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# Intragroup Communication in a Public Goods Experiment with Nested Exchanges

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## Abstract

Agents can often choose between providing a public good through a small, local exchange or a larger, global exchange. This paper reports a public goods experiment with a local exchange, which benefits the contributor's local group, and a global exchange, which benefits all the participants. The paper investigates the effects of intragroup communication on participants' allocation decisions. It finds that intragroup communication nearly eliminates free-riding but can also reduce intergroup cooperation.

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# 1. Introduction

Individuals often belong to a group that is nested inside a larger group. For example, an individual may reside in a neighborhood that is one of many neighborhoods in a city. Similarly, an employee may work in a department that is one of several departments in an organization. In many cases, individuals can provide public goods through their local group or through a larger, global group. For example, residents can contribute resources to construct a neighborhood park or a city park. Similarly, countries can address issues such as air pollution through a domestic resolution or through a global agreement.

This is the first paper to investigate the effects of intragroup communication on the participants' allocation decisions in a public goods experiment where individuals can contribute resources to a global exchange or to a smaller, nested local exchange. It concludes that intragroup communication significantly reduces allocations to the private exchange, but also significantly increases allocations to the local exchange. Therefore, intragroup communication decreases self-serving behavior but increases group-serving behavior leading group to act in a similar way to individuals in a public goods experiment with a single exchange.

Blackwell and McKee (2003) also utilize a public goods experiment with nested exchanges. They find that participants prefer to contribute to a local exchange, but they do not study the effects of communication. Individuals often only interact with members of their local group because communication within a larger group is too costly or difficult (Brewer and Schneider, 1990). This paper helps elucidate if local groups are likely to reach intergroup cooperation over the provision of public goods when only intragroup communication is feasible. It shows that intragroup communication nearly eliminates free-riding but it also reduces intergroup cooperation and can potentially reduce efficiency.

Most participants contribute some tokens to the group exchange in public good experiments with a voluntary contributions mechanism even though the dominant strategy is to contribute nothing (Marwell and Ames, 1981; Schneider and Pommerehne, 1981; and elsewhere). The average contribution to the group exchange remains positive though smaller when the game is repeated (Isaac, Walker and Thomas, 1984; and Isaac, McCue and Plott, 1985) or when the participants gain experience (Marwell and Ames, 1980; and Palfrey and Prisbrey, 1997). Recent research shows that most contributions occur for strategic reasons and not because of confusion or warm-glow, which is a positive feeling that people get from helping others (Yamakawa, Okano, and Saijo, 2016).

Non-binding communication tends to lead to more cooperation in public goods experiments, but it does not eliminate free-riding (Duffy and Feltovich, 2002; Charness and Grosskopf, 2004; Blume and Ortmann, 2007; Isaac, McCue and Plott, 1985; Isaac and Walker, 1988; Bochet, Page, and Putterman, 2006; and Cason and Khan, 1999). Communication about the importance of cooperation can even improve contributions in public good experiments with successive generations of players (Hillis and Lubell, 2015). However, communication among players must be continuous and not discrete to avoid a decay in contribution (Oprea, Charnes, and Friedman, 2014; and Palfrey, Rosenthal and Roy, 2017).

Communication may increase allocations to the group exchange because it raises trust and gives participants an opportunity to make promises regarding their contributions (Orbell, van de Kragt and Dawes, 1988). Additionally, communication may help establish a group identity, which tends to raise contributions to the group exchange (Dawes, McTavish, and Shaklee, 1977; Brown-Kruse and Hummels, 1993; Solow and Kirkwood, 2002; and Haruvy et al., 2017). Furthermore, communication increases the joy that individuals receive from cooperating

(Berlemann, Dittrich, and Markwardt, 2009). Communication can help build trust, especially when individuals are allowed to make contributions in order to establish trust before they communicate (Barbieri, 2012).

