Coordinating Cooperation: Local and Global Norms in Public-Good Provision

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ABSTRACT

We study how communication structures affect voluntary cooperation when individuals belong simultaneously to a local subgroup and a larger global group. In a repeated public-good experiment, participants are assigned to a large global group divided into three smaller subgroups. We vary communication across three conditions: no communication, subgroup communication, and subgroup communication plus communication among subgroup delegates. We also vary whether participants can contribute only to a global public good or can allocate contributions between a global and a local public good. When only the global public good is available, contributions increase with the scope of communication: subgroup communication raises contributions, and delegate communication raises them further by improving coordination across subgroups. When both public goods are available, participants without communication direct most contributions to the less efficient local public good. Subgroup communication increases total contributions, but primarily by strengthening coordination on the local public good. Delegate communication shifts contributions away from the local public good and toward the globally efficient public good. The analysis of the chat data shows that communication affects not only whether participants reach agreements, but also which contribution norm is implemented.

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1. Introduction

Cooperation is often organized locally, while its returns may extend more broadly, as in settings where local public goods generate spillovers beyond the jurisdictions or groups that provide them (Besley and Coate, 2003). Workers belong to teams within firms, faculty members to departments within universities, municipalities to regions, and countries to international agreements. In such settings, individuals may contribute to public goods that primarily benefit those close to them or to public goods that benefit a larger collective. A department may devote resources to its own activities or to an initiative that benefits the entire organization. A municipality may prioritize local infrastructure or contribute to a regional project. A country may invest political resources in domestic programs or in international agreements. These examples share a common feature: the local public good is often more visible, easier to discuss, and easier to monitor, whereas the global public good may generate larger aggregate returns.

This distinction creates a problem that goes beyond the standard under-provision of public goods. In a standard public-good environment, the main question is whether individuals contribute at all. In a multilevel environment, the question is also where cooperation is directed. In other words, what type of cooperation norm will emerge? Groups may sustain high levels of voluntary contributions yet still fail to allocate them efficiently. In particular, cooperation may be coordinated around a local public good that is attractive to individuals who can observe and communicate with one another, even when the globally efficient outcome requires contributions to a broader public good.

This paper examines how communication structures shape the selection of contribution norms in an intergroup public-goods environment. The central question is not simply whether communication increases cooperation. Rather, it is whether communication coordinates participants around a local or global contribution norm. When only one public good is available, the natural norm concerns the level of contribution to that good. When both local and global public goods are available, several plausible norms can compete: contribute locally, contribute globally, or split contributions between the two. Which norm becomes focal may depend on who can communicate with whom. Local communication may coordinate subgroup members on a local norm, while communication across subgroups may be needed for a global norm to emerge. The same institution that sustains cooperation may therefore either improve or worsen efficiency, depending on the level at which it operates.[1]

A large body of experimental literature examines institutions that help groups overcome social dilemmas. One of the most robust findings is that communication increases cooperation in

[1]Related evidence from coordination games shows that communication-network structure affects outcomes. See, for example, Charness et al. (2021) on clustering, Brandts and Cooper (2025) on centralized communication between divisions, and Choi and Lee (2014) on network position in coordination.

voluntary-contribution and common-pool-resource games (Ostrom and Walker, 1991; Ledyard, 1995; Chaudhuri, 2010). Communication can be especially effective when it allows participants to exchange free-form messages via chat or face-to-face communication (Bochet et al., 2006).[2] Even limited communication can matter. For example, one-way communication from a leader to group members increases contributions and reduces dispersion in voluntary-contribution experiments (Koukoumelis et al., 2012). These findings suggest that communication does more than transmit information. It helps participants make commitments, form shared expectations, and create social pressure to follow through.

The mechanisms through which communication affects cooperation are closely tied to social norms. First, communication can support the informal enforcement of contributions. Participants can state expectations, make promises, identify low contributors, and express disapproval of deviations from agreed behavior. These responses are non-material, but they affect behavior when participants care about norm compliance, self-image, or others' disapproval (Akerlof, 1980; Bicchieri, 2002). Second, communication can support coordination. If social preferences or norm compliance make high-contribution outcomes behaviorally relevant, a public-good game becomes a coordination problem in which participants must select among multiple possible contribution norms (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Bicchieri et al., 2018). Communication reduces strategic uncertainty by allowing participants to propose a rule, express support for it, and form shared expectations about which deviations will be considered unacceptable (Duffy and Feltovich, 2002; Brandts and Cooper, 2007; Brandts et al., 2019). Importantly, the contribution norm that becomes focal is not fixed. Prior evidence shows that contribution norms are themselves objects of coordination: when different contribution rules can be interpreted as fair, groups may settle on and enforce different norms depending on the environment in which cooperation takes place (Reuben and Riedl, 2013). In our setting, the relevant norm conflict concerns the public good to which cooperation is directed: subgroup communication may make a local contribution norm focal, whereas communication across subgroups may be needed for a global contribution norm to emerge. Thus, communication may coordinate not only actions but also the contribution norm that participants expect others to follow and enforce (Fehr and Schurtenberger, 2018; Andrighetto et al., 2013).[3]

Most experimental evidence on communication in public-good games focuses on settings where the communication network and the public-good externality coincide. Participants can typically observe or communicate with all members of the group affected by the public good. This is an important benchmark, but it abstracts from a central feature of many social and economic envi-

[2]See also Kerr and Kaufman-Gilliland (1994) on communication, commitment, and group identity in social dilemmas, and Sally (1995) for a meta-analysis of communication and cooperation.

[3]Related experimental evidence shows that communication can generate social ties and that prosocial behavior depends on the structure of the resulting network: helping decreases with social distance and increases with degree centrality (Erkut and Reuben, 2025).

ronments: communication networks are incomplete. Individuals often communicate most easily with members of their own local group (Kossinets and Watts, 2006), while the consequences of their actions extend to a larger collective.[4] In such cases, local communication may create accountability within the subgroup, but it may not create common expectations across the full group affected by the public good.

The incompleteness of communication networks is especially important when local and global public goods coexist. Prior work on local and global public goods without communication shows that participants often favor local or club goods, even when these goods are less efficient from the larger group's perspective. Blackwell and McKee (2003) find that contributions to a local club good often exceed those to the global public good. Similarly, Fellner and Lünser (2014) show that when individuals belong to both local and global groups, initially high contributions to the more efficient global public good can unravel in favor of stable local cooperation unless global contributions are observable. Related evidence shows that the availability of multiple public goods can increase total giving by giving participants more ways to coordinate contributions (Todd L. Cherry and David L. Dickinson, 2007). Finally, evidence from cross-national public-good experiments also suggests that identity matters for allocation across levels: stronger global identity is associated with more giving to global public goods and less to local ones (Buchan et al., 2009). Together, these findings suggest that individuals do not merely decide how much to cooperate. They also decide which group their cooperation should serve.

We test these ideas in a laboratory experiment with repeated interaction, incomplete information about individual behavior, and varying communication structures. Participants are assigned to fixed global groups of nine, each divided into three local subgroups of three. Individual contribution information is local: participants observe the individual contributions of their own subgroup members but see only aggregate information about the other two subgroups. Communication occurs via non-binding chat every five periods. We vary communication in three ways. In one condition, participants cannot communicate. In a second condition, participants can communicate only within their local subgroup. In a third condition, participants can communicate within their subgroup and, in addition, one randomly selected delegate from each subgroup can communicate with delegates from the other subgroups.

We combine these communication structures with two public-good environments. In the first, participants can contribute only to a global public good that benefits all nine members of the global group. In the second, participants can allocate their endowment between the global public good and a local public good that benefits only the three members of their subgroup. The local public good has a higher marginal per-capita return but is less efficient from the

[4]Experimental evidence on restricted communication includes one-way communication (Andreoni and Rao, 2011; Koukoumelis et al., 2012), communication within subgroups (Jeffrey T Polzer et al., 2001), and asymmetric communication that excludes some participants (Abbink et al., 2022).

global group's perspective: one point contributed to the local public good generates 1.8 points of total surplus, whereas one point contributed to the global public good generates 2.7 points. Therefore, the design creates a trade-off between a locally attractive public good and a globally efficient public good.

The experiment addresses three questions. First, when only the global public good is available, is communication within local subgroups sufficient to sustain global cooperation, or is cross-subgroup communication needed? Second, when both local and global public goods are available, does local communication promote efficient cooperation, or does it coordinate participants on the local public good? Third, when communication across subgroups is possible through delegates, does it shift the contribution norm toward the globally efficient public good, and are such global agreements implemented?

The first set of results comes from treatments with only the global public good. Contributions increase with the scope of communication. Without communication, participants contribute 40% of their endowment on average. Subgroup communication raises average contributions to 57% of the endowment, and delegate communication raises them further to 80%. Subgroup communication sharply reduces within-subgroup dispersion of contributions, indicating that it aligns behavior among subgroup members. However, delegate communication is needed to reduce between-subgroup dispersion and sustain higher global contributions. This shows that communication is not only a local enforcement device. When the public good benefits the entire global group, communication across subgroup boundaries plays an important role in coordinating expectations at the relevant level.

The second set of results shows that the availability of a local public good alters the allocation of cooperation. Without communication, participants contribute more in total when the local public good is available, but most of those contributions go to the local public good. On average, participants contribute 43% of their endowment to the local public good and 24% to the global public good. Thus, the local public good increases total contributions but crowds out contributions to the more efficient global public good. Subgroup communication amplifies this pattern. It raises total contributions to 93% of their endowment, but almost all of the increase comes from higher contributions to the local public good, which accounts for 65% of their endowment. Global contributions remain essentially unchanged. Therefore, local communication sustains cooperation, but it channels it toward the locally targeted, less efficient public good.

Delegate communication changes the composition of contributions. In treatments with both local and global public goods, adding communication across subgroups increases average global contributions from 25% to 50% of their endowments and reduces local contributions from 65% to 34%, while total contributions remain high at 87% of their endowments. Therefore, the main effect of delegate communication is not an increase in total cooperation but a reallocation of cooperation from the local public good toward the globally efficient public good. This result is important because it shows that even limited communication across subgroups can help overcome the local bias created by subgroup communication and local observability.

The content of the chat data clarifies the mechanism. Participants frequently reach explicit agreements in all communication treatments, so the main difference across treatments is not whether communication produces agreement. Rather, the communication structure changes the content of the agreement. In treatments with only subgroup communication and both public goods available, subgroup agreements primarily favor the local public good. When delegates can communicate across subgroups, both subgroup-level and delegate-level agreements shift sharply toward the global public good. However, delegate-level agreements are implemented less completely than subgroup agreements. Deviations from delegate agreements combine moderate free riding on global contributions with a partial reallocation of contributions back to the local public good. This suggests that delegate communication can identify a more efficient contribution norm, but that this norm can conflict with the more immediate and enforceable contribution norm agreed upon within subgroups.

