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Talking Behind Your Back: Asymmetric Communication in a Three-person Dilemma*

Klaus Abbink Lu Dong Lingbo Huang

October 9, 2018

Abstract

Communication has been regarded as one of the most effective devices in promoting team cooperation. But asymmetric communication sometimes breeds collusion and is detrimental to team efficiency. Here, we present experimental evidence showing that excluding one member from team communication hurts team cooperation: the communicating partners collude in profit allocation against the excluded team member, and the latter reacts by refraining from exerting effort. We further show that allowing the partners to reach out to the excluded member helps to restore cooperation and fairness in profit allocation. But it does not stop the partners from talking behind the other member. They sometimes game the system by tricking the excluded member to contribute but then grabbing all profits for themselves.

Keywords: communication, fairness, collusion, allocation, team cooperation, laboratory experiment

JEL Classification: D62, H41, C79, C90, D63,

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Do you think that history professors chat about the reasons for World War One when they meet for lunch, or that nuclear physicists spend their coffee breaks at scientific conferences talking about quarks? Sometimes. But more often, they gossip about the professor who caught her husband cheating, or the quarrel between the head of the department and the dean, or the rumors that a colleague used his research funds to buy a Lexus.

—Yuval Noah Harari, *Sapiens*

1 Introduction

Sophisticated communication skills make Homo sapiens unique. It is also one of the most researched solutions to social dilemmas, and numerous experiments support the view that communication helps enhance cooperation (Dawes et al., 1977). For example, pre-play communication has been widely acknowledged to increase the provision of public goods (Isaac and Walker,1988; Brosig et al., 2003; Bochet et al., 2006; Oprea et al., 2014; see Balliet, 2009 for a meta-analysis) and optimize the use of common pool resources (Ostrom et al., 1992). With the capacity to communicate, people are more inclined to trust one another (Charness and Dufwenberg, 2006), to coordinate on a more efficient outcome (Brandts and Cooper, 2007), and to improve efficiency in a collective jury decision-making process (Goeree and Yariv, 2011).

However, not all communication is well-intentioned. An important aspect of our social life is that communication can be exclusionary. Sometimes, in the form of gossip, the subject of a conversation is deliberately excluded. It is annoying to see people talk behind your back while you cannot interpret their conversations. "They must have been talking about the weather!" you may comfort yourself, but more likely, you are worried that their conversation has a negative impact on your wellbeing.[1] Similarly, in economic organizations, exclusionary communication can be harmful to a team's unity and harmony. Senior employees may reach backroom deals against newcomers in remuneration allocations. Consequently, the

[1]Though gossip, broadly defined, is not necessarily all bad. Anthropologists and evolutionary psychologists celebrate the view that the ability of gossiping is essential for human cooperation, because gossipers share useful information on who could be trusted and allow a small band to expand into a larger band (Dunbar, 1988).

anticipation of exploitation is likely to damage the exploited member's motivation to work for the team.[2]

Here, we present a laboratory experiment to study the effect of exclusionary communication on team cooperation. Specifically, we stage a private communication channel in a three-member team where two out of the three team members (the partners) can exchange private pre-play messages. The third member (the lone person), while knowing that the other team members are engaging in a private conversation, is blind to its content. We also study situations where in addition to the private communication channel, the partners can exchange messages in a public communication channel, where the content is accessible to the lone person.

Since our purpose is to study the detrimental effect of communication, we select a team production game where team members exert almost full effort (which is socially optimal) without communications. In this game (Dong et al., 2018), after every member has made an investment to the team project, each decides how to allocate a fraction of the team profit to the other two members. Thus, a member's payoff from the team project only depends on the other two members' allocations to her. Because members cannot directly allocate profit to themselves, they are likely to follow an impartiality norm by allocating according to the other member's relative investment to each other.[3] Dong et al. (2018) show theoretically that if every member follows this norm and expects all others to do the same, then full cooperation can be sustained in a subgame perfect equilibrium. Their lab experiment supports this prediction and finds that about 90 percent of the time, participants allocated fairly toward other team members.[4]

However, both the impartiality norm and the expectation of others to follow this norm might be fragile to the situation where only a subset of the team members could engage in exclusionary conversations. In theory, if the partners collude by allocating all of their fraction of the team profit to each other, then the lone person would optimally choose not to invest.

[2]Related, labor economists have long documented the harm of wage discrimination and nepotism on firm productivities (Becker, 1971; Goldberg, 1982).

[3]See classical works by Adams (1965) and Selten (1978). Laboratory experiments have shown participants often adhere to this proportional norm even in the presence of other sharing norms such egalitarian and ingroup favoritism (Konow, 2000; Cappelen et al., 2007, 2013; Dong and Huang, 2018) and they are also willing to enforce such a norm by costly punishing norm violators (Bernhard et al., 2006; Goette et al., 2006).

[4]In contrast to the standard voluntary contributions mechanisms used in many economics experiments, this mechanism generates highly cooperative outcomes in its canonical form. This makes it a particularly useful benchmark for the study of factors that are potentially detrimental to cooperation, like talking behind someone's back. The standard public good game, in absence of mechanisms like punishment, reliably leads to the rapid collapse of cooperation, thus allowing little room to make things even worse (see Chaudhuri, 2010 for a survey).

With this allocation profile, the colluding situation in which only the partners make full investment and the lone person does not invest can also be sustained in a subgame perfect equilibrium. Importantly, the partners' expected payoff under the *collusion equilibrium* is no higher than the *full investment equilibrium*. There is little *ex post* incentive for the partners to collude against the lone person.

Our experiment design exploits the conflict of interest between the partners and the lone person in this team production game. By providing the partners the opportunity of talking behind the lone person (via free-form online text chat) and isolating the lone person from any communication, we aim to answer the following questions: will the partners talk behind the lone person? Will their investment and allocation decisions conform to the collusion equilibrium? How would the partners' talking behind affects the lone person's investment?

We find that when the partners could communicate privately, over 95 percent of the time they took upon this chance to talk. Further, exclusionary communication between the partners was detrimental to team cooperation: the partners allocated much less fairly toward the lone person than when they could not talk. In fact, about half of the time, they coordinated on allocating nothing to the lone person. The lone person significantly reduced her investment to under 20 percent in the last round, whereas the partners consistently invested at almost full level. As a result, the lone person only earned about half of the amount that the partners earned.

Having established that the staged exclusionary communication harms team cooperation, we next investigate whether the opportunity for the partners to reach out to the lone person, and the opportunity for the lone person to talk back, can reboot fair allocation and high investment. To this end, we introduce two additional treatments. In one treatment, we allow the partners to exchange messages in a public communication channel in which the content is read-only to the lone person. In the other treatment, we open up all communication channels, both private and public, so that communication is symmetric between the partners and the lone person. By comparing to the private communication only situation, we ask how the partners choose to talk in the private or public channel, and whether the partners make fairer allocations and the lone person makes higher investment?

We find that while the partners talked in the public communication channel about 90 percent of the time, they continued to talk behind the lone person in their private channel over 60 percent of the time. This seems surprising given that the lone person would know about the partners' talking behind her and might react to it by lowering her investment.

Nevertheless, the lone persons increased their effort considerably, especially when she could also participate in the public communication. Further, the partners on average allocated significantly more fairly toward the lone person than when they could only talk privately. As a result, the lone person earned significantly more than when there was no public communication opportunity. Altogether, this evidence suggests that the capacity to reach out to the lone person is generally conducive to a fairer and more cooperative team outcome.

We analyze the content of the messages in all communication channels to understand how they affect group members' investment and allocation decisions. First, when the partners could only talk privately, in 70 percent of the time, they suggested unfair allocation toward the lone person. In contrast, with the presence of the public communication channel, they were much less likely to talk about unfair allocation privately and diverted to topics about fair allocation and high investment in the public channel. Second, the lone person's investment increased with the partners' promises about fair allocation and high investment in the public communication channel. Third, the partners generally allocated according to their own messages. But we also find that they sometimes played tricks: on the one hand, they encouraged the lone person to make high investment in the public channel; on the other hand, they plotted against the lone person in the private channel.

A final and interesting observation is that the lone person, facing equal investments from both anonymous partners, frequently allocated in an extreme manner, that is, they allocate everything to one of the partners and nothing to the other. And they were more likely to do so when they were excluded from the partners' conversation. We interpret this behavior as a kind of revenge or punishment to a random member of the partners or as an attempt to disturb the partners' relationship. This further suggests that exclusionary communication hurts team's harmony not just because of the partners' collusion but also due to the lone person's diversion from the impartiality norm (perhaps as a passive last-ditch effort of self-defense).

Our study primarily contributes to the literature on laboratory experiments evaluating the effects of communication on strategic outcomes, especially those that explore potentially harmful effects of communication. For example, in group contests, Cason et al. (2012) show that within-group communication leads to more aggressive group competition and lower overall efficiency. Cason et al. (2017) further show that even only one group can communicate, the detrimental effect persists. Moreover, they also find that players actively seek with-group communication, though jointly restricting it would have led to higher payoffs for all members. In an auction setting, Agranov and Yariv (2018) find that communication facilitates collusions among bidders, especially when side payment is allowed. Thus, communication leads to lower winning bids and lower efficiency of the auction format. In all these studies, communication is *symmetric* within a group, and inefficiency either comes from a group's inability to coordinate with the other group, or an individual's tendency to voluntarily collude in auctions. Our experiment features an *asymmetric* communication within a group, and we study, to what extent, such communication structure is disruptive to an otherwise socially optimal situation.

In terms of both game and communication structures, our study is mostly related to several studies on communication in legislative bargaining. All of these studies use Baron and Ferejohn's (1989) bargaining setting as their underlying game. In this game, a randomly chosen proposer suggests a division of a fixed amount of money among all group members. The division is only implemented when the majority of the group members agree with the proposer. Thus, a proposer can form a coalition with some members and allocates zero to all others to pass his proposal. Similar to our team production setting, communication may facilitate such coalitions or collusions. In Agranov and Tergiman (2014), with group size of five, players can send messages to any subset of group members in different channels. They find that, compared to no communication, such communication structure allows proposers to form coalitions and extract a significantly higher fraction of the resource. Baranski and Kagel (2015) find similar results when only bilateral communication is allowed between group members. Baron et al. (2017) further compare two communication channels in three-member groups. In one treatment, only bilateral communication is allowed, and in the other, only public communication among all three members is allowed. They find that the majoritarian allocation—suggesting zero to one of the group members—is more likely when communication is bilateral (thus exclusive), and the universal allocation—suggesting equal shares among all three members—is more likely when communication is public. Our experiment results echo these bargaining studies by suggesting that private communication is more conducive to collusions and unequal allocations than public communication.

Despite some similarities, there are important distinctions between their bargaining studies and ours. The most important difference is that coalitions and allocations are always Pareto efficient in their bargaining games whereas collusions are inefficient in our team production games. The difference stems from the fact that a team production stage precedes the profit allocation stage in our study, and the profit to be allocated is endogenously affected by allocation strategies. Thus, communication not only affects resource allocations but also team efficiency. In legislative bargaining, however, a proposer only decides to allocate an arbitrary amount of money among group members. We believe the interplay between resource redistribution and group cooperation is an important aspect of many economic and social situations. There are other differences, including that there is no voting procedure in our game but instead every group member has a right to allocate an equal fraction of the profit to other members; different matching protocols; and different overarching research questions and implications. Another novel design feature is that the fact of the partners' talking behind is known to the lone person, as she receives a string of hashtags whenever the partners converse privately. Given all these differences, we do not suggest our results are directly comparable to these bargaining studies. Nevertheless, our study might help to understand the general impact of asymmetric communication on profit redistribution across these studies.

Finally, out paper is related to the literature on social exclusion. Previous studies show that social exclusion can strongly affects the efficiency and equity. In an Ultimatum-type three-person bargaining game, Okada and Riedl (2005) find that a good number of participants are excluded from bargaining and earn nothing. They explain this inefficient and unfair situation as the result of the interplay of selfish and reciprocal behavior within coalitions. Further, the psychological feeling of being social excluded can also influence economic outcomes. For example, in a theoretical framework, Akerlof and Kranton (2003) show that socially excluded groups may oppose the mainstream culture purely out of their psychological needs for unique identity. It is hypothesized that these groups experience utility loss when engaging in activities consistent with the social norm of mainstream society despite that the deviation from this norm is economically undesirable for all groups. In a public goods game experiment, Candelo et al. (2017) find that contributions from low-income Hispanic residents to local organizations decrease with perceptions of social exclusion. The main reason is that the perception of social exclusion implies a perception of unequal access to the benefits of the local public goods. Thus, compared to those who expect full integration into the society, those who feel excluded may receive lower returns from public goods and therefore have a weaker motive to contribute. While sharing similar insights, our paper demonstrates in a laboratory setting how social exclusion can endogenously arise with asymmetric communication in an otherwise homogeneous population and how that adversely affects excluded participants' motivation for team production.

2 Experiment Design

2.1 Basic Setup and Theory Prediction

The underlying game is the same as in Dong et al. (2018). We replicated their design in the *Symmetric Matching* treatment (or SymMatch). The game was repeated for 8 rounds. In each round, participants were randomly matched in groups of three[5] and they were asked to make two decisions:

Investment Decision—Players were endowed with 10 Experimental Currency Units (ECUs) at the beginning of each round. They had to simultaneously decide how many ECUs (if any), e_i, to contribute to a group project; they kept the amount left.

Allocation Decision—After all players had made their investment decisions, ECUs in the group project were summed up and multiplied by 1.8, i.e., $\Pi = 1.8 \cdot \sum_{i=1}^{3} e_i$. Players were informed of other group members' contributions and the total value of the group project. Then they decided how to divide $\frac{1}{3}\Pi$ between the *other* two group members. That is, each player i decided an allocation of a_{ij} to player j and a_{ik} to player k, with $a_{ij} + a_{ik} = \frac{1}{3}\Pi$. Note that there were no restrictions on how players should divide this amount, but she *had to* divide between the others, without burning money or allocating anything to herself.