Researchers examined the effects of intragroup communication in a variety of different games. Intragroup communication increases intergroup competition in an Intergroup Prisoner Dilemma (Bornstein, Winter, and Goren, 1996; and Goren and Bornstein, 2000). Intragroup communication also increases coordination among group members in a weakest-link game (Cason, Sheremeta, and Zhang, 2012). Communication within teams increases costly efforts and communication between teams reduces costly effort by individuals in coordination games with intergroup competition, (Sutter and Strassmair, 2009). Generally, groups tend to be more competitive and more self-serving than individuals (Insko et al., 1994; Bornstein and Yaniv, 1998). Thus, intragroup communication increases collaboration within groups, but could potentially move individuals away from the socially optimal outcome.

Allowing participants to communicate within small subgroups in a point-provision public goods experiment with a single group exchange increases contributions to the public exchange (Braver and Wilson, 1986). Thus, if participants consider themselves a part of a global group, then intragroup communication may lead participants to contribute more to the global exchange. Research shows that the provision of truly global public goods is challenging because of the existence of heterogeneous preferences, but is manageable through voluntary collective action (Seo, 2016; and Ramses and Jones, 2013).

# 2. Experimental design

Participants in the experiment were students from the University of Hawai‘i at Mānoa who were solicited from various undergraduate classes. During each session, the first eight students to arrive were randomly assigned to one of two four-person groups called local groups. They participated in either the Continuous Communication (CC) treatment or the No Interaction (NI) treatment. Each treatment was repeated in four independent sessions. In total, 64 individuals participated in 8 independent sessions.

Participants in the NI treatment were not allowed to communicate with one another and did not know who the other members of their local group were. Participants in the CC treatment were introduced to other members of their local group and were permitted to communicate with them at the beginning of each decision period. The participants were seated facing away from each other and were instructed not to communicate except during the communication sessions in the CC treatment. An assistant read the instructions for the experiment out loud and then the participants were asked to complete two exercises to make sure that they knew how to calculate their payoffs.[1]

The experiment began after all the participants completed the exercises. Each session consisted of one trial period and 10 decision periods. Participants in the NI treatment were not allowed to interact with one another while participants in the CC treatment were permitted to communicate with other members of their local group for three minutes before each decision period. Participants in the CC treatment were told that they could talk about anything they want as long as they do not threat one another or offer one another side payments. Participants were also prohibited from asking other participants about their allocations in previous periods or from volunteering such information about themselves. The communication rules were designed to assure that participants in the CC treatment had the same payoff structure as participants in the NI

[1] The instructions for the experiment are available at:
www.dropbox.com/s/22xzkhpy8f4psiw/Instructions%20for%20Experiment%20%28PG%29.docx?dl=0

treatment. An assistant remained with each local group to assure that the communication rules were followed. The groups sat in separate rooms during the communication sessions.

In both treatments, participants were asked to divide 25 tokens between their private exchange, their local exchange, and the global exchange each period. In order to avoid any framing effects, discussed by Andreoni (1995) and Park (2000), the private, local, and global exchanges were referred to as exchanges A, B, and C respectively. Each token allocated to the private exchange yielded one Experimental Peso (EP) to the participant. Each token allocated to the local exchange had a Marginal Per Capita Return (MPCR) of .6 EP to the participant and to the other three members of their local group. Each token allocated to the global exchange had an MPCR of .4 EP to the participant and to the seven other participants in the session. At the end of the experiment, participants received 4 cents for every Experimental Peso that they earned.

Participants were given two minutes each period to decide on their allocations. They each wrote their decision on a slip of paper and the slips were collected by an assistant who inputted the data into an Excel spreadsheet. The spreadsheet automatically calculated the payoffs for each participant from each of the three exchanges. The assistant then wrote the earnings from each exchange, the total earnings for the period, and the cumulative earnings up to that period for each participant on slips of paper. Then, the assistant folded the slips for privacy and handed them back to the participants. Participants were required to record their earnings every period on a separate paper. After all the participants recorded their earnings, a new decision period would begin. At the end of the session, participants were paid their cumulative earnings plus a five-dollar fee for showing up in cash. Participants were paid in private.