The paper contributes to three strands of literature. First, it contributes to the literature on communication in public-good games by showing that the effectiveness of communication depends on the relationship between the communication network and the public good's externality structure. Prior work shows that communication increases cooperation, even in settings with limited or one-way communication. We show that, in a nested public-good environment, the scope of communication determines whether cooperation is coordinated locally or globally. Second, the paper contributes to the literature on social norms and norm enforcement by showing that communication affects not only compliance with a norm but also the selection of the norm itself. In multilevel public-good environments, local and global contribution norms may conflict. Third, the paper contributes to the literature on local and global public goods by showing that the availability of a local public good can increase total contributions while worsening the allocation of contributions from the perspective of global efficiency (Blackwell and McKee, 2003; Buchan et al., 2009).

The broader implication is that institutions designed to facilitate communication should be evaluated not only by whether they increase cooperation but also by the extent to which they coordinate behavior. Local communication can be highly effective, but it may make local norms more salient and easier to enforce. Cross-group communication can redirect cooperation toward global efficiency, but it may create competing obligations when global agreements conflict with local ones. For intergroup public goods, the central institutional problem is therefore not simply to create more communication, but to design communication channels that allow efficient global contribution norms to emerge and become credible within local groups.

2. Experimental design

The experiment has a 3 × 2 between-subjects design. The first treatment dimension varies the communication structure: no communication, communication within local subgroups, and communication within local subgroups plus communication among subgroup delegates. The second treatment dimension varies the set of public goods available to participants. In the *Global* treatments, participants can contribute only to a global public good. In the *Local* treatments, participants can allocate their endowment between the global public good and a local public good. We first describe the global public-good environment and the communication structures, and then describe the treatments that introduce the local public good.

At the beginning of the experiment, participants were randomly assigned to fixed global groups of nine. Each global group k was partitioned into three fixed local subgroups, indexed by $s \in \{1, 2, 3\}$, with three participants per subgroup, indexed by $i \in \{1, 2, 3\}$. The interaction lasted fifteen periods. In each period, every participant received an endowment of 20 points and simultaneously chose how much to contribute to the global public good. Points not contributed were kept by the participant. Each point contributed to the global public good increased the earnings of every member of the nine-person global group by 0.3 points. Thus, in the treatments with only the global public good, the period earnings of participant i in subgroup s of group k in period t is given by

$$\pi_{i,s,k,t} = 20 - g_{i,s,k,t} + 0.3 \sum_{r=1}^{3} \sum_{j=1}^{3} g_{j,r,k,t},$$

where $g_{i,s,k,t} \in [0, 20]$ denotes participant i's contribution to the global public good.

Unlike in the standard linear public goods game, information about individual contributions is limited to the local subgroup. Specifically, at the end of each period, participants observed the individual global contributions of the members of their own subgroup and the mean global contribution in each of the other two subgroups. They did not observe the individual contributions of participants outside their subgroup.

Communication was implemented through non-binding chat windows. In the treatments with communication, chat windows opened for five minutes before periods 1, 6, and 11.[5] Participants could chat freely, but were instructed not to reveal identifying information or use offensive language. We implemented three communication structures:

- *None*: Participants could not communicate with one another.
- *Subgroup*: Participants could communicate with the other two members of their own subgroup through a common subgroup chat window. Communication was therefore public within the

[5]We chose not to allow communication in every period to prevent experimental sessions from becoming too lengthy. This design choice is also motivated by evidence that the effect of communication persists across subsequent periods (e.g., Bochet et al., 2006; Koukoumelis et al., 2012).

subgroup, and participants could not send bilateral private messages.

- *Delegates*: Participants could communicate both within and across subgroups. As in *Subgroup*, all participants had access to a shared chat window with other members of their subgroup. In addition, one participant in each subgroup was randomly selected as a *delegate* at the beginning of the experiment. Delegates retained this role throughout the fifteen periods and had access to an additional chat window to communicate with delegates from the other two subgroups.

2.1. Local public goods

The second set of three treatments introduces a local public good. These treatments use the same three communication structures described above. As before, each participant received an endowment of 20 points in every period. Participants could allocate this endowment between the global public good, which benefited all nine members of the global group, and a local public good, which benefited only the three members of their own subgroup. Each point contributed to the global public good increased the earnings of every member of the global group by 0.3 points. Each point contributed to the local public good increased the earnings of every member of the contributor's subgroup by 0.6 points. The period earnings of participant i in subgroup s of group k in period t is therefore given by

$$\pi_{i,s,k,t} = 20 - g_{i,s,k,t} - \ell_{i,s,k,t} + 0.3 \sum_{r=1}^{3} \sum_{j=1}^{3} g_{j,r,k,t} + 0.6 \sum_{j=1}^{3} \ell_{j,s,k,t},$$

where $g_{i,s,k,t}$ denotes participant i's contribution to the global public good and $\ell_{i,s,k,t}$ denotes the participant's contribution to the local public good. The sum of contributions could not exceed a participant's endowment $g_{i,s,k,t} + l_{i,s,k,t} \leq 20$.

Note that the local public good has a higher marginal per capita return than the global public good, but it is less efficient because it benefits only three participants rather than nine. A point contributed to the local public good generates a total return of $0.6 \times 3 = 1.8$ points, whereas a point contributed to the global public good generates a return of $0.3 \times 9 = 2.7$ points. The design, therefore, creates a trade-off between a locally targeted public good with a higher individual return and a globally efficient public good with a larger aggregate return.

The information structure again reflected the distinction between local and global interaction. At the end of each period, participants observed, for each member of their subgroup, the amounts contributed to both the global and the local public goods. They also observed the mean global contribution in each of the other two subgroups. They did not receive information about other subgroups' contributions to local public goods.

Combining the three communication structures with the two public-good environments yields six treatments. We refer to treatments by combining the public-good environment and the

Table 1. Treatment characteristics

Characteristic	*Global treatments*			*Local treatments*		
	None	*Subgroup*	*Delegates*	*None*	*Subgroup*	*Delegates*
Global public good	✓	✓	✓	✓	✓	✓
Local public good				✓	✓	✓
Communication within subgroups		✓	✓		✓	✓
Communication between delegates			✓			✓

communication structure; for example, *Global-Delegates* denotes the treatment with only the global public good and delegate communication, whereas *Local-Delegates* denotes the treatment with both public goods and delegate communication. Table 1 summarizes the treatment characteristics.

3. Predictions

We organize the predictions around two benchmarks. The first is the standard own-earnings-maximization benchmark. In every treatment, contributing to a public good is privately costly. A participant who keeps one point earns one point from doing so. A participant who contributes one point to the global public good receives only 0.3 points back directly, and a participant who contributes one point to the local public good receives only 0.6 points back directly. Thus, both types of contribution are dominated in the stage game. Since the game is finitely repeated, backward induction implies zero contributions to all public goods in all treatments. The second benchmark is the total-earnings-maximization benchmark. From the perspective of the nine-person global group, a point contributed to the global public good generates $0.3 \times 9 = 2.7$ points of total surplus. A point contributed to the local public good generates $0.6 \times 3 = 1.8$ points of total surplus. Keeping a point generates one point of individual surplus. Hence, in all treatments, the socially efficient outcome is full contribution to the global public good.

The own-earnings-maximization benchmark is unlikely to describe participants' behavior. A large experimental literature finds positive contributions in public good games, even in the absence of formal enforcement institutions (Ledyard, 1995). We therefore expect positive contributions in the *Global-None* treatment, but also expect them to decline over time, as is standard in finitely repeated voluntary-contribution mechanisms.

Our main interest is not simply whether communication increases cooperation, but how the structure of communication changes the pattern of cooperation. In our setting, communication may affect three distinct margins: the level of contributions, the persistence of contributions over time, and, when both public goods are available, the allocation of contributions between the local and global public goods. Previous work shows that communication increases contributions in public-goods games and mitigates the decline in contributions across periods (see Chaudhuri, 2010). However, the effect of communication may conceal different underlying mechanisms. Following Ostrom and Walker (1991), we distinguish between two closely related channels through which communication may sustain cooperation: informal enforcement and coordination.

First, communication can facilitate informal enforcement. Participants can express disapproval and verbally sanction group members who contribute less than others. These sanctions are non-material, but they may nevertheless affect behavior if participants care about norm compliance, self-image, or the disapproval of others (Akerlof, 1980; Bicchieri, 2002).[6] Prior work shows that verbal sanctions can increase cooperation even when they do not change material payoffs (e.g., Masclet et al., 2003; Noussair and Tucker, 2005).

Second, communication can facilitate coordination. If participants have other-regarding preferences or care about complying with social norms, the public-goods game becomes a coordination game with multiple equilibria, where playing a high-contribution equilibrium is riskier than playing a low-contribution equilibrium when participants are uncertain about whether others will also contribute (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Bicchieri et al., 2018). Communication can reduce this strategic uncertainty by allowing participants to agree on a contribution norm and to coordinate expectations about what others will do (e.g., Riechmann and Weimann, 2008).[7]

In our design, the distinction between enforcement and coordination is especially important because the communication structure need not coincide with the externality structure of the public good. Individual contribution information is local: participants observe individual contributions within their own subgroup, but only aggregate information about the other subgroups. As a result, communication within a subgroup may be effective at creating local accountability but insufficient to coordinate behavior across the full nine-person group. Delegate communication is designed to test whether even limited communication across subgroups can overcome this problem.

3.1. Predictions with only a global public good

In the treatments with only the global public good, the relevant outcome is the level of contribution to that good. The global public good benefits all nine participants, but in the *Global-Subgroup* treatment, communication is restricted to groups of three. This creates a possible mismatch between the group that can communicate and the group that benefits from cooperation.

[6] A related mechanism is promise-keeping. Communication allows participants to make explicit commitments, and breaking a promise may be psychologically costly (Charness and Dufwenberg, 2006).

[7] Communication may therefore coordinate not only actions, but also the particular norm that participants expect to be followed and enforced (Fehr and Schurtenberger, 2018; Andrighetto et al., 2013).

The treatments with both public goods introduce a second consideration: participants choose not only how much to contribute, but also where to direct their contributions. This creates a tension between local attractiveness and global efficiency. The global public good is more efficient, but the local public good has two features that may make it behaviorally attractive. First, it has a higher marginal per-capita return for the contributor, 0.6 rather than 0.3. Second, its beneficiaries are the two other members of the participant's own subgroup, whose individual contribution behavior is observable and, in the communication treatments, discussable. The local public good is therefore less efficient, but more immediate, more observable, and easier to coordinate around.

Relative to *Global-None*, we expect *Global-Subgroup* to increase contributions. Subgroup communication allows participants to discuss contribution levels, make promises, and express disapproval toward identifiable low contributors within the subgroup. It should therefore strengthen local accountability and reduce disagreement within subgroups about how much to contribute. We therefore also expect lower within-subgroup dispersion in contributions in *Global-Subgroup* than in *Global-None*.

However, subgroup communication does not fully solve the coordination problem created by the nine-person global public good. A subgroup can agree internally to contribute, but its members may remain uncertain about whether the other two subgroups will do the same. This uncertainty makes high contributions risky. Thus, if communication works only through local informal enforcement, most of the communication effect should already appear in *Global-Subgroup*. If, instead, cross-subgroup coordination is important, then adding delegate communication should further increase contributions.