Player i's share of the group project was determined by the allocations from the other two group members, that is, a player i's earning in that round was $\pi_i = 10 - e_i + a_{ji} + a_{ki}$. At the end of each round, players were informed about the contributions and earnings of all group members.

The game has multiple subgame-perfect equilibria, because each player is indifferent to any way of allocation in the allocation stage (her own payoff is not affected). Depending on the allocation rule(s) chosen, any investment decision can be part of a subgame perfect equilibrium. However, some straightforward allocation rules can lead to a subgame perfect equilibrium in which all players fully invest, i.e. *full investment equilibrium*. Examples of

[5] In the SymMatch, the matching of the three-person group was pre-determined by the computer software, and the software also randomized the display of players' contribution decisions on the screen in each round. In this way, players were not be able to track whom they had been previously paired with. We use different matching protocols in other treatments, see details later.

such rules are to allocate proportionally to the other players' relative investment,[6] or to allocate everything to the player who invested more than the other player (split equally in case of a tie).[7] In our experiment, every group member receives 18 ECUs at the full investment equilibrium. These rules are intuitive and leave little incentive to deviate, and they can explain high overall investment in the previous experiments and in our replication.[8]

Many more outcomes can be sustained as subgame perfect equilibria. Of specific interest is a strategy combination in which two players collude at the allocation stage, i.e. they allocate their entire assigned share ($\frac{\Pi}{3}$) to each other. Consequently, the third player who receives no share in return (she cannot allocate anything to herself), will best respond by investing nothing. As a result, the colluding members receive the same expected payoff as in the full investment equilibrium.[9] Thus, the *collusion equilibrium* is no more profitable for the two colluding members than the full investment equilibrium.[10] In our experiment, each of the colluding members receives an average of 18 ECUs and the exploited member receives 10 ECUs at the collusion equilibrium. While this kind of collusive behavior was rarely observed in Dong et al. (2018) and in our replication (the SymMatch), all of the following treatments aim to investigate various communication conditions under which collusion may or may not arise. Our hypothesis is that communication serves as a coordination device, and different communication structures can make one of the two subgame perfect equilibria (i.e. full investment equilibrium and collusion equilibrium) focal.

2.2 Private (Exclusionary) Communication Treatments

Our strategy is to first investigate the effect of asymmetric or exclusionary communication. To bolster its potential effect, we also create asymmetry among three players in the match-

[6]Dividing a joint production according to each member's input, or distributive justice, has long been studied by sociologists and economists (Homans, 1958; Adams, 1965; Selten, 1978). Players' tendency to reward others based on their contribution to the group outcome has also been shown in numerous laboratory experiments (Konow, 2000; Cappelen et al., 2007; Baranski, 2016; Dong and Huang, 2018).

[7]See Dong et al. (2018) for a complete theoretical analysis of this full investment equilibrium.

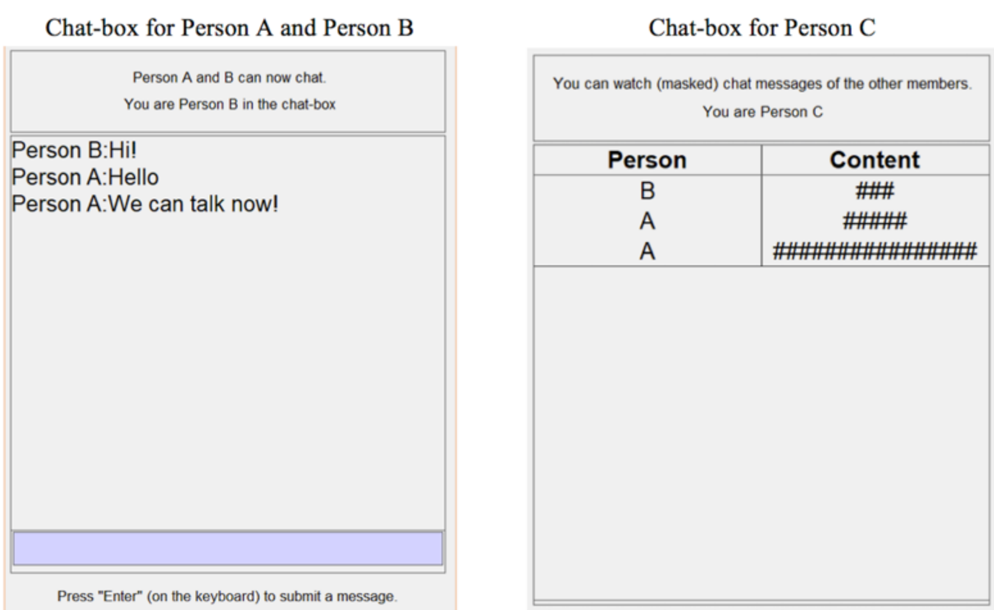
[8]In a voluntary contribution mechanism, there is no allocation stage. Instead, every player receives an equal share of the group profit. The only theoretical prediction is for players to free ride and contribute nothing; laboratory experiment generally find very low contribution rates (Andreoni, 1988; Dong et al., 2018).

[9]Note that as is true in our experiment, we assume that the lone person cannot identify individual partner so that she cannot selectively allocate to a specific partner.

[10]Different from the full investment equilibrium, we do not impose an assumption on the lone person's allocation. In fact, this collusion equilibrium is a continuum of equilibria: in the investment stage, the partners invest everything and the lone person invests zero. In the allocation stage, the partners allocate everything to each other and the lone person allocates in any way she wants.

ing protocol, and we use this matching protocol for all of the following treatments. At the beginning, participants were randomly assigned to the role of person A, person B and person C. This role assignment remained the *same* for all rounds throughout the experiment. Persons A and B were *the partners* and they would always be paired in the same group, while person C was *the lone person* and she would switch groups every round. By design, a person C would only meet the same pair of persons A and B once during the experiment.[11] The asymmetric matching captures some real-world situations where exclusions of some members are expected. For example, in organizations, senior employees, whose ties have been strengthened through repeated interactions, might collude against newcomers by assigning to them disproportionally heavy workloads. They might also exclude the newcomers from important conversations and agreements on corporate strategies and profit sharing plans. In what follows, we introduce three treatments where we gradually increase the salience of the asymmetry in relationships among group members.

Figure 1: Screenshot of the private chatbox



Notes: The left panel shows the private chatbox for the partners, and the right panel is what the lone person saw. The number of hashtags equals the length of the message, including spaces and punctuations.

No Communication treatment (or NoCom) is the same as the SymMatch except for this asymmetric matching protocol described above. The NoCom serves as the *baseline*

[11]Each session was planned to have 24 participants with 8 persons A, 8 persons B and 8 persons C. The game was repeated for 8 rounds, so each person C met each pair of persons A and B exactly once. The instructions made this matching protocol clear to participants and comprehension questions were used to ensure that they understand this.

for all the following treatments. That is, *all the following treatments adopt this asymmetric matching protocol*, which therefore allows us to *casually* identify the effects of various communication structures.

Private Communication treatment (or PrivCom), based on the NoCom, opens up a private communication channel between the partners. Specifically, at the beginning of each round, the partners had 90 seconds to send unrestricted numbers of free-form messages to each other. Whenever a message was exchanged between the partners, the lone person saw a string of hashtags, where the number of hashtags equals the length of the message (including spaces and punctuations). Figure 1 shows a sample screenshot of the private communication. This design feature makes the lone person aware that whenever hashtags appears on his screen, the other two group members are talking behind him.

Private Communication with Friend treatment (or PrivComFri) differs from the PrivCom treatment only in that the partners in the experiment are actual friends. Specifically, in our recruitment email, we asked participants to bring one of their friends.[12] Participants arrived at the lab in pairs. We then ensured that the partners were played by the actual pair of friends, whereas the remaining participants played as the lone person (so they were never in the same group with their friend). Thus, by strengthening the social tie between the partners, we want to know whether they would collude more often in the allocation stage.

In sum, all the three treatments share the common feature that the lone person is always excluded from the repeated interaction and partners' private communication. The hypothesis is that if the partners can talk behind the lone person, we expect the group outcome to be closer to the collusion equilibrium.

2.3 Public Communication Treatments

The above three main treatments are designed to understand how exclusionary communication affects team efficiency. For that purpose, we deliberately isolated the confounding factors such as the capacity to engage in public communication. Yet, the partners may want to reach out to the lone person to encourage them to contribute to team production, and the lone person may also want to participate in team conversation to pledge allegiance or

[12]In the experiment invitation letter, we wrote "to participate in this experiment, you are required to bring one person who knows you well. He/she needs to be 1) someone you know (e.g., a friend, a housemate, someone on your course, etc.); 2) someone who can attend this study with you; and 3) someone who should have registered on our system."

persuade the partners for fair shares. Allowing communication in public spheres can potentially promote team productivity and restore fair allocation. Yet, the collusion equilibrium suggests that the partners do not face payoff loss when they collude in allocation decisions. Indeed, they may have some payoff to gain if the lone person still invests a positive amount. Thus, we expect to observe similar behavioral patterns as in the private communication treatments under two scenarios. The first is when the partners predominantly choose to talk privately when they can talk publicly. The second is when the partners talk both privately and publicly but with different contents: they privately talk about collusion while publicly encouraging the lone person to invest. We thus introduce two additional treatments: the first allows the partners to reach out to the lone person and the second further allows the lone person to engage in team communication.

Private and Public Read-Only treatment (or PubReadOnly) is the same as the PrivCom except that partners, in addition to private communication, can also communicate publicly. Public messages can be read by all group members. In other words, the partners can either speak in a private chatbox, or in a public chatbox, or in both chatboxes with the same or different contents. To be comparable with the PrivCom, public communication is read-only for the lone person, meaning that she cannot send any messages. Public communication offers an opportunity for the partners to reach out to the lone person. For example, they may use it to persuade the lone person to invest more to the group project and they may make real or fake promises of fair allocation. We want to know whether providing such an opportunity will improve teamwork efficiency.[13]

Lastly, *All-Channels Communication* treatment (or AllChanCom) opens up both private and public communication channels for *all* group members. Each player can choose to send messages either in a public chatbox where all players can read the message, or in private channels where only the targeted group member can read the message. Whenever a message is exchanged in a private channel, the untargeted group member receives a string of hashtags (as shown in Figure 1). This is the *only* treatment where the lone person can send messages to the partners. Table 1 summarizes the experiment design.

[13]There can be many other design possibilities to allow the partners to reach out to the lone person. For example, each of the partners can respectively communicate to the lone person privately other than publicly. But it may create an unintended effect of breeding distrust between the partners, as they may worry their partner might strike some deal with the lone person and collude against themselves. The present study aims to understand the dynamics between the partners and the lone person rather than the distrust between the partners (though it might be an interesting question in itself).

2.4 Procedures

The experiment was conducted at the Monash Laboratory for Experimental Economics (MonLEE) with students recruited from a university-wide subject pool using the online recruitment software SONA. The experiment programmed in z-Tree (Fischbacher, 2007) included a total of 570 participants in 25 sessions, that is, 4 sessions for each treatment (except for 5 sessions for the PrivComFri treatment).

Participants were randomly seated in a partitioned computer terminal upon arrival. The experimental instructions (see Appendix A) were provided to every participant in paper form and were read aloud by the experimenter. The experiment started once all participants completed their comprehension questions about the instructions. At the end of each session, participants filled a post-experiment survey including demographic questions. Participants were then privately paid with AU$1 for every 8 ECUs they accumulated plus AU$5 for showing up, and they left the laboratory one at a time. A typical session lasted about one hour with average earnings of 21.8 Australian Dollars (16.8 US dollars or 13.6 Euros).

Table 1: Experiment Design

Treatment	**Matching Protocol**	**Communication Method**	**No. of Participants**
SymMatch	Random match each round	No Communication	72
NoCom	Fixed A and B (partners) meet a different C (lone person) in each round.	No Communication	96
PrivCom		Private chatbox for partners	96
PrivComFri		Private chatbox for partners who are actual friends	120
PubReadOnly		Private *and* public chatbox for partners	90
AllChanCom		Private chatbox for partners chatbox for *all* players	96
		Total:	570

Notes: 1) In the SymMatch, each session consists of 18 participants. 2) For the other treatments, each session consists of 24 participants so to have 8 pairs of partners and 8 lone persons. The experiment has 8 rounds where each pair of the partners meets the lone person exactly once. 3) Only 21 participants showed up in two sessions of the PubReadOnly. In these two sessions, 7 pairs of partners and 7 lone persons interact for 7 rounds.

3 Experiment Results

We begin our analysis by studying how exclusionary communication affects investment and allocation (section 3.1). We then explore the effect of the additional public communication opportunity (section 3.2). In section 3.3, we analyze communication messages to understand how different communication configurations affect collusion and investment. We also briefly discuss the lone person's allocation decisions in section 3.4.

3.1 No Communication and Private Communication

3.1.1 Investment

Figure 2 shows the average investment over eight rounds. In the baseline NoCom, we found that the lone person invested less than the partners in every round (5.8 vs. 7.8, $p = 0.02$).[14] When the partners could communicate privately, the lone person invested even less, only about a third of the partners' investment, regardless of whether the partners were anonymously paired strangers or actual friends: 3.59 vs. 9.00 in the PrivCom ($p = 0.02$) and 2.49 vs. 9.33 in the PrivComFri ($p = 0.01$);[15] the lone persons' investment between the two private communication treatments is not significant ($p = 0.22$).[16] While most partners (83.3%) invested fully in the two private communication treatments, only 15.1% of the lone persons made full investments; in fact, 49.7% of the time, the lone persons invested zero (see Figure 3). Compared to the NoCom, the investment gaps between the partners and the lone person are significantly larger in the private communication treatments (PrivCom vs. NoCom: $p = 0.02$; PrivCom vs. NoCom: $p = 0.01$). These results suggest that the partners' capacity to talk behind the lone person is detrimental to team cooperation.

