultural evolutionary path.

2.1.1 The cargo *system*

The *cargo* system is a defining feature of social organization in indigenous communities throughout Oaxaca (Monaghan and Cohen 2000) and Mesoamerica more broadly (Cancian 1965; Mulhare 2000; Carrasco 1961). This institution consists of a hierarchical ladder of unpaid, civil-religious posts (*cargos*, lit. "burdens") that each citizen must ascend over the course of adulthood. *Cargo*-holders administer crucial public goods, including public safety, infrastructure, and drinking water.

The *cargo* system is a hybrid institution. Although partially a Spanish import to Colonial Mexico, the institution likely built on pre-existing indigenous practices. Based on analyses of Aztec records, Carrasco (1961) argued that age-graded "ladder" systems existed for warriors, priests, and merchants– although it remains unclear whether similar systems existed in Pre-Conquest Oaxaca (Chance and Taylor 1985). Moreover, although the top, most prestigious *cargo* positions are Spanish, some lower *cargos*, which often involved providing personal services to top *cargo*-holders, likely had indigenous origins. Supporting this idea, some of these *cargos* have indigenous names (e.g. *topil*) (Chance and Taylor 1985; Chance 1989).

In Yateé, men typically serve 12 *cargos*, totaling about 8.5 years of service (Table 1). At the bottom of the ladder, youths begin their career as *topil*, running errands for elder *cargo*-holders and guarding the municipal building. Moving up the ladder, the costs and responsibilities of *cargos* rise. For example, "the Authorities" comprise a group of four top *cargo*-holders whose duties

include organizing public works projects, managing the town's money, and adjudicating conflicts. The Authorities work all day, every day for the entire year, precluding any subsistence or wage labor. Their duties also include hosting social gatherings for the community, implying substantial financial outlays. Serving *cargos* is one of the essential duties of a male citizen of Yateé. Citizens are named to *cargos* by the Communal Assembly; serving when called upon is obligatory.

As shown in Table 1, the *cargo* system organizes citizens into age-classes. This age-class system, though common cross-culturally (Bernardi 1985), is unusual within the contemporary Oaxacan context. These groups serve as a locus of organization in several aspects of civic life, including the Communal Assembly and *tequios* (communal labor).

2.1.3 Communal Assembly

The Communal Assembly of citizens holds the highest power. While the Authorities have influence during their year, the Communal Assembly ultimately rules. The Authorities must bring issues to the Assembly to decide. The Assembly keeps a vigilant eye on the Authorities, swiftly imposing punishment if they err.

During an assembly, male citizens sit organized by group (Figure S7), debate issues, and vote by raised hand. A quorum (at least 50%) of active citizens must be present for a decision to be made; the decision of the majority prevails. Failure to attend an assembly is punished with a fine (amount determined within each group). Around 16 regular assemblies are convened per year to discuss public works; plan the annual patron saint festival; and name the following year's *cargo*-holders. The Authorities can also call *ad hoc* assemblies to deal with pressing issues (see S2.2).

TABLE 1. The *Cargo* System of San Francisco Yateé

Age-class ("Group")	*Cargo*	Primary Function(s)	Duration
Bi wego' ("Youths")	1. *Topil* ∗	When a young man leaves school, he is called to join the first group, *bi wego'* ("Youths"), where he serves his first two *cargos*. *Topiles* and *policias* run errands for the Authorities; guard the municipal building; respond to minor community matters.	6 months
	2. *Policía* ∗		1 year
Bi' yez ("Young citizens")	3. *Mayor de vara* ∗	Upon marriage, a man passes into *bi' yez* ("Young citizens"). *Mayores de vara* intervene when *topiles/policías* cannot resolve an issue (e.g. fights, unruly drunkard, car accident).	6 months
	4. Committee		1 year
	5. Commission		1-1.5 months
Benne' gole yez ("Elder citizens")	6. *Regidor* ∗	After completing the first 5 *cargos* in the ladder, a man passes into *benne' gole yez* ("Elder citizens"). *Regidores* intervene when *mayores de vara* cannot resolve an issue; can stand in for a member of Authorities in their absence	1 year
	7. Committee		1 year
	8. Commission		1-1.5 months
	9. One of the following ("the Authorities"):		
	Agente municipal ∗	Plan and organize public works projects; deal with paperwork and government bureaucracy	
	Suplente del agente ∗	Town treasurer; assist *Agente* with administration of public works	1 year
	Alcalde Unico Constitucional ∗	Adjudicate interpersonal conflicts (e.g. marital or property disputes); impose fines; collect taxes (*cooperaciones*)	
	Suplente del alcalde ∗	Oversee public street lighting; assist *Alcalde* with conflict adjudication	

TABLE 1. The *Cargo* System of San Francisco Yateé *(continued)*

Age-class ("Group")	*Cargo*	Primary Function(s)	Duration
	10. Committee	After completing the required *cargos* of the *benne' gole yez* group, a man passes into *benne' gole xwan* ("Elder and older men").	1 year
	11. Commission		1-1.5 months
Benne' gole xwan ("Elder and older men")	12. One of the following:		
	Síndico ∗	Oversee and advise Authorities; solve serious issues and calm tensions within community; has power to impose punishments; oversees safety and maintenance in town (e.g. calls *tequios*)	1 year
	Mayordomo	Watch over the Catholic Church (sleep at Church, open it in the morning, freshen flowers, etc.); ring the church bells; sponsor the celebrations of *Semana Santa* (Easter Week)	
Reservados ("Reserves")	Those who have passed the age of 65 no longer serve *cargos*.		

Notes: The *cargo* system consists of a hierarchical ladder of unpaid, civil-religious posts (*cargo*s, lit. "burdens") that each male citizen must ascend over the course of adulthood. Within this system, men are organized into age-classes called "groups"; as they complete *cargos*, they move up in group. *Cargos* marked with "∗" denote those in the *cabildo*, or town hall. The men of the *cabildo* work closely during their year of service, for example independently accomplishing small *tequios,* facilitating assemblies, and maintaining public safety. The four committees in Yateé administer public goods: School Committee, Drinking Water Committee, Health Clinic Committee, and Communal Mill Committee. The commissions relate to the annual patron saint festival: Kitchen Commission, Rodeo Commission, Dance Commission, Sports Commission, and Band Commission. Yateé formally gained the legal right to communal land tenure in the 1970s, prompting the creation of the Commissariat of Communal Lands and Supervisory Board. The Commissariat manages the town's communal resources, including land, firewood, and sand. The Commissariat comprises three *cargos*: Treasurer, Supervisory Councilor, and President, rising from the *bi' yez, benne' gole yez*, and *benne' gole xwan* groups, respectively. Each of these *cargos* can replace a *cargo* on the traditional ladder.

2.1.4 Tequio

Tequio is communal labor that benefits the community (Figure 1A). All male citizens must give *tequio*, although older men do lighter labor. *Tequios* are organized by group: each group is assigned to meet a goal (e.g. transport 30 bags of sand from the river for a construction project), which they self-organize to accomplish. Many important public works in Yateé were accomplished by *tequio*, including the construction of the municipal building, sewerage system, and piped water system. The Authorities may call emergency *tequio*, for example to clear a landslide or contain a wildfire. All citizens also do an annual *tequio* to clear the boundary– a 6-meter-wide gap in vegetation (Figure S8)– between Yateé and its neighbors. In a region where land is communally controlled and territorial disputes commonly erupt between communities, clearing the boundary ensures that everyone knows where it is. It also helps prevent wildfire from spreading in from neighboring communities, thus delivering an important public good.

2.1.5 Citizenship

The town is the primary locus of identity for many indigenous Oaxacans (Dennis 1987; Nader 1964; Monaghan and Cohen 2000; Martínez 2013), and the people of Yateé are no exception. With this identity comes strict rules of membership. A citizen of Yateé has the right to cultivate communal lands, extract resources such as firewood, and receive drinking water and sewerage services to their house. In exchange, citizens must serve and support their community. Active male citizens of the Communal Assembly (men up to age 65) must (1) attend assemblies and vote, (2) serve *cargos*, (3) give *tequio*, and (4) pay a town tax (*cooperación,* lit. "cooperation"). Widows and unwed mothers– with no husband to do their part– must likewise give light *tequio* and pay a tax. As in many Oaxacan communities (Martínez 2013), traditionally only Yateé natives

A B

Figure 1. Community members cooperate. (A) Men do *tequio* to clear a small landslide from the main road. (B) Women make bean *tamales* for a *convivio.* They pat out *masa* (corn dough), smear it with bean paste, form *tamales*, and wrap them in banana leaves. Some of this labor is *gozona*. Source: CMC

were considered citizens. However, likely because of the small population and heavy flow of outmigration, today Yateé incorporates immigrant men as active citizens after about 6 months of residence. After several years, they may gain full rights. In 2022, there were 106 men on the roster of active citizens and an additional 31 men on the roster of "retired" citizens (*reservados*). Migrant men living elsewhere were not included on these rosters, but they still owe *cargos* and taxes.

2.2 *Gozona* (mutual aid institution)

Gozona (Yateé Zapotec: *wzon*) is a mutual aid institution. *Gozona* has traditionally been practiced in Zapotec communities throughout the Sierra Norte (Nader 1964; Cruz Díaz 1982; de la Fuente 1949), and similar institutions exist in other Oaxacan groups, such as *guelaguetza* among Central Valley Zapotecs (Stephen 2005) and *saa sa'a* among Mixtecs (Monaghan 1990). Although little is known about the history of *gozona* in the Sierra Norte, archival and archaeological evidence suggests that *guelaguetza* dates to the Pre-Columbian period among Central Valley Zapotecs

(Flores-Marcial 2015). In Yateé, *gozona* facilitates mutual aid in several domains, including celebrations and agricultural labor.

2.2.1 Celebration gozona

Gozona occurs most frequently in the context of social gatherings, such as weddings, funerals, and *convivios* (festive gatherings to which all community members are typically invited). A couple may voluntarily host a *convivio*, for example as part of the ritual of donating a bull for the annual patron saint festival. However, many *convivios* are hosted by top *cargo*-holders and their wives as part of official duties. A *convivio* typically involves music, dancing, a procession, and one or more special meals. Providing and preparing a huge quantity of food constitutes the main cost of hosting. Here enters *gozona*.

The process of *gozona* begins with a public announcement made over the town's loudspeakers, inviting citizens to the hosting household to help with preparations. On the appointed day, community members arrive bearing contributions such as cash, dried corn, beans, sugar, coffee, cacao, and salt. A host stations themself in the kitchen to receive the contributions and record them in a notebook. Some people stay to work, which the host also records. While both men and women do *gozona*, their tasks are gendered. For example, women help prepare food, wash dishes, and clean tables (Figure 1B), while men carry firewood, hang a tarp to protect the *convivio* from the elements, and slaughter the pig or bull. During the days when people do *gozona*, the hosts show respect and gratitude by providing food and drink. At these festive "work parties," people gossip, share meals, and perhaps enjoy an alcoholic beverage. Notwithstanding, they work very hard.

The hosts reciprocate *gozona* by "returning the help". *Gozona* does not need to be reciprocated in exact kind– a pound of cacao for a pound of cacao– but it must be reciprocated in

a time of need. Bringing by some bread on a normal Tuesday does not count. Rather, the help must be returned when the person is hosting their own *convivio*, wedding, or funeral. The process of returning the help can take years: one informant reported that she was still working on returning the help for a *convivio* hosted 12 years earlier.

Importantly, *gozona* must be given freely. For example, informants describe *gozona* as "help from the heart" and say that it is "our pleasure to help". Informants make a clear distinction between *gozona* and help that is given as part of a formal duty. For example, the host may seek out a woman to serve as head cook or request that the *mayordomos* of the church bring a saint's statue to the *convivio*. To make the request, the host gifts food and beverage to "give respect" to the person. However, their help is not *gozona* because it has been formally requested or is part of official *cargo* duties. Instead, *gozona* must be freely offered. It must also be voluntarily reciprocated. People do not speak of *gozona* as being "owed", and one cannot demand that someone reciprocate it.

2.2.2 Harvest gozona

"Harvest *gozona*" or "work *gozona*" is another traditionally important setting for *gozona*. This *gozona* is used for labor-intensive agricultural tasks that are difficult to accomplish alone, such as harvesting coffee, planting corn, or weeding fields. The mechanics of harvest *gozona* differ significantly from celebration *gozona*. Here, when a person needs help, he or she approaches a friend, family member, or other social partner to ask if they would like to "do *gozona*". The person being asked can decline. The partners come to an agreement about the exchange. Usually, days of labor are exchanged (e.g. 2 days of labor in the asker's fields, which he or she will reciprocate by working 2 days in the accepter's fields when they need help). Thus, this type of *gozona* is predicated on a more formal agreement. In keeping with this formality, informants speak of harvest

gozona as being "owed" and "paid". Harvest *gozona* still exists in Yateé, but informants report that it is declining.

2.2.3 Other forms of gozona

Yateé engages in music *gozona*– the exchange of bands between communities during patron saint festivals (S2.3). In the past, *gozona* was also common during housebuilding, but this institution has disappeared (S2.4).

3. Methods

We studied the nature of these institutions using four core methods: ethnography, vignettes, surveys with psychological scales, and a behavioral economic game with institution priming. Our quantitative measures were gendered: generally, men responded to prompts about *UyC*, while women responded to prompts about *gozona.* While not ideal, this methodological choice reflects a combination of the fact that women do not participate in *UyC* and participants' time constraints.

3.1 Ethnography

To build a nuanced understanding of these institutions, we leveraged participant observation (e.g. helping women prepare for *convivios*; attending communal assemblies), focus groups, and interviews. In addition to providing rich detail about the institutions, our ethnographic approach foregrounds community members' perspectives on *gozona* and *UyC*. To that end, we reported our research findings back to the community and invited feedback (S3.1). We also note that YVV and NVM are Zapotec scholars from nearby communities with deep insight into local practices, worldviews, and beliefs. Nonetheless, we acknowledge that as outsiders to Yateé, our interpretations of the local institutions cannot fully capture the emic perspective.