We therefore expect contributions to be highest in *Global-Delegates*. Delegate communication allows the three subgroups to exchange plans, establish common expectations, and create at least some accountability across subgroup boundaries. Although delegates do not make communication fully public within the nine-person group, they provide a channel for transmitting subgroup-level intentions and norms. Consequently, we expect delegate communication to increase global contributions relative to subgroup communication alone, reduce dispersion in average contributions across subgroups, and attenuate the decline in contributions over time.

These considerations imply the following directional prediction: with only the global public good, contributions should satisfy *Global-None* $<$ *Global-Subgroup* $<$ *Global-Delegates*. Subgroup communication should mainly improve coordination within subgroups, whereas delegate communication should additionally improve coordination across subgroups.

3.2. Predictions with global and local public goods

The treatments with both public goods introduce a second consideration: participants choose not only how much to contribute, but also where to direct their contributions. This creates

a tension between local attractiveness and global efficiency. The global public good is more efficient, but the local public good has two features that may make it behaviorally attractive. First, it has a higher marginal per-capita return for the contributor, 0.6 rather than 0.3. Second, its beneficiaries are the two other members of the participant's own subgroup, whose individual contribution behavior is observable and, in the communication treatments, discussable. The local public good is therefore less efficient, but more immediate, more observable, and easier to coordinate around.

For this reason, we expect that introducing a local public good will reduce contributions to the global public good in the absence of communication. In *Local-None*, participants may still contribute positive amounts, but the local public good is likely to attract a substantial share of contributions because it offers a higher private return and requires coordination among only three participants rather than nine. Thus, relative to *Global-None*, the availability of the local public good may increase total contributions while lowering contributions to the global public good.[8]

The effect of subgroup communication on efficiency is ambiguous, but not on the likely direction of coordination. In *Local-Subgroup*, participants can communicate only with those who benefit from the local public good and whose individual local contributions are observed. This makes the local public good the natural object of discussion, agreement, and informal enforcement. Subgroup communication can also be used to discuss contributions to the global public good, but any such agreement remains exposed to uncertainty about the behavior of the other two subgroups. We therefore expect subgroup communication to increase total contributions primarily by increasing contributions to the local public good. It should also reduce within-subgroup dispersion in both local and global contributions, since subgroup members can agree on a common allocation rule. Whether total earnings increase will depend on whether the increase in contributions to the local public good is sufficiently large to compensate for any decrease in contributions to the global public good.

Delegate communication changes the nature of the coordination problem. In *Local-Delegates*, subgroups can communicate indirectly with one another, facilitating coordination on the more efficient global public good. If delegates successfully transmit subgroup intentions and establish a common contribution norm, contributions should shift from the local public good toward the global public good. The effect on total contributions is less clear: delegate communication may increase total contributions, but it may also primarily reallocate contributions from the local to the global public good. The more robust prediction is therefore: delegate communication should increase the share of contributions directed to the global public good and reduce reliance

[8]Previous research without communication has shown that participants often contribute to local public goods. For example, with parameters that are not far from ours, Blackwell and McKee (2003) find that contributions to the local public good often exceed those to the global public good (see also Buchan et al., 2009).

on the less efficient local public good.

At the same time, the *Local-Delegates* treatment is likely to generate heterogeneity across global groups. Groups may differ in whether delegates succeed in establishing a global norm, whether subgroup members follow the agreements made by their delegates, and whether communication converges on full global contribution or on a mixed local-global allocation. Thus, delegate communication should improve the possibility of efficient coordination, but it need not eliminate variation across global groups.

These considerations imply the following three directional predictions. First, without communication, the availability of the local public good should draw contributions away from the global public good. Thus, global contributions should be lower in *Local-None* than in *Global-None*, and a substantial share of contributions in *Local-None* should be directed to the local public good. Second, subgroup communication should increase total contributions, but the increase should occur primarily through higher contributions to the local public good. Thus, *Local-Subgroup* should exhibit higher total contributions than *Local-None*, but not necessarily higher global contributions. Third, delegate communication should shift contributions toward the more efficient global public good. Thus, relative to *Local-Subgroup*, *Local-Delegates* should have higher global contributions and a higher global share of total contributions, while local contributions should decline.

4. Experimental procedures

The experiment was conducted at the LINEEX laboratory in Valencia in the spring of 2010. We followed standard experimental economics procedures: participants made incentivized decisions, interacted anonymously, received neutrally framed instructions, and were not deceived. The computerized experiment was programmed in z-Tree (Fischbacher, 2007).

Upon arrival, participants were randomly assigned to seats in the laboratory. They then read the instructions and answered control questions designed to verify their understanding of the decision environment. A sample of the instructions is provided in Appendix A. Once all participants had completed the instructions and control questions, they played the game for 15 periods.

Participants were identified during the experiment only by anonymous identification numbers. These identifiers appeared in the chat windows and on the feedback screens that displayed the individual contributions of other members of the participant's subgroup. At the end of the experiment, participants were paid privately and in cash. Experimental points were converted into euros at a rate of 30 points = €1. Average earnings were €17.

In total, 432 undergraduate students participated in the experiment. We ran 12 sessions with 36 participants per session. Each treatment was implemented in two sessions, yielding

72 participants, 24 local subgroups, and 8 independent global groups per treatment. Sessions lasted approximately 45 minutes.

5. Results

The experiment includes 432 participants, divided into 144 subgroups and 48 global groups. Each treatment contains 72 participants, 24 subgroups, and 8 independent global groups. We organize the analysis around three outcomes: the level of contributions, the trend of contributions over time, and the dispersion of contributions within and between subgroups. The first two outcomes capture the extent and persistence of cooperation. The dispersion measures capture the extent to which participants coordinate in their contribution behavior.

Given the panel structure of the data, we analyze treatment differences in contribution levels with mixed-effects models of the form $c_{i,s,k,t} = \alpha + \beta X_{i,s,k,t} + \eta_{s,k} + \nu_{i,s,k} + \epsilon_{i,s,k,t}$, where $c_{i,s,k,t}$ denotes the contribution of participant i in subgroup s of global group k in period t, $X_{i,s,k,t}$ is a vector of treatment indicators, $\eta_{s,k} \sim \mathcal{N}(0, \sigma_S^2)$ is a subgroup random effect, $\nu_{i,s,k} \sim \mathcal{N}(0, \sigma_I^2)$ is an individual random effect, and $\epsilon_{i,s,k,t} \sim \mathcal{N}(0, \sigma^2)$ is the error term. Standard errors are clustered at the global-group level. To analyze trends over time, we estimate the same specification after adding the period number and its interactions with the treatment indicators. The trend reported in the tables is the average change in contributions per period. All p-values reported for treatment differences in contribution levels and trends are based on these regressions. The regression tables are available in Appendix B.

Since we are interested in understanding the degree of coordination within and between subgroups, we analyze different measures of variability in contributions. First, *within-subgroup* dispersion in each period is defined as the standard deviation of contributions within each subgroup: $sd^W_{s,k,t} = \sqrt{\frac{1}{3}\sum_j^3 (c_{j,s,k,t} - \bar{c}_{s,k,t})^2}$, where $\bar{c}_{s,k,t} = \frac{1}{3}\sum_j^3 c_{j,s,k,t}$. This measure captures how closely the three members of a subgroup coordinate with one another. Second, *between-subgroup* dispersion within global groups in each period is defined as the standard deviation of the mean subgroup contributions within each global group: $sd^B_{k,t} = \sqrt{\frac{1}{3}\sum_s^3 (\bar{c}_{s,k,t} - \bar{c}_{k,t})^2}$, where $\bar{c}_{k,t} = \frac{1}{3}\sum_s^3 \bar{c}_{s,k,t}$. This measure captures whether the three subgroups in the same global group coordinate on similar contribution levels. In line with the analysis of contribution levels, we test treatment differences in dispersion with panel regressions, with treatment dummies as independent variables and random effects for subgroups when possible.

5.1. Only global public good

We begin with the treatments in which participants can contribute only to the global public good. Table 2 reports mean contributions, trends, and dispersion measures for the three communication structures. Figure 1 shows mean contributions by five-period blocks.

Table 2. Contributions in treatments with only the global public good

Note: Contributions are measured in points out of a 20-point endowment. Means are calculated over all participants and periods in a treatment. The trend is the average change in contributions per period. The within-subgroup standard deviation is the average standard deviation of individual contributions within each three-person subgroup. The between-subgroups standard deviation is the average standard deviation of mean subgroup contributions within each global group.

Treatment	**Mean**	**Trend**	**Standard deviation**	
			within subgroups	**between subgroups**
Global-None	8.00	−0.48	4.53	3.05
Global-Subgroup	11.43	−0.69	1.89	4.04
Global-Delegates	16.09	−0.34	1.90	2.11

In *Global-None*, participants contribute 8.00 points on average, or 40 percent of their endowment. Contributions significantly decline over time, with an estimated trend of −0.48 points per period ($p < 0.001$). This pattern is consistent with the standard finding that contributions in finitely repeated public-goods games are positive initially but decline with repetition (Ledyard, 1995; Bochet et al., 2006).

Communication raises contributions substantially. In *Global-Subgroup*, where participants can communicate only with the other members of their own subgroup, mean contributions significantly increase from 8.00 to 11.43 points ($p = 0.050$). Thus, even communication that is restricted to subgroups increases contributions to the global public good. However, subgroup communication does not prevent the decline in contributions over periods ($p < 0.001$). The estimated trend in *Global-Subgroup* is somewhat steeper, at −0.69 points per period, indicating that local communication raises contribution levels but does not, by itself, stabilize cooperation.

Adding communication between subgroup delegates further increases global contributions. Mean contributions in *Global-Delegates* are 16.09 points, significantly higher than in *Global-Subgroup* ($p = 0.018$). Delegate communication also attenuates the decline in contributions: the estimated trend is −0.34 points per period, which is significantly lower than in *Global-Subgroup* ($p = 0.028$) but is not significantly different from that in *Global-None* ($p = 0.241$). These results indicate that communication is not merely a local enforcement device. When the public good benefits all nine members of the global group, communication across subgroups is important for sustaining high contributions.

The dispersion measures clarify the coordination effects of the different communication structures. Subgroup communication sharply reduces dispersion within subgroups: the within-subgroup standard deviation falls from 4.53 in *Global-None* to 1.89 in *Global-Subgroup* and 1.90 in *Global-Delegates* ($p < 0.001$ for both). This is consistent with the idea that subgroup chat is already sufficient to coordinate behavior among the three members of a subgroup.