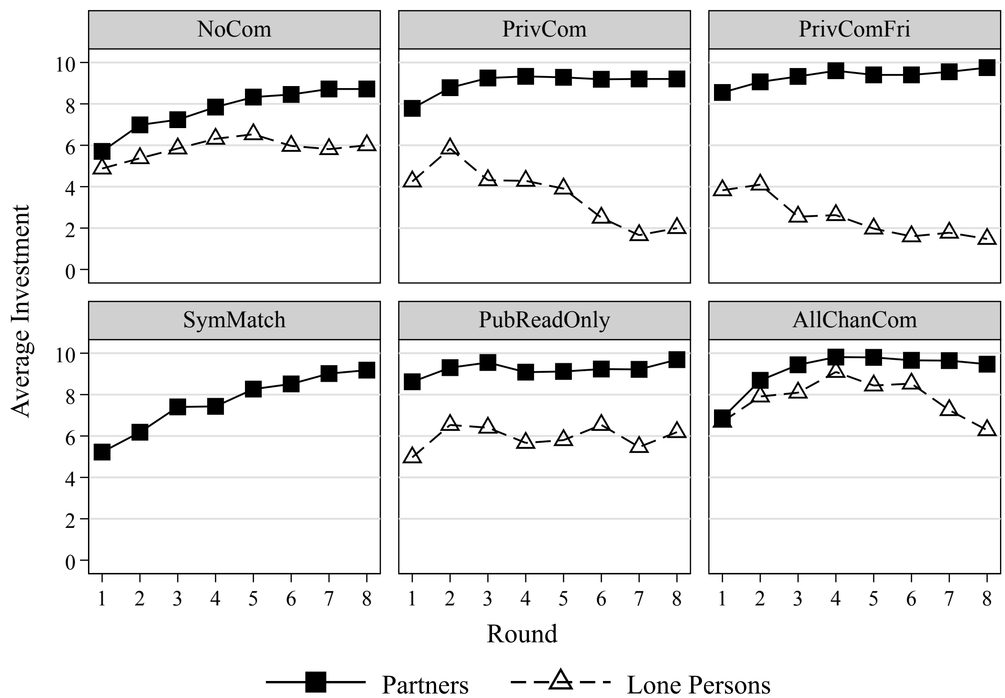
Result 1. *The lone person invested significantly less than the partners. When the partners could communicate privately, the investment gap widened: the lone person invested only about*

[14]Unless otherwise stated, test statistics for the differences between partners and lone persons (within a treatment) are from Wilcoxon rank-sum tests. We treat each session's average investment for the partners and lone persons as an independent observation.

[15]Of particular interest is the lone person's investment decisions in the first round: the investment gap between the partners and the lone persons is negligible in the NoCom ($p = 0.15$) but significant in the PrivCom and PrivComFri (ps < 0.001). We interpret this result as that the lone persons, seeing the partners "talking behind," anticipate exploitation (thus invest less) in the first round, even without actual experience.

[16]Unless otherwise stated, test statistics for treatment differences are produced by Wilcoxon rank-sum tests. We used a session's average as an independent observation.

Figure 2: Time-path of the Average Investment by Treatment



one third of the partner's investment, regardless of whether the partners were anonymously paired strangers or actual friends.

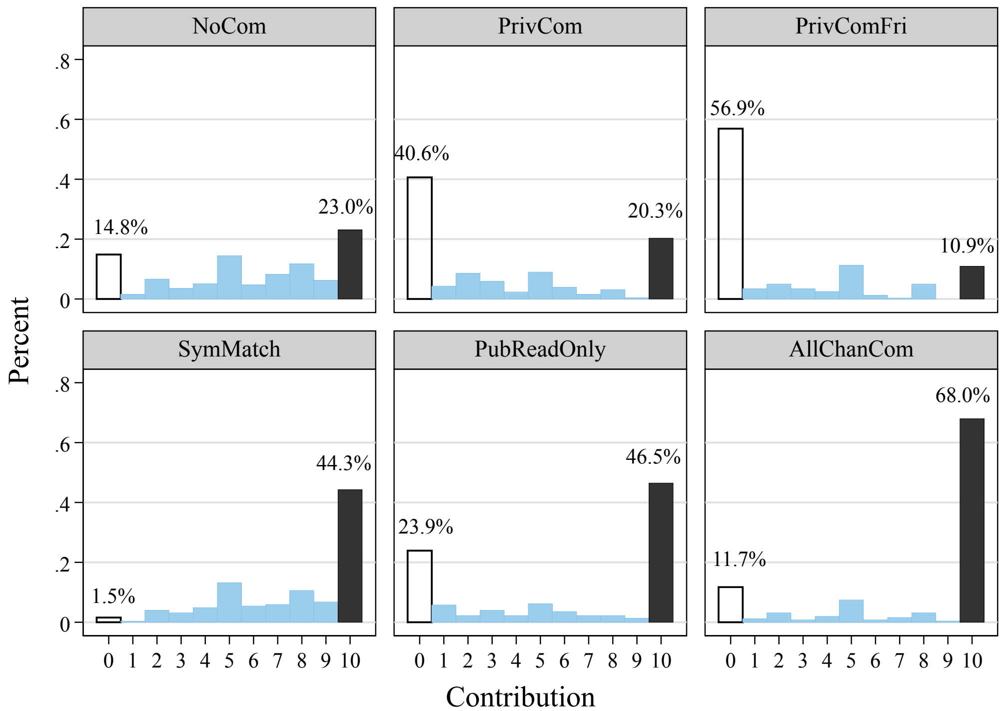
3.1.2 Partners' Allocation

Why would the lone person underinvest and whether the partners colluded against the lone person? To answer these questions, we first focus on a subsample where the lone person made full investment.[17] Figure 4 displays the distribution of the group profit allocated to these lone persons (except for the SymMatch where the distribution is for all players who invested fully). A fully invested player would receive at least 15, if others allocate proportionally.[18] For example, in the SymMatch 92.1% players received fair shares. In contrast, receiving zero is a clear sign of exploitation from both of the other two players. In

[17]Since this subsample represents a relatively small portion of the full sample, we only take this evidence as suggestive. We nevertheless discuss this because it provides a sharp view on the partners' allocation decisions.

[18]Suppose that the lone person invested 10 and the partners allocate proportionally, if the partners both invested 10 (which occurred 77.8% of the time), the lone person would receive 18; if both partners invested no less than 4 (which occurred 98.3% of the time), the lone person would receive no less than 15.4.

Figure 3: Distribution of the lone persons' investment



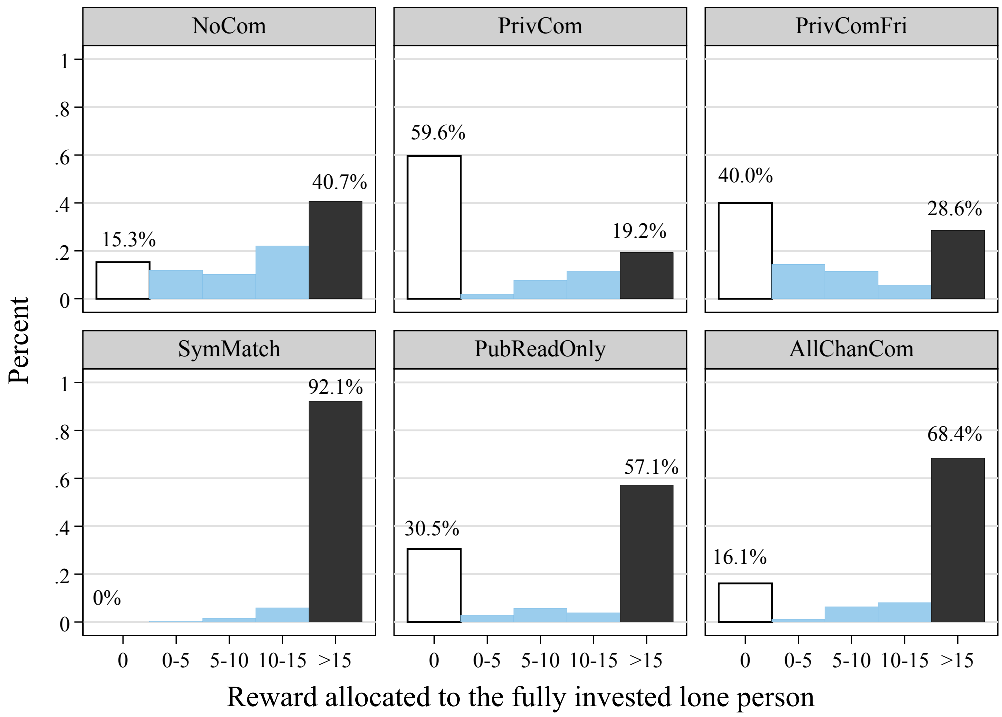
the baseline NoCom, 15.3% of the fully invested lone persons received zero. Yet, in private communication treatments, about half of the time, the fully invested lone persons received zero (59.6% in the PrivCom and 40.0% in the PrivComFri). In other words, even in these cases where the lone person fully cooperated, the partners colluded against the lone person by allocating everything to each other and leaving nothing to the lone person.

Next, we use a random effects regression model to study the full sample of the partners' allocation decisions (except in the SymMatch where we studied all players' allocation decisions). The dependent variable is the relative share of the group profit player i allocates to her partner j (in the SymMatch, the "partner" is a randomly selected group member), and the independent variables is j's investment relative to the lone person k:

$$\frac{a_{ij}}{a_{ij}+a_{ik}} = \beta_0 + \beta_1 \frac{e_j}{e_j+e_k} + \varepsilon_i$$

In this specification, β_0 measures a fixed amount of share allocated to j, regardless of j's relative investment, and β_1 measures the proportional share based on j's investment

Figure 4: Group profit allocated to the fully invested lone person



Notes: This figure only includes cases where the lone person made full investment in a round. There are 59 out of 256 (23.0%) cases in the NoCom, 52 out of 256 (20.3%) cases in the PrivCom, 35 out of 320 (10.9%) cases in the PrivComFri, 105 out of 226 (46.5%) cases in the PubReadOnly and 174 out of 256 (68.0%) cases in the AllChanCom. For the SymMatch, we include 255 out of 576 (44.3%) cases where a player invested 10 in a round.

relative to k. Under the proportional allocation, players allocate strictly according to others' relative investment, i.e. $\beta_0 = 0$ and $\beta_1 = 1$. At the other end of the spectrum, where players allocate everything to their partner regardless of the relative investment, i.e. full collusion, we have $\beta_0 = 1$ and $\beta_1 = 0$. In the intermediate case where the partners partially collude, they reserve a fixed share, β_0, where $0 < \beta_0 < 1$, to one another, and allocate less than proportionally ($0 < \beta_1 < 1$). A pair of larger β_0 and smaller β_1 indicates a greater degree of favoritism between the partners. (Note that as β_0 increases β_1 naturally decreases and vice versa). We can use this pair of parameters to capture the degree of favoritism in the partners' allocation decisions.

Table 2 reports the estimates. Consistent with Dong et al.(2018), players allocated proportionally in the SymMatch ($\beta_0 = 0$ and $\beta_1 = 1$, $p = 0.387$, F-test). For example, if player j increases her relative investment by one unit, player i allocates 0.87 more relative units in his share of team profits to player j. In contrast, in all other treatments, β_0 is significantly higher than zero ($p < 0.001$), indicating a positive fraction of the group profit went to the partner regardless of the partner's relative investment. The estimated fraction was 34.6% in the NoCom and went up to 61.8% in the PrivCom and 65.8% in the PrivComFri, indicating stronger favoritism between the partners when they could communicate privately.[19]

Favoritism, which can be only unilateral, does not necessarily imply collusion, which is mutual. Adopting the terms defined in the regression model, we use $\frac{a_{ij}}{a_{ij}+a_{ik}} - \frac{e_j}{e_j+e_k}$ to measure the degree of favoritism a partner showed to the other partner. We then estimate the correlation of the favoritism between the partners using a random effects regression (with the favoritism measure of one of the partners randomly selected as the dependent variable and that of the other partner as the independent variable). We found that the degree of favoritism was highly correlated in the NoCom ($r = 0.487, p < 0.001$), the PrivCom ($r = 0.726, p < 0.001$) and the PrivComFri ($r = 0.881, p < 0.001$). By further adding the interaction between treatment dummies and favoritism measure, the regression also shows that the correlation in the private communication treatments is significantly stronger than the NoCom. Thus, favoritism in allocation is the result of the collusion between the partners and strengthened by social ties.

Table 2: Random effects model on the share allocated to the partner

Dependent Variable:	Share Allocated to the Partner $\frac{a_{ij}}{a_{ij}+a_{ik}}$					
Treatments:	SymMatch	NoCom	PrivCom	PrivComFri	PubReadOnly	AllChanCom
β_1: Partner's relative investment $\frac{e_j}{e_j+e_k}$	0.867***	0.602***	0.350***	0.340***	0.488***	0.760***
	(0.106)	(0.037)	(0.034)	(0.086)	(0.073)	(0.048)
β_0: Constant	0.061	0.346***	0.618***	0.658***	0.461***	0.238***
	(0.053)	(0.033)	(0.021)	(0.083)	(0.057)	(0.030)
#Clusters	4	4	4	5	4	4
#Observations	576	512	512	640	452	512

Notes: This table shows a player's allocation to their partner in a round. Lone persons' allocations are excluded. *** denotes 1% significance level. Standard errors are clustered at session level.