# 3. Results and analysis

The main objective of the experiment was to investigate the effects of intragroup communication on participants' allocation decisions in a public goods experiment with nested exchanges. The data from the experiment are summarized below.

Table I. Allocations by session and by treatment[2]

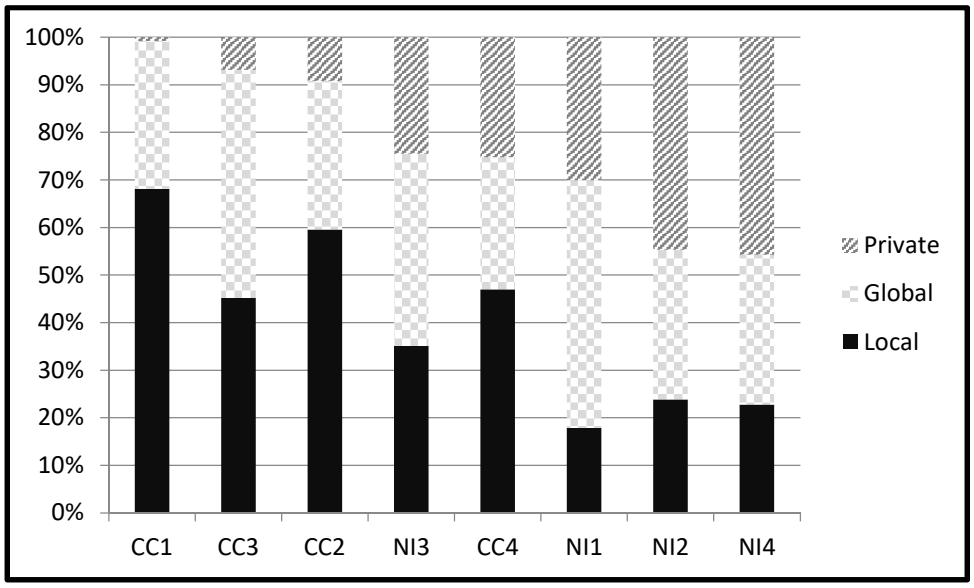
| | Private Exchange | | | Local Exchange | | | Global Exchange | | |
|---|---|---|---|---|---|---|---|---|---|
| **Session** | **All** | **Time 1** | **Time 2** | **All** | **Time 1** | **Time 2** | **All** | **Time 1** | **Time 2** |
| **CC Average** | **10.5** | **11.5** | **9.0** | **54.9** | **47.4** | **62.5** | **34.5** | **39.6** | **29.4** |
| **Std. Dev.** | ***10.3*** | ***8.5*** | ***11.4*** | ***11.0*** | ***17.9*** | ***5.9*** | ***9.2*** | ***15.1*** | ***5.3*** |
| **CC1** | 0.8 | 1.6 | 0.0 | 68.2 | 66.6 | 69.7 | 31.1 | 31.8 | 30.3 |
| **CC2** | 9.2 | 11.5 | 6.9 | 59.6 | 57.5 | 61.9 | 31.3 | 31.0 | 31.5 |
| **CC3** | 6.9 | 10.3 | 3.5 | 45.3 | 27.5 | 63.0 | 48.1 | 62.2 | 34.0 |
| **CC4** | 25.0 | 22.4 | 25.5 | 46.6 | 37.9 | 55.3 | 27.6 | 33.5 | 21.7 |
| **NI Average** | **36.3** | **31.2** | **41.3** | **24.9** | **30.4** | **19.4** | **38.9** | **38.4** | **39.4** |
| **Std. Dev.** | ***10.6*** | ***9.1*** | ***12.6*** | ***7.3*** | ***7.2*** | ***7.9*** | ***9.8*** | ***7.6*** | ***12.0*** |
| **NI1** | 30.1 | 26.8 | 33.3 | 17.9 | 24.3 | 11.4 | 52.1 | 48.9 | 55.3 |
| **NI2** | 44.7 | 35.5 | 53.8 | 23.9 | 31.5 | 16.3 | 31.5 | 33.0 | 29.9 |
| **NI3** | 24.5 | 21.0 | 28.0 | 35.1 | 40.1 | 30.0 | 40.5 | 38.9 | 42.0 |
| **NI4** | 45.8 | 41.6 | 50.0 | 22.8 | 25.8 | 19.7 | 31.5 | 32.6 | 30.3 |