3.2 Social norm vignettes

To quantify norms about participating in *gozona* and *UyC*, women ($N = 22$) responded to three vignettes about *gozona*, while men ($N = 23$) responded to three vignettes about *UyC*. The *gozona* vignettes featured a protagonist who failed to (1) offer celebration *gozona* when the need was announced, (2) reciprocate celebration *gozona*, and (3) reciprocate harvest *gozona*. The protagonist in the *UyC* vignettes (1) skipped an emergency *tequio*, (2) refused to serve a *cargo*, and (3) did a poor job in his *cargo*. All participants also responded to three control vignettes about norm violations unrelated to *gozona* or *UyC*, such as disrespecting an elder.

After each vignette, participants were asked to rate how good or bad the action was; how good or bad other people in the community would think it was; how it would affect their reputation; and whether they should be rewarded or punished (5-point response scales; details in S3.2). After the *gozona* vignettes, participants were also asked how likely it was that other people in the community would help the protagonist in the future. Finally, participants responded to a free-response question, "What do you think of [the protagonist's] action?".

To capture overall strength of normative beliefs about participating, we averaged across all vignettes and responses within each domain, creating a *Gozona* Judgment Index, *UyC* Judgment Index, and Control Judgment Index (details in S3.2). Indices were standardized; higher value indicates a harsher judgment.

3.3 Survey measures

Participants completed surveys that included questions about demographics, prosociality, and participation in *gozona* and *UyC*-related activities (Table 2, see S3.3 for details).

TABLE 2. Survey measures

Variable	Measure	Description	Gender Surveyed	Source
Willingness to Help	Generalized Altruism	"I would help a fellow community-member, even if they could never return the help" (5-point scale, "strongly disagree" to "strongly agree")	Both	Original
Likelihood of Donating to Sick Child	Generalized Altruism	"Imagine that a child in your neighborhood was very ill and staying in the hospital. The child's family could not afford the hospital bills and asked community members to donate money to help out. How likely would you be to donate money to the child's family?" (5-point scale, "very unlikely" to "very likely").	Both	Original
Shared Fate Index	Fitness Interdependence	Measure of perceived interdependence. Scale includes items like, "When my community feels good, I feel good" and "My community and I rise and fall together" (5-point scale, "strongly disagree" to "strongly agree"). To create the scale, we averaged across 5 items (Cronbach's $\alpha = 0.77$ [95% CIs 0.68, 0.87]).	Both	Ayers et al. (2023)
Willingness to Offer *Gozona*	*Gozona* Participation	"Imagine that a man in the community died in an accident, leaving behind a wife and three children. The bells rang to announce the death, and some people went to provide support– corn, coffee, and other supports. How likely would you be to bring food or other support to the dead man's family?" (5-point scale, "very unlikely" to "very likely").	Both	Original

TABLE 2 (*continued)*. Survey measures

Variable	Category	Description	Gender Surveyed	Source
Willingness to Attend Emergency *Tequio*	*Usos y Costumbres* Participation	"Imagine that during the rainy season, a landslide destroyed part of the main road leading into Yateé. Now, imagine that the *síndico* called a *tequio* to fix the road. How likely would you be to attend the *tequio* to help fix the road or support in some other way?" (5-point scale, "very unlikely" to "very likely").	Men	Original
Frequency of *Tequio* Attendance	*Usos y Costumbres* Participation	Participants reported how often they attend *tequio* (5-point scale, "never" to "always)"	Men	Original
Frequency of Communal Assembly Attendance	*Usos y Costumbres* Participation	Participants reported how often they attend Communal Assembly (5-point scale, "never" to "always)"	Men	Original
Attended Most Recent Communal Assembly	*Usos y Costumbres* Participation	Participants reported whether they attended the most recent assembly (Yes/ No)	Men	Original

Notes: Because both men and women participate in *gozona,* participants of both genders were asked about their willingness to offer *gozona*. Because only men regularly participate in *UyC* activities, only male participants were asked about *UyC* participation. For more details about these measures, please refer to the Supplemental Materials (S3.3).

3.4 Priming experiment

To probe for specific evidence of internalized norms driving cooperation, we employed a priming paradigm. A prime is an unconscious reminder of a concept. Participants played an anonymous 4-player Public Goods Game twice: once after hearing control vignettes, and once after hearing prime vignettes related to *gozona* (women) or *UyC* (men) norm violations (see SA2.3 for details). We hypothesized that the unconscious reminder of the institutions would activate internalized cooperative social norms, leading participants to cooperate more in the Public Goods Game.

3.5 Data analysis

We used multiple regression to explore the relationship between normative beliefs about *gozona* and *UyC* and various psychological and behavioral outcomes. To maximize power in our small samples, we leveraged repeated measures. Questions about prosocial psychology and *gozona* participation were repeated several months after the initial survey as part of another study, resulting in two observations per participant. Questions about participation in *UyC* activities were asked only once. We standardized and stacked the three continuous measures of *UyC* participation, resulting in three observations per participant.

Our analysis used Linear Mixed Effects Regression with random intercepts for participants (R package lme4, version 1.1–23; see S3.5 for details). Most models control for age, educational attainment, and material security. When analyzing *UyC* participation, we controlled for educational attainment, wage labor participation dummy variable, and status as a *Reservado* (over 65, no longer required to participate). Data and code are available at: https://osf.io/he5xa/overview?view_only=91121ab11b9d4c9b90f625ef25187353.

4. Results and discussion

To elucidate if and how these culturally-evolved institutions shape cooperation, we begin by establishing that behaviors related to *gozona* and *UyC* are associated with the social norms described above. Then, we consider how these costly norms are stabilized. Finally, we consider whether these institutions tap aspects of evolved psychology, including direct reciprocity and interdependence psychology.

4.1 *Gozona* and *usos y costumbres* are governed by social norms

Is cooperation in the domains of *UyC* and *gozona* governed by social norms? In vignettes, Figure 2 shows that participants judged violations in both contexts as "bad" (*gozona* mean = 1.03, bootstrapped 95%CIs(BCIs)[0.88, 1.20]; *UyC* mean = 1.12[0.99, 1.26]) and expected that other community members would feel similarly (*gozona* mean = 0.89[0.77, 1.05]; *UyC* mean = 1.13[0.99, 1.29]). That is, it is common knowledge that people *should* cooperate in these domains. Importantly, cooperation in *UyC* and *gozona* is also enforced (see Section 4.3).

Free responses add color to these quantitative findings. Participants called the *gozona* violators "lazy", "ignorant", and "selfish" and expressed disdain for the *UyC* violators' lack of solidarity. For example, participants explained that he's "taking advantage of the town", "it's a lack of respect […] and a mockery of the citizens", and "the town is a team– to not accept the *cargo* means that you don't want to be part of the team". These results suggest that the protagonists were indeed breaking social norms– failing to live up to local cooperative standards– and as a result inspiring intense displeasure among participants. These free-responses give the impression of internalized norms, with violations spurring negative gut reactions (see S4.2 for further ethnographic evidence of norm internalization).

However, we observed no effect of the priming manipulation designed to probe for evidence of internalized norms driving cooperation. Consistent with other work using priming experiments in field contexts (Purzycki et al. 2022), we suspect that the cognitive load associated with the Public Goods Game wiped out any potential priming effects (see S4.3).

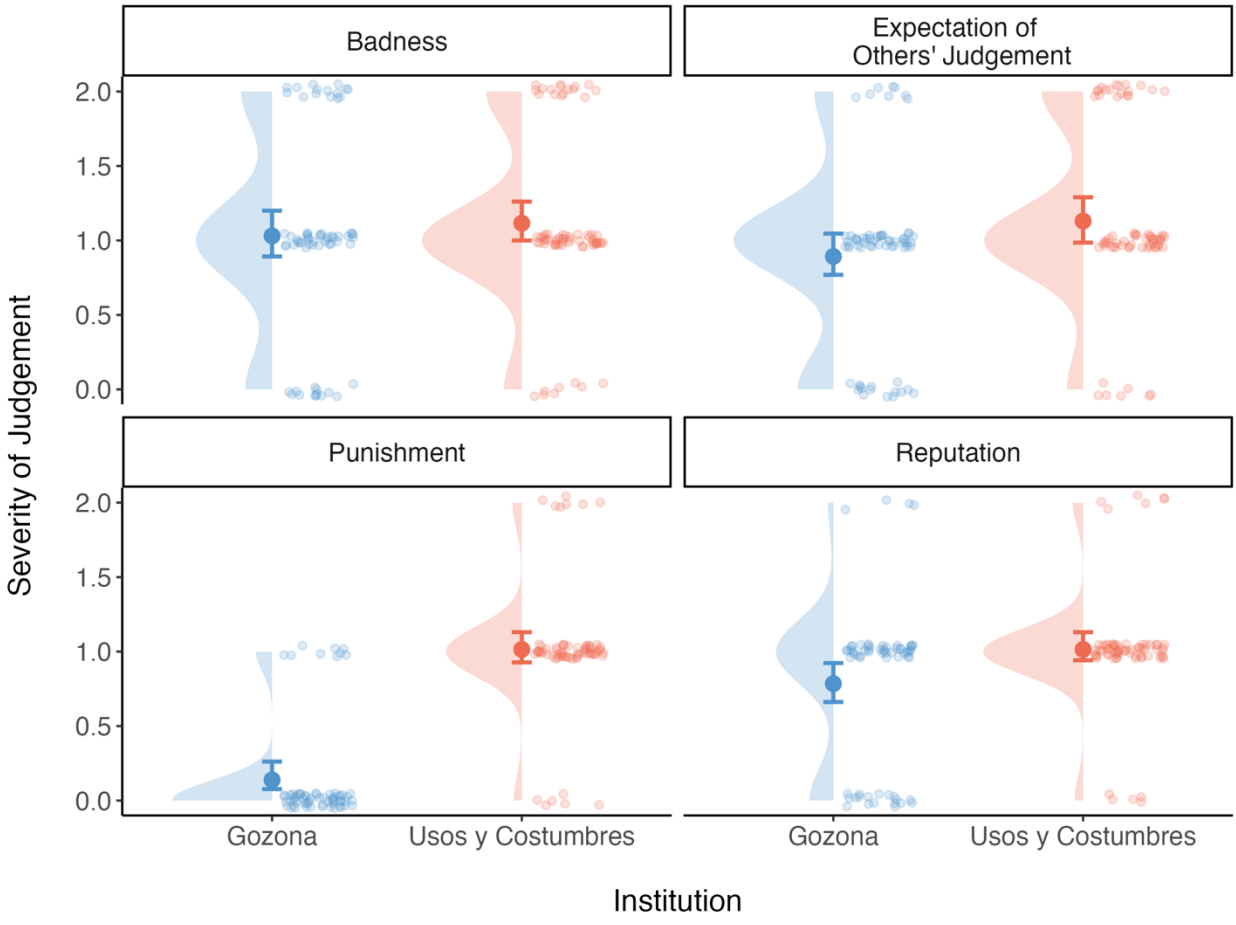

Figure 2. Severity of judgements about *gozona* and *usos y costumbres* norm violations. Pooling across three *gozona* (blue) and three *usos y costumbres* (red) vignettes, panels show judgements about how bad the action was; how bad other community members would think it was; how bad of a person others would judge the protagonist to be; and how severely he/she should be punished. A score of "0" corresponds to a neutral judgement, "1" corresponds to "bad"/ "punished", and "2" corresponds to "very bad"/ "highly punished". Large points represent averages, with error bars representing bootstrapped 95% confidence intervals. Raw data (small points) and distributions (half violin) are also plotted.

4.2 Norms correspond to domain-specific cooperation

Gozona and *UyC* norms apply only to specific contexts. The severity of participants' normative judgments about *gozona* and *UyC* is associated with a greater willingness to cooperate within each respective domain– but not with general prosocial inclinations (generalized altruism). Figure 3A shows that, among women, a one standard deviation increase in our *Gozona* Judgment Index is associated with a 0.35 standard deviation increase (95%CIs[0.00, 0.70]) in people's willingness to offer *gozona* to a new widow. This suggests that women who hold stronger norms about *gozona* are more likely to participate in *gozona*. Figure 3B shows that, among men, a one standard deviation increase in *UyC* Judgment Index is associated with a 0.21[0.05, 0.37] standard deviation increase in *UyC* participation– self-reported frequency of attending Communal Assembly, attending *tequio*, and willingness to attend an emergency *tequio* to fix a washed-out road. This suggests that men who hold stronger norms about *UyC* are more motivated to participate in their duties as citizens of Yateé.