To further support the claim that the partners' unfair allocations resulted in the lone

[19] Table B1 in Appendix B shows the treatment comparisons of the partner's allocation decisions. The regression results also suggest that private communication led to fewer proportional allocations than the NoCom (larger β_0 and smaller β_1, $p < 0.001$). Additionally, the partner's allocation decisions were similar between the PrivCom and the PrivComFri.

person's low investment, we estimate a random effects regression to test how the way the lone person was treated in a previous round affected her investment in the current round. The dependent variable is one round change in the lone person's investment, and the independent variables are categorized by how much the lone person received in the previous round (from a different pair of partners): nothing, less than proportional share (but not nothing), more than proportional share, and proportional share which serves as the omitted category. Table 3 reports the estimates. Receiving less than the proportional amount (or nothing) from the partners had no impact on the lone person's next round investment in the NoCom, but had significantly negative effects in both private communication treatments. Interestingly, when the partners were actual friends, the lone person significantly lowered her investment even when she received a more than proportional share in the previous round. This seems to imply that the lone person placed little trust on the new pair of partners to treat her fairly even when her experience in the previous round was positive. These results highlight the adverse impact of the "talking behind" environment on the lone person's investment even absent of actual unfair allocations.[20]

Result 2. *A direct contributor to the lone person's low investment is that the lone person received less than the proportional share of the group profit from the partners. Compared to the no communication treatment, exclusionary private communication more frequently results in collusions between the partners.*

3.1.3 Earnings

As we learnt that the lone person underinvested and the partners colluded against the lone person, it is not surprising that the lone person earned significantly less than the partners. In the NoCom, the lone person on average earned 11.7 while the partners earned 17.7 ($p = 0.02$). The earning gap was widened in the private communication treatments (see Figure 5): the lone person only earned less than half of the partners' earnings (PrivCom: 9.1 vs. 19.1, $p = 0.02$; PrivComFri: 9.1 vs. 18.9, $p = 0.01$).

When we calculated the percent of investments resulting in a positive return (i.e., those in which the share received is greater than the invested amount), the partners' investment almost always yielded positive returns ($> 96\%$, see Table 4). In contrast, the lone person

[20]In Table B2 of Appendix B, we report a similar regression analysis for the partner's investment. We find that the partner's investment was largely unaffected by how they were treated by their partner or by the lone person in the previous round. The only exception is when the partners were actual friends, receiving a more than proportional share from the other partner significantly increased her investment in the next round.

Table 3: Share received last round and the one round change in lone person's investment

Dependent Variable:	One Round Change in Lone Person's Investment				
	NoCom	PrivCom	PrivComFri	PubReadOnly	AllChanCom
Receive nothing	-1.227	-3.945***	-2.589***	-2.664***	-1.431
	(1.315)	(0.357)	(0.221)	(0.959)	(0.994)
Receive less than proportional	-0.573	-1.404***	-1.547***	-1.615**	0.104
	(0.375)	(0.458)	(0.456)	(0.732)	(0.560)
Receive more than proportional	0.106	-0.202	-0.547***	5.681***	3.186**
	(0.369)	(0.306)	(0.130)	(1.169)	(1.411)
Constant	0.477***	1.131***	0.547***	0.764***	0.014
	(0.119)	(0.084)	(0.130)	(0.266)	(0.355)
Observations	224	224	278	196	224
Cluster	4	4	5	4	4

Notes: This table uses random effects models to estimate how a lone person was treated in the previous round affected his one-round change in investment. ** and *** denote 5% and 1% significance levels, respectively. Standard errors are clustered at session level.

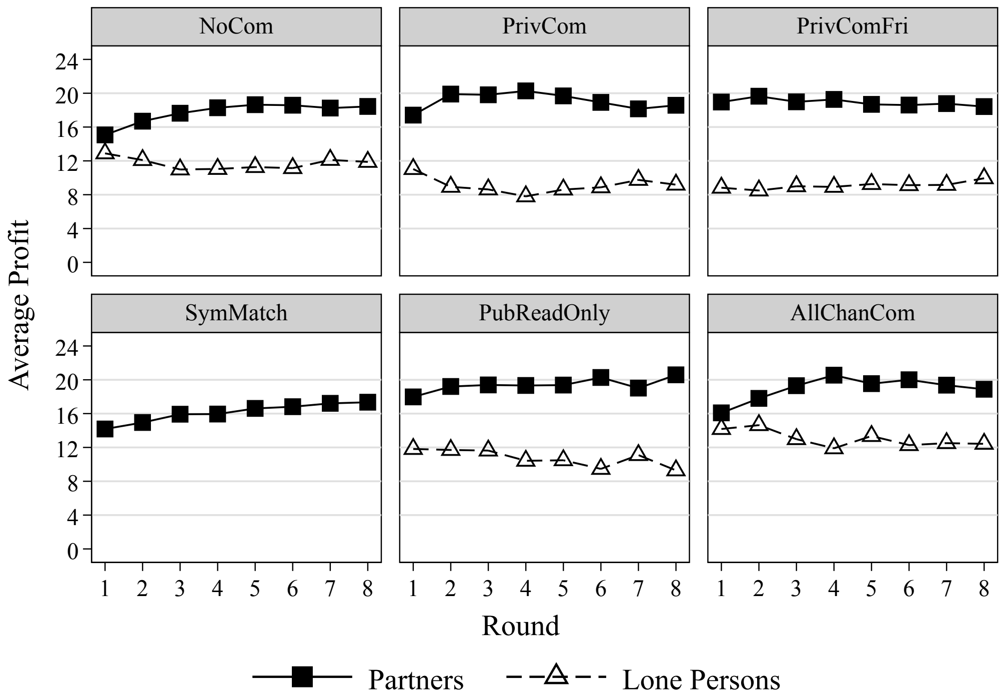
received a positive return in 65.2% of the time in the NoCom; the percent dropped to 27.0% in the PrivCom and 15.0% in the PrivComFri. With private communication, about one-third of the time, the lone persons received a negative return for their investment (i.e., the share received is less than their invested amount), whereas almost no partner received a negative return.

Result 3. *Lone persons earned significantly less than the partners. With exclusionary communication between the partners, the lone person only earned half of what the partner earned. In a significant amount of time, lone persons received a negative return from their investment.*

3.2 Public Communication

So far, we have established that private communication damaged team cooperation. The partners colluded against the lone person by allocating more than proportional shares to each other. As a result, the lone person underinvested and earned less than the partners. We next investigate whether public communication helps lift the team from this collusive

Figure 5: Time-path of the Average Profit by Treatment



situation.

In the PubReadOnly, the partners can send messages in a public channel to reach out to the lone person, though the lone person cannot send any message back. We found that the lone person invested more in this treatment compared to the PrivCom (5.93 vs. 3.59, $p = 0.02$), and about half of the time (46.5%) they made full investment. But the investment gap between the lone person and the partners remained significant (5.93 vs. 9.20, $p = 0.02$).

In the AllChanCom, the lone person can further send messages either privately or publicly to the partners (the partners can also send private messages to the lone person). The lone person on average invested 7.8, and they made full investment in about 68.4% of the time.[21] Further, while the lone person still invested significantly less than the partners

[21] The average group investment, 8.7, was the highest among all treatments (except for the SymMatch where the difference is marginal, $p = 0.13$, it is higher than other treatments, ps < 0.02).

Table 4: Investments and Returns

	Positive Returns		Negative Returns	
Treatment	Partners	Lone	Partners	Lone
NoCom	96.5%	65.2%	2.1%	24.6%
PrivCom	96.7%	27.0%	2.5%	36.7%
PrivComFri	98.0%	15.0%	0.1%	31.3%
PubReadOnly	96.0%	45.6%	2.4%	33.2%
AllChanCom	97.7%	66.4%	2.1%	22.3%

(7.8 vs. 9.2, $p = 0.02$), the investment gap is similar to that of the NoCom ($p = 0.25$).[22]

Result 4. *Compared to the private communication treatments, in the* PubReadOnly *where the partners can reach out to the lone person in a public channel, the lone person invested more. When the lone person can also send messages back (*AllChanCom*), the lone person invested even more.*

Did the partners treat the lone person fairly in allocation decisions with public communication? We revisit Figure 3 and Table 2 and 3 for evidence. First, the partners were less likely to allocate nothing to the fully-invested lone person than in the private communication treatments: 23.9% in the PubReadOnly and 11.7% in the AllChanCom. In fact, more than half of the time (54.3% in the PubReadOnly and 61.5% in the AllChanCom), the partners allocated fairly toward the lone person who invested fully. The fraction is significantly higher than the private communication treatments ($p < 0.001$).

Next, Table 2 shows that the partners still did not allocate proportionally in public communication treatments, as the coefficient of partner's relative investment β_1 is significantly less than one ($p < 0.001$). But compared to the PrivCom, β_1 in the PubReadOnly is significantly larger and β_0 is smaller, indicating that the partners allocated more proportionally when they could reach out to the lone person than when they could not. Compared

[22] It is worth nothing that the lone person's investment noticeably dropped in the last two rounds after a steady climb in previous rounds. By focusing on the lone person's one round change in investment in the last two rounds (the same regression as Table 3), we however do not find that their investment changes were significantly correlated with the way they were treated in previous rounds. While noting that the evidence is only suggestive given the low number of observations in the last two rounds (N=64), it suggests that the drop might be mainly driven by the lone person's anticipation that the partners would exploit them in the last few rounds.

to the PubReadOnly, β_1 increases significantly and β_0 decreases in the AllChanCom. This result suggests that including the lone person in group communication led to still fairer profit allocations. In fact, allocations to the lone person are fairest in the AllChanCom among all treatments (except the SymMatch; see Table B1 in Appendix B).

Further, Table 3 shows that similar to the private communication treatments, the lone person in the PubReadOnly lowered her investment when she received nothing or less than proportional share in the previous round. In the AllChanCom, however, unfair allocations do not appear to discourage the lone person from investing. Importantly, in contrast to the private communication treatments, the lone person invested more in the PubReadOnly and AllChanCom, when she received more than proportional shares in the previous round. These results indicate that the lone person tended to place more trust on the partners to treat her fairly when the partners could talk to her and when she could also participate in the conversation.

Turning to the earnings (Table 4), the lone person earned significantly more with public communication compared to the private communication treatments (PubReadOnly vs. PrivCom: 10.38 vs. 9.10, $p = 0.02$; AllChanCom vs. PrivCom: 13.03 vs. 9.10, $p = 0.01$). Also, the lone person was more likely to receive positive returns with public communication (45.6% of the time in the PubReadOnly and 66.4% in the AllChanCom). However, there are still 33.2% of the time, their investment yielded negative returns in the PubReadOnly and 22.3% of the time in the AllChanCom (the latter is similar to the NoCom). Further, the earning gap between the lone person and the partners was narrowed, though it still remained significant (PubReadOnly: 10.38 vs. 19.32, p = 0.02; AllChanCom: 13.03 vs. 18.94, $p = 0.08$). The earning gap in the AllChanCom is however very close to that of the baseline NoCom ($p = 1.00$).

Result 5. *Compared to the private communication treatments, the partners allocated more proportionally when public communication was available. When the lone person could further participate in the communication, the partners allocated even more proportionally. Though the lone person in the public communication treatments still earned less than the partners, they earned significantly more than the lone person in the private communication treatments.*

3.3 Analysis of Conversations

In this section, we analyze players' messages in various channels to shed light on why private communication rendered the partners behave unfairly toward the lone person and caused the

Table 5: Descriptive statistics of conversations

	Treatments:	PrivCom	PrivComFri	PubReadOnly	AllChanCom
Private AB	Any Messages	98%	95%	67%	60%
	Lines of Messages	12.1	21.5	8.5	6.1
	Total Characters	239.8	296.0	162.9	105.8
Public (AB)	Any Message			88%	92%
	Lines of Messages			7.3	8.4
	Total Characters			152.5	136.9
Public (C)	Any Message				94%
	Lines of Messages				4.6
	Total Characters				71.1

Notes: 1) The statistics are summarised as conversations occurred per group per period. 2) "Any Messages" refers to the fraction of groups where at least one message was sent in that channel. Among these groups, "Lines of Messages" refers to the average number of messages by designated person types in that channel and "Total characters" refer to the total volume of letters, spaces and punctuations. 3) "Public(AB)" means the messages sent by the partners in the public channel, and "Public(C)" means the messages sent by the lone person in the public channel.

latter to underinvest, and why public communication helped bring about fairer allocations and higher investment from the lone person.

3.3.1 Descriptive Statistics of Conversations

We first look at the volumes of messages exchanged in each communication channel. Table 5 shows that over 95% of the time the partners communicated in the two private communication treatments. However, when the public channel was available, partners were more likely to exchange messages in the public channel than in their private channel. For example, only two thirds of the partners talked in private channels in the PubReadOnly, and the volume of messages were further reduced by one-third in the AllChanCom. It looks like that the partners were eager to reach out to the lone person, presumably to encourage the lone person to invest, though not necessarily planning to allocate fairly. In the AllChanCom, the lone person talked 94% of the time with comparable volumes of messages to an average partner. But the lone person did not seem to attempt to communicate with one of the partners privately, or vice versa.[23] These statistics are consistent over the course of 8 rounds (see Figure B1 in Appendix B).

[23]Message exchanges occur in 29% of the cases in the Private AC channel and 21% in the Private BC channel. In each conversation, about 3.5 lines (or about 43 characters) were exchanged; they are mostly greetings to each other.