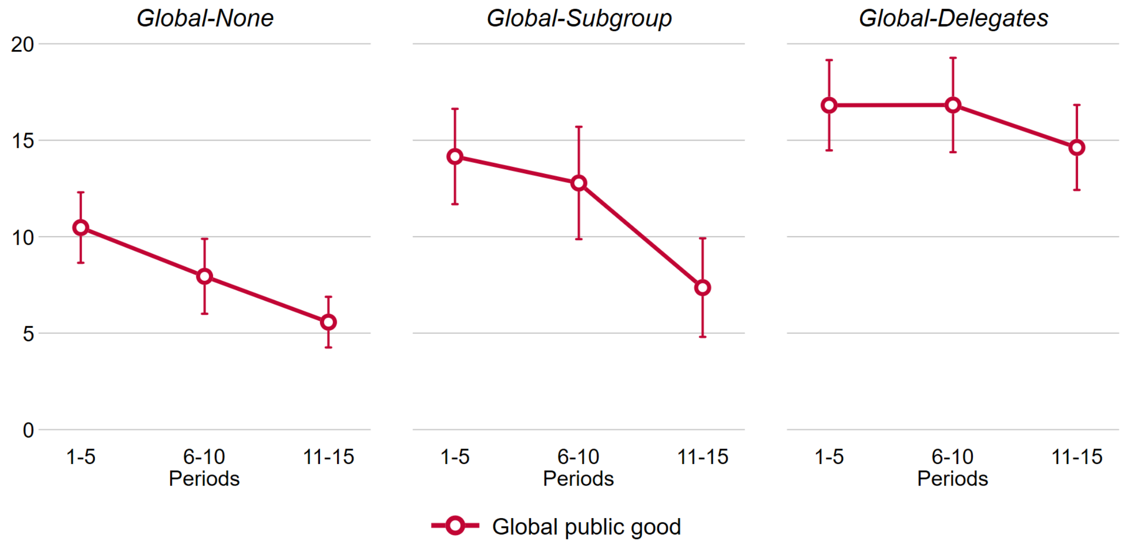

Figure 1. Mean contributions in treatments with only the global public good

Note: Mean contributions in 5-period blocks in treatments with only the global public good. The error bars correspond to 90% confidence intervals estimated using a mixed-effects linear regression with subgroup and individual random effects and standard errors clustered at the global-group level.

The pattern is different for coordination between subgroups. Between-subgroup dispersion increases from 3.05 in *Global-None* to 4.04 in *Global-Subgroup*, suggesting that subgroup communication may lead different subgroups to coordinate internally on different contribution levels, although this difference is not statistically significant ($p = 0.166$). Once delegate communication is added, between-subgroup dispersion falls to 2.11, significantly lower than in *Global-Subgroup* ($p = 0.020$). Thus, delegate communication improves alignment across subgroups, which is precisely the level at which coordination is required for the global public good.

We summarize these findings as our first two results.

Result 1 *When only the global public good is available, contributions increase with the scope of communication. Communication within subgroups raises global contributions relative to no communication, and communication between subgroups via delegates produces an additional increase. Delegate communication also slows the decline in contributions relative to subgroup communication alone, indicating that between-subgroup communication helps sustain cooperation in the global public good.*

Result 2 *Communication affects the level at which participants coordinate. Communication within subgroups sharply reduces dispersion among members of the same subgroup, but it does not reduce dispersion between subgroups. Communication between subgroups via delegates reduces between-subgroup dispersion, aligning behavior at the level at which coordination is required for the global public good.*

Table 3. Contributions in treatments with global and local public goods

Note: Contributions are measured in points out of a 20-point endowment. Means are calculated over all participants and periods in a treatment. The trend is the average change in contributions per period. The within-subgroup standard deviation is the average standard deviation of individual contributions within each three-person subgroup. The between-subgroups standard deviation is the average standard deviation of mean subgroup contributions within each global group.

				Standard deviation	
Treatment	**Public good**	**Mean**	**Trend**	**within subgroups**	**between subgroups**
	Global	4.83	−0.36	3.41	2.04
Local-None	Local	8.54	0.07	3.97	4.55
	Total	13.37	−0.29	3.59	4.74
	Global	5.45	−0.14	1.38	2.79
Local-Subgroup	Local	13.07	0.12	1.83	3.67
	Total	18.52	−0.03	0.92	1.67
	Global	10.43	−0.49	1.13	1.46
Local-Delegates	Local	6.88	0.37	2.10	2.99
	Total	17.31	−0.12	1.86	2.41

5.2. Global and Local Public Goods with Communication

We next turn to the treatments in which participants can allocate their endowment between the global public good and the local public good. Table 3 reports contributions to each public good, total contributions, trends, and dispersion measures. Figure 2 displays mean contributions by five-period blocks.

Without communication, the availability of the local public good substantially changes the level and allocation of contributions. In *Local-None*, participants contribute 13.37 points in total, which is significantly more than in *Global-None*, where participants can contribute only to the global public good ($p < 0.001$). However, most of these contributions are directed to the local public good. Average local contributions are 8.54 points, compared with 4.83 points to the global public good. Thus, roughly two-thirds of total contributions go to the less efficient local public good. Moreover, global contributions are significantly lower in *Local-None* than in *Global-None* ($p = 0.013$). Therefore, the local public good crowds out contributions to the global public good, even though the global public good generates a higher total surplus. Interestingly, the trend in contributions is different between local and global contributions. While contributions to the global public good significantly decrease over periods ($p < 0.001$), contributions to the local public good do not ($p = 0.413$).

Subgroup communication alone increases total contributions, but it does so almost entirely by increasing contributions to the local public good. Total contributions rise from 13.37 in *Local-*

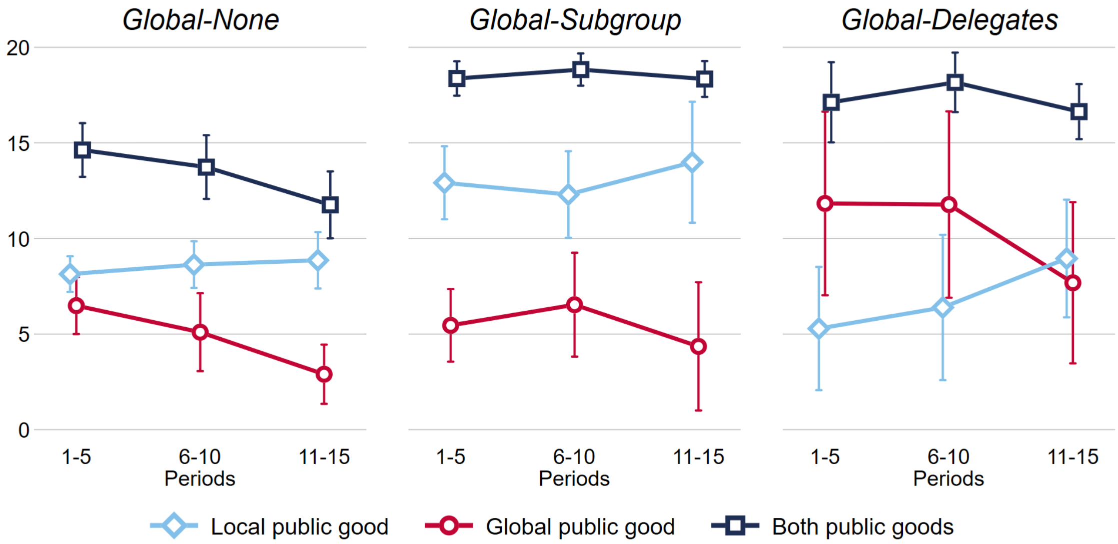

Figure 2. Mean contributions in treatments with both global and local public goods

Note: Mean contributions in 5-period blocks in treatments with global and local public goods. The error bars correspond to 90% confidence intervals estimated using a mixed-effects linear regression with subgroup and individual random effects and standard errors clustered at the global-group level.

None to 18.52 in *Local-Subgroup* ($p < 0.001$). Local contributions significantly increase from 8.54 to 13.07 points ($p = 0.001$), whereas global contributions increase marginally from 4.83 to 5.45 points ($p = 0.681$). As a result, the local public good accounts for about 71 percent of total contributions in *Local-Subgroup*. These results support the prediction that local communication increases cooperation but directs it toward the locally targeted public good.

The dispersion measures show that subgroup communication also improves local coordination. Relative to *Local-None*, within-subgroup dispersion in *Local-Subgroup* falls from 3.41 to 1.38 for contributions to the global public good, from 3.97 to 1.83 for contributions to the local public good, and from 3.59 to 0.92 for total contributions (all these differences are statistically significant, $p < 0.001$). Hence, subgroup communication leads subgroup members to make more similar allocation decisions. However, these coordinated decisions favor the local public good rather than the more efficient global public good. In this sense, subgroup communication solves a local coordination problem while leaving the global allocation problem largely unresolved.

Delegate communication further changes the level and allocation of contributions. Global contributions further rise from 5.45 points in *Local-Subgroup* to 10.43 points in *Local-Delegates*. This increase is large in magnitude but only weakly significant ($p = 0.079$). At the same time, local contributions significantly fall from 13.07 to 6.88 points ($p = 0.005$). Total contributions remain high, decreasing sligtly from 18.52 to 17.31 ($p = 0.230$). Thus, the primary effect of delegate communication is not to increase the total amount contributed, but to reallocate contributions from the less efficient local public good toward the more efficient global public good. The global share of total contributions increases from approximately 29 percent in *Local-*

Subgroup to approximately 60 percent in *Local-Delegates*.

The dispersion measures show that within-subgroup dispersion in *Local-Delegates* remains low compared to *Local-None* ($p < 0.006$) and is similar to that in *Local-Subgroup* ($p > 0.106$). However, relative to *Local-Subgroup*, between-subgroup dispersion tends to be lower in *Local-Delegates*. The difference in between-subgroup dispersion is statistically significant for contributions to the global public good ($p = 0.049$) but not for contributions to the local public good ($p = 0.486$). Hence, delegate communication facilitates coordination not only within subgroups but also between, making higher global contributions possible.[9]

Finally, comparing the treatments with local and global public goods with the corresponding global-only treatments shows that the availability of a local public good increases total contributions under each communication structure. The increase is especially pronounced without communication and with only subgroup communication ($p < 0.001$) and less so with delegate communication ($p = 0.445$), where contributions were already high with only the global public good. However, higher total contributions do not necessarily imply higher efficiency, as the presence of the local public good shifts some contributions away from the more efficient global public good. If we test differences in earnings, we find that the local public good does not significantly increase earnings in any of the communication structures ($p > 0.263$).

The next three results summarize these findings.

Result 3 *When both public goods are available and communication is absent, participants direct their contributions to the local public good. The availability of the local public good increases total contributions but reduces contributions to the global public good compared to treatments with only a global public good. Thus, introducing a local public good increases cooperation but worsens the allocation of contributions from the perspective of global efficiency.*

Result 4 *Subgroup communication when both local and public goods are available increases total contributions and improves coordination within subgroups, but it does so primarily by increasing contributions to the local public good. Global contributions do not increase significantly. Local communication, therefore, sustains cooperation but channels it toward the local, less-efficient public good.*

Result 5 *Delegate communication shifts the allocation of contributions toward the globally efficient public good. Relative to subgroup communication alone, global contributions are substantially higher, local contributions fall significantly, and total contributions remain unchanged.*

[9] We should note that, delegate communication seems to increase variance between global groups. This is seen in the confidence intervals of Figure 2. Overall variation in contributions is higher. Given that dispersion within and between subgroups is lower, the higher overall variation is due to global groups coordinating on different allocations. Some groups use the delegate channel to shift strongly toward the global public good, whereas others continue to rely more heavily on local contributions.