[2] NI Average and CC Average are the averages across all the sessions in the NI treatment and CC treatment respectively. All: Shows the average allocations throughout each session (period 1 to 10). Time 1: Shows the average allocations in periods 1 through 5. Time 2: Shows average allocations in periods 6 through 10.

Like other public goods experiments, communication decreased free-riding.

*Observation 1: Participants in the Continuous Communication treatment retained fewer tokens for themselves than participants in the No Interaction treatment.*

Figure 1. Allocations to each exchange by session




*Support:* On average, participants allocated 10.48% of their tokens to their private exchange in the CC treatment compared to 36.25% in the NI treatment. When the sessions are ordered from the session with the lowest to the session with the highest allocation to the private exchange, the three lowest sessions are CC sessions and the three highest sessions are NI sessions. A Wilcoxon-Mann-Whitney test, done by comparing the average allocation throughout each session (periods 1 through 10), shows that there is only a .0286 probability that communication did not lead participants to reduce their allocations to their private exchange. Thus, one can conclude that participants in the CC treatment allocated fewer tokens to the private exchange with a .05 level of significance.

Intragroup communication allowed participants to coordinate their actions and may have helped create a sense of trust among the members of each local group. Most of the local groups in the CC treatment largely suppressed free-riding behavior. Furthermore, unlike most other public goods experiments, allocations to the private exchange decreased over time when intragroup communication was permitted. Most participants in the CC treatment reduced their allocation to the private exchange during the last five periods of play. Also, only 7 out of the 32 participants in the CC treatment retained any tokens for themselves in the last period of play even though there was no strategic reason for them to cooperate. By contrast, 30 out of the 32 participants in the NI treatment allocated at least some tokens to their private exchange during the last period of play.

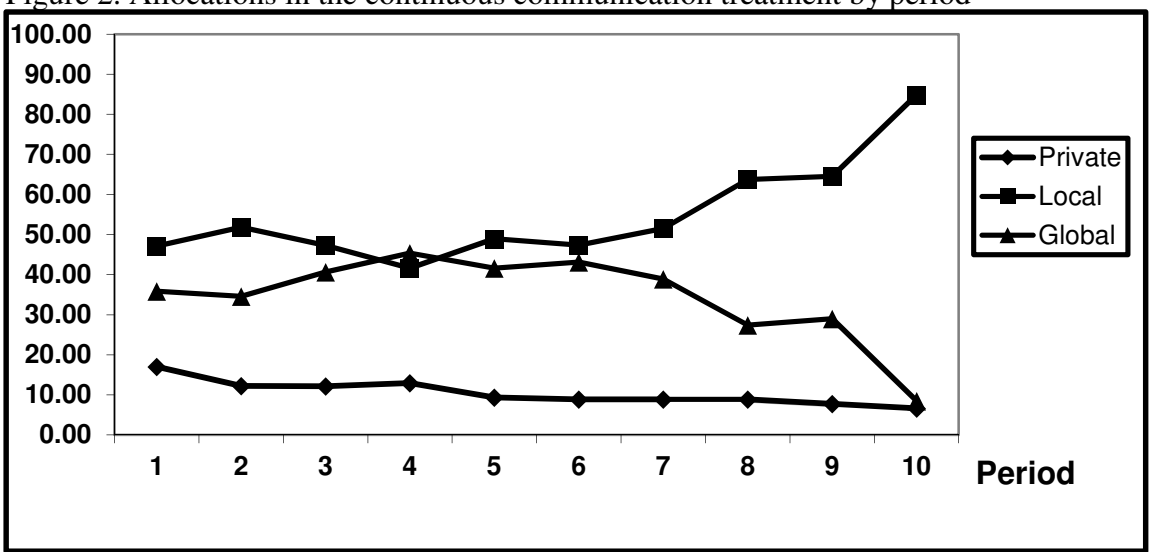
Intragroup communication largely suppressed free-riding behavior but it also led local groups to act as self-serving agents by getting their members to focus on the group-rational decision.