We next study the content of conversations in each channel. To do that, we employed a different pair of two research assistants (who were not aware of our research questions) for each treatment. Their tasks were to assign the conversation in each group of each channel for each round to one or more semantic domains. For the two private communication treatments, we classify the conversation as "Fair" (the partners planned to allocate proportionally to each other's relative investment), "Less than fair" (the partners planned to allocate less than proportionally, but not nothing to the lone person), "Nothing" (the partners planned to allocate nothing to the lone person regardless of her investment), "Other" (the partners planned to allocate according to other strategies), and "Concern for C" (the partners showed pity to the lone person or they laughed at the lone person's misfortune).[24] For the two public communication treatments, we further classify the conversation in the private and public channels as "High contribution" (the partners suggested high contribution (> 5) from the lone person). Moreover, for the AllChanCom, we additionally label the lone person's messages as "Fair" (the lone person asked for fair allocation from the partners) and "High contribution" (the lone person suggested high contribution (> 5) from the partners). Table 6 reports the frequency of each semantic domain by channel and by treatment.[25]

Table 6: Fraction of conversation belonging to each semantic domain

Chanel	Content	PrivCom	PrivComFri	PubReadOnly	AllChanCom
Private AB	Allocate fair amount to C	11%	11%	11%	3%
	Allocate less than fair to C	14%	23%	12%	5%
	Allocate nothing to C	53%	54%	22%	9%
	Allocate other fraction to C	25%	14%	17%	5%
	Concern for C	66%	75%	29%	15%
	Suggest high investment			44%	13%
Public (AB)	Allocate fair amount to C			63%	75%
	Allocate less than fair to C			8%	0%
	Allocate nothing to C			3%	0%
	Allocate other fraction to C			34%	7%
	Concern for C			27%	5%
	Suggest high investment			75%	83%
Public (C)	Ask for fair allocation				66%
	Suggest high investment				69%

Notes: 1) The statistics are summarized as conversations occurred per group per period. 2) "Public(AB)" refers to the messages sent by the partners in the public channel, and "Public(C)" means the messages sent by the lone person in the public channel.

[24] We also asked research assistants to classify the conversation as "Same Strategy" when the partners planned to use the same strategy as last round and as "Else" for all other contents. In our data analysis, if the coder ticks "Same strategy", we impute the categories of the current round from the categories chosen by the coder for the previous round. Appendix C includes the instructions for the content analysis.

[25] We classify a conversation to a semantic domain if at least one of the research assistants assigns it to that domain. We also conduct the same analysis by classifying a conservation to a domain if and only if both research assistants assign it to the same domain. The analysis produces qualitatively similar results.

More than half of the time, conversations in the private communication treatments were about allocating unfairly toward the lone person. The frequency of these conversations decreased in the public communication treatments. In public channels, not surprisingly, partners talked about different things; they often encouraged the lone person to invest more and promised fair allocations. For example, the partners suggested fair allocation 63% of the time in public conversations in the PubReadOnly, and this increased to 75% in the AllChanCom.

The public channel, albeit encourages cooperation, also breeds an opportunity for the partners to play trick against the lone person. For example, while partners can conspire unfair allocations toward the lone person in their private channel, they can suggest high investment and promise fair allocations in the public channel. In this way, they deliberately trick the lone person and exploit the spoils. Among all cases where the partners both suggested fair allocation and advocated high investment in the public channel, they suggested unfair allocations toward the lone person in their private channel 18.7% of the time in the PubReadOnly. But this figure decreased to 10.1% in the AllChanCom.[26]

Result 6. *In private communication treatments, 95% of the time, partners exchanged messages. They were talking about allocating unfairly toward the lone person most of the time. When public channels were present, partners were more likely to communicate in public channels than private channels. They often talked about fair allocations in the public channel. Sometimes partners played the trick where they conspired unfair allocation toward the lone person in private channels but suggested high investment and promised fair allocation in public channels.*

3.3.2 Conversation Contents and the Lone Person's Investment

Recall from Section 3.2 that lone persons' investment increased when public communication channels were present. We next estimate a random effects regression to investigate whether the lone person's investment decisions are correlated with communication contents. The dependent variable is the lone person's investment, and the independent variables include

[26] These partners' actual allocations were indeed unfair. For those partners who suggested unfair allocations in private but high investment and fair allocation in public, they on average allocated 2.3 to the lone person in the PubReadOnly and 6.9 in the AllChanCom. To see whether their plan is correlated with their allocation decisions at the individual level, we estimate the same regression as in Table 2 only for the subsample where the partners suggested high contribution in the public channel and unfair allocation in the private channel. The results show that $\beta_1 = 0.141$ in the PubReadOnly and 0.373 in the AllChanCom, both of which are not significantly different from zero (though the number of observations is low). Thus, the partners' allocation is much less fair than in the full sample.

different semantic domains of the messages exchanged in the public channel classified separately for the partners (AB) and the lone person (C). We also include the length of hashtags (same as total characters as in Table 5) lone persons saw in the partners' private channel to understand the effect of the "talking behind" on lone person's investment.

Table 7 reports the estimates. We first look at the effect of "hashtags" (from the partners) on the lone person's investment. In the PrivCom, the lone person's investment decreased marginally for each hashtag they saw. The average length of each conversation was about 240 characters; thus the lone person lowered their investment by about 1 unit seeing conversations they cannot interpret. The effect of seeing hashtags is also significant in the PubReadOnly: for an average length around 160 characters, it decreased the lone person's investment by around 0.8 unit. However, in the PrivComFri and the AllChanCom, seeing hashtags did not appear to matter for the lone persons' investment. One explanation is that in the PrivComFri the lone person's investment was already very low even when the partners did not talk behind him; and thus it left little room for his investment to go further down. In the AllChanCom where the lone person could talk in the public channel, her investment is probably more likely to be affected by the conversation in the public channel.

For the effects of semantic domains in the public channel, in the PubReadOnly, the lone person's investment significantly increased by around 2 units when the partners suggested both fair allocation and high contributions. In the AllChanCom, the lone person's investment only positively correlated with her own suggestion of fair allocation and high investment. The partners' suggestions of fair allocation and high investment had positive effects but are not statistically significant.[27] All other domains appeared to have no significant impact on the lone person's investment.

Result 7. *For the lone persons, the length of hashtags from the partners' exclusive conversations had negative effects on their own investment, especially when public channels was present and when the lone person could not talk back. The partners' suggestion of fair allocation and high suggestion in public channels led to higher investment from the lone person in the* PubReadOnly*. The lone person's own suggestion of fair allocation and high investment in public channel correlated with their higher investment in the* AllChanCom*.*

[27]The effects of the partners' messages are largely picked up by the lone person's messages, suggesting that their talks are highly correlated. If we do not include the lone person's semantic domains, the partners' suggestions of fair allocation and high investment are jointly significant and increases the lone person's investment by 3.3 units.

Table 7: Lone person's investment and Messages

	Dependent Variable: Lone person's investment			
	PrivCom	PrivComFri	PubReadOnly	AllChanCom
Number of hashtags from PrivateAB	-0.004*	-0.000	-0.005***	-0.006
	(0.002)	(0.001)	(0.001)	(0.006)
Public (AB): fair allocation			0.912*	0.236
			(0.525)	(1.245)
Public (AB): less than fair			-1.503	0.000
			(1.429)	(.)
Public (AB): nothing to C			1.004	0.000
			(1.432)	(.)
Public (AB): concern for C			0.488	-0.876
			(0.468)	(0.564)
Public (AB): high investment			1.168***	1.151
			(0.258)	(0.995)
Public (C): fair allocation				0.441*
				(0.232)
Public (C): high investment				2.203***
				(0.610)
Constant	4.535***	2.533***	5.034***	5.277***
	(0.431)	(0.475)	(0.607)	(0.437)
Observations	256	320	226	256
Clusters	4	5	4	4

Notes: 1)This table uses random effect models to estimate the determinants of person C's contribution. 2) The coefficients of "Public (AB): less than fair" and "Public (AB): nothing to C" cannot be estimated in the AllChanCom because there is no conversation in the channel that can be categorized as such. 3) *, ** and *** denote, respectively, 10%, 5%, and 1% significance levels. Standard errors are clustered at session level.

3.3.3 Conversation Contents and the Partners' Allocation

Last, we look at whether these semantic domains are correlated with the partners' actual allocation decisions. We augmented the regression in Table 2 by adding dummy variables of whether the partners communicated in corresponding channels and the semantic domains about allocation (fair allocation, less than fair allocation, zero allocation). We also include "concern for C," as it is likely to correlate with the partners' intention to be fair. In the AllChanCom, the lone person's semantic domain of fair allocation is included.[28] We further interact the partner's relative investment with different semantic domains to see the marginal effect of each domain on β_1, i.e. the weight on the proportional share in allocation decisions.

Table 8 reports the results. Unsurprisingly, the partners' message in their private channels are consistent with their allocation decisions across all treatments: when fair allocation was suggested in private, their allocation decisions were indeed much fairer as indicated by the significant decrease in the fixed share to the other partner and the increase in the proportional share;[29] when unfair allocation (zero allocation) to the lone person was suggested, the partners were much less fair. The results also suggest that the fact of partners' exchanging messages in private led to fairer allocation in the private communication treatments; this could be explained as that the partners who sent no messages in a round (which occurred less than 5% of the time) might reach an agreement in the previous round for unfair allocations.[30] When the partner could also talk in public, their exchanging messages in private led to less fair allocations. When the partners expressed concerns for the lone person in private, they were more likely to allocate proportionally, especially in the private communication treatments. We interpret it as sentimental expressions contributing to fairer allocation decisions.

In the PubReadOnly, the partners' speaking in the public channel led to fairer allocations as the fixed share to the other partner decreased and they allocated more often according to the other partner's relative investment. However, suggesting fair allocation in public channels are not significantly correlated with their actual allocations. This can be

[28]As the lone person's "high contribution" domain is highly correlated with the "fair allocation" domain, we do not include it in the regression.

[29]The only exception is in the PubReadOnly where it goes in the right direction but is not statistically significant.

[30]Note that the intercept and β_1 estimate of the regression show that in the baseline cases where no messages were sent in private, the partners allocated almost everything to each other regardless of the lone person's investment.

Table 8: The effect of semantic domains on the relative share allocated to the partner

	Dependent Variable: Share Allocated to the Partner			
	PrivCom	PrivComFri	PubReadOnly	AllChanCom
β_1: Partner's relative investment	-0.159	0.019	0.211***	0.843***
	(0.514)	(0.032)	(0.047)	(0.063)
A&B in Private AB Channel				
A&B speak in Private Channel	-0.491	-0.366***	0.040	0.176**
	(0.459)	(0.015)	(0.112)	(0.074)
Allocate fair to C	-0.295***	-0.541***	-0.202***	-0.221***
	(0.086)	(0.107)	(0.076)	(0.030)
Allocate unfair to C	0.368***	0.330***	0.323***	0.272***
	(0.131)	(0.036)	(0.054)	(0.104)
Concerns for C	-0.042***	-0.132**	-0.069	-0.100
	(0.006)	(0.065)	(0.109)	(0.160)
Relative Inv. × A&B speak privately	0.705	0.361***	-0.017	-0.167**
	(0.619)	(0.019)	(0.156)	(0.083)
Relative Inv. × Allocate fair to C	0.236*	0.548***	0.206**	0.279***
	(0.130)	(0.107)	(0.093)	(0.047)
Relative Inv. × Allocate unfair to C	-0.398***	-0.333***	-0.377***	-0.268*
	(0.143)	(0.030)	(0.087)	(0.155)
Relative Inv. × Concern for C	0.061*	0.146**	0.080	0.092
	(0.036)	(0.067)	(0.135)	(0.202)
A&B in Public Channel				
A&B speak in Public channel			-0.511***	-0.040
			(0.051)	(0.141)
Allocate fair to C			0.167	-0.037
			(0.134)	(0.111)
Allocate unfair to C			0.368***	0.000
			(0.087)	(.)
Concern for C			-0.077	-0.016
			(0.051)	(0.057)
Relative Inv. × A&B speak publicly			0.543***	0.096
			(0.039)	(0.199)
Relative Inv. × Allocate fair to C			-0.150	0.049
			(0.150)	(0.179)
Relative Inv. × Allocate unfair to C			-0.396***	0.000
			(0.152)	(.)
Relative Inv. × Concern for C			0.073	0.027
			(0.068)	(0.043)
C in Public Channel				
C speaks in Public channel				0.093
				(0.134)
Suggest fair allocation				-0.030
				(0.048)
Relative Inv. × C speak publicly				-0.130
				(0.156)
Relative Inv. × Allocate fairly				0.060
				(0.047)
Constant	0.935**	0.972***	0.715***	0.111
	(0.383)	(0.031)	(0.037)	(0.071)
Observations	512	640	452	512
Clusters	4	5	4	4

Notes: 1) This table uses random effects models to estimate the effects of semantic domains in each communication channel on the relative share allocated to the partner. 2) *, ** and *** denote, respectively, 10%, 5%, and 1% significance levels. Standard errors are clustered at session level.

explained as that speaking in the public channel is highly correlated with suggesting fair allocation. When the partners suggested unfair allocation (zero allocation) in public channels, they were indeed less proportional. In the AllChanCom, messages in public channels do not correlated with the partners' allocation decisions. The lone persons' ask for fair allocations also does not appear to matter for the partners' allocation decisions. Note that the intercept and β_1 estimate of the regression show that in the baseline cases where no messages were sent in the public channel, the partners allocated almost proportionally to the other partner's relative investment. These results seem to suggest that fair allocations might be considered as a norm when every group member could participate in conversations.