In Figure 3C, we see that neither the *Gozona* Judgment Index ($\beta = -0.15[-0.53, 0.22]$) nor the *UyC* Judgment Index ($\beta = -0.27[-0.58, 0.03]$) is positively associated with general willingness to help a community member. If anything, *UyC* Judgment Index may be *negatively* associated with this measure– participants who make harsher judgments about *UyC* norm violations report less willingness to help a community member who might never return the help. Similarly, neither index is associated with willingness to donate to the family of a sick child (*Gozona*: $\beta = 0.02$ [–0.44, 0.49]; *UyC*: $\beta = -0.06$ [–0.40, 0.28]). This suggests that the relationship between norm judgements and willingness to cooperate in *gozona* or *UyC* can be explained neither by demand effects, nor by general prosocial inclinations. If demand effects or generalized altruism were driving the results,

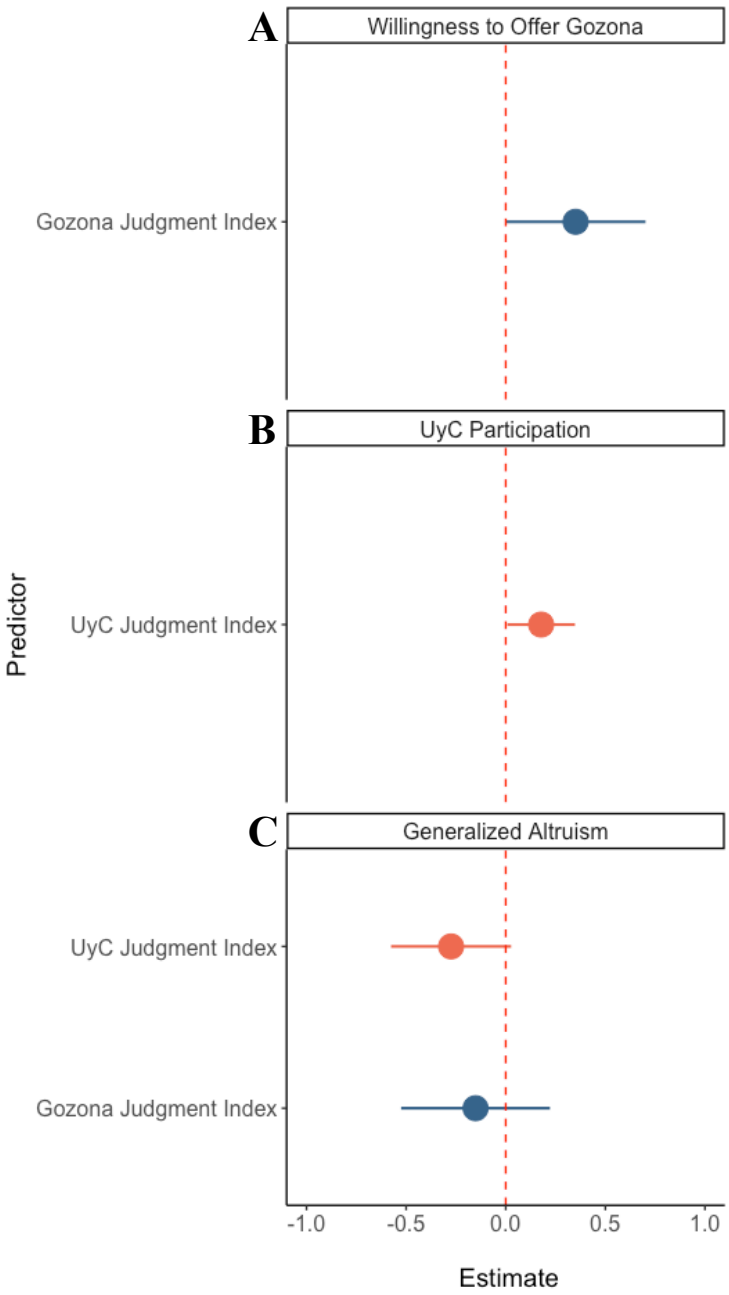

Figure 3. Normative beliefs about *gozona* and *usos y costumbres* are associated with domain-specific, but not generalized, prosociality. Plots show coefficients and 95% confidence intervals from LMER models with random intercepts for participant. **(A)** Coefficients on the *Gozona* Judgment Index when predicting willingness to offer *gozona* to a new widow (2 observations of outcome per participant from several months apart). **(B)** Coefficients on the *Usos y Costumbres* Judgment Index when predicting self-reported frequency of attendance at Communal Assembly, self-reported frequency of attendance *tequio*, and willingness to attend an emergency *tequio* (stacked outcomes, three observations per participant). **(C)** Coefficients on the *Usos y Costumbres* Judgment Index and *Gozona* Judgment Index when predicting willingness to help a community member, even if they could never return the help (2 observations of outcome per participant from several months apart). Models in panels A and C include controls for education, age, and material security. The model in panel B includes controls for education, wage labor, and age above 65. All variables are standardized.

we'd expect to see positive associations between norm judgements and other measures of prosociality. Instead, these results suggest that *UyC* and *gozona* norms drive domain-specific cooperation, consistent with our hypothesis.

4.3 How are these norms sustained, given than that they involve costly actions?

People spend time, energy, and money to participate in *UyC* and *gozona*, while foregoing opportunities and risking injury (e.g. clearing landslides). Participants were clear about these costs: for example, in describing *UyC,* informants spoke strongly of service as a "burden." When asked whether people "like" serving *cargos*, very few informants agreed, despite the potential for an interview demand effect. While several mentioned feeling pride in serving their town, most responses invoked obligation, for example: "whether you want to or not, it's required", "it's not that they like it– it's obligatory", "*cargos* are very burdensome, very difficult", and "no one escapes from *cargos*." Given these costs, why do the people of Yateé continue to cooperate in these domains? How are *gozona* and *UyC* norms sustained? Here, we explore this question.

4.3.1 Reputation (indirect reciprocity)

In indirect reciprocity, individuals modulate their behavior towards a target based on that target's past record– that is, their reputation. When a person violates a cooperative norm, their reputation suffers, leading to targeted exploitation (negative indirect reciprocity, Bhui et al. 2019) or loss of future help (positive indirect reciprocity, Panchanathan and Boyd 2004). The threat of these outcomes motivates adherence to the costly, cooperative norm. In line with formal models (Panchanathan and Boyd 2004; Bhui et al. 2019), lab-based experiments (Nowak and Sigmund 2005), and studies in small-scale societies (Glowacki and Lew-Levy 2022) that demonstrate the

power of indirect reciprocity to stabilize cooperation, we found that reputation plays a role in both *UyC* and *gozona.*

First, ethnographic evidence suggests that defections are socially costly. Men who fail to adequately fulfill their *UyC* duties lose social status. For example, several informants relayed the story of a man who recently served as one of the Authorities. The community judged his performance as unsatisfactory. The Assembly voted to briefly throw him in jail and has since then rejected him– he has lost his right to speak in assemblies; no group accepts him; he is not called to *tequio*; and it is unclear if he will ever serve his final *cargo*. Describing another recent case in which a top *cargo*-holder failed to adequately fulfill his duties, one informant described the man's great shame and loss of social standing, explaining, "No one pays attention to him, because his image is tarnished– he fell very low." The reputational costs of defecting in *UyC* are heavy.

Likewise, community members who defect in *gozona* suffer social consequences. Some informants reported that community members would withhold support from a person who fails to reciprocate *gozona*. For example: "The people say that it isn't fair, so the people don't go when [the defector] needs a favor." According to some, this is also true of people who consistently fail to offer *gozona*– they will not receive help when they need it. In contrast, informants agree that people who do lots of *gozona* get lots of support in return.

Vignette data presented in Figure 2 corroborate this ethnographic evidence, showing that defections in *gozona* and *UyC* damage a person's reputation. Participants reported that community members would think that an *UyC* defector was a "bad" person (mean judgment = 1.01, BCI[0.94, 1.13]) and a *gozona* defector was a somewhat bad person (mean = 0.78[0.66, 0.92]).

Our vignette data also confirm that *gozona* defections can lead to the loss of future support. On average, *gozona* defectors were judged to be somewhat unlikely to receive future support

(mean = 0.55[0.25, 0.86]). Moreover, *gozona*-related reputational damage predicts expected loss of future help. A one standard deviation increase in expected reputational damage is associated with 0.28[0.07, 0.52] standard deviation decrease in the expected likelihood that the protagonist will receive future help. In contrast, expectations of others' judgments about how bad the action is does not strongly predict likelihood of future help ($\beta = 0.14$[–0.07, 0.36]). So, the effect is specific to expected reputational damage, providing compelling evidence that *gozona* social norms are stabilized by positive indirect reciprocity.

In line with predictions from formal models of norm stabilization via indirect reciprocity (Panchanathan and Boyd 2004; Bhui et al. 2019), gossip[1] is an important mechanism for disseminating information about who cooperates and who does not. People keep a keen eye out for non-cooperators, particularly in the context of *UyC*; in the words of one informant, "the community is watching." When they observe something that doesn't meet their standards, they gossip and complain about it. For example, when the Authorities committed an error involving the mismanagement of town funds for a public works project, this was the topic of intense discussion, spilling into several assemblies. While ultimately resolved, informants reported that the Authorities' image was "very badly tarnished." Although less evidence about *gozona* emerged, informants suggested that "everybody knows" who helps and who does not, suggesting a substantial role for gossip.

4.3.2 Punishment

In punishment, individuals pay a cost to sanction a violator. The threat of facing punishment for defecting motivates individuals to adhere to cooperative norms. Formal modeling

[1] Following standard practice in the evolution of cooperation literature, we use the term "gossip" to refer to communication about a person that may be relevant to their value as a cooperative partner.

has revealed that punishment can stabilize cooperation in a variety of ways, including when people copy each other's tendency to punish (Henrich and Boyd 2001); people can coordinate their punishment (Boyd et al. 2010); groups pool resources beforehand to ensure violators are sanctioned (Sigmund et al. 2010); punishment acts as a costly signal of trustworthiness (Jordan et al. 2016); or there are graduated sanctions with the possibility of ostracism for repeat offenders (Noblit and Henrich 2023). Our data show that punishment is an important stabilizing mechanism in *UyC*, but not *gozona.*

The topic of sanctions frequently arose in interviews and casual conversation about *UyC.* Some violations merit a predetermined sanction meted out by the citizen's group or Authorities, while others are punished by the Assembly's collective decision. Cash fines are the most common sanction. For example, each group annually decides how much to fine their members for missing *tequio* or assembly, ranging from $100MXN(~$5USD) - $300MXN(~$15USD) in 2022. Each group self-polices, collects fines, and redistributes the money within the group, rewarding those who attended everything with the largest share– a stick and a carrot. Highlighting the institutionalized nature of these sanctions, vignette free responses revealed high agreement about what sanction would be appropriate for skipping an emergency *tequio*: 81% said the protagonist should be fined and 10% said he should be fined and jailed. Meanwhile, the Assembly collectively punishes the Authorities for errors, with recent examples including steeply fining them for mismanaging community funds (S4.5); fining and removing an *agente* from his *cargo* due to alcoholism; shaming and removing an *agente* from his *cargo* for failing to fulfill ritual duties; and jailing and stripping an *alcalde* of his rights as a citizen after a bad performance.

Repeat offenders are subject to graduated sanctions. For example, migrants living in Los Angeles sometimes refuse to serve their required *cargos*. The first couple of times that a migrant

refuses, the Assembly fines him $15,000MXN (~$840USD). If he continues to refuse, the community cuts his house's access to water and sewerage. If he still refuses, he is formally expelled from the community, meaning that he may never return; his family cannot sell or transfer ownership of his lands; and he cannot be buried in the town cemetery (whereas most migrants are repatriated for burial). The community most recently expelled a migrant for repeatedly refusing to serve *cargos* in 2017. Vignette free responses about what punishment would be appropriate for refusing to serve a *cargo* capture the variation in possible sanctions on this graduated scale: 60% mentioned fines, 15% service cutoff, and 10% expulsion.

Vignette data confirm that sanctioning is an integral element of *UyC*, but not *gozona*. While norm violations in these two domains were judged as similarly bad and reputation-damaging, only *UyC* violations were judged as punishment-worthy. Nearly all participants thought that *UyC* violations should be punished, while very few thought that *gozona* violations should be punished (Figure 2). Responses to the control vignettes, which were presented to both men and women, suggest that this difference cannot be explained by sex differences in people's willingness to punish (see S4.6). Rather, this pattern seems to reflect a real difference in the role of punishment in these two institutions.

Based on our data, we can only speculate about how punishment stabilizes cooperation in the context of *UyC*. Given that some decisions about punishment are made by the Assembly, coordinated punishment (Boyd et al. 2010) seems likely. During an assembly, citizens voice their opinions, including suggesting specific punishments for the violation under discussion. Others signal approval with whistles and cheers. This broadcasting of intent to punish is a key feature of coordinated punishment, where individuals only punish when others signal their intent to do so (Boyd et al. 2010). Ultimately, citizens vote by raised hand, providing a final opportunity to

confirm that others are choosing to punish. We also see compelling evidence of ostracism (Noblit and Henrich 2023) in the system of graduated sanctions with the possibility of expulsion from the community; and for pool-punishment (Sigmund et al. 2010) in the institutionalized nature of some sanctions.

Finally, while third-party mediation (Singh and Garfield 2022; Wiessner 2020) exists in Yateé (Table 1; S4.7), we found no evidence for third-party mediation in the enforcement of *UyC*.

4.4 Do these institutions tap aspects of human evolved psychology?

In addition to stitching together different cooperation-sustaining mechanisms, cultural evolutionary theory suggests that institutions can exploit features of our evolved psychology to further enhance cooperation (Henrich and Muthukrishna 2021). Here, we show that *gozona* norms likely tap evolved psychologies for direct reciprocity and interdependence. Meanwhile, we find little evidence that *UyC* norms harness evolved psychology.

4.4.1. Gozona *harnesses an evolved psychology for direct reciprocity*

Research in small-scale societies (Jaeggi et al. 2016; Ready and Power 2018; Apicella et al. 2012) suggests that direct reciprocity– the tendency to cooperate with repeated interaction partners– plays an integral role in dyadic cooperation. Because *gozona* is a reciprocity-based institution, norms for *gozona* likely tap evolved psychology for direct reciprocity. The clearest evidence comes from the fact that people use notebooks to meticulously record the *gozona* that they receive when they host a celebration or funeral. As they "return the help"– a process that may take years– they cross names off the list. This suggests a strong role for tit-for-tat accounting in celebration *gozona*, facilitated by cultural technology (written records). Similar systems have been observed in other societies, such as funeral gifting among the Chaldeans (Henrich and Henrich

2007). Illustrating that people in Yateé think about *gozona* in terms of direct reciprocity, one informant laid it out clearly: "If the person doesn't return the favor, well, why would I go help them again? I won't go anymore. If he came to help me, I'll return the favor. If we went once and they didn't return the favor, there ends the circle of *gozona*." Crucially, people use this tit-for-tat approach in the context of *gozona*, but not in all the other domains of life where it might apply.

There is some evidence that third parties play a role in stabilizing *gozona* direct reciprocity. Formal models have revealed that direct reciprocity is not particularly stable under realistic real-world conditions, including when partners make alternating rather than simultaneous decisions (Park et al. 2022) and when perception errors are frequent (Boyd and Mathew 2021). In communities with shared norms, third-party adjudication can stabilize otherwise flimsy direct reciprocity (Boyd and Mathew 2021). As we've seen in the vignette results, people in Yateé take an interest in *gozona* violations in which they are not involved– judging these violations and the perpetrators as "bad". Free responses further reveal that third parties strongly disapprove when someone fails to reciprocate *gozona*. Responding to the vignettes in which someone failed to reciprocate celebration *gozona* or harvest *gozona*, 41% and 60% of participants, respectively invoked reciprocity. Comments included, "it's bad, one must know how to reciprocate support" and "it was bad because he agreed to do *gozona*– he had to return the favor, or close the *gozona*". Together, this evidence suggests that social norms, operating via third-party observers, help stabilize *gozona* direct reciprocity.