The main effect of delegate communication is therefore a reallocation of contributions from the local public good toward the globally efficient public good, rather than an increase in total cooperation.

5.3. Chat coding Analysis

To better understand how communication affected behavior, we coded more than 19,000 lines of chat. The coding identifies whether a communication round produced an explicit contribution agreement, the contribution levels specified in that agreement, and the extent to which subsequent contributions deviated from the agreed levels. This allows us to distinguish three margins through which communication may affect cooperation: whether participants reach an agreement, what contribution norm they select conditional on reaching an agreement, and whether they subsequently comply with that agreement.

Because agreed contribution levels are observed only when an agreement is reached, we analyze the chat data using a two-part mixed-effects model. We index the three communication rounds by $r \in \{1, 2, 3\}$, corresponding to the chats before periods 1, 6, and 11. The first part of the model estimates the probability that a communication round produces an explicit agreement. Since agreements are binary, we use logit specifications. For subgroup chats, we estimate $a_{s,k,r} = \alpha^A + \beta^A X_{s,k,r} + \eta^A_{s,k} + \epsilon^A_{s,k,r}$, where $a_{s,k,r}$ denotes the latent propensity of subgroup s in global group k to reach an agreement in communication round r and $\epsilon^A_{s,k,r}$ the idiosyncratic error term, assumed to follow a standard logistic distribution. The second part of the model estimates the agreed contribution level conditional on an agreement being reached. For subgroup agreements, we estimate, for each public good $PG \in \{G, L\}$, $\hat{c}^{PG}_{s,k,r} = \alpha^{PG} + \beta^{PG} X_{s,k,r} + \eta^{PG}_{s,k} + \epsilon^{PG}_{s,k,r}$ for observations with $a_{s,k,r} = 1$, where $\hat{c}^{PG}_{s,k,r}$ denotes the agreed contribution to public good PG. The vector X includes treatment indicators. The terms $\eta^A_{s,k}$ and $\eta^{PG}_{s,k}$ are random intercepts for subgroups. We estimate the agreement and agreed-contribution equations jointly using maximum likelihood and clustering standard errors on global groups. We let the random intercepts in the two equations be correlated, allowing unobserved factors that make a subgroup more likely to reach an explicit agreement to also be associated with the contribution level selected in that agreement. We use the same approach for delegate chats, except we use global group random effects rather than subgroup random effects.

To measure compliance with agreements, we calculate the deviation between actual and agreed contributions. Specifically, for each agreement and public good, we define the deviation as the mean contribution by the relevant set of participants in the five periods following the communication period minus the agreed contribution level. Therefore, negative values indicate that actual contributions fell short of the agreement. Deviations are analyzed conditional on an agreement being reached, using the same mixed-effects model.

Table 4 reports the agreement rates, agreed contribution levels, and deviations from agreed

Table 4. Agreement rate and agreed contribution levels by treatment

Note: Subgroups refer to agreements within subgroups. Groups are agreements between subgroups made through delegates. Agreement rates correspond to the fraction of chat rounds in which an explicit agreement is reached. Agreed contributions correspond to the mean contribution to a public good (global or local) prescribed in agreements. Deviation from the agreed contribution is the mean difference between the actual contribution to a public good (global or local) in the five periods following the communication round and the agreed contribution by the relevant participants.

Treatment	Agreement between	Agreement rate	Agreed contribution to the public good		Deviation from the agreed contribution	
			Global	Local	Global	Local
Global-Subgroup	Subgroups	0.93	13.13		-1.56	
Global-Delegates	Subgroups	0.97	18.56		-1.86	
	Groups	0.71	19.71		-2.98	
Local-Subgroup	Subgroups	0.96	5.48	13.39	0.11	-0.15
Local-Delegates	Subgroups	0.92	13.68	5.92	-1.71	-0.04
	Groups	0.88	17.14	2.86	-5.61	3.39

contributions for treatments with communication.

Explicit agreements are common. In subgroup chats, agreement rates exceed 0.92 across all treatments and do not differ significantly ($p = 0.759$). Thus, participants almost always use subgroup communication to formulate an explicit contribution agreement. Delegate chats also frequently produce agreements, although agreement is significantly less common at the delegate level than within subgroups in *Global-Delegates*, where the estimated agreement rate is 0.71 for delegate chats compared with 0.97 for subgroup chats ($p = 0.001$).

The agreed contribution levels closely mirror the contribution patterns documented above. In the global-only treatments, subgroup agreements specify an average global contribution of 13.13 points in *Global-Subgroup* and 18.56 points in *Global-Delegates*. This difference is statistically significant ($p < 0.001$). Delegate-level agreements in *Global-Delegates* specify an even higher contribution level, 19.71 points, close to full contributions. Thus, when only the global public good is available, expanding the communication structure raises not only actual contributions but also the contribution norm explicitly selected in communication.

The treatments involving local public goods show a stronger compositional effect. In *Local-Subgroup*, subgroup agreements direct most contributions to the local public good: the agreed contribution is 13.39 points to the local public good and only 5.48 points to the global public good. By contrast, in *Local-Delegates*, subgroup agreements shift sharply toward the global public good. The agreed global contribution rises to 13.68 points, while the agreed local contribution falls to 5.92 points. Both differences relative to *Local-Subgroup* are statistically significant ($p < 0.003$ for each comparison). Delegate-level agreements in *Local-Delegates* shift even further toward the efficient public good, specifying 17.14 points to the global public good and only 2.86

points to the local public good.

These patterns are important because they show that communication does not merely change the likelihood of agreement. Agreement rates are high in all communication treatments. Instead, the main effect of the communication structure is on the content of the agreements. When communication is restricted to subgroups, participants coordinate on the local public good. When communication across subgroups is possible, even indirectly through delegates, agreements shift toward the globally efficient public good.

Next, we assess how closely participants comply with these agreements by examining the difference between the amounts contributed and the amounts agreed. In the global-only treatments, actual contributions fall short of subgroup agreements by 1.56 points in *Global-Subgroup* and 1.86 points in *Global-Delegates*. Both deviations are statistically different from zero ($p < 0.041$), but they do not differ significantly from each other ($p = 0.743$). This pattern is consistent with the interpretation that communication raises contributions partly by allowing participants to agree on an explicit contribution norm. Deviations from delegate-level agreements in *Global-Delegates* are larger: actual contributions are 2.98 points below the agreed level ($p = 0.003$). This partly reflects that delegate-level agreements are very ambitious, with agreed contributions close to the maximum possible, but it also suggests that enforcing an agreed-contribution norm is more difficult across subgroups.

The introduction of a local public good in *Local-Subgroup* strengthens compliance with agreements within subgroups. In this treatment, deviations from subgroup agreements are essentially zero: actual contributions differ from agreed contributions by 0.11 points for the global public good and by -0.15 points for the local public good (neither difference is statistically significant, $p > 0.885$). This provides evidence that the high local contributions in *Local-Subgroup* are not due to individual preferences or free-riding. Instead, they are the outcome of explicit within-subgroup coordination on an agreed-upon contribution norm.

Lastly, allowing subgroups to communicate via delegates in *Local-Delegates* not only shifts subgroup agreements toward the global public good but also reintroduces a moderate amount of free-riding on the global component of the agreement. Actual global contributions are 1.71 points below the subgroup-level agreement ($p = 0.076$), while local contributions are almost exactly equal to the agreed amount ($p = 0.931$). Interestingly, deviations from delegate-level agreements are much larger. Relative to the amounts delegates agree on, participants contribute 5.61 fewer points to the global public good ($p = 0.003$) and 3.39 more points to the local public good ($p = 0.002$). In other words, when participants deviate from the contributions delegates agreed on, they do not simply keep the money. They partially redirect contributions back to the local public good. This pattern reflects a conflict between contribution norms at different levels: delegates articulate a more efficient global norm, but subgroup agreements prescribe lower global contributions and higher local contributions. Subsequent behavior lies closer to the subgroup-level agreement, suggesting that local agreements remain the more salient or more enforceable reference point for participants' choices.

The chat evidence, therefore, supports the interpretation that delegate communication can identify the efficient contribution norm but does not always make that norm fully enforceable. Subgroup communication produces agreements that are easier to monitor and implement, but these agreements tend to favor the local public good when both public goods are available. Communication among delegates produces agreements that strongly favor the global public good, but compliance with those agreements is less complete, particularly when competing local agreements are more tilted toward the local public good.

We summarize these as our last two results.

Result 6 *The communication treatments differ more in the content of agreements than in the probability of reaching agreements. Explicit agreements are common in all communication treatments. When both local and global public goods are available and communication is restricted to subgroups, agreements primarily favor the local public good. When communication across subgroups is possible through delegates, both subgroup-level and delegate-level agreements shift sharply toward the global public good.*

Result 7 *Compliance with agreements depends on the level at which the agreement is made. Subgroup agreements are implemented closely, especially when the local public good is available and there is no communication between subgroups. Delegate-level agreements allocate higher global contributions and lower local contributions, but are implemented with less fidelity. Deviations from delegate agreements combine free-riding on global contributions with a partial reallocation of contributions back to the local public good, reflecting a conflict between subgroup-level and delegate-level contribution norms.*

6. Conclusions

This paper examines how communication structures influence voluntary cooperation when individuals belong simultaneously to local subgroups and a larger global group. In such settings, the central problem is not only whether individuals cooperate but also which contribution norm they coordinate on. Cooperation may be locally successful yet inefficient from the perspective of the larger global group if contributions are directed toward a locally attractive but less socially efficient public good. The experiment isolates this problem by varying both the set of available public goods and the structure of non-binding communication.

The first set of results confirms the standard finding that communication increases cooperation in public-good environments, but also qualifies it in an important way (Ostrom and Walker, 1991; Ledyard, 1995; Chaudhuri, 2010). When only the global public good is available, communication within subgroups raises contributions and aligns behavior among subgroup members. However, subgroup communication alone does not fully solve the coordination problem faced by the global group. Communication between subgroups through delegates further increases global contributions, improves coordination between subgroups, and slows the decline in contributions relative to communication within subgroups alone. Thus, communication is not merely a local enforcement device. It is also a mechanism for creating shared expectations across the units whose actions jointly determine the returns to cooperation.

This result has direct implications for the design of institutions in settings with spillovers across local units. Many organizations and political systems rely on local deliberation, monitoring, or accountability, even when the consequences of action extend beyond the local unit (Besley and Coate, 2003; Oates, 2005). Our results suggest that such local communication can improve cooperation but may be insufficient when efficient provision requires coordination across subgroups. Even limited cross-group communication, such as communication through representatives, can help groups converge on a common global contribution norm. The relevant design question is therefore not simply whether communication is possible, but whether the communication network connects actors at the level at which the externality operates.

The treatments with both global and local public goods illustrate why this distinction matters. The local public good offers a higher marginal individual return and is easier to observe and discuss within the subgroup, but it yields lower total surplus than the global public good. When this local option is introduced, total contributions rise, yet much of the increase goes to the local public good. Without communication, participants contribute significantly less to the global public good than when only the global public good is available. Subgroup communication amplifies this pattern: it raises total contributions and improves coordination within subgroups, but primarily by increasing contributions to the local public good. Hence, local communication promotes cooperation, but not necessarily efficient cooperation.