Result 8. *The partners' private conversations are largely consistent with their actual allocation decisions. In the* PubReadOnly*, speaking in the public channel made the partners allocate more proportionally. In the* AllChanCom*, fair allocation might already be considered as a norm, as the messages in the public channel did not appear to matter to the partners' allocation.*

3.4 Lone Person's Allocation

We have found that the partners' allocation decisions were biased against the lone person. Here, we briefly examine how the lone person allocated between the partners. Since in our experiments there is little reason for the lone person to be biased against one of the anonymous partners; the most natural allocation is proportional to their relative investment. In the case where the partners invested equally (which often occurred), the lone person was expected to allocate equally between them.[31] However, it is possible that the lone person might not allocate fairly out of anger or disappointment if she had been treated unfairly in previous rounds. Thus, unfair allocations may serve as a kind of the lone person's revenge or punishment toward a random member of the partners (recall in the experiment design that the lone person cannot identify individual partner). Or it may serve a strategic purpose: by causing unequal returns to the partners, it may disturb the partners' trusting relationship which is at least partly based on mutual benefits. Figure 6 shows the lone person's allocation when the partners invested an *equal* amount. The allocation falls into three categories: equal split, all-or-nothing (i.e. one partner received everything and the other received nothing), and any else allocations in between. We find that in many cases the lone person didn't allocate equally. In particular, a substantial number of allocations is all-or-nothing. Interestingly, it appears that at the treatment level the fairer the partners' allocation, the less likely the

[31] One third of the pie is always a multiply of 0.2, so it can be easily divided by 2.

lone person would do the all-or-nothing allocation. The all-or-nothing allocation almost never happened in the SymMatch. But it happened strikingly 40% of the time in the two private communication treatments. In the public communication treatments where the partners' allocation was fairer than in the private communication treatments, the all-or-nothing allocation happened about 10%∼20% of the time.[32] Nevertheless, this kind of arbitrary allocation does not appear to matter to the partners' investment as we do not observe significant difference in their investment across treatments.[33]

4 Conclusions

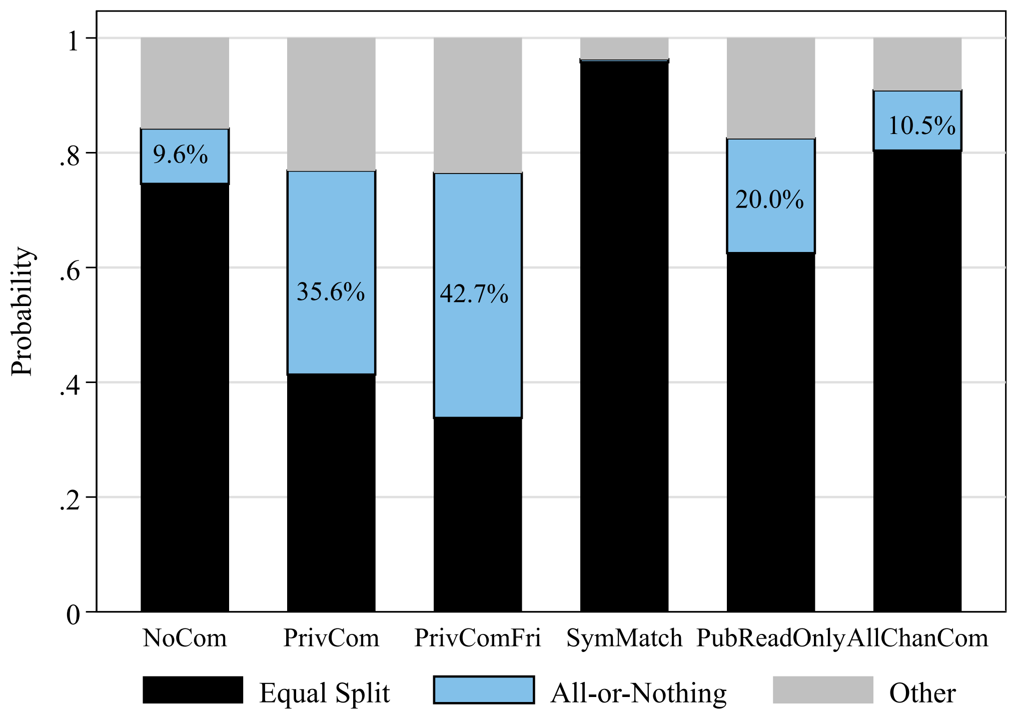
Our goal in this study is to investigate the role of exclusionary communication in a team production setting. In this setting, communication is viewed as a device to facilitate coordination on investment and profit allocation within a team. Specifically, we designed a laboratory experiment where we vary the opportunity to communicate among team members and study how team productivity and profit allocation change accordingly. In all treatments, a team consists of three members: two persons as partners who are always paired together and a third person as a lone person who only meet each pair of the partners once in the experiment.

Our findings show that exclusionary communication between the partners has an asymmetric impact on the partners' and the lone person's investments and the way that team profits are allocated. Relative to the case where no communication is allowed, the partners colluded in profit allocation against the lone person who reacted by significantly reducing the investment to the team project. The content of the partners' conversations revealed that the partners plotted against the lone person by suggesting unfair profit allocation toward the lone person most of the time. When the partners can additionally reach out to the lone

[32]At the individual level, however, we do not find that the likelihood of the all-or-nothing allocation is correlated with the lone person's experience about the partners' allocations in previous rounds (See Table B3 in Appendix B for random effects regressions on the likelihood of the all-or-nothing allocation). Thus, this seems to suggest that the lone person did so *not* directly because of their bad experience in previous rounds, but probably as a strategic move to "punish" one of the partners even though they would not meet each other again. Table B4 in Appendix B additionally shows the number of times a pair of partners made the all-or-nothing allocation in each treatment. It shows that there are at least some lone persons who often made the all-or-nothing allocation. For example, in the PrivComFri, there are 10 persons (out of 40) who did so at least six times.

[33]See Table B5 in Appendix B for random effects regressions on the one-round change in the partners' investment for the subsample where the two partners invested an equal amount. We find that the partners' investment changes were largely not significantly correlated with whether they received zero or everything from the lone person in pervious rounds (with receiving something in between as the reference category).

Figure 6: Lone persons' allocations to the partners who invested equally



Notes: This figure shows lone persons' allocation decisions toward the partners who invested equally. All-or-Nothing is to allocate all to one of the partners and nothing to the other. Below are the number of observations for each treatment: 189 out of 576 (32.8%) in the SymMatch, 114 out of 256 (44.5%) in the NoCom, 219 out of 256 (85.5%) in the AllChanCom, 225 out of 256 (87.9%) in the PrivCom, 302 out of 320 (94.4%) in the PrivComFri, and 200 out of 226 (88.5%) in the PubReadOnly.

person via a public communication channel, we observe that the lone person invested more to the team project and was more likely to receive fair profit shares from the partners. However, it did not preclude the partners from talking behind the lone person in their private channel. They sometimes gamed the system by tricking the lone person into investing in the public channel but plotting against her in their private channel.

Our study broadly contributes to the understanding of communication in strategic situations. With a few exceptions, the coherent message from this experimental literature is that communication helps participants to coordinate on a Pareto efficient outcome. Our study suggests, however, that compared to no communication, exclusionary communication can be detrimental to team cooperation. Our analysis of the excluded member's behavior further shows that this harmful effect is not just restricted to the colluding members' unfair profit allocation toward the excluded member and the latter's low investment, but also the excluded member's deviation from the fairness norm in her own profit allocation. One way to restore team cooperation and fairness in profit allocation is to include the lone person in the partners' communication, which helps rebuild trust between the partners and the wary lone person. This capacity to freely communicate to every group member might be an asset to team cooperation in and of itself since we find some evidence that fairness in profit allocation might be considered as a norm under such an environment (unless the partners explicitly plotted against the lone person in their private channel; see Result 8).

Altogether, our study suggests that institution designers should carefully consider the mode of communication and especially should remove the obstacle in communications that could result in talking-behind situations. In modern organizations with the increasingly diverse team composition, talking behind or office politics may naturally arise due to conflicts of interest or simply natural attrition among colleagues sharing similar temperament. It is therefore of paramount importance to reconcile different needs and views by encouraging all-around communication such as in compulsory team-building events. At a larger societal level, such all-round communication becomes more challenging but the principle remains the same. For example, in some countries, policy makers should make social programs that encourage communication between natives and immigrants to mitigate biased perceptions of each other.[34] To promote public support for certain law or regulation, law makers should

[34] A recent large-scale survey on the opinion for wealth redistribution with immigrants show that respondents' support for redistribution increases when provided with information on the "hard work" of immigrants, but not when provided with information on the number or origin of immigrants (Alesina et al., 2018). This seems to suggest that natives' outgroup discrimination is mitigated by immigrants' earned entitlement through effort, consistent with the meritocratic view of fairness. This effect, however, tends to subdue when respondents are prompted to think in detail about immigrants' other characteristics such as less perceived education, lower income and being religiously and culturally more distant than themselves.

make transparent conflicts of interest among various affected parties to encourage better mutual understanding.

In our view, an interesting direction for future research is to explore how the lone person's reaction to the partners' collusion can be harnessed to the betterment of team cooperation. Specifically, if the lone person were able to identify individual partner and direct the all-or-nothing allocation to a specific rather than a random partner, then this allocation strategy might be an effective deterrence to the partners' collusion. Other possible deterrence might be repeated plays between the partners and the lone person or the lone person's ability to observe the partners' allocation before deciding her allocation. Another direction is to further vary the communication structure. For example, if only bilateral communication is allowed between team members, team cooperation might be harder to build than when all members can directly exchange messages in the public communication channel. On the other hand, the lone person might be more likely to attempt to strike some side deal with one of the partners and this might render team cooperation still harder.

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Appendix A. Experimental Instructions

[We present the experimental instructions below, along with the screenshots. The following paragraph is the same for all treatments:]

Welcome! You are taking part in a decision-making experiment.You have earned $5 for showing up on time. In addition, you can earn more money in this experiment. The amount of money you earn will depend upon the decisions you make and on the decisions other people make. Your earnings in this experiment are expressed in EXPERIMENTAL CURRENCY UNITS, which we will refer to as ECUs. At the end of the experiment you will be paid IN CASH using a conversion rate of $1 for every 8 ECUs of earnings from the experiment (final payment will be rounded to the nearest 10 cents). Everyone will be paid in private. Please do not communicate with each other during the experiment. If you have a question, feel free to raise your hand, and an experimenter will come to help you. Your unique Participant ID number is shown on top of your instructions. To ensure anonymity, your actions in this experiment are linked to this Participant ID number and at the end of the experiment you will be paid by Participant ID number.

[The following paragraph is only present in the SymMatch*:]*

The experiment consists of 8 decision rounds. In each round, you will be in a group with two other people, but you will not know which of the other two people in this room are in your group. The people in your group will change from round to round, and in particular you will never be matched with the same set of two other participants twice in each sequence. At the beginning of each round, you will be randomly allocated a participant identification letter, either A, B, or C. (Thus, your identification letter may change from round to round). Your total earnings for the experiment will be the sum of the earnings in all rounds.

[The following paragraph is only present in the PrivCom, PrivComFri, PubReadOnly *and* AllChanCom*:]*

The experiment consists of 8 decision rounds. In each round, you will be divided into groups of three, so you will be in a group with two other participants. But you will not know which of the other two people in this room are in your group. At the beginning of the experiment, you will be either a Person A, B, or C. Your role will remain the same for the whole experiment. If you are Person A (or B), you will ALWAYS be grouped with a SAME Person B (or A) for the whole experiment, and you will meet a DIFFERENT Person C from round to round, that is, you will never meet the same Person C again. If you are Person C, you are to be grouped with DIFFERENT pairs (Persons A and B) from round to round. In other words, each group consists of a pair of two persons and a different third person in each round. Each decision round has three phases:

[The following paragraph is only present in the PrivCom *and* PrivComFri*:]*

Phase 1: Chat At the beginning of each round, Persons A and B in each three-person group can chat via an online chatting program: they can type whatever they want in the lower box of the chat program (e.g., discussing game strategies). The messages will be only seen by Persons A and B. Meanwhile, Person C in the group will see a string of "#"s each time one of Persons A and B types a message. The length of "#"s equals the length of the message (including spaces and punctuations). This chat phase will last 90 seconds.(see the following screenshot *[see Figure 1 in the main text]*)

[The following paragraph is only present in the PUBREADONLY*:]*

<u>Phase 1: Chat</u> At the beginning of each round, Persons A and B in each three-person group can chat via an online chatting program: they can type whatever they want in the lower box of the chat program (e.g., discussing game strategies). This chat phase will last 90 seconds. There are two chat boxes: 1)In Private ChatBox, the messages will be only seen by Persons A and B. Meanwhile, Person C in the group will see a string of "#"s each time one of Persons A and B types a message. The length of "#"s equals the length of the message (including spaces and punctuations). 2) In Public ChatBox, the messages will be shared by all group members, that is, Person A, Person B and Person C can all see the message. But Person C cannot type messages. (see the following screenshot *[reproduced as in Figure A3 below]*)

[The following paragraph is only present in the ALLCHANCOM*:]*

<u>Phase 1: Chat</u> At the beginning of each round, all participants can chat via an online chatting program: they can type whatever they want in the lower box of the chat program (e.g., discussing game strategies). This chat phase will last 90 seconds. They can either chat via private chatbox or public chatbox: 1) In Private ChatBox, the messages will be only seen by the two persons indicated on top of the chat box. Meanwhile, the other person in the group will see a string of "#"s each time one of the pairs types a message. The length of "#"s equals the length of the message (including spaces and punctuations). 2) In Public ChatBox, the messages will be shared by all group members. (see the following screenshot *[reproduced as in Figure A4 below]*)

[The rest of the instruction is the same for all treatments:]

<u>Phase 2: Contribution Choice</u> Each individual begins each round with an endowment of 10 tokens in their Individual Fund. Tokens in Individual Fund are worth 1 ECU each. Each three-person group begins with a Group Fund of 0 ECUs each round. You decide independently and privately whether or not to contribute any of your tokens from your Individual Fund into the Group Fund. Tokens in Group Fund are worth 1.8 ECU each. In other words, each token that a person adds to the Group Fund reduces the value of his/her Individual Fund by 1 ECU. Each token added to the Group Fund by a group member increases the value of the Group Fund by 1.8 ECUs. Each person can contribute up to a maximum of 10 tokens to the Group Fund. Decisions must be made in whole tokens. That is, each person can add 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 tokens to the Group Fund. You must press the "Calculate" button to see how many ECU will remain in your Individual Fund, once you are ready, you can click the "Next" button to proceed.