*Observation 2: Participants in the Continuous Communication treatment contributed more tokens to the local exchange than participated in the No Interaction treatment.*

Support: On average, participants in the Continuous Communication treatment contributed 54.9% of their tokens to the local exchange, while participants in the No Interaction treatment contributed 24.9% of their token to the local exchange. A Wilcoxon-Mann-Whitney test, done by comparing the average allocation throughout each session, shows that there is only a .0143 probability that intragroup communication had no effect on the allocation to the local exchange. Therefore, one can conclude with a 5% level of significance that intragroup communication increases the allocation of participants to the local exchange.

All the local groups in the CC treatment made some attempt to cooperate with members of the other local group by contributing tokens to the global exchange. However, they consistently contributed more tokens to the local exchange. Furthermore, in the last period of play, participants in the CC session decreased their allocation to the global exchange from 29.00% to 8.50% of the tokens while increasing their allocation to the local exchange from 64.50% to 84.88%. Local groups in the CC treatment appear to act as self-interested agents would in a public goods experiment with a single exchange. They engaged in some strategic cooperation with the other local group, gradually reduced their contribution to the global exchange, and engaged in little intergroup cooperation in the last period of play as can be seen in Figure 2.

Figure 2. Allocations in the continuous communication treatment by period




# 4. Conclusion

This paper reports the results of a public goods experiment with nested exchanges. Participants in the experiment allocated tokens among their private exchange, a local exchange, which only benefited members of their local group, and a global exchange, which benefited all of the participants in the session. This paper investigates the effects of intragroup communication on participants' behavior.

The experiment reveals that intragroup communication substantially reduces free-riding behavior. Even in the last period of play, few participants in the CC treatment retained any tokens

for themselves. However, participants in the CC treatment contributed a smaller portion of their public contribution to the global exchange than participants in the NI treatment. Moreover, the amount of intergroup cooperation decreased over time and substantially fell in the last period of play. Thus, intragroup communication helped reduce self-serving behavior but it may have also hindered intergroup cooperation.

In this experiment, the Pareto optimal solution was for the participants was to contribute all of their tokens to the global exchange resulting in a payoff of 80 Experimental Pesos per period for each participant since the participants have a combined total of 200 tokens and the global exchange has an MPCR of .4 Experimental Pesos. Participants in the CC treatment made, on average, 73.99 EP per period resulting in an efficiency rate of around 92.5% while participants in the NI treatment made, on average, 55.14 EP per period resulting in an efficiency rate of around 68.9%. Therefore, the impact of the reduction is self-serving behavior due to intragroup communication outweighed the impact of the increase in group-serving behavior. However, these results may be sensitive to the MPCR of each exchange and the size of the local groups and cannot be generalized to all experiments with nested public exchanges.

The research discussed here can be expanded by looking at a third treatment in which there is intergroup communication. It is likely that participants in such a treatment would contribute more tokens to the global exchange than the participants in the CC treatment discussed here. However, it is also possible that participants in such a treatment will exhibit more free-riding because cooperation may be more difficult to achieve in a larger group.

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