This finding connects the paper to prior work showing that individuals often favor local or club goods when local and global public goods coexist (Blackwell and McKee, 2003; Buchan et al., 2009; Fellner and Lünser, 2014). The present paper's contribution is to show how communication structures affect this allocation problem. Local communication does not merely reveal pre-existing preferences for the local public good. It helps establish a contribution norm centered on the local public good. This distinction is important for policy. Institutions evaluated solely on whether they increase participation, giving, or voluntary contributions may appear successful even when they direct effort away from the level that produces the greatest aggregate return.

Delegate communication reallocates cooperation. In the local-public-good environment, allowing communication across subgroups substantially increases the global share of contributions and significantly reduces local contributions, while total contributions remain high. The main effect of delegate communication is therefore compositional: it shifts cooperation from the local public good toward the globally efficient public good. This suggests that representative communication can be a useful institutional tool when full communication among all affected parties is impractical. However, the effect is incomplete. The increase in global contributions is heterogeneous across global groups, and behavior does not fully converge to the efficient global allocation.

The analysis of the chat data clarifies the mechanism. Participants frequently reach explicit agreements across all communication treatments, so the main difference across treatments is not whether communication produces agreement. Rather, the communication structure changes the content of the agreement. When communication is restricted to subgroups, participants coordinate on agreements that favor the local public good. When communication across subgroups is possible through delegates, both subgroup-level and delegate-level agreements shift toward the global public good. This evidence supports the view that contribution norms are endogenous objects of coordination: groups must not only decide whether to cooperate but also which contribution norm should guide behavior (Bicchieri et al., 2018; Reuben and Riedl, 2013; Fehr and Schurtenberger, 2018).

The chat data also reveal a conflict between contribution norms at different levels. In the treatment with both public goods and communication via delegates, delegate-level agreements prescribe higher global contributions and lower local contributions than subgroup-level agreements do. Therefore, participants cannot fully comply with both contribution norms. Actual behavior lies closer to the subgroup-level agreement. Deviations from delegate agreements reflect a combination of moderate free-riding on the global public good and a noticeable reallocation of contributions back to the local public good. This pattern suggests that local norms remain more salient or easier to enforce, even when delegates agree on a more efficient contribution norm. Hence, even though delegates recognize the efficient contribution norm, it does not automatically become behaviorally binding within subgroups. For the global contribution norm to influence contributions, it must be communicated back to subgroup members and incorporated into the local agreement governing cooperative behavior.

The broader implication is that institutions that facilitate communication should be evaluated not only on whether they increase cooperation but also on how they structure the selection of contribution norms. Local communication can generate high compliance, but it may lock groups into locally oriented norms. Between-group communication can shift attention toward global efficiency, but it may also create competing obligations when global and local agreements conflict. Therefore, the institutional challenge is to create communication channels that enable efficient global contribution norms to emerge while ensuring those norms are credible in local settings where behavior is monitored and enforced.

Several questions remain for future research. One concerns the design of communication among local subgroups. In this paper, we use randomly-selected delegates who have no formal authority beyond access to an additional chat channel. Future work could examine whether elected delegates, rotating delegates, delegates with reporting obligations, or delegates whose agreements require subgroup ratification are better able to transmit global norms back to local groups. A second question concerns transparency. If all subgroup members could observe delegate discussions, delegate agreements might become more salient and easier to enforce. A third question concerns the interaction between communication and formal institutions. Weak sanctions, reputation systems, matching contributions, or voting procedures may help align local incentives with global efficiency without eliminating the advantages of local accountability.

Our main conclusion is that communication is powerful, but its effects are structurally contingent. In more complex public-good settings, communication does not merely increase or decrease cooperation. It determines who coordinates with whom, which contribution norm becomes focal, and whether cooperation is directed toward local or global objectives. The policy problem is therefore not simply to create more communication, but to design communication networks that enable efficient global contribution norms to emerge and remain credible within the local groups where behavior is observed, discussed, and enforced.

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Online appendices for: Coordinating Cooperation: Local and Global Norms in Public-Good Provision

Appendix A contains a sample of the instructions from the experiment. Appendix B contains the regression tables on which the data analysis is based.

Appendix A. Instructions

Below is an English translation of the instructions for the *Local-Delegates* treatment (the experiment was run in Spanish). The instructions for other treatments are similar and available upon request.

Instructions

You are participating in an experiment on economic decision making. During the experiment you will be able to earn money. Your exact earnings will depend on your and other players' decisions. These instructions describe the decisions you and other participants will make and how they determine your earnings. It is therefore important that you read them carefully.

During the experiment, all the interaction between you and other participants will take place through the computers. Please do not talk with other participants. If you have any questions, please raise your hand; one of us will come to answer your question. Note that the experiment is anonymous: that is, your identity will not be revealed to others and the identity of others will not be revealed to you.

During the experiment your earnings will be calculated in points. At the end of the experiment points will be converted to dollars at the following rate:

30 points = 1 dollar

General instructions

In the experiment, all participants are randomly divided into *groups of 3 people*. Nobody knows the identity of other group members, and nobody will be informed who was in which group after the study. To distinguish each other within their group, each participant will be randomly assigned to be either group member 1, group member 2, or group member 3.

Groups will stay constant during the experiment. In other words, you will be a member of the same group and keep the same number within your group throughout the entire experiment.

During the experiment your group will interact with *two other groups*, and these groups will be the same two groups throughout the experiment.

The experiment is divided into *15 rounds*. In every round you will have to make a decision.

Your decision

At the beginning of each round, each participant is given an endowment of 20 points. Your decision consists of choosing: how many points to invest in your group's Project A, how many points to invest in Project B, and how many points to keep for yourself. For example, you may invest 5 points in Project A, 10 points in Project B, and keep 5 points for yourself. All decisions are made simultaneously.

Only members of your group can invest in your group's Project A. Note that each of the two groups has their own Project A, which only members of that group can invest in. By contrast, all group members in your group plus all the group members in the other two groups can invest in Project B. It follows that only members of your group receive profits from your group's Project A, but everyone in your group and the two other groups receive profits from Project B.

How to calculate your profits

Your profit consists of three parts:

1. The points that you keep to yourself whereby 1 point kept = 1 point in profit.
2. The profit from your group's Project A. This profit is calculated as follows: Your profit from Project A = 0.6× the total investment of your group in Project A
3. The profit from Project B. This profit is calculated as follows: Your profit from Project B = 0.3× the total investment of all groups in Project B

Your total profit is therefore:

$$\begin{gathered}(20 - \text{your investment in Project A} - \text{your investment in Project B}) \\ + 0.6 \times (\text{your group's total investment in Project A}) \\ + 0.3 \times (\text{all groups' total investment in Project B})\end{gathered}$$

Remember: the total investment in Project A is the sum of points invested in Project A by members of *your group*, and total investment in Project B is the sum of points invested in Project B by members of *all three groups* (i.e., the points invested by your group plus the sum of points invested by members in the other two groups).

A way to think about your decision is to think about how you invest 1 point. You have three possibilities:

1. You can keep the point to yourself, which increases your own profit by 1 point and leaves the profits of others unchanged.

2. You can invest the point in Project A, which increases total investment in your group's Project A by 1 point. Consequently, your profit increases by $0.6 \times 1 = 0.6$ points, and the profit of your other two group members also increases by 0.6 points. In other words, the total profit of your group increases by 1.8 points.
3. Invest the point in Project B, which increases total investment in Project B by 1 point. Consequently, your profit increases by $0.3 \times 1 = 0.3$ points, the profit of your other two group members also increases by 0.3 points, and the profit of each member in the other two groups also increases by 0.3 points. In other words, the total profit of your group increases by 1.2 points, and the total profit of the three groups (yours and the other two) increases by 2.7 points.

Note that just like you can increase the profits of others by investing in Project A and Project B, your own profit increases with the points other members in your group invest in Project A, as well as with the points anyone in the three groups invests in Project B.

The profit of every participant is calculated in the same way.

Example:

Suppose that:

- You keep 5 points, invest 10 points in Project A, and 5 points in Project B.
- The other two group members in your group invest a sum of 20 points in Project A and a sum of 15 points in Project B.
- The participants in the two other groups invest a sum of 30 points in Project B.

In this case, the total amount invested in Project A is $10 + 20 = 30$ points, which means that your profit from Project A is $0.6 \times 30 = 18$ points. The total amount invested in Project B is $5 + 15 + 30 = 50$ points, which means that your profit from Project B is $0.3 \times 50 = 15$ points. Consequently, your total profit consists of the sum of the points you keep (5 points), the profit from Project A (18 points), and the profit from Project B (15 points), which equals $5 + 18 + 15 = 38$ points.

Communication

At the beginning of *rounds 1, 6, and 11*, everyone will be able to communicate with members of their own group, and in addition, some people will be able to communicate with members of other groups.

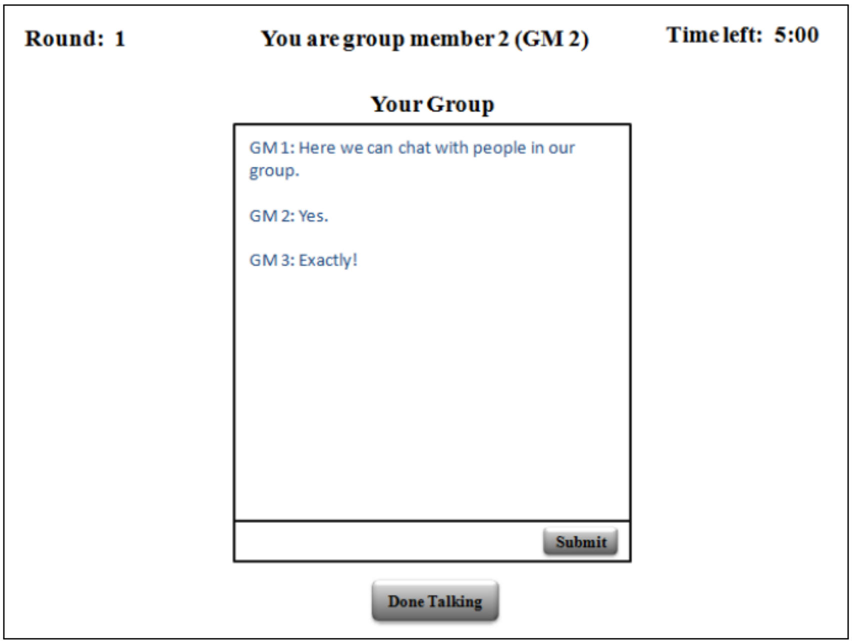
Specifically, people in your group will be able to communicate with each other through a shared chat box. No person outside your group can see the conversation in your group's chat box.

Moreover, one person (and only one) in your group will be able to communicate with one person in each of the other two groups. We refer to these people as the groups' *agents*. In addition to the chat box used to communicate with individuals in their own group, agents have another chat box in which they can communicate with the agents of the other two groups. The conversation in the agents' chat box will be visible only to the agents. In each group, the person assigned to be group member 1 will be the group's agent throughout the experiment.