Phase 3: Allocation Choice After all participants have made their decisions for the round, the computer will tabulate the results: ECUs in Group Fund = 1.8 × (Sum of tokens in the Group Fund). You then decide how to allocate ONE-THIRD of the ECUs in the Group Fund between the other two group members. The sum of your allocations between the other two group members will be one-third of ECUs in the Group Fund. In other words, each person can only divide one-third of ECUs in the Group Fund for the other two group members, and their own share of the Group Fund will be determined by the allocation decisions of the other two group members. Specifically, 1) Person A will divide one-third of ECUs in the Group Fund between Person B and Person C. 2) Person B will divide one-third of ECUs in the Group Fund between Person A and Person C. 3) Person C will divide one-third of ECUs in the Group Fund between Person A and Person B. The other two group members' individual contributions to the Group Fund and their roles will be shown on the upper right table when you are making the allocation choices. Click the calculator button on the lower-right corner if you need assistance with calculation.

Feedback and Earnings After all participants have made their decisions for the round, the computer will show the results. A person's share of the Group Fund will be determined at the end of phase 3. Your earnings from the Group Fund will be the sum of ECUs that the other two group members allocate to you. At the end of each round, you will receive information on your Group Fund earnings and your total earnings for that round. You will also be informed of all group members' contributions to the Group Fund, their allocation decisions and their earnings in ECUs for that round. Your total earnings for the experiment will be the sum of the earnings in all rounds.This completes the instructions. Before we begin the experiment, to make sure that every participant understands the instructions, please answer several review questions on your screen.

Figure A1. Contribution Decision

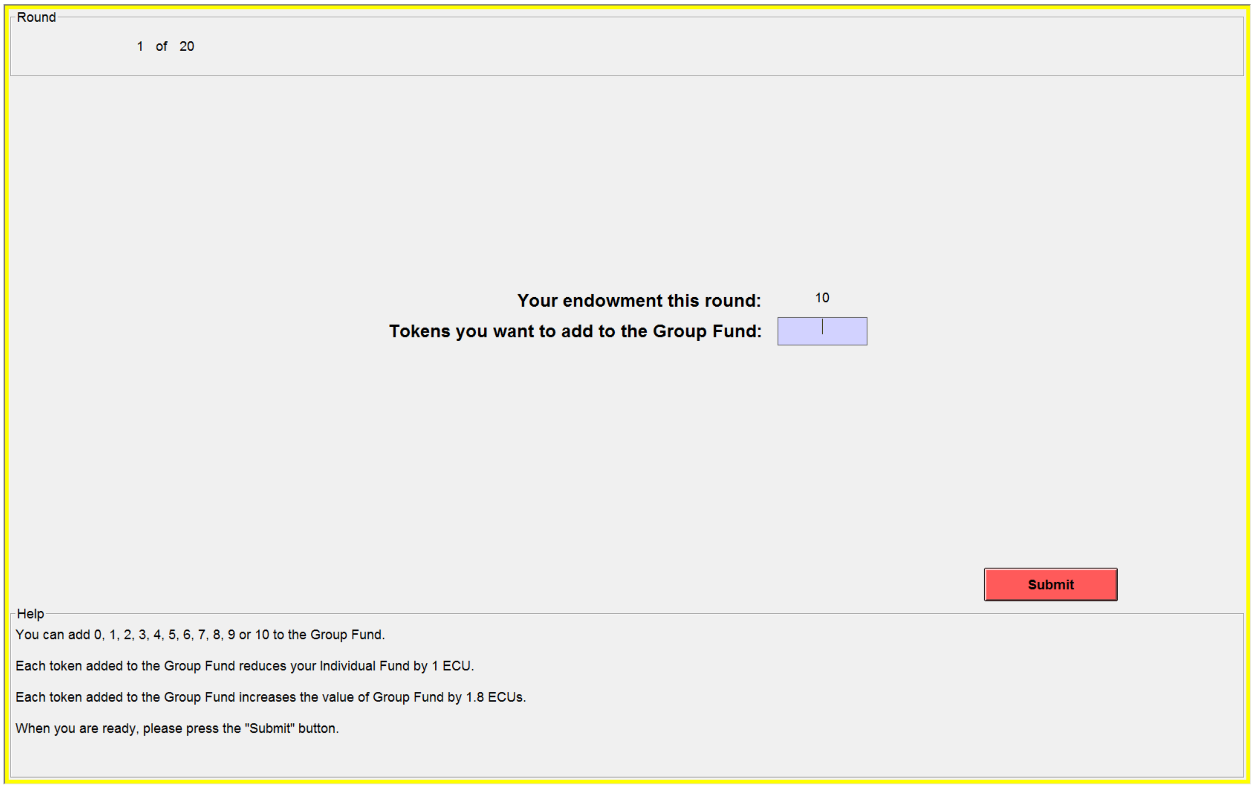


Figure A2. Allocation Decision

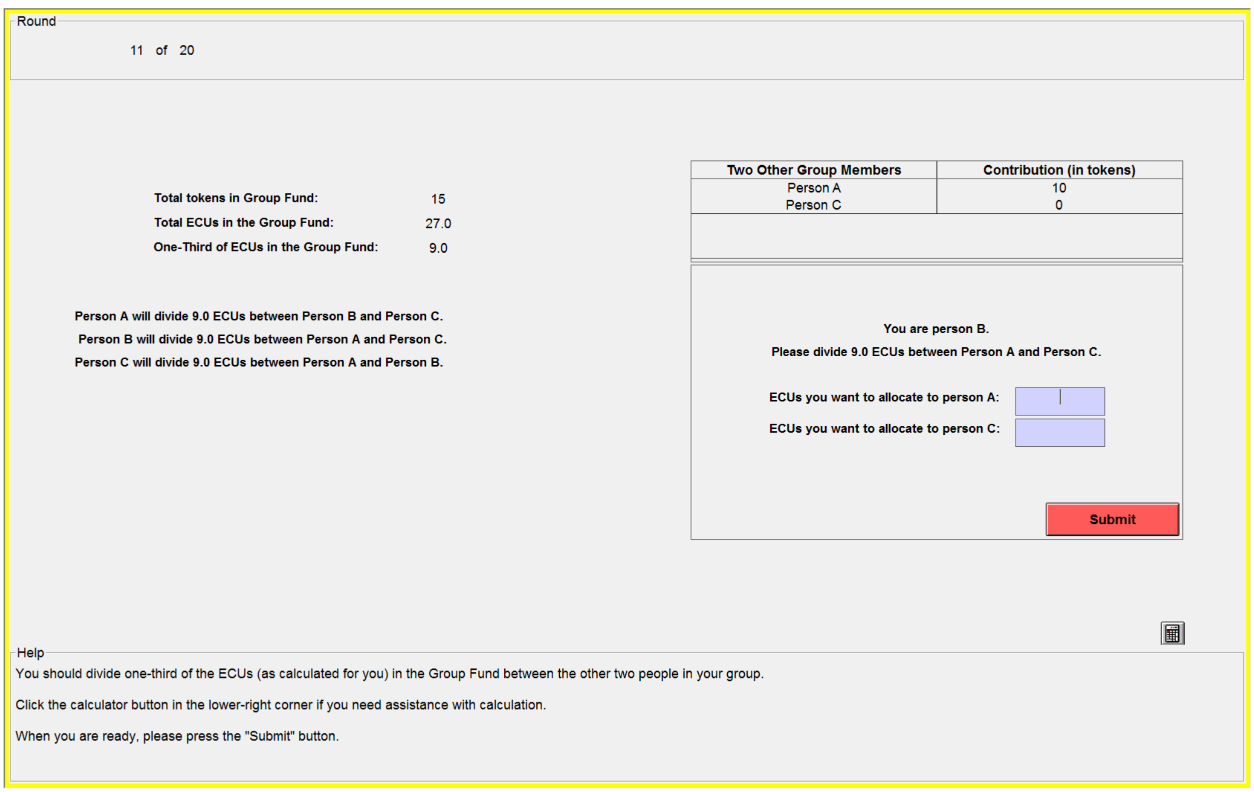
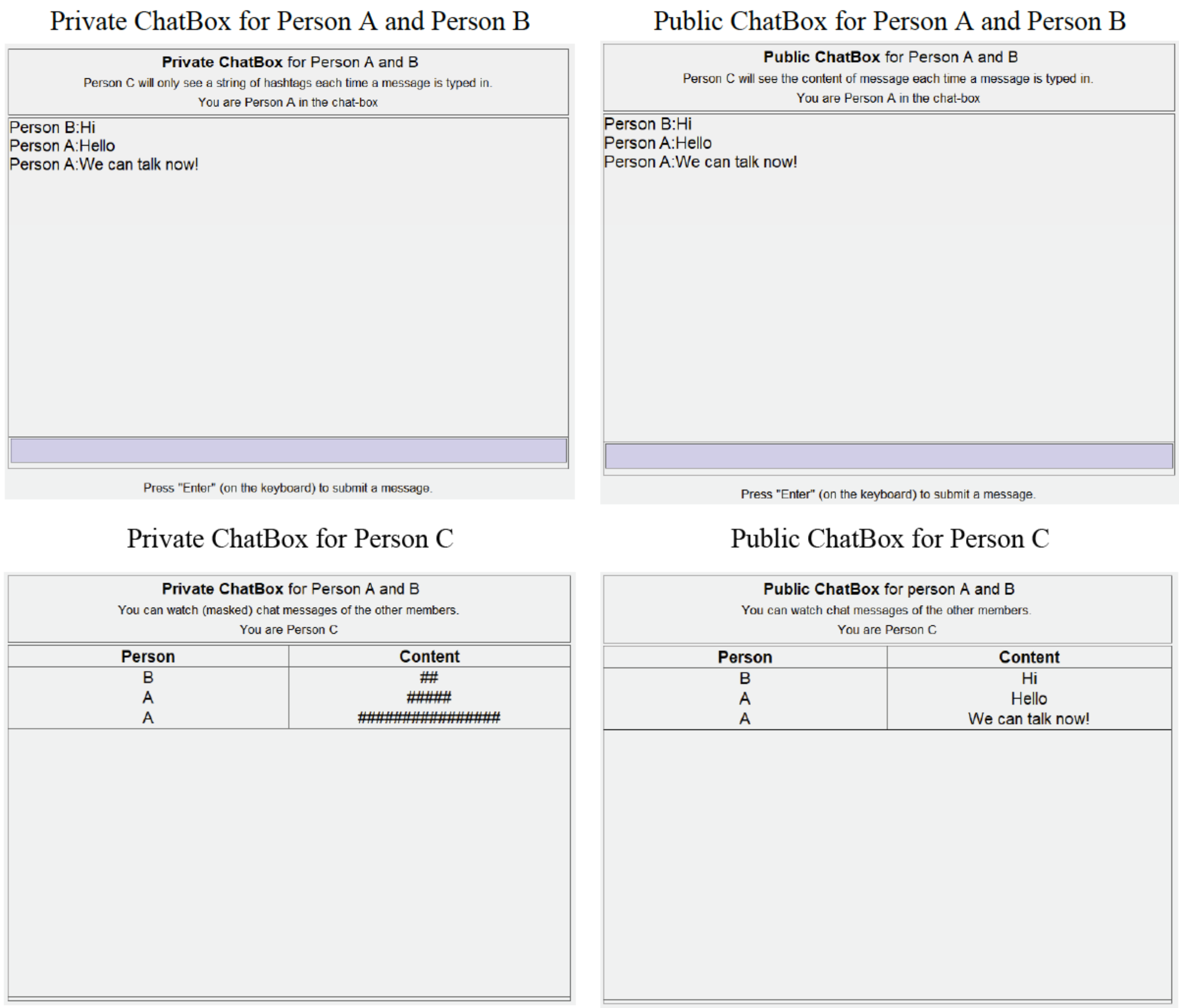


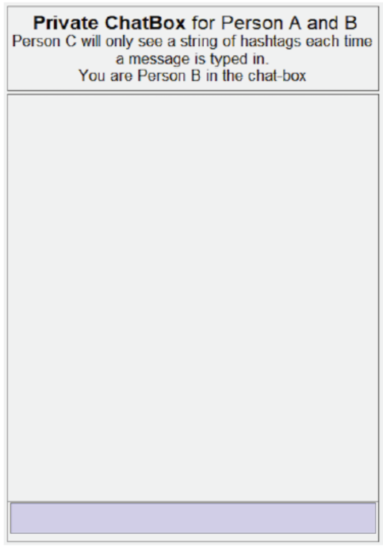
Figure A3. Chatboxes for the PubReadOnly



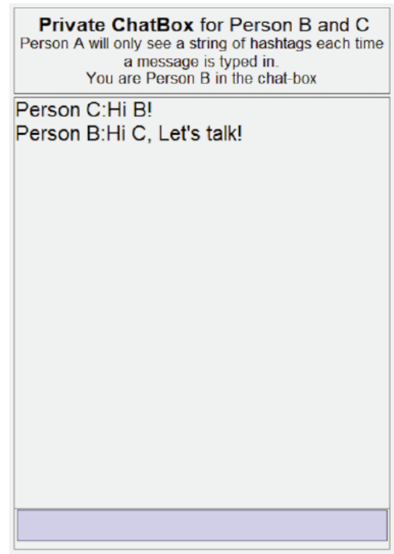
Notes: The upper two Chatboxes are for Person A and Person B. They can choose whether to exchange messages in either the Private Chatbox or the Public Chatbox. The lower two Chatboxes are what Person C will see. For example, Person C will only see hashtags for the message exchanged in Private Chatbox for person A and B, and Person C can read the content of the messages exchanged in Public Chatbox. Though Person C cannot type messages.