However, direct reciprocity does not seem to play a role in *UyC.* A priori– and based on theory (Boyd and Richerson 1988)– there is little reason to expect that direct reciprocity would be involved in *UyC*, since this institution facilitates larger-scale cooperation rather than dyadic

cooperation. Indeed, ethnographic interviews yielded no evidence of direct reciprocity in *UyC* and no one alluded to direct reciprocity in *UyC* vignette free responses.

4.4.2 Gozona *and* usos y costumbres *norms may tap interdependence psychology*

Researchers have theorized that humans have an evolved "interdependence psychology" that fosters cooperation between people whose fitnesses are intertwined(Aktipis et al. 2018; Fiske 1992; Roberts 2005; Tomasello et al. 2012; Henrich and Muthukrishna 2021). Fitness interdependence can emerge in many ways, including sharing genes, sharing offspring, and living in a group that pools risks and benefits (Cronk, Steklis, et al. 2019). Some have argued that interdependence psychology arose via gene-culture coevolution. According to this hypothesis, the cultural evolution of norms and institutions that pool risks, costs, and benefits within a group created selection pressures for the capacity to recognize and cooperate with those on whom one's fitness depends (Henrich 2020; Henrich and Muthukrishna 2021; see S1.3.3). Institutions that create (1) relationships based on mutual aid, sharing, or exchange or (2) corporate groups with shared rights and obligations are hypothesized to foster interdependence (Cronk, Steklis, et al. 2019; Henrich 2020).

Ethnographic evidence suggests a role for interdependence psychology in both *gozona* and *UyC. Gozona* constructs a web of reciprocal relationships, making it a good candidate for building interdependence within a community. Speaking to this, in her discussion of *gozona* and other reciprocal institutions in the Zapotec community of Talea de Castro, Nader (1964) argued that these institutions build complex networks of "cross-linkages" between community-members. Similarly, Zapotec scholar Luna's (2010) description of the Zapotec worldview evokes something akin to a psychology of interdependence, highlighting the importance of cooperation, reciprocity, and solidarity (which he later links to *gozona*, p. 90-91):

> *"Being born in small human settlements allows us to experience the need for collective survival. In other words, being born in small communities linked to the land made cooperation, reciprocity, [and] solidarity naturally occurring elements of human relationships, and with this, "the we" flourished in the mind, because in truth we depended on others, we could live thanks to others."* (p. 33, translated from Spanish)

While we do not have social network data on *gozona*, anecdotal evidence indicates that *gozona* networks are dense. Several informants relayed how many people had offered *gozona* when they hosted a *convivio*. At the low end, one informant reported that 26 people did *gozona* when he and his wife voluntarily hosted a *convivio* to celebrate a saint's feast. At the high end, another informant relayed that 90 people did *gozona* when she and her husband hosted an obligatory *convivio* as part of his *cargo*. According to the 2010 census, 26 people constitute about 8% of adults in Yateé or representation from 15% of households, while 90 people constitute about 25% of adults or just over 50% of households. Given that there are many *convivios* each year, these numbers indicate that the people of Yateé are enmeshed in a dense network of *gozona* relationships.

Moreover, *gozona* is relevant to fitness. *Gozona* is reserved for contexts where the goal cannot be accomplished alone or by a nuclear family: feeding the community, building a house, and doing labor-intensive agricultural work. Building a house and doing subsistence agriculture tasks have clear fitness impacts– one cannot live a healthy life without shelter and food. We argue that celebration *gozona* also impacts fitness by alleviating economic strain on *cargo*-holders (see S4.8 for an ethnographic example).

UyC also likely build interdependence within the community. First, through the collective effort of male citizens, *UyC* facilitate the provisioning of fitness-relevant public goods such as clean drinking water, well-maintained streets and footpaths on steep terrain (Figure S9), and the

communal mill for daily grinding of corn (the staple food). Second, under *UyC*, Yateé functions as a corporate group that collectively owns resources such as land and water. Collective resources are administered by three *cargo*-holders who form the Commissariat of Communal Lands (Table 1 notes). These resources are fitness-relevant. Although subsistence agriculture has waned in recent decades, 86% of our sample of 42 households reported cultivating at least one crop in the past year. In addition, residents rely on communally owned forests for gathering firewood, the primary cooking fuel. The communally owned resources also include sand and gravel extracted from the river, which are used in and sold to fund public works projects (Figures S10, S11). Highlighting the importance of communal resources, many indigenous Oaxacan towns have long histories of violent inter-community conflict over land (Dennis 1987; Yannakakis 2008; López-Bárcenas 2004) (S4.9). Yateé's most recent violent intergroup conflict dates to the mid-1990s, although simmering tensions persist with the closest neighboring community.

4.4.3 Quantitative evidence suggests a role for interdependence in gozona

Vignette and survey data suggest that interdependence is implicated in *gozona*. First, women who feel more interdependent with the community hold stronger normative beliefs about *gozona*. A one standard deviation increase in Shared Fate Index, a psychological measure of perceived fitness interdependence (Ayers et al. 2023), is associated with a 0.54[–0.08, 1.16] standard deviation increase in *Gozona* Judgement Index. Second, in the full sample of participants who completed the survey (men and women, $N = 48$), Figure 4 shows that a one standard deviation increase in Shared Fate Index is associated with a 0.30[0.07, 0.53] standard deviation increase in likelihood of offering *gozona* to a newly widowed woman. This suggests that people who feel more interdependent with the community are more inclined to participate in *gozona*. Shared Fate Index is also positively associated with likelihood of donating money to the family of a sick child,

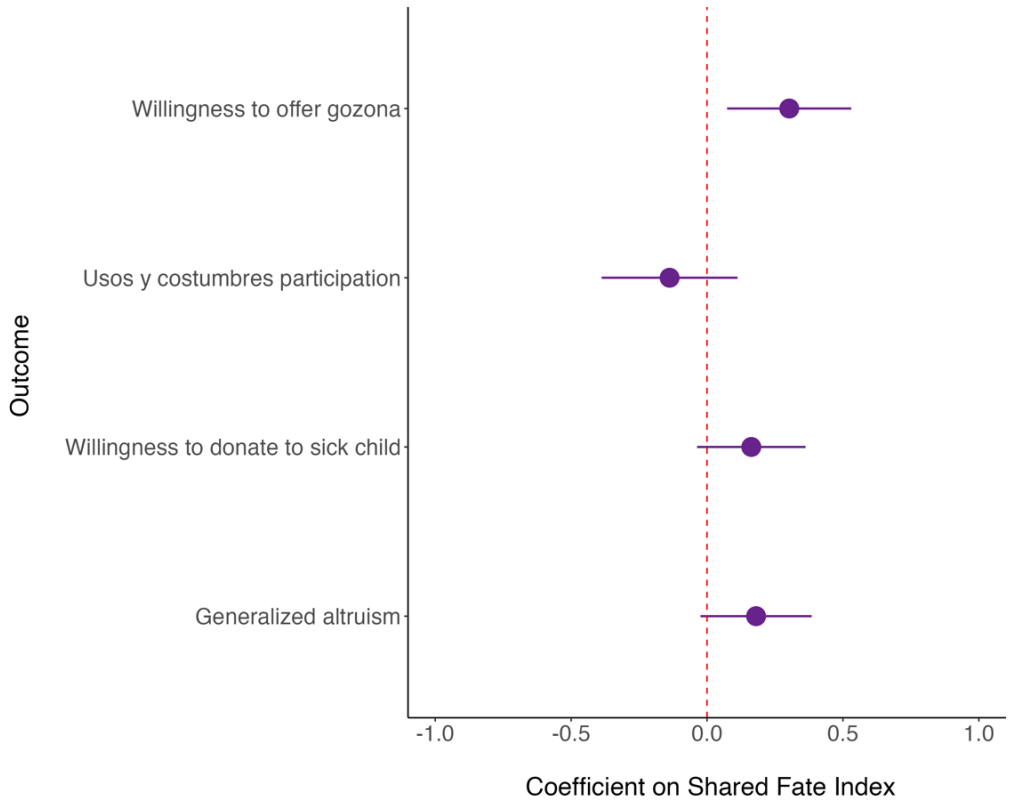

Figure 4. Shared Fate Index is associated with willingness to offer *gozona*, but not participation in *usos y costumbres* activities. Plots show coefficients on Shared Fate Index and 95% confidence intervals from LMER models with random intercepts for participant. Models predicting willingness to offer *gozona*, willingness to donate, and generalized altruism include controls for education, age, and material security (2 observations of outcome per participant from several months apart). The model predicting *usos y costumbres* participation among men stacks self-reported frequency of attendance at Communal Assembly, self-reported frequency of attendance *tequio*, and willingness to attend an emergency *tequio* (three observations total per participant). This model includes controls for education, wage labor, and age above 65. All variables are standardized.

not a traditional context for *gozona* (β = 0.16[–0.04, 0.36]) and general willingness to help (β = 0.18[–0.02, 0.39], although these coefficients are smaller and the 95% confidence intervals include 0 (Figure 4). All in all, these results suggest that interdependence psychology is intertwined with *gozona*, and may explain broader prosocial inclinations.

However, quantitative analyses provide no evidence that interdependence is implicated in *UyC*. The coefficients linking the Share Fate Index to both the severity of judgements about *UyC* violations and participation are small, negative, and poorly estimated. Given the ethnographic context, the lack of association between perceived interdependence and *UyC* is surprising.

However, the formalization and severity of exogenous punishment may deplete people's intrinsic motivation arising from a sense of interdependence (Bowles 2008).

5. Conclusions

In this paper, we integrated ethnographic and quantitative data to explore how two institutions sustain cooperation within a Zapotec village. We found clear evidence that both *gozona* and *usos y costumbres* are governed by social norms that drive context-specific cooperation. In contrast, these norms were not associated with generalized prosociality. This finding is inconsistent with the view that human cooperation results purely from genetically evolved cognitive capacities such as kin altruism or direct reciprocity. Moreover, results revealed that these institutions exploit distinct but overlapping sets of mechanisms to stabilize cooperation. Both institutions harness indirect reciprocity (reputation). Meanwhile, direct reciprocity plays an important role in *gozona*, while punishment is integral to *usos y costumbres*. Although ethnographic evidence strongly suggests that both *gozona* and *usos y costumbres* build interdependence, quantitative analyses present a murkier picture, yielding evidence of a role in *gozona* alone. Overall, this study provides support for cultural evolutionary theory, which suggests that as cooperative institutions culturally evolve, they stitch together different cooperation-sustaining mechanisms. We also shed light on the rich diversity of culturally evolved institutions– even within a single, small-scale society, different institutions exploit different mechanisms to stabilize cooperation.

Social structure in Yateé is not static– the future will look different than the present, which already looks different from the past. Several forces are eroding *gozona* and *usos y costumbres*. Market integration, and associated increases in wealth and wage labor, are undermining *gozona*.

Housebuilding *gozona* has already disappeared, replaced by several paid construction workers– a pattern that has also been observed in other Sierra Norte towns (Beltran Morales 1982). Informants report that harvest *gozona* is likewise declining. One probable reason is that subsistence agriculture is slowly being replaced by wage labor, whether locally or as a migrant. While most households still cultivate, few entirely rely on subsistence agriculture. Informants often spoke of the need for harvest *gozona* in the past because there was no money to pay workers. Meanwhile today, some people decline to do harvest *gozona* because they would prefer to be paid as day-laborers.

Similarly, market integration and migration are slowly undermining *usos y costumbres*. The *cargo* system, wherein men provide years of free labor to the community, is antithetical to full participation in a market economy. So far, Yateé's men appear to be balancing the opposing demands of achieving economic prosperity while serving the community. Relatively few men do wage labor while living in Yateé, but the vast majority migrate to work elsewhere at some point. In a sample of 29 men, only 28% reported currently doing any wage labor, but 86% had a history of outmigration. Informants spoke of carefully planning their *cargo* careers– trying to fulfill several posts in rapid succession during youth, leaving to earn money for several years, then returning to finish the ladder. Although migrants are regularly named to *cargos*, some refuse to return, and many informants lamented the challenges of filling *cargo* positions with an ever-dwindling pool of men. Whether Yateé's *cargo* system someday crumbles or adapts to the new socioeconomic landscape, there is little doubt that it will change.

Broadly, these dynamics suggest an interesting tradeoff. While market integration may expand the sphere of cooperation, fostering greater impersonal prosociality (Henrich et al. 2010, 2001; Rustagi 2023), it may come at a cost to smaller-scale cooperation within the community, as local, culturally evolved institutions that sustain cooperation slowly erode.

7. Acknowledgements

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Supplementary materials for:

Zapotec cooperative institutions: Exploring the psychological and social mechanisms

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S1. Theoretical background

S1.1 Norms psychology, norms, and cooperation

Cultural evolutionary theory suggests that the emergence of social norms in early human groups drove the co-evolution of social learning capacities and cognitive tools specialized for dealing with norms ("norm psychology"). Humans are primed to recognize, remember, and adopt norms, as well as to identify and punish norm violations (Chudek & Henrich, 2011). Supporting the idea that these capacities are innate, norm psychology comes online early in development– by 18 months, children have already developed normative expectations, and by 3 years they actively follow and enforce norms (Schmidt et al., 2019; Schmidt & Tomasello, 2012). Because of our evolved norm psychology, social norms and institutions can infiltrate human minds, molding psychology and behavior. Norm psychology allows the mind to adapt to the local institutional environment over the course of ontogeny. During this process, norms can become internalized, transforming into proximate motivations, heuristics, and preferences. When this happens, adherence becomes automatic; we must "think" in order to break the norm (Chudek & Henrich, 2011; Henrich, 2016; Rand, 2016).