You will be able to chat freely except that, in order to maintain anonymity, *you are NOT allowed to convey any information that could help others identify who you are.* If such a message is conveyed you will not receive payment for the experiment.

Screens and order in which decisions are made

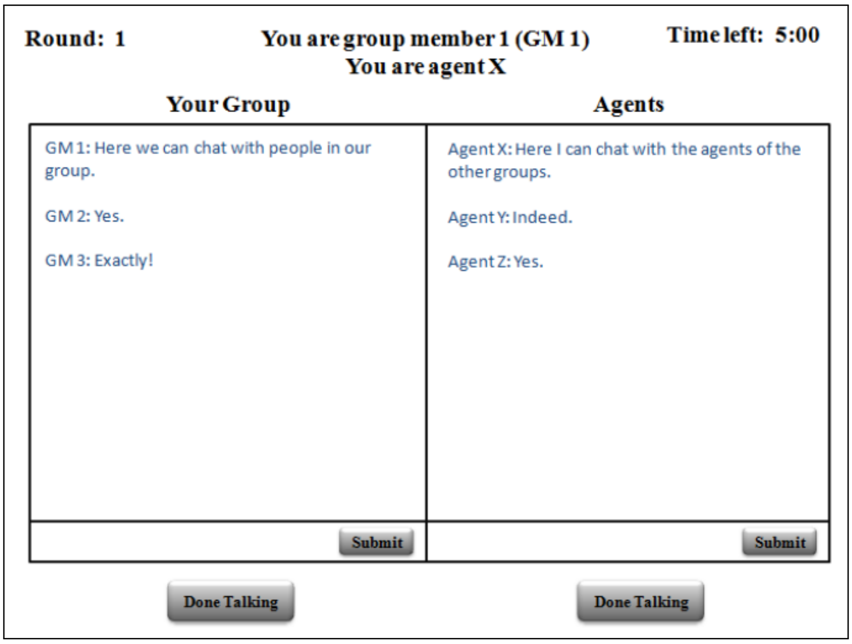
In rounds 1, 6, and 11, the first screen is the chat screen. Group members 2 and 3 see the following screen.



In the chat box, you may communicate with other members of your group. Note that in order to save space, "group member" has been abbreviated to "GM". To send a message to your group, type it into the input field at the bottom of the box and hit the "Enter" key on your keyboard.

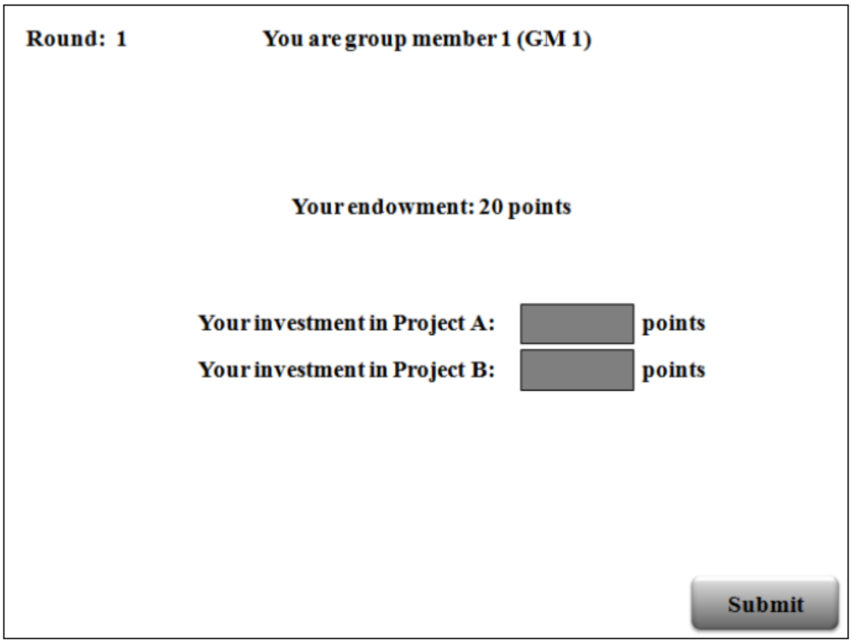
On the bottom of the screen you will see the time left for chatting. However, if you would like to finish the chat session before the time runs out, you can click on the "Done Talking" button. The chat session will end if all group members click on the button.

Since group member 1 is an agent, group member 1 has an additional chat box for communicating with other agents. Thus, group member 1 sees the following screen.



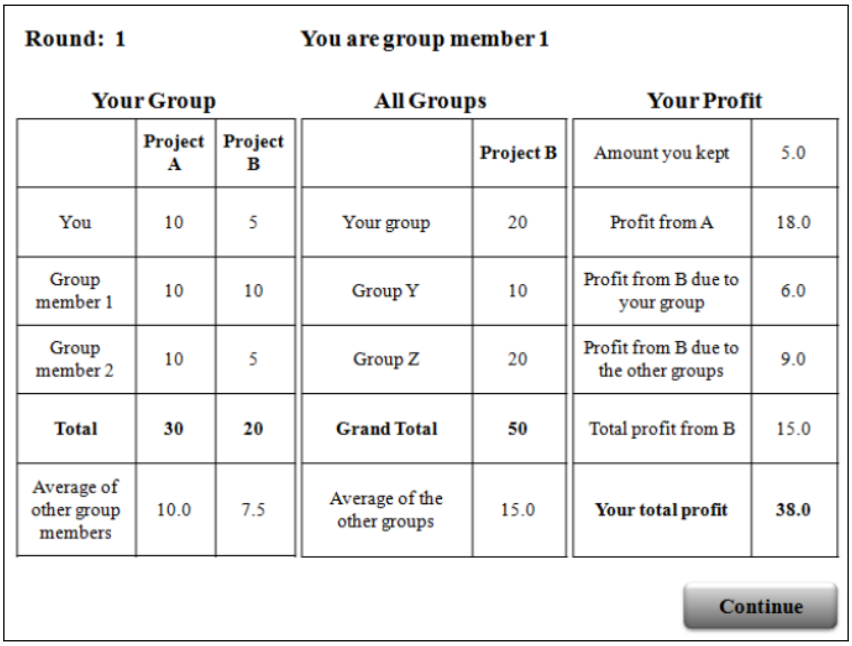
To send a message to agents from other groups, type it into the input field at the bottom of the Agents chat box and hit the "Enter" key on your keyboard.

After the chat screen, you will see the screen where you make your investment decision. The screen looks as follows:



In this screen you decide the amount you wish to invest in your group's Project A and in Project B. The difference between what you invest in the two projects and your endowment is the amount that you keep for yourself. To make your investment decision, type a number in the respective field and click on the "Submit" button.

After everyone has made their investment decision, the results screen will appear. The results screen looks as follows:



Round: 1 **You are group member 1**

Your Group

	Project A	Project B
You	10	5
Group member 1	10	10
Group member 2	10	5
Total	**30**	**20**
Average of other group members	10.0	7.5

All Groups

	Project B
Your group	20
Group Y	10
Group Z	20
Grand Total	**50**
Average of the other groups	15.0

Your Profit

Amount you kept	5.0
Profit from A	18.0
Profit from B due to your group	6.0
Profit from B due to the other groups	9.0
Total profit from B	15.0
Your total profit	**38.0**

Continue

The left side of the screen has a box labeled “Your Group”. This box contains the investment decisions of each of your group members and yourself, the average investments of the other two group members, and the total investments in your group. The information in this box is visible only to individuals in your group. The middle of the screen has a box labeled “All Groups”. This box contains the total investment in Project B by your group as well as the other two groups, the average total investment in Project B of the other two groups, and the grand total investment in Project B. The information in this box is visible to all individuals. Finally, the right side of the screen has a box labeled “Your Profit”. This box contains your profit in this round and it explains how the profit was determined. The information in this box is visible to you (although, note that with the information in the left box, the profits of everyone in your group can be calculated by your group members).

Raise your hand if you have any questions. Otherwise please click on the “Done” button.

Appendix B. Regression tables

Table B1 presents the mixed-effects regressions used to evaluate treatment differences in contributions. The regression equation in columns I, II, and III is $c_{i,s,k,t} = \alpha + \beta X_{i,s,k,t} + \eta_{s,k} + \nu_{i,s,k} + \epsilon_{i,s,k,t}$, where $c_{i,s,k,t}$ denotes the contribution of participant i in subgroup s of global group k in period t, $X_{i,s,k,t}$ is the vector of treatment indicators, $\eta_{s,k}$ and $\nu_{i,s,k}$ correspond to subgroup and individual random effects and $\epsilon_{i,s,k,t}$ to the error term. Standard errors are clustered at the global-group level. To analyze trends, in columns IV, V, and VI, we estimate the same specification, adding the period number interacted with the treatment indicators. Columns I and IV correspond to contributions to the global public good, columns II and V to contributions

Table B1. Treatment differences in contributions and profits

Notes: Mixed-effects regressions with individual contributions (columns I-VI) or earnings (column VII) as the dependent variable. Independent variables include treatment indicators, with *Local-None* as the omitted category, and the period number interacted with the treatment indicators in columns IV, V, and VI. All regressions include subgroup and individual random effects. Standard errors are clustered at the global-group level. ***, **, and * indicate statistical significance at 0.01, 0.05, and 0.10, respectively.

	Public good contributions			Public good contributions			Total
	Global	Local	Total	Global	Local	Total	Profit
	I	II	III	IV	V	VI	VII
Global-None	3.17**		−5.38***	4.12**		−3.85**	−1.45
	(1.28)		(1.35)	(1.72)		(1.65)	(2.19)
Global-Subgroup	6.60***		−1.94	9.20***		1.24	4.39
	(1.69)		(1.74)	(2.05)		(2.00)	(2.88)
Global-Delegates	11.26***		2.71*	11.05***		3.08*	12.30***
	(1.56)		(1.62)	(1.75)		(1.68)	(2.67)
Local-Subgroup	0.62	4.52***	5.14***	−1.14	4.17**	3.03***	4.67**
	(1.51)	(1.23)	(1.04)	(1.95)	(1.65)	(1.13)	(1.97)
Local-Delegates	5.60**	−1.67	3.94***	6.60*	−4.07	2.54	8.19**
	(2.68)	(1.95)	(1.30)	(3.69)	(2.53)	(1.67)	(3.26)
Global-None × period				−0.48***		−0.48***	
				(0.06)		(0.06)	
Global-Subgroup × period				−0.69***		−0.69***	
				(0.12)		(0.12)	
Global-Delegates × period				−0.34***		−0.34***	
				(0.11)		(0.11)	
Local-None × period				−0.36***	0.07	−0.29***	
				(0.10)	(0.09)	(0.05)	
Local-Subgroup × period				−0.14	0.12	−0.03	
				(0.20)	(0.20)	(0.07)	
Local-Delegates × period				−0.49**	0.37**	−0.12	
				(0.23)	(0.15)	(0.11)	
Constant	4.83***	8.54***	13.37***	7.75***	7.96***	15.71***	35.05***
	(0.84)	(0.51)	(0.94)	(1.02)	(0.54)	(0.91)	(1.45)
Subgroup random effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual random effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6480	3240	6480	6480	3240	6480	6480
Participants	432	216	432	432	216	432	432
Subgroups	144	72	144	144	72	144	144
Groups	48	24	48	48	24	48	48
χ^2	62.34	15.10	120.58	225.85	24.02	528.59	33.80

to the local public good, and columns III and VI to total contributions. Column VII contains the same specification but uses total earnings in the experiment as the dependent variable.