Figure A4. Chatboxes for the ALLCHANCOM

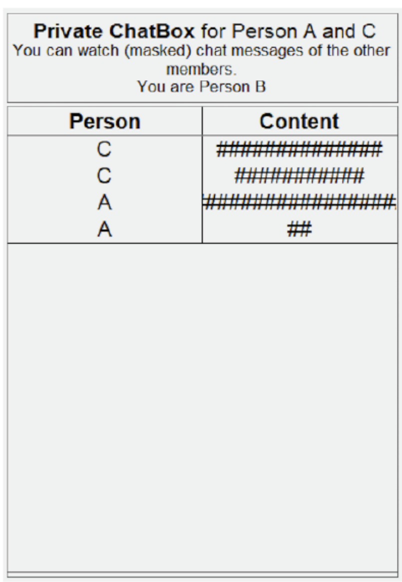
Private ChatBox for Person A and Person B



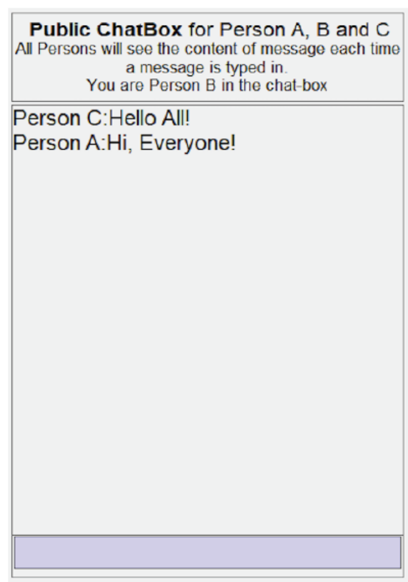
Public ChatBox for Person B and Person C



Private ChatBox for Person A and Person C



Public ChatBox for Person A, B and C



Notes: The screenshot shows four chatboxes person B will see. For example, Person B can exchange private messages with person A (in Private ChatBox for Person A and B), the messages exchanged there will be displayed as hashtags for person C. Likewise, the messages exchanged in Private ChatBox for Person B and C will be displayed as hashtags for person A; Person B can only see hastags when messages exchanged between Person A and C. In Public ChatBox, all participants can see the messages exchanged.

Appendix B. Further statistical analysis

Table B1: Treatment Comparison: Random effect model on the share allocated to the partner

Dependent Variable:	Share Allocated to the Partner $\frac{a_{ij}}{a_{ij}+a_{ik}}$		
	(1)	(2)	(3)
Base Category:	NoCom	PrivCom	PubReadOnly
β_1: Partner's relative investment $\frac{e_j}{e_j+e_k}$	0.603***	0.346***	0.485***
	(0.033)	(0.033)	(0.069)
PrivCom $\times \frac{e_j}{e_j+e_k}$	-0.257***		
	(0.046)		
PrivComFri $\times \frac{e_j}{e_j+e_k}$	-0.267**	-0.010	
	(0.088)	(0.088)	
PubReadOnly $\times \frac{e_j}{e_j+e_k}$	-0.112	0.145*	
	(0.072)	(0.072)	
AllChanCom $\times \frac{e_j}{e_j+e_k}$	0.154**	0.410***	0.274***
	(0.053)	(0.053)	(0.082)
PrivCom	0.275***		
	(0.036)		
PrivComFri	0.315***	0.039	
	(0.083)	(0.081)	
PubReadOnly	0.113	-0.162**	
	(0.058)	(0.054)	
AllChanCom	-0.106**	-0.381***	-0.224***
	(0.039)	(0.033)	(0.060)
Constant	0.346***	0.621***	0.463***
	(0.029)	(0.020)	(0.054)
#Observations	2628	2116	964

Notes: 1)This table shows player's allocation to their partners in *all* treatments. Lone persons' allocations are excluded. 2) NoCom is the base category in column 1; PrivCom is the base category in column 2; PubReadOnly is the base category in column 3. 3) *, ** and *** denote, respectively, significance at the 10-percent, 5-percent and 1-percent levels. Standard errors are clustered at session level.

Table B2: How allocation affects partners' one-round change in investment

Dependent Variable:	One round change in one of the partner's investment				
Treatment:	NoCom	PrivCom	PrivComFri	PubReadOnly	AllChanCom
Gets less than proportional from their partner	-0.267 (0.366)	0.225 (0.189)	0.103 (1.098)	0.983 (0.602)	0.980** (0.468)
Gets more than proportional from their partner	0.254 (0.205)	-0.218 (0.176)	0.352*** (0.133)	-0.012 (0.071)	0.189* (0.106)
Gets less than proportional from the lone person	-0.402 (0.255)	-0.357 (0.286)	-0.110 (0.237)	0.023 (0.153)	0.736 (0.606)
Gets more than proportional from the lone person	0.100 (0.206)	-0.256 (0.263)	0.248 (0.259)	0.322 (0.252)	0.215 (0.200)
Constant	0.384*** (0.120)	0.445* (0.268)	-0.065 (0.272)	-0.030 (0.152)	0.150 (0.142)
N	448	448	556	392	448

Notes: 1)This table shows the determinants of partners' one-round change in effort. The base category is where the partner receives proportional share from both her partner and the lone person. 2) *, ** and *** denote, respectively, significance at the 10-percent, 5-percent and 1-percent levels. Standard errors are clustered at session level.

Table B3: How allocation affects partners' one-round change in effort level

Dependent Variable:	1 if the lone person adopts "All-or-Nothing" next round				
Treatment:	NoCom	PrivCom	PrivComFri	PubReadOnly	AllChanCom
Gets less than proportional from the partners	0.010 (0.039)	-0.075 (0.089)	-0.025 (0.063)	0.024 (0.023)	0.009 (0.052)
Gets more than proportional from the partners	0.093 (0.086)	-0.123 (0.164)	0.072 (0.353)	-0.053 (0.194)	0.116 (0.165)
Constant	0.069 (0.045)	0.426*** (0.064)	0.452*** (0.045)	0.205** (0.082)	0.096* (0.051)
Observations	91	174	225	152	175

Notes: 1)This table shows the determinants of lone persons' adoption of "all-or-nothing" strategy in the subsequent round. The base category is where the lone person receives a proportional amount from the partners. 2) *, ** and *** denote, respectively, significance at the 10-percent, 5-percent and 1-percent levels. Standard errors are clustered at session level.

Table B4: Distribution of Lone persons' All-or-Nothing Allocation Strategy

Number of All-or-Nothing Allocations	Treatment					
	SymMatch	NoCom	PrivCom	PrivComFri	PubReadOnly	AllChanCom
0	56	17	4	6	12	17
1	8	9	5	6	4	5
2	4	1	3	5	4	5
3	4	3	6	6	5	4
4	0	0	5	6	2	0
5	0	1	4	1	2	0
6	0	1	4	4	1	0
7	0	0	1	3	0	1
8	0	0	0	3	0	0
Mean number of A-or-N:	0.39	0.97	3.1	3.3	1.7	1.1
Number of (lone) persons	72	32	32	40	30	32

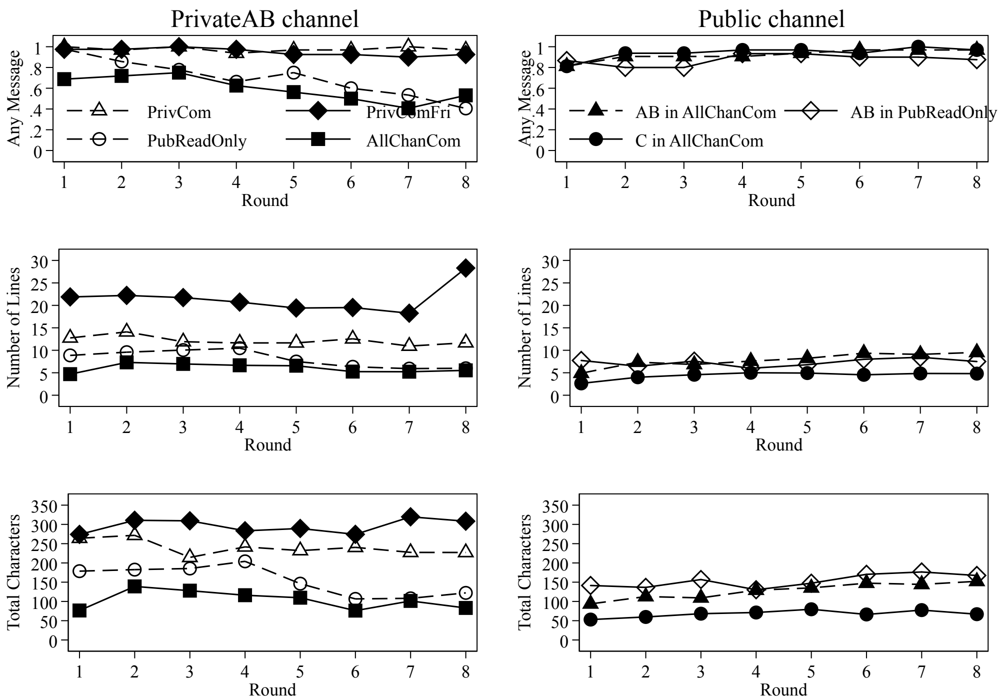
Notes: This table shows the distribution of lone persons' All-or-Nothing allocation strategies by treatment. Except for the SymMatch treatment where we count all participants' decisions, we only count lone persons' decisions in the other treatments.

Table B5: How Lone persons' all-or-nothing allocation affects partners' investment

Dependent Variable:	One round change in one of the partner's investment				
Treatment:	NoCom	PrivCom	PrivComFri	PubReadOnly	AllChanCom
Gets all from	-0.273	-0.141	0.239*	0.167	-1.256
the lone person	(0.373)	(0.102)	(0.133)	(0.166)	(1.094)
Gets nothing from	-0.626	-0.265	0.072	-0.181	-1.413
the lone person	(1.056)	(0.198)	(0.079)	(0.297)	(1.125)
Constant	-0.079	0.099	-0.026	-0.151	0.098
	(0.239)	(0.093)	(0.106)	(0.146)	(0.149)
Observations	194	394	522	346	376

Notes: 1)This table shows whether a partner receives all or receives nothing from the lone person affects her one-round change of investment. 2) The regressions only include cases where both partners made the same investment. 3) *, ** and *** denote, respectively, significance at the 10-percent, 5-percent and 1-percent levels. Standard errors are clustered at session level.

Figure B1: Evolutionary statistics of conversation



Notes: This figure shows the evolution of "Any Message", "Number of Lines", and "Total Characters" in different communication channels over 8 rounds. The volume and frequency of communication remain roughly consistent over time.

A Instructions for Content Analysis

For each treatment, we employed two research assistants (who are unaware of our research purpose) to code participants' conversations. Below is the instructions given to the assistant who coded messages in the PrivCom. *Instructions for the other treatments are similar with additional categories (see main text).*

You will be given a list of messages. These messages were written by participants in an experiment. The following is a summary of the experiment:

1. Each group consists of three participants. They are randomly assigned to be Person A, Person B, and Person C. Their roles are fixed during the whole experiment.
2. There are in total 8 rounds, during which Persons A and B are always paired together. But Person C meets different pairs of Persons A and B every round.
3. Persons A and B have 90 seconds before each round to discuss (hence the list of messages) with each other, while Person C cannot see the content of the message.
4. After the 90 seconds, Persons A, B, and C play the following game: 1) each participant is endowed with 10 tokens at the beginning of each round; 2) each participant decides independently how many tokens to invest in a group fund, and keeps the tokens that are not invested; 3) the tokens invested to the group fund will be pooled together and multiplied by a factor of 1.8; 4) each participant allocates one third of the group fund between the other two group members. 5) each participant's payoff in a round is then the sum of the uninvested tokens and the share of the group fund received from the other two group members.

Your task is to classify the conversations between A and B in each round according to the categories given to you. While for coding the conversations, please use the following categories (you can pick multiple categories for the same conversation):

For Person A and B:

1. suggested a FAIR share to C (proportional to C's relative investment). Note that this includes suggesting fair allocation to all group members.
2. suggested a LESS THAN FAIR share (but more than nothing) to C.
3. suggested to allocate NOTHING to C.
4. suggested to use OTHER allocation strategies.
5. suggested to use the SAME STRATEGY as last round.

6. concerned about C's welfare. This includes any conversation mentioning C: either showing pity or laughing at C's misfortune.
7. talked about something else.

Note: In A and B's conservations, they may explicitly discuss the allocations to C or discuss the allocations to each other (A and B). In either case, please select the category according to their intent of allocations to C.

While for coding the conversations, please pay attention to the following:

- You should code all conversations independently. Please do not discuss with anyone else how to code the conversations.
- Your job is to evaluate how Persons A and B decided their allocations to C.
- The unit for coding is the whole conversation in each channel of each group in a round, not every message.
- When you complete the coding, please go through the entire list of messages a second time to (i) review all your codes and revise them if needed for accuracy; (ii) make sure that you have coded every conversation.

To evaluate the conversations, you need to first understand the experiment. The instructions attached below are the instructions the participants read in the experiment. Please read them carefully, answer the comprehensive questions, and email me the answers. Only after you answered all the questions correctly, can you begin to code the messages.