Our norm psychology facilitates cooperation in response to cooperative norms. Recent cross-cultural research on children has charted the coincident emergence of prosocial behavior and attention to prosocial norms across development. Children across diverse societies show similar patterns of prosociality early in development. However, they begin to diverge towards local adult behavior during middle childhood, around the same time that they become responsive to novel norms about prosociality (House et al., 2013, 2020). This suggests an important role for norm psychology and social norms in shaping prosociality and generating cross-cultural variation in prosocial behavior. Other work has specifically demonstrated the power of internalized norms to

influence prosocial behavior. For example, many researchers use anonymous, one-shot behavioral economics games to study the relationship between institutions and prosociality (Henrich et al., 2001, 2010; Purzycki et al., 2016; Rustagi, 2023). Because these games involve no possibility of punishment or reputational damage, behavior in this context is thought to reflect intrinsic motivation– internalized norms (Henrich & Ensminger, 2014). Further evidence comes from studies using time pressure. When forced to make allocation decisions quickly, WEIRD participants exhibit greater cooperation in a one-shot Public Goods Game (Rand et al., 2012). This again highlights the role of internalized norms– emerging here as quick, automatic allocation decisions– in directing prosocial behavior.

S1.2 But how are cooperative norms sustained?

Norms can foster cooperation– but what sustains these norms? A norm that demands individuals pay a cost to benefit the group can easily collapse. To see why, imagine a group of fishermen trying to preserve a dwindling fish stock. They devise a rule: each fisherman can catch no more than 100lbs of fish per week. On his boat, Mark faces a decision. Should he follow the rule and limit his catch, meaning less income for his family? Or should he ignore the rule, catch as many fish as possible, and reap the benefits of a good payday? Assuming everyone else follows the rule, Mark stands to gain a lot by defecting– the fish stocks will remain healthy, but his income will increase. Unfortunately, every fisherman is making the same calculus. In this classic collective action problem, free-riders quickly swamp cooperators and the public good crumbles. No one adheres to the fishing limit, the fish population crashes, and everyone is worse off. In the face of these dynamics, how are cooperative norms sustained?

Formal evolutionary modeling has identified several mechanisms that can stabilize costly behaviors. Although the models were originally devised specifically to understand the emergence

of cooperation, the results indicate that the mechanisms that sustain cooperation can, in fact, sustain *any* similarly costly behavior. Thus, in a broader sense, these models reveal the mechanisms that maintain costly norms– including cooperative norms (Henrich & Muthukrishna, 2021). Cultural evolutionary theory suggests that, as cooperative institutions culturally evolve in different social and ecological settings, they harness different cooperation-sustaining mechanisms (Henrich & Muthukrishna, 2021).

S1.2.1 Indirect reciprocity and reputation

One set of formal models highlights the role of indirect reciprocity in stabilizing cooperative norms. Here, individuals modulate their behavior towards a target based on that target's past record– that is, their reputation. In its simplest form, termed *negative* indirect reciprocity, communities tolerate the exploitation of members with a bad reputation. For example, when someone earns a bad reputation for stealing from his neighbor or failing to contribute in a cooperative task, others can steal *his* crops without facing any consequences (Bhui et al., 2019). In *positive* indirect reciprocity, individuals decline to help those with a bad reputation, instead offering help only to well-reputed group members. Formal modeling shows that both negative (Bhui et al., 2019) and positive (Panchanathan & Boyd, 2004) indirect reciprocity can sustain group cooperation. When a person violates a cooperative norm, their reputation suffers. The threat of targeted exploitation or loss of future help motivates adherence to the cooperative norm. Evidence from lab-based experiments with behavioral economics games (Nowak & Sigmund, 2005) and studies in small-scale societies (Glowacki & Lew-Levy, 2022) indicate that indirect reciprocity and reputation play a significant role in human cooperation.

S1.2.2 Costly punishment

A second set of formal models emphasizes the power of costly punishment for sustaining cooperative norms. Punishment involves paying a cost to sanction a violator. This contrasts with indirect reciprocity, wherein individuals pay no cost to sanction– they merely withhold help or even benefit by exploiting the violator. The threat of facing punishment for defecting motivates individuals to adhere to cooperative norms. However, the possibility that people will decline to pay a cost to punish non-cooperators– termed "second-order free-riding"– poses a challenge to costly punishment models.

Nonetheless, models have overcome this challenge to show that costly punishment can sustain cooperation in many ways. For example, conformist transmission can stabilize cooperation as people copy each other's tendency to punish (Henrich & Boyd, 2001). Cooperation is also sustained when people can coordinate their punishment, only following through when enough group members have signaled an intent to punish (Boyd et al., 2010). Punishing is also effective when it acts as a costly signal of trustworthiness, enhancing the reputation of the punisher and increasing the likelihood that other cooperators will choose to partner with them (Jordan et al., 2016). Finally, light or graduated sanctions with the possibility of ostracism for repeat offenders– a pattern that recurs in many small-scale societies– has recently been shown to effectively stabilize cooperation (Noblit & Henrich, 2023).

S1.3 Institutions can harness features of evolved psychology

In addition to stitching together different cooperation-sustaining mechanisms, cultural evolutionary theory suggests that institutions can exploit features of our evolved psychology (Henrich & Muthukrishna, 2021). The human mind has several evolved capacities that can be harnessed to support cooperation beyond close kin and repeated interactants.

S1.3.1 Kin altruism

Kin altruism– a tendency to help one's blood relatives– is a genetically-evolved foundation of human cooperation. Born out of formal modeling (Hamilton, 1964), kin selection theory has been repeatedly supported by empirical research. For example, social network-based studies have found that as genetic relatedness increases, so does the probability of food sharing (Kangiqsujuaq Inuit: Ready & Power, 2018) and gifting-giving (Hadza: Apicella et al., 2012). Kin-based institutions tap kin altruism, reinforcing, directing, and expanding it. In unilineal kinship systems, for example, culturally-acquired norms about who constitutes "family" direct kin altruism towards one parent's kin, and suppress it towards the other's. At the same time, kinship systems can expand kin altruism to encompass non-genetic relatives, such as affines and fictive kin (Henrich, 2020; McNamara & Henrich, 2017).

S1.3.2 Direct reciprocity

Direct reciprocity, or the tendency to cooperate with a repeated interaction partner, is another genetically evolved feature of the human mind. Evidence from formal modeling (Axelrod & Hamilton, 1981), research with non-human primates (Jaeggi & Gurven, 2013) and studies in small-scale societies (Apicella et al., 2012; Jaeggi et al., 2016; Jaeggi & Gurven, 2013; Ready & Power, 2018) suggest that reciprocity plays an integral role in dyadic cooperation, independent of kinship. Direct reciprocity in humans can take the form of in-kind exchange (e.g. meat for meat), but also complex reciprocal trade (e.g. meat for labor) (Jaeggi et al., 2016). Fiske (1992) identifies reciprocity (which he calls "equality matching") as one of four possibly universal forms of human social relationship.

Norms and institutions can harness reciprocal altruism and shape patterns of reciprocity (Henrich & Muthukrishna, 2021). For example, developmental psychologists have documented

that hearing normative stories about positive reciprocity can increase children's tendency to offer a sticker to an agent who gave them a sticker in the past (Chernyak et al., 2019). Moreover, the ontogeny of positive reciprocity differs across cultures, suggesting a role for norms (House, 2017). Institutions that create relationships based on reciprocity, such as mutual aid institutions, likely tap reciprocal altruism.

S1.3.3 Interdependence psychology

Finally, researchers have theorized that humans have an evolved "interdependence psychology" that fosters cooperation between people whose fitnesses are intertwined (Aktipis et al., 2018; Balliet et al., 2017; Barclay, 2020; Fiske, 1992; Henrich & Muthukrishna, 2021; Roberts, 2005; Tomasello et al., 2012). Fitness interdependence can emerge in many ways, including sharing genes, sharing offspring, and living in a group that shares risks and benefits (Cronk, Steklis, et al., 2019). Some have argued that interdependence psychology arose via gene-culture coevolution. According to this hypothesis, the cultural evolution of norms and institutions that pool risks, share costs, and spread benefits within a group created a selection pressure for the capacity to recognize and cooperate with those on whom one's fitness depends (Henrich, 2020; Henrich & Muthukrishna, 2021). At the most basic level, consider meat-sharing norms in mobile hunter-gatherer groups. Hunting is a high-risk, high-reward foraging strategy; most hunters successfully make a kill on only a small proportion of days (Hill & Hurtado, 2009). When game is shared among the entire band, the fitnesses of band members become entangled. For example, the health and well-being of the children of Hunter A depend in part on Hunter B. If Hunter B falls ill, the groups' collective hunting returns will diminish, and the calorie intake of Hunter A's children will decline. So, the fitness of Hunter A and his children depend in part on Hunter B. Expanding the circle, if Hunter B's wife can nurse him back to health, *her* health and survival also

contribute to the fitness of Hunter A and his children. Thus, social norms and institutions, such as those governing food sharing, can create situations in which the fitnesses of even indirectly connected individuals become intertwined. In this setting, selection should favor (i) the ability to assess one's fitness interdependence with others, perhaps via cues like eating together, working together, and sharing social ties, and (ii) the tendency to help and support those on whom one's fitness depends (Henrich, 2020; Henrich & Muthukrishna, 2021). Given that risk-pooling norms like food sharing have long been part of the human repertoire, this line of reasoning suggests that humans evolved an interdependence psychology.

Once such a psychology is in place, certain kinds of institutions may trigger it. First, researchers have suggested that institutions that create relationships based on mutual aid, sharing, or exchange should generate interdependence (Cronk, Steklis, et al., 2019; Henrich, 2020). Beyond establishing reciprocity-based prosociality between partners, these institutions should generate broader interdependence within groups where mutual support is widespread. If you have an exchange partner on whom you depend in times of need, and that partner has other partners in the community on whom *they* depend, you should be concerned about the well-being of those other partners; their fitness is intertwined with yours. Second, institutions that create corporate groups with shared rights and obligations should foster interdependence (Cronk, Steklis, et al., 2019; Henrich, 2020). For example, when groups collectively control and protect important resources such as agricultural lands or herds of cattle, each member's ability to contribute to productivity and defense impacts the well-being of other group members.

S1.4 Summary

In this section, we have introduced a cultural evolutionary framework for understanding how institutions shape cooperation. We argued that the norms that comprise institutions can be

internalized, transforming cooperative rules into proximate preferences. We also identified a series of psychological and social mechanisms that institutions can tap to sustain and further enhance cooperation, even in the absence of norm internalization. We highlighted the roles of indirect reciprocity (reputation), punishment, and evolved psychological capacities such as direct reciprocity and interdependence.

S2. Ethnographic background

S2.1 Field site

San Francisco Yateé (population 430), known colloquially as Yateé, is a Zapotec community in the mountainous Sierra Norte region of Oaxaca. Approximately 430 people live in the village (INEGI, 2020), while a large migrant community resides in Los Angeles, California. Yateé has a mixed agrarian and market-based economy. Residents rely on slash-and-burn agriculture to cultivate small, hillside plots. The main crops are *milpa* (intercropped corn, beans, and squash), bunching onions, and coffee. Households supplement cultivated crops with products purchased at regional markets and local stores. Many households also sell products at regional markets, and some residents do wage labor.

S2.2 Communal Assembly

In addition to regularly scheduled assemblies, *ad hoc* assemblies can be convened to make pressing decisions. Early in the COVID-19 pandemic, for example, the Communal Assembly decided to close town borders, ban social gatherings, and institution a mask mandate (Figure S6).

The Authorities facilitate the meeting from a head table, while citizens sit organized by group (Figure S7). Some decisions are made within groups. For example, the *benne' gole xwan* ("Elder and older men") decide who among them will be named as *Mayordomo* and *Síndico*, the

final *cargos* of the ladder (Table 1). Similarly, each group annually decides how much they will fine their members for missing assembly or *tequio*.

S2.3 Music *gozona*

"Music *gozona*" is yet another distinct context and form of mutual aid that exists in the Sierra Norte region. Music *gozona* is the exchange of musical bands between communities. Music is an integral part of patron saint *fiestas* in the Sierra Norte– a band plays from the early hours of the morning well into the night, accompanying processions, dancing, masses, performances, and more. Although every town has at least one band, it would likely be impossible for a single band– or even two bands– to sufficiently cover the musical needs of a *fiesta*. Usually, 2-3 visiting bands join the town band, and they all take turns playing throughout the 4-5 days of *fiesta*. Communities arrange "music *gozona*", such that the band in Town A plays at the *fiesta* of Town B, and then the band of Town B reciprocates by playing at the *fiesta* of Town A. For example, in spring 2022, Yateé's band went to play at the *fiesta* of the nearby town San Tomás Lachita. Lachita's band then came to play at Yateé's patron saint *fiesta* in October 2022.

It is possible that music *gozona* helps build intercommunity ties. The musicians in the band socialize during the fiesta, forming between-community friendships and social ties. In line with this idea, in his mid-century ethnography of the Sierra Norte town Villa Hidalgo Yalálag, de la Fuente (1949) noted that Yalálag's intergroup relations were marked by "permanent distrust", but that music *gozona* helped normalize intergroup relations after a rupture.

S2.4 Housebuilding *gozona*

In the past, *gozona* was common during housebuilding– another task that is difficult to accomplish alone. In the old days, when houses were still constructed out of adobe, people would come to help make the adobe bricks, carry them to the building site, and build the house.

Housebuilding *gozona* continued to exist after the transition to cement-block construction, specifically for pouring the concrete slab roof (*gozona de colado*, trans: "concrete roof *gozona*"). As for celebration *gozona,* housebuilding *gozona* began with an announcement over the loudspeaker inviting citizens to help out. While men did the building labor, women came to help prepare food for the workers. Housebuilding *gozona* has disappeared in Yateé over the past couple of decades.