Table B2 presents the mixed-effects regressions used to evaluate treatment differences in dispersion. The regression equation in columns I, II, and III is $sd^{W}_{s,k,t} = \alpha^{W} + \beta^{W} X_{s,k,t} +$

Table B2. Treatment differences in dispersion

Notes: Mixed-effects regressions of the mean standard deviation of contributions within subgroups in columns I-III and of the mean standard deviation of mean subgroup contributions within a global group in columns IV-VI. Independent variables include treatment indicators, with *Local-None* as the omitted category. Regressions in columns I-III include subgroup random effects, and those in columns IV-VI include group random effects. Standard errors are clustered at the global-group level. ***, **, and * indicate statistical significance at 0.01, 0.05, and 0.10, respectively.

	Public good contributions			Public good contributions		
	Global	Local	Total	Global	Local	Total
	I	II	III	IV	V	VI
Global-None	1.12**		0.94**	1.02**		−1.69**
	(0.56)		(0.45)	(0.41)		(0.69)
Global-Subgroup	−1.52***		−1.70***	2.01***		−0.70
	(0.54)		(0.44)	(0.69)		(0.89)
Global-Delegates	−1.50**		−1.69***	0.07		−2.63***
	(0.60)		(0.50)	(0.59)		(0.82)
Local-Subgroup	−2.02***	−2.14***	−2.67***	0.75	−0.87	−3.07***
	(0.53)	(0.42)	(0.36)	(0.69)	(0.83)	(0.77)
Local-Delegates	−2.28***	−1.87***	−1.73***	−0.58*	−1.56*	−2.33**
	(0.56)	(0.58)	(0.62)	(0.35)	(0.87)	(1.01)
Constant	3.41***	3.97***	3.59***	2.04***	4.55***	4.74***
	(0.44)	(0.29)	(0.29)	(0.26)	(0.50)	(0.62)
Subgroup random effects	Yes	Yes	Yes	No	No	No
Group random effects	No	No	No	Yes	Yes	Yes
Observations	2160	1080	2160	720	360	720
Subgroups	144	72	144			
Groups	48	24	48	48	24	48
χ^2	69.58	28.60	107.84	26.83	3.43	22.34

$\eta_{s,k} + \epsilon^W_{s,k,t}$, where $sd^W_{s,k,t}$ denotes the standard deviation of contributions within subgroup s of global group k in period t, $X_{s,k,t}$ is the vector of treatment indicators, $\eta_{s,k}$ are subgroup random effects and $\epsilon^W_{s,k,t}$ the error term. The regression equation in columns IV, V, and VI is $sd^B_{k,t} = \alpha^B + \beta^B X_{k,t} + \gamma_{s,k} + \epsilon^B_{s,k,t}$, where $sd^B_{k,t}$ denotes the between-subgroups standard deviation, which we construct by first taking the mean contribution of each subgroup in global group k in period t and then calculating the standard of these three means. Once again, $X_{k,t}$ is the vector of treatment indicators, $\gamma_{s,k}$ are group random effects, and $\epsilon^B_{k,t}$ is the error term. Standard errors are clustered at the global-group level.

Table B3 presents the two-part mixed-effects models used to evaluate treatment differences in agreement rates and agreed contribution amounts. The first part estimates the probability that a communication round produces an explicit agreement using a logit specification. In columns I and II, we estimate $a_{s,k,r} = \alpha^A + \beta^A X_{s,k,r} + \eta^A_{s,k} + \epsilon^A_{s,k,r}$, where $a_{s,k,r}$ denotes the latent propensity of subgroup s in global group k to reach an agreement in communication round

r, $X_{s,k,r}$ is the vector of treatment indicators, $\eta^A_{s,k}$ are random intercepts for subgroups, and $\epsilon^A_{s,k,r}$ the error term. The second part estimates the agreed contribution level conditional on an agreement being reached. In columns I and II, we estimate, for each public good $PG \in \{G, L\}$, $\hat{c}^{PG}_{s,k,r} = \alpha^{PG} + \beta^{PG} X_{s,k,r} + \eta^{PG}_{s,k} + \epsilon^{PG}_{s,k,r}$ for observations with $a_{s,k,r} = 1$, where $\hat{c}^{PG}_{s,k,r}$ denotes the agreed contribution to public good PG. Once again, the vector $X_{s,k,r}$ is the vector of treatment indicators, $\eta^{PG}_{s,k}$ are random intercepts for subgroups, and $\epsilon^{PG}_{s,k,r}$ the error term. We estimate the agreement and agreed-contribution equations jointly using maximum likelihood, clustering standard errors for global groups, and allowing the random intercepts in the two equations to be correlated. In columns III and IV, we use the same approach for delegate chats, except we use global group random effects rather than subgroup random effects. The estimated coefficients in the table are reported as marginal effects in percentages for the first part of the model and as point estimates in points for the second part of the model.

Table B4 presents the two-part mixed-effects models used to evaluate treatment differences in the deviation between actual and agreed contributions, or more specifically, the difference between the mean contribution of the relevant participants in the five periods following a communication round minus the agreed contribution level. The first part estimates the probability that a communication round produces an explicit agreement using a logit specification. In columns I and II, we estimate $a_{s,k,r} = \alpha^A + \beta^A X_{s,k,r} + \eta^A_{s,k} + \epsilon^A_{s,k,r}$, where $a_{s,k,r}$ denotes the latent propensity of subgroup s in global group k to reach an agreement in communication round r, $X_{s,k,r}$ is the vector of treatment indicators, $\eta^A_{s,k}$ are random intercepts for subgroups, and $\epsilon^A_{s,k,r}$ the error term. The second part estimates the deviation from the agreed contribution level conditional on an agreement being reached. In columns I and II, we estimate, for each public good $PG \in \{G, L\}$, $\Delta^{PG}_{s,k,r} = \alpha^{PG} + \beta^{PG} X_{s,k,r} + \eta^{PG}_{s,k} + \epsilon^{PG}_{s,k,r}$ for observations with $a_{s,k,r} = 1$, where $\Delta^{PG}_{s,k,r}$ denotes the difference between actual and agreed contribution to public good PG. Once again, the vector $X_{s,k,r}$ is the vector of treatment indicators, $\eta^{PG}_{s,k}$ are random intercepts for subgroups, and $\epsilon^{PG}_{s,k,r}$ the error term. We estimate the agreement and contribution-deviation equations jointly using maximum likelihood, clustering standard errors for global groups, and allowing the random intercepts in the two equations to be correlated. In columns III and IV, we use the same approach for delegate chats, except we use global group random effects rather than subgroup random effects. The estimated coefficients in the table are reported as marginal effects in percentages for the first part of the model and as point estimates in points for the second part of the model.

Table B3. Estimated probability of making an agreement and of the agreed amount

Notes: Two-part mixed-effects models. The first part estimates the probability that a communication round produces an explicit agreement using a logit specification. The second part estimates the agreed contribution level conditional on an agreement being reached. The results for agreements within subgroups for contributions to the global public good are presented in column I, and for the local public good in column II. The results for agreements between subgroups via delegates for contributions to the global public good are presented in column III, and for the local public good in column IV. The estimated coefficients for the first part are reported as marginal effects in percentage points, and those for the second part as point estimates. Independent variables include treatment indicators, with *Local-Delegates* as the omitted category. Regressions in columns I-II include subgroup random effects, and those in columns III-IV include group random effects. Standard errors are clustered at the global-group level. ***, **, and * indicate statistical significance at 0.01, 0.05, and 0.10, respectively.

Agreements	Withing-subgroups		Between-subgroups	
Public good	Global	Local	Global	Local
	I	II	III	IV
First stage: Probability of reaching an agreement				
Global-Subgroup	0.45			
	(4.61)			
Global-Delegates	3.80		−16.70	
	(4.37)		(11.18)	
Local-Subgroup	2.36	3.49		
	(4.77)	(4.44)		
Constant	92.94***	92.02***	87.51***	87.50***
	(3.65)	(3.40)	(5.90)	(6.11)
Second stage: Agreed contribution amounts				
Global-Subgroup	−0.52			
	(2.71)			
Global-Delegates	5.15**		2.44	
	(2.48)		(1.68)	
Local-Subgroup	−7.93***	7.28***		
	(2.59)	(2.42)		
Constant	13.35***	6.08***	17.26***	2.73
	(2.41)	(2.23)	(1.65)	(1.70)
Subgroup random effects	Yes	Yes	No	No
Group random effects	No	No	Yes	Yes
Observations	288	144	48	24
Subgroups	96	48		
Groups	32	16	16	8
Log likelihood	-923.95	-480.13	-123.68	-69.66

Table B4. Estimated deviations from the agreed amount

Notes: Two-part mixed-effects models. The first part estimates the probability that a communication round produces an explicit agreement using a logit specification. The second part estimates the difference between the mean actual contributions in the subsequent five periods minus the agreed contribution level, conditional on an agreement being reached. The results for agreements within subgroups for contributions to the global public good are presented in column I, and for the local public good in column II. The results for agreements between subgroups via delegates for contributions to the global public good are presented in column III, and for the local public good in column IV. The estimated coefficients for the first part are reported as marginal effects in percentage points, and those for the second part as point estimates. Independent variables include treatment indicators, with *Local-Delegates* as the omitted category. Regressions in columns I-II include subgroup random effects, and those in columns III-IV include group random effects. Standard errors are clustered at the global-group level. ***, **, and * indicate statistical significance at 0.01, 0.05, and 0.10, respectively.

Agreements	Withing-subgroups		Between-subgroups	
Public good	Global	Local	Global	Local
	I	II	III	IV
First stage: Probability of reaching an agreement				
Global-Subgroup	1.12			
	(4.21)			
Global-Delegates	5.24		−16.67	
	(3.69)		(11.18)	
Local-Subgroup	3.79	3.68		
	(4.29)	(4.30)		
Constant	91.91***	91.91***	87.50***	87.50***
	(3.24)	(3.27)	(5.89)	(6.10)
Second stage: Agreed contribution amounts				
Global-Subgroup	0.25			
	(1.18)			
Global-Delegates	−0.12		2.42	
	(1.35)		(2.38)	
Local-Subgroup	1.82	−0.06		
	(1.28)	(1.22)		
Constant	−1.75*	−0.08	−5.76***	3.39***
	(0.99)	(0.93)	(1.90)	(1.12)
Subgroup random effects	Yes	Yes	No	No
Group random effects	No	No	Yes	Yes
Observations	288	144	48	24
Subgroups	96	48		
Groups	32	16	16	8
Log likelihood	-827.72	-439.31	-137.03	-71.56