S3. Methods

S3.1 Ethnographic fieldwork and community engagement

Data for this study were collected during 4 months of fieldwork in Yateé as part of a larger research project in the community (April-June & October 2022). Throughout our time in the village, we engaged in ethnographic research in an effort to build a rich and textured understanding of how *gozona* and *usos y costumbres* function– something that cannot be accomplished through purely quantitative approaches. Our ethnographic approach included participant observation, focus groups, and interviews in Spanish and Zapotec. *Gozona*-focused participant observation included helping women with their preparations for *convivios* and attending *convivios*. Because *usos y costumbres* is a male domain in Yateé, *usos y costumbres*-focused participant observation was a little more difficult for female researchers. However, with permission, CMC attended communal assemblies (to which women in Yateé are not invited). She also made a sustained effort to observe men participating in their *usos y costumbres* duties, for example hanging around the Town Hall building and dropping by when she saw men doing *tequio*. In addition to providing rich detail about how *gozona* and *usos y costumbres* function in Yateé, these ethnographic methods provided opportunity for community members to share their perspectives and opinions about their local practices.

We sought input from the community about the research in several ways. First, during data collection, we regularly sought counsel from several local advisors about the research process. Second, we returned to Yateé approximately one year after data collection to present results to the community. During this visit, CMC gave a public presentation summarizing the methods and key findings from the study. The entire community was invited to attend the public presentation via repeated announcements over the town's loudspeaker system in the days leading up to the presentation. At the end of the presentation, questions, comments, and feedback were encouraged. In addition to this public forum, CMC visited the households of many participants during this visit in order to discuss the research with them.

Upon the request of the community, CMC also wrote an 80-page ethnographic report which detailed many of Yateé's cultural practices as they existed in 2022 and provided a summary of the main results from the research project. She gave printed copies of this report to be kept in the town archive, the primary school, and the secondary school. We further supported the community economically, for example by funding primary school fieldtrips to visit Monte Albán (the archaeological site of an important pre-Columbian Zapotec city).

We acknowledge that, as outsiders to Yatée, we may never fully understand *gozona* and *usos y costumbres* from the local perspective. Nonetheless, we have made our best effort to reflect community members' views about their practices by incorporating ethnographic insights into the main text. Moreover, we note that YVV and NVM are Zapotec scholars from nearby communities in the Sierra Norte region, with deep insight into local beliefs, worldviews, and practices. CMC has spent a total of 8 months doing fieldwork in Oaxaca, including comparative ethnographic work in several other Zapotec communities.

This research was approved by the Harvard University Committee on the Use of Human Subjects.

S3.2 Norm violation vignettes

To quantify normative beliefs about *gozona* and *usos y costumbres*, 45 participants responded to a series of vignettes about norm violations. Women (N = 22) responded to three vignettes about *gozona*, while the men (N = 23) responded to three vignettes about *usos y costumbres*.

The *gozona* vignettes:

(1) Failure to offer celebration *gozona*

During Semana Santa, the authorities made an announcement over the loudspeaker. They let everyone know that the Mayordomos had corn that was ready to grind and make into tortillas for the fiesta. Although she didn't have anything important that she needed to do that day, one woman ignored the announcement. Instead of helping to make tortillas, she spent the day watching TV in her house.

(2) Failure to reciprocate celebration *gozona*

A week after the Fiesta de Octubre, the Suplente Alcalde and his wife hosted a celebration for the community. Many people came to bring supplies and help out. The wife wrote down the names of all of the people who donated or helped, including the name of her neighbor, who brought cacao and helped make tortillas. The next year, the neighbor's son got married, and the neighbor needed lots of help for the celebration. However, even though the Suplente Alcalde's wife had the time and the resources, she decided not to help her neighbor– she just didn't feel like it. She went to the wedding, but didn't bring any food or help out at all.

(3) Failure to reciprocate harvest *gozona*

A man needed help harvesting coffee. He asked his friend if he would like to do gozona *to help harvest the coffee. The friend agreed, and spent two days helping harvest coffee. A few weeks later, the friend told the man that his coffee was ready to harvest and he needed help. However, even though he had plenty of time, the man refused to return the favor to help harvest the coffee. He just didn't want to do it.*

The *usos y costumbres* vignettes:

(1) Skipping a *tequio*

The Síndico called a tequio *to fix the road after a big storm. The announcement was made over the loudspeaker so that everyone in the community knew about it. But, on the day of the* tequio*, one man didn't show up. Instead, he spent the day watching TV in his house. When people asked why he wasn't there, he said that he just didn't want to go.*

(2) Refusing a *cargo*

In the Communal Assembly, a man was named Alcalde*. This man had a successful business, was economically stable, and his family was healthy. However, he refused to accept the* cargo*. When people asked him why he refused, he said that he just didn't want to do it.*

(3) Bad job in *cargo*

In assembly, a man was named as Treasurer of the Commissariat of Communal Lands. During his year of service, the Treasurer took $100,000MXN of community funds. He used the money to renovate his house.

After hearing each vignette, participants were asked to make several judgements about the protagonist's behavior,

1) *Badness:* How good or bad was the action?
2) *Expectation of others' judgements:* How good or bad will other people think it was?
3) *Reputation:* How good or bad of a person will other people think the protagonist is?
4) *Punishment:* Should the protagonist be rewarded or punished?

In addition, after the *gozona* vignettes, participants were asked how likely it was that other people in the community would help the protagonist in the future. Responses were scored on a 5-point scale from -2 (Very bad / Highly punished / Very unlikely) to 2 (Very good / Highly rewarded/ Very likely). Finally, after each vignette, participants responded to a free-response question, "What do you think of the protagonist's action?".

To measure the overall strength of normative beliefs about *gozona* and *usos y costumbres*, we created several scales. The *Gozona* Judgment Index averages responses to all 5 judgement questions for the three *gozona* vignettes, which were highly internally consistent (Cronbach's α = 0.85, 95% CIs[0.79, 0.90]). Similarly, Principal Component Analysis (PCA) revealed that all questions loaded positively on the first principal component, which explained 36% of the variance. For *usos y costumbres*, the *Usos y Costumbres* Judgment Index averages responses to all 4 judgement questions for the three *usos y costumbres* vignettes (1st PC explains 36% of the variance). PCA and Cronbach's α analysis revealed that three items were negatively correlated with the other items: badness and others' badness judgements about the vignette featuring a *cargo*-holder who embezzles town funds, and others' badness judgement about a man who refuses to serve a *cargo*. An alternative scale with these three items excluded was created (Cronbach's α = 0.79, 95% CIs [0.72, 0.87]). All analyses were repeated with this *Usos y Costumbres* sub-scale. Results do not depend on which version of the scale is used (see Supplementary R code for full

results). All scales were standardized and reversed so that a higher value indicates a harsher judgement.

S3.3 Survey measures

S3.3.1 Prosocial psychology measures

We measured several facets of prosocial psychology. To capture generalized altruism, participants gave their level of agreement with the statement "I would help a fellow community-member, even if they could never return the help" (5-point scale, Strongly disagree – Strongly Agree). As a second measure, we asked participants how likely they would be to donate money to the family of a sick child to help with hospital bills. Specifically, they heard the following vignette: "Imagine that a child in your neighborhood was very ill and staying in the hospital. The child's family could not afford the hospital bills and asked community members to donate money to help out. How likely would you be to donate money to the child's family?" (5-point scale, Very unlikely – Very likely). Finally, to assess perceived fitness interdependence, we used the Shared Fate Scale (Ayers et al., 2023). This 6-item scale asks participants how much they agree or disagree with statements like, "When my community feels bad, I feel bad" and "My community and I rise and fall together" (5-point scale, Strongly disagree – Strongly Agree). Participants struggled with the reverse-coded item ("I don't care whether my community thrives or not"), so we removed it. The remaining 5 items were highly internally consistent (Cronbach's $\alpha = 0.79$ [95% CIs 0.67, 0.86]), so we averaged them to create a Shared Fate Index.

S3.3.2 Participation in gozona

To measure willingness to participate in *gozona*, we asked participants how likely they would be to offer aid in a common *gozona* context: the death of a community member. Participants heard the following vignette: "Imagine that a man in the community died in an accident, leaving

behind a wife and three children. The bells rang to announce the death, and some people went to provide support– corn, coffee, and other supports. How likely would you be to bring food or other support to the dead man's family?" (5-point scale, Very Unlikely to Very Likely). That is, how likely would they be to offer *gozona*?

S3.3.3 Participation in usos y costumbres *activities*

We measured men's participation in *usos y costumbres* in several ways. First, we assessed willingness to participate in *tequio* by using a short vignette. Participants heard the following t vignette: "Imagine that during the rainy season, a landslide destroyed part of the main road leading into Yateé. Now, imagine that the *síndico* called a *tequio* to fix the road. How likely would you be to attend the *tequio* to help fix the road or support in some other way?" (5-point scale, Very Unlikely to Very Likely). Men were also asked: (1) how often they attend *tequio* (5-point scale, Never – Always), (2) whether they attended the most recent *tequio* (Yes/ No), (3) how often they attend Communal Assembly (5-point scale, Never – Always), and (4) whether they attended the most recent assembly (Yes/ No). Because all but one participant reported attending the most recent assembly, this outcome was not analyzed.

S3.4 Public Goods Game

Participants played an anonymous, one-shot Public Goods Game (PGG) with three other community members. In this game, each participant was given an endowment of $100MXN and told that they can split it however they like between a "personal" envelope and a "common fund" envelope. They were told that each player was being asked to make the same decision, and that any money in the common fund envelope would be doubled and divided equally among the four players. At the end of the game, participants received any money that they placed in the personal envelope, in addition to their share of the common fund envelope. This behavioral economics game

measures cooperation, since the group can do best if everyone contributes to the common fund, but an individual can do best if they defect while everyone else contributes. Participants heard instructions, watched a series of demonstrations about how the game could be played, and then answered a series of test questions before playing.

Participants played the PGG twice: a primed version and a control version. Primes consisted of the *gozona* (women) or *usos y costumbres* (men) vignettes, while the control condition consisted of three norm violation vignettes that were unrelated to either institution. Participants completed the first set of vignettes, played a PGG, completed the second set of vignettes, and played a second PGG. The order of presentation of prime and control vignettes was counterbalanced. The participants heard the instructions for the PGG after the first set of vignettes. Because the instructions and test questions are long, we inserted a reminder of the vignettes right before gameplay. After the test questions, the data collector looked down at their tablet in surprise and said, "Oh gosh, it looks like there was one more question about the stories I told you earlier that I was supposed to ask. Sorry about that." The data collector then repeated the last vignette and asked the participant the free-response question: "What do you think about [the protagonist's] action?".

S3.5 Data analysis

In the basic analysis, for participant *i*:

$$Y_i = \beta_0 + \beta_1 Judgment_i + \theta_i + \sigma_i + \varepsilon_i$$

where:

- Y is the outcome variable, e.g., willingness to offer *gozona* or generalized altruism
- $Judgment$ is either the *Gozona* or *Usos y Costumbres* Judgment Index

– θ is a vector of covariates for participant *i*

– σ is the random intercept for participant *i*

– ε is the error term

S4. Results and discussion

S4.1 Vignette judgments

Comparing within the three *gozona* vignettes, the protagonist who failed to offer celebration *gozona* was judged most leniently, while failing to reciprocate harvest *gozona* was judged most harshly (Figure S1). Given the formal nature of harvest *gozona*, this makes sense. Within the *usos y costumbres* vignettes, the vignette featuring corruption in a *cargo* role prompted the harshest responses, while refusing a *cargo* and skipping *tequio* were judged slightly more leniently. Free responses revealed that some participants extended the benefit of the doubt to the protagonist, thinking up ways to excuse their non-cooperation. The vignettes were designed to avoid this (specifying, for example, that the woman who didn't offer *gozona* "had nothing important to do that day", or that the man who refused a *cargo* was "economically secure and his family was healthy").

Comparing across vignette domain, participants felt that on average, *gozona* and *usos y costumbres* violations were similarly bad. However, participants expected that other community members would judge the *usos y costumbres* violations a little more harshly than the *gozona* violations, on average. This difference is driven by the lenient judgements of the protagonist who failed to freely offer celebration *gozona.* Failures to reciprocate *gozona* were judged similarly harshly as dereliction of *usos y costumbres* norm duties (Figure S3).

S4.2 Ethnographic evidence for internalized social norms

We found suggestive evidence that cooperative norms governing *gozona* and *usos y costumbres* have been internalized. First, participants' free responses to the vignettes, using moralizing language to express disdain for the protagonists, give the impression of internalized norms. These responses suggest that external standards of behavior about *gozona* and *usos y costumbres* have become internal preferences. When someone fails to live up to those standards, it inspires a negative gut reaction. Similarly, ethnographic evidence suggests that *gozona*– particularly help and support freely offered in times of need– has seeped into people's identity. People of Yateé view their community as full of respect, welcoming, and supportive, in contrast to nearby towns where "the people are bad" and there is much envy and conflict. One informant revealed her view that this supportive inclination is an intrinsic quality, suggesting that it springs from "a root" from the ancestors. Illustrating that *gozona* is part of the group identity, people often spoke in the first-person plural when talking about it: "here, we help one another", "we are there for one another in times of difficulty and *fiesta*", "here, we support [each other] a lot", "we very much like to [offer] support". Finally, while careful to clarify that *gozona* is not formally required, informants describe feeling that they must engage in it. For example, one man alluded to an internalized sense of duty, noting that "[offering *gozona*] is not required, but one feels obligated." While not definitive, this ethnographic evidence strongly suggests internalized norms facilitate cooperation in the contexts of *usos y costumbres* and especially *gozona*.

S4.3 Public goods game

We observed no effect of the priming manipulation designed to probe for specific evidence of internalized norms driving cooperation. Among women, there was no change in contributions to the Common Fund when comparing decisions after *gozona* vignettes to those after control vignettes ($\beta = 0.5[-8.3, 9.3]$, $p = 0.91$). Similarly, among men, priming *usos y costumbres* had no

significant effect on contributions. If anything, there is a small, imprecisely estimated decline of about $6MXN of the $100MXN endowment after *usos y costumbres* priming ($\beta = -5.9$[–14, 2.8], $p = 0.17$).

Although there is no way to know for sure, we suspect that the cognitive load associated with the Public Goods Game wiped out any potential priming effects. Many participants found the game challenging to understand and exerted ample cognitive effort during the lengthy instructions and test questions. These null effects are not unprecedented. While many experiments have successfully identified effects of priming on behavioral economics games (reviewed in Cohn & Maréchal, 2016), results have been mixed. Many studies fail direct replication (e.g. Belaus et al., 2018), and scholars have argued that we should expect priming results to depend on contextual and population-specific features (Cesario, 2014). Priming studies with behavioral economics games in small-scale societies have often yielded unexpected (Cronk, 2007) or null (Purzycki et al., 2022) results.

S4.4 Judgments about institution-related norm violations are highly correlated with judgments about control norm violations

Results suggest that people who hold strong norms in one domain also hold strong norms in another domain. While we were unable to examine correlations between *Gozona* and *Usos y Costumbres* Judgment Indices, we explore the relationship between each index and judgments about control norm violation vignettes. Among women, a one standard deviation increase in *Gozona* Judgment Index is associated with 0.65 increase in Control Judgment Index ($\beta = 0.65$ bootstrapped 95%CIs[0.14, 1.16], $p < 0.05$), controlling for age, education, and material security. Similarly, among men, a one standard deviation increase in *Usos y Costumbres* Judgment Index is associated with 0.65 increase in Control Judgment Index ($\beta = 0.65$ [0.23, 1.07], $p < 0.001$). This result may explain why men who make harsher judgments about *usos y costumbres* norm

violations also report a greater willingness to offer *gozona* to a widow ($\beta = 0.38$ [–0.05, 0.80], $p = 0.07$).

S4.5 Ethnographic examples of punishment of the Authorities

The Authorities face scrutiny, and the Assembly swiftly punishes errors. Given that the Authorities manage the community's money, the Assembly pays special attention to their accounting. The Assembly convenes for quarterly reviews of expenditures, during which a representative from each group scrutinizes every expense. The Assembly typically fines the Authorities for any error (e.g. missing receipt) or evidence of potential mismanagement of funds, up to $25,000MXN (~$1,300 USD). Sometimes, the Assembly takes other steps to sanction a member of the Authorities. Recent examples include fining and removing an *agente* from his *cargo* due to alcoholism; shaming and removing an *agente* from his *cargo* for failing to fulfill ritual duties; and jailing and stripping an *alcalde* of his rights as a citizen after a bad performance.

S4.6 Little evidence of a sex difference in willingness to punish

Responses to the control vignettes, which were presented to both men and women, suggest that the difference in punishment judgments about *usos y costumbres* versus *gozona* vignettes cannot be explained by sex differences in willingness to punish. Men and women made similar judgements of badness and reputation about control vignettes, although women on average judged the actions as slightly worse ($t(130) = 2.33$, $p < 0.05$). Compared to men, women said that these actions were marginally less worthy of punishment; however, the sex difference is not significant ($t(132) = –1.7$, $p = 0.09$) (Figure S4). Together, this suggests that women in Yateé may be slightly less prone to punish norm violations. However, the difference in punishment judgements for *gozona* versus *usos y costumbres* violations is much larger than the sex difference in control vignettes. This implies a real difference in the role of punishment in these two institutions.

S4.7 The role of third-party mediation in Yateé

Some recent research in small-scale societies, including the Enga of Papua New Guinea and Mentawai of Indonesia, has highlighted the role of third-party mediation rather than third-party punishment in restoring cooperation after conflicts (Singh & Garfield, 2022; Wiessner, 2020). Formalized third-party mediation exists in Yateé: the central role of the *alcalde* is to serve as a judge, adjudicating conflicts within the community (Table 1). He may be called to mediate marital problems, property disputes, and other interpersonal conflicts. However, we saw no evidence for third-party mediation in the enforcement of *usos y costumbres*, which relies instead on institutionalized, graduated sanctions.

S4.8 Celebration gozona *is relevant to fitness*

We argue that celebration *gozona* impacts fitness by alleviating economic strain. Importantly, hosting a *convivio* is an obligatory duty for top *cargo*-holders. *Gozona* substantially reduces the burden of these costly celebrations. For example, the most expensive *cargo*-sponsored celebration is *Semana Santa* (Easter Week). Each year, two men jointly sponsor *Semana Santa* as part of their final *cargo*, *mayordomo*. One recent *mayordomo* estimated that he spent between $40,000MXN and $50,000MXN (approximately $2,050 - $2,500 USD) on *Semana Santa*. Average daily wage in Yateé is about $250MXN (~$13USD), meaning that *Semana Santa* costs an equivalent of 160-200 days of wage labor. However, thanks to cash and in-kind *gozona* contributions, he estimated that his true costs were only $10,000 - $15,000MXN. Moreover, without the *gozona* labor provided by community members, he estimated that his costs would have been closer to $80,000MXN because he would have had to hire people to help. Therefore, *gozona* alleviates a substantial portion of the huge economic costs of serving a top *cargo*.

S4.9 Intergroup conflict in Oaxaca

Highlighting the importance of communal resources, many indigenous Oaxacan towns have long histories of violent inter-community conflict over lands (Dennis, 1987; López-Bárcenas, 2004; Yannakakis, 2008). In 2001, for example, Oaxaca recorded 656 ongoing agrarian conflicts (López-Bárcenas, 2004). Many conflicts are legal in nature, but can also involve the mobilization of male citizens to invade neighboring towns, burn crops, destroy houses, and set cattle loose, sometimes resulting in injuries and deaths (Cook, 2014; Dennis, 1987). Yateé's most recent violent intergroup conflict dates to the mid-1990s, although simmering tensions persist with the closest neighboring community. Speaking to the long history of intergroup conflict in Yateé, several versions of the origin story of the town's name (Zapotec *Ya'ade*, "Hill of Ashes", referring a sacred hill) evoke violent conflict. In one version, the community originally settled on the sacred hill, but was forced to move to its current location after a nearby community burnt it to the ground during a territorial dispute. In another version, the people of Yateé defended themselves by throwing ashes in the faces of invaders from a neighboring community.

S4.10 Possible sex difference in relationship between interdependence and strength of norms

There may be a sex difference in the relationship between perceived fitness interdependence and the strength of social norms. Analysis of the control norm violation vignettes– to which both men and women responded– reveals a large, significant interaction between Shared Fate Index and sex on the severity of judgements ($\beta = 1.04$, bs95%CIs[0.21, 1.87], $p < 0.01$). That is, Shared Fate Index strongly predicts the severity of judgments about control norm violations among women, but not among men. This sex difference may be driving the difference in association between *Usos y Costumbres* versus *Gozona* judgements and Shared Fate Index (main

text, section 4.4.3). However, we cannot directly test this hypothesis because men did not respond to the *gozona* vignettes, and women did not respond to *usos y costumbres* vignettes.

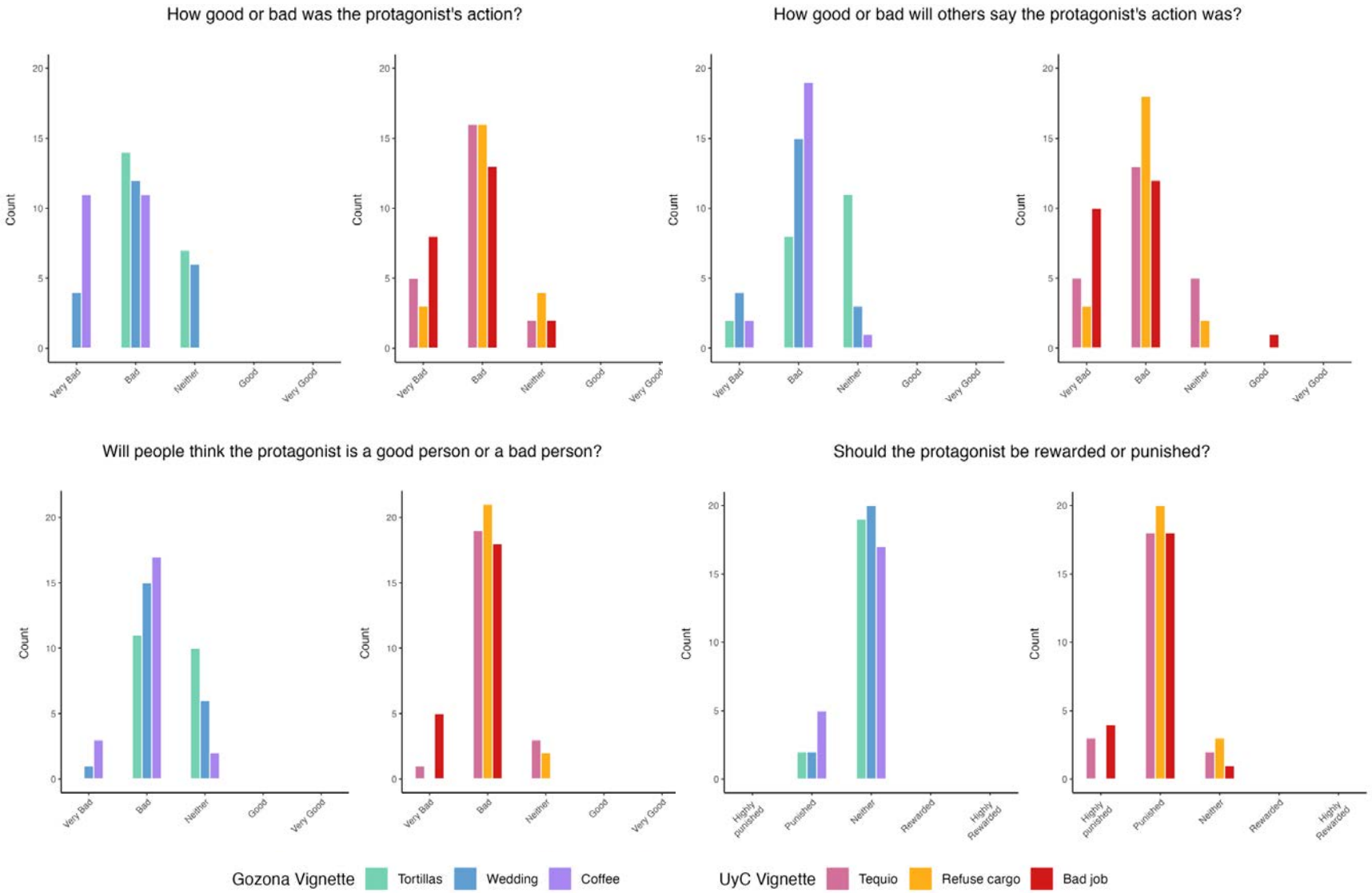

Figure S1. Histograms of judgements about *gozona* and *usos y costumbres* norm violations. Women ($N = 22$) responded to three vignettes about *gozona*, while men ($N = 23$) responded to three vignettes about *usos y costumbres*. The "Tortillas" vignette featured a woman who declined to offer celebration *gozona* when the need was announced. The "Wedding" vignette" featured a failure to reciprocate celebration *gozona*, while the "Coffee" vignette featured a failure to reciprocate harvest *gozona.* In "*Tequio*", a man skipped an emergency *tequio*. "Refuse *cargo*" featured a man who refused to accept a *cargo* when nominated, while "Bad job" featured a man who embezzled town funds in his position as a *cargo*-holder.

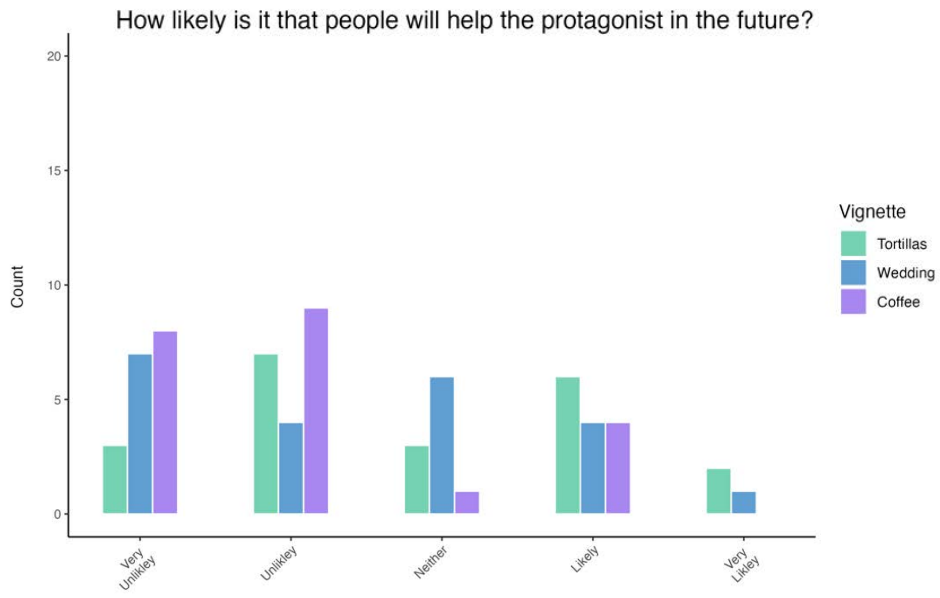

Figure S2. Histogram of judgements about whether community members will help *gozona* norm violator in the future. Women ($N = 22$) responded to three vignettes about *gozona*, The "Tortillas" vignette featured a woman who declined to offer celebration *gozona* when the need was announced. The "Wedding" vignette" featured a failure to reciprocate celebration *gozona*, while the "Coffee" vignette featured a failure to reciprocate harvest *gozona*.

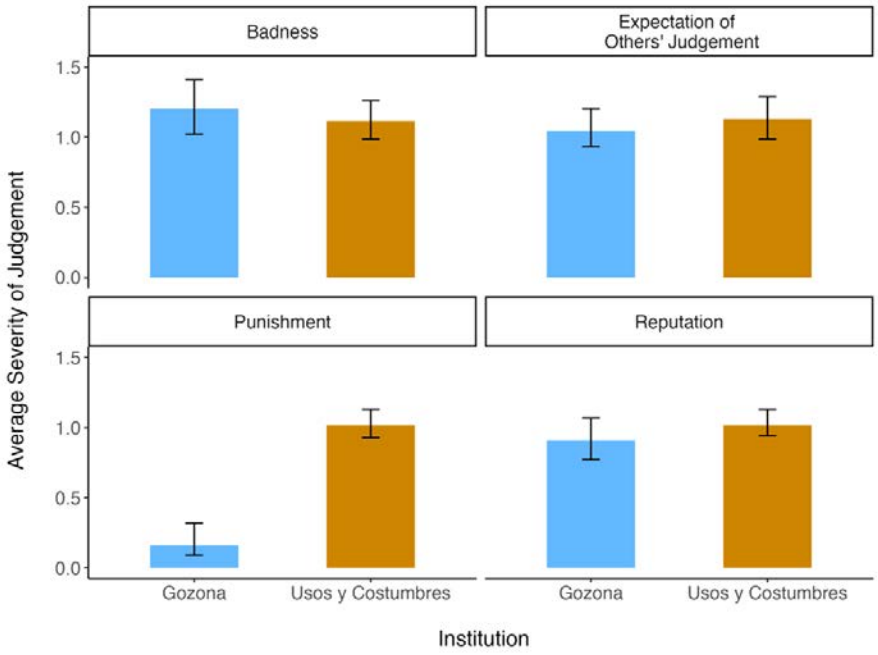

Figure S3. Average severity of judgements about *gozona* defection and *usos y costumbres* norm violations. Averages pool across two *gozona* vignettes featuring a failure to reciprocate *gozona* (blue; excludes vignette about failure to offer *gozona*) and three *usos y costumbres* (orange) vignettes. Panels show average judgements about how bad the action was; how bad other community members would think it was; how bad a person others would judge the protagonist to be; and how severely he/she should be punished. Error bars represent bootstrapped 95% CIs.

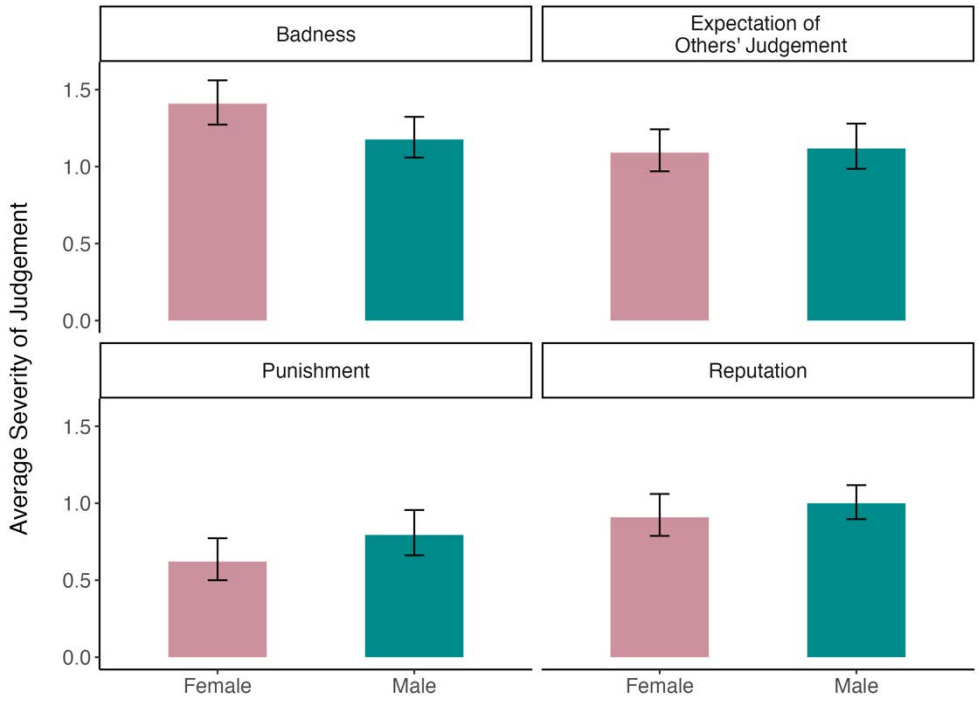

Figure S4. Average severity of judgements about control norm violations. Responses by women (N = 22) and men (N = 23) are averaged separately. Panels show average judgements about how bad the action was; how bad other community members would think it was; how bad a person others would judge the protagonist to be; and how severely he/she should be punished. Error bars represent bootstrapped 95% CIs.

Figure S5. San Francisco Yateé. The hill in the background is the sacred hill for which the town is named: Zapotec *Ya'ade*, "Hill of Ashes". Source: C. M. Curtin

Figure S6. Anti-COVID-19 measures. (A) Border closure sign. This sign on the main road outside Yateé reads, "WARNING: Due to health risks, outsiders and vendors are prohibited from entering. Avoid sanctions [fines] on the part of the Municipal Authorities." The sign was erected early in the COVID-19 pandemic, when– like many indigenous Oaxacan communities– Yateé closed its town borders to prevent the entry of disease. The sign remained up in 2022, although the borders had been reopened by that point. **(B) Mask mandate sign**. This sign reads, "ATTENTION! By decree of the Assembly in the locality of San Francisco Yateé, the use of masks is obligatory. Those who do not wear masks will be sanctioned [fined]." Source: C. M. Curtin.

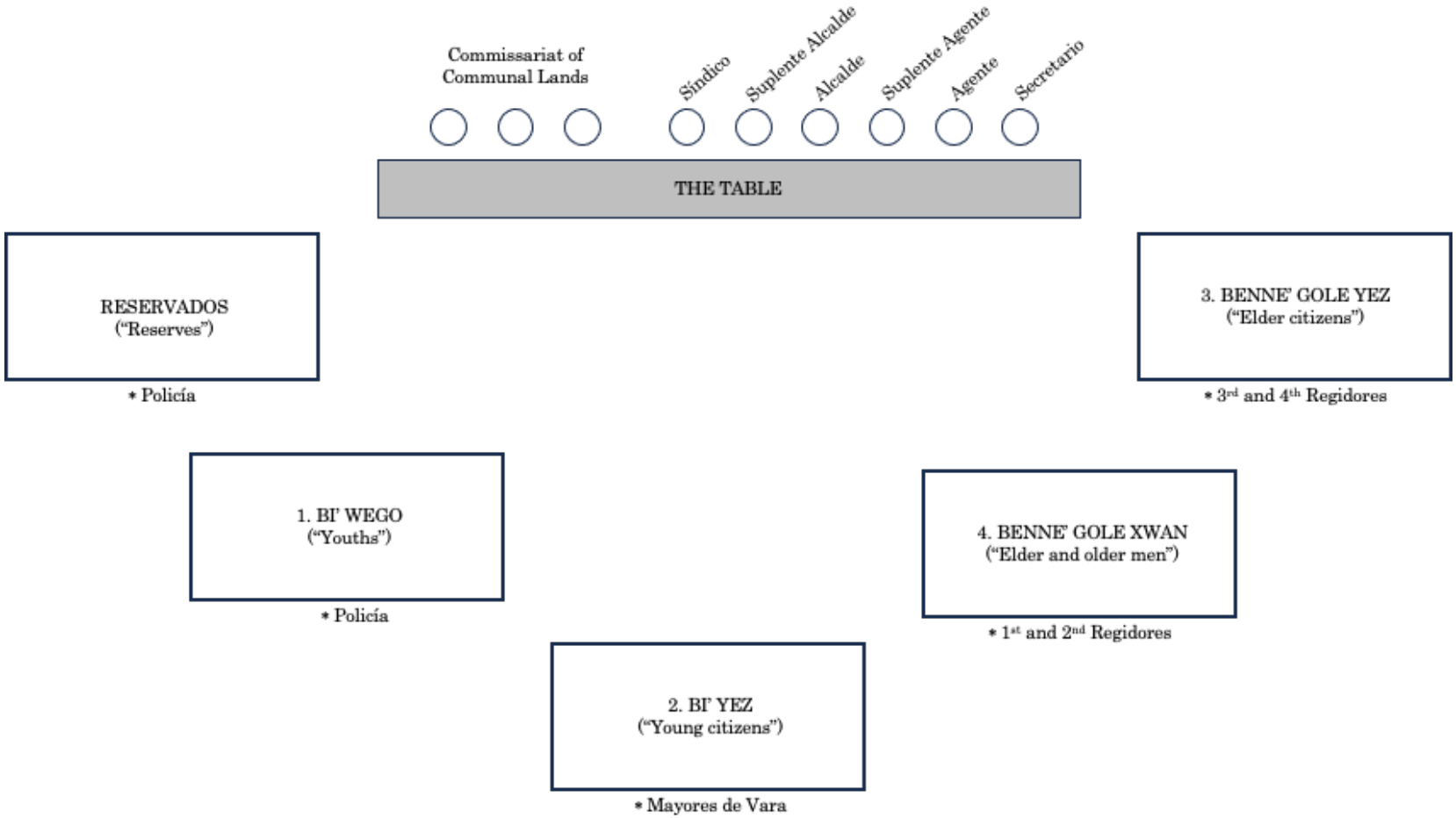

Figure S7. Communal Assembly diagram. The Assembly is spatially organized by groups. The Authorities, *Síndico*, members of the Commissariat of Communal Land, and secretary facilitate the assembly from a head table know as *la mesa* ("the table"). Citizens sit with their groups. Each group has one or two representatives– *cargo*-holders in the *cabildo* ("town hall") who are in charge of administering the group (denoted with "*"). Representatives keep track of assembly and *tequio* attendance, collect fines from their group members, take note of group decisions (e.g. who the group nominates to a *cargo*), and communicate with *la mesa*.

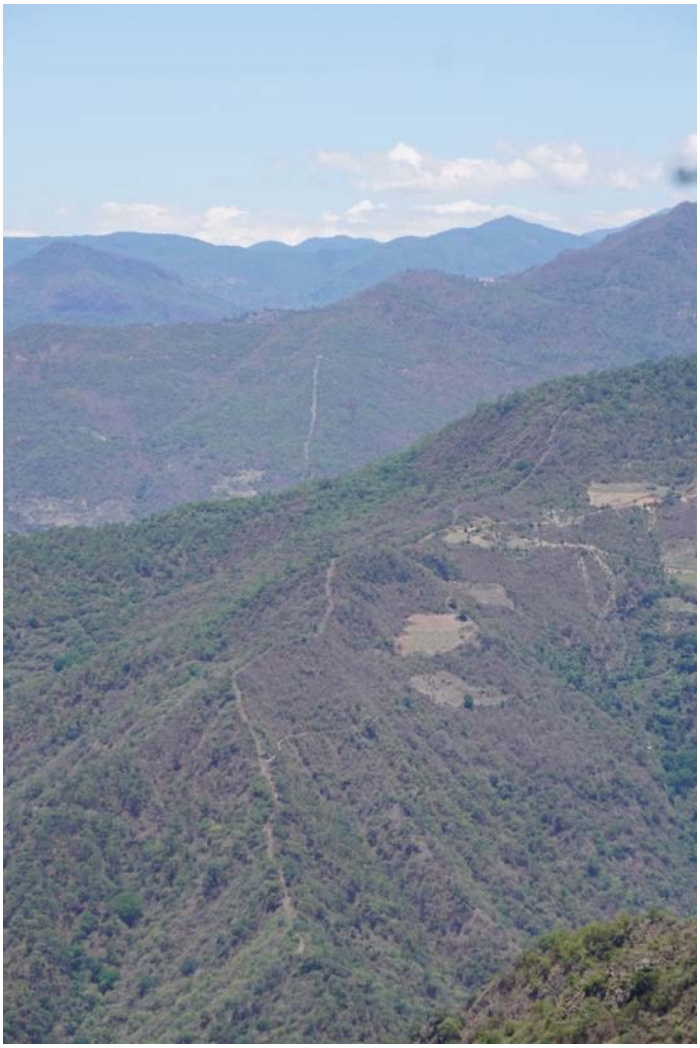

Figure S8. The "gap" marking the boundaries between communities. In Oaxaca, community boundaries are literally written onto the landscape. The boundary, known as *la brecha* ("the gap"), consists of a 6-meter-wide gap in vegetation. Citizens are called to do an annual *tequio* to clear the boundary between Yateé and its neighbors. In a region where land is communally controlled and territorial disputes commonly erupt between communities, clearing the boundary ensures that everyone knows where it is. It also helps prevent the spread of wildfire from neighboring communities during the dry season, thus providing an important public good for Yateé. Here, looking west from Yateé, we see the gap between two neighboring communities. Source: C. M. Curtin.

Figure S9. Well-maintained pathways (A) and roads (B) on steep terrain. Yateé is built on the mountainside. The town is crisscrossed with well-maintained pathways and small roads that include treading for the slippery rainy season. This is one example of a public good that is provided through the *usos y costumbres* system. Source: C. M. Curtin.

Figure S10. Yateé's communal resources. Yateé's communally owned resources include sand and gravel that are used in and sold to fund public works projects. **(A)** The "Hill of Sand" (*Cerro de Arena*), a sand quarry, in the foreground (the sacred Hill of Ashes is in the background). This was traditionally Yateé's source of sand, which was carried manually or by donkey to town. **(B)** In recent years, Yateé has shifted to extracting sand and gravel from the river between the mountains, which can now be reached by car. Ownership of the river is split between Yateé and neighboring communities– each community owns a portion. This image shows a sign on the path towards the river, which reads: "Entrance to this place prohibited without the permission of the Commissariat of Communal Lands of San Francisco Yateé." Source: C. M. Curtin.

Figure S11. **A new road constructed in 2022**. The road makes it easier to get to the river to extract sand and gravel. It also provides more rapid access to agricultural fields. Although people reach their fields by foot, the road makes rapid access possible. This is especially important during the dry season (the end of which coincides with burning of fields in preparation for planting), when rapid response to contain fires is necessary. Construction cost the community approximately $377,000MXN (~$20,000USD). The funds, administered by the Commissariat of Communal Lands, came from selling communal resources (sand, gravel, firewood), fines when people extract resources without permission, and interest on loans to community members. Source: C. M. Curtin.

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