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Masseter-facial neurotomy for facial palsy reanimation: What happens after masseter denervation?

Histomorphometric and stomatognathic functional analysis

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The impact of leader communication on free-riding: An incentivized experiment with empowering and directive styles

Organizations often appoint leaders to foster cooperation. This paper studies the effect of leader communication on free-riding behavior using controlled and incentivized experiments. Leaders are asked to choose public messages from a set that induces a particular leadership style and to send them to subjects matched in groups to play a repeated, finite-horizon public good game. Using a between-subjects design, empowering and directive message sets are studied. Treatments are implemented with and without opportunities for two-way leader follower communication to study the impact of free-form communication. In the absence of opportunities for two-way leader follower communication, leaders assigned to the empowering messages treatment are more effective in mitigating free-riding than leaders assigned to the directive messages treatment. In its presence, contributions in both treatments are higher. The design allows for the study of a more interactive form of directive leadership by combining directive public messages with two-way leader follower communication.

Key words: leader communication, leadership style, free-riding, experiments, public good game.

JEL: C92, D23, H41, L23.

1. Introduction

Leadership, from an economics perspective, focuses largely on how leaders convince individuals to follow them (Hermalin, 1998). This process is thought to be of particular importance to help address the free rider problem. Free riding is a subject of considerable interest in experimental economics because of the tension between self-interest and more pro-social motives. Research on the relationship between leadership and free riding has concentrated mainly on cases of *leading by example*, where the leader is the first one to make a contribution that is visible to followers (Arbak and Villeval 2013; Güth et al. 2007; Haigner and Wakolbinger 2010; Moxnes and van der Heijden 2003; Normann and Rau 2015; Potters et al. 2005; Rivas and Sutter 2011; Sutter et al. 2007). Yet, the results from this approach are mixed, and there is a need to understand the potential effects of leadership on free riding beyond the leading by example framework. Towards this end, we borrow from the traditional literature on leadership styles (Bass & Bass, 2008) in order to study the conditions under which particular leadership styles can reduce free-riding behavior. Specifically, we focus on the impact of leadership styles, both with and without opportunities for two-way leader follower communication.

This paper reports an experiment with a 2x2 between-subject design to vary the leadership style, empowering or directive, as well as the presence or absence of two-way leader follower communication. In the experiment, followers are matched to play a public goods game over 16 periods. Leadership style is controlled using a procedure that provides leaders with a set of pre-written messages to choose and communicate to all group members at the beginning of each period. The procedure allows for control by implementing the possible style elements exogenously, while avoiding the use of fake messages sent by fictitious leaders. In addition to leadership styles, two-way leader follower communication is implemented with the ability to

send free-form messages between the leader and followers so that they can communicate bilaterally. Leaders and followers in the two-way leader follower communication condition are given two minutes per period to communicate privately.

By using incentivized experiments to investigate the impact of both leadership styles and communication channels on mitigating free-riding behavior, this paper builds on the existing experimental economics literature on communication in leader-follower environments. In particular, there is a relatively large literature that considers the impact of leader communication in mitigating coordination failures. Brandts and Cooper (2007), Chaudhuri and Paichayontvijit (2010) and Brandts et al. (2015) report a positive effect of leader communication on reducing coordination failures, but Weber et al. (2001) find that speeches given by randomly selected subjects may not be effective in promoting coordination in large groups. In settings closer to ours, Koukouvelis et al. (2012) observe that the introduction of one-way communication in a public goods game may increase contributions substantially. One-way communication is implemented by having one group member who can send a free-form text message to the other members of the group. With these findings in mind, we contribute to this literature by considering the communication effects on free riding while also considering leadership styles.

In addition, this study of communication effects and leadership styles in a naturalistic form helps bridge experimental economics and the leadership literature in several ways. First, the experimental economics perspective toward the study of leadership styles offers new methodological possibilities to the leadership literature. The standard psychological approach to leadership style experiments is to use either deception where subjects are not interacting with real leaders (e.g., Rodgers et al., 2013) or to use vignettes where subjects

imagine how they would respond to a hypothetical leader (e.g., Christie et al., 2011; Menges et al., 2015). Moreover, this leadership research often relies on perceptual measures as dependent variables. Such approaches can seem artificial, which minimizes their generalizability. Our approach in this paper offers an alternative to these traditional methods because, in economics, experiments are used to measure behavioral outcomes without the use of deception. Following these prescriptions of experimental economics, we ask individuals to make real leadership choices that then lead to behavioral outcomes in a simple incentivized public goods game that is played by actual experimental participants. Although leadership research has not yet integrated game theoretical settings such as public goods games, our general approach is also applicable for psychological leadership experiments and may enhance their overall generalizability.

Another way this study bridges the two literatures is that experimental economics, with a few exceptions, has not previously investigated the connection between leadership styles and free-riding (Dal Bó & Dal Bó, 2014; Antonakis et al., 2019). Although leadership research, outside of economics, focuses little on the issue of free riding, there is a great deal of interest in the topic of motivation. Leadership research is intensely focused on how leaders may motivate followers to engage in behavior that benefits organizations (Bass & Bass, 2008). Thus, the leadership literature may have much to contribute to experimental economics research in terms of understanding what factors may cause individuals to reduce free riding.

Next, in order to better understand the role of leadership styles and communication channels on free riding behavior, we adopt a minimal context approach that is common in experimental economics research (e.g. Brandts & Cooper, 2007; d'Adda et al., 2017). To some leadership researchers, adding in two way leader follower communication may seem

“basic” as it commonly exists in organizational environments. Yet, this approach allows us to first understand the context where there is no communication (i.e. the no-two-way leader follower communication treatment) and then to add a contextual feature like two-way leader follower communication to better understand the incremental effect of that feature. The objective is to establish the building blocks by which to understand the effects of empowering and directive leadership styles on free riding, and then to build on this foundational knowledge by adding increasing levels of context in future research. This approach may provide fundamental insights into the dyadic causal relationships between leaders and followers (Avolio et al. 2003, Bass and Bass 2008, De Rue et al. 2011, Hill et al. 2014). Yet, despite our minimal context approach and the lack of some of the richness that is common in leadership research, our experiment is not completely devoid of practical context. Admittedly, there are fewer contexts where leaders do not communicate with followers (i.e. no two-way leader follower communication). However, Bell and Kozlowski (2002) discuss how the members of virtual teams are often selected based on their functional capabilities, and therefore there is less need for leaders to monitor their followers’ activities. Followers are given responsibilities and expected to carry them out (i.e. self-managing teams) with little interaction with the leader. Thus, our experimental economics approach does offer some plausible “real life” insights.

Overall, the intended contribution of this approach is to identify the conditions under which leadership styles and channels of communication may mitigate free-riding as well as understanding the processes that guide leader communication in the context of these two leadership styles. Zehnder et al. (2017) explain that effective leadership implies that leaders choose “the leadership style best suited to the situation in which the leader needs to lead,” and thus there are various leadership styles that need to be studied. Our approach starts to

establish the causal relationships that govern the impact of two prominent leadership styles in two communication channels on free-riding. In this way, the results show that, in the absence of two-way leader follower communication, an empowering leadership style is more effective at reducing free riding in comparison to a more directive leadership style. In the presence of two-way leader follower communication, both directive and empowering leadership styles are effective. The implication of these results is that two-way leader follower communication leads to a decrease of free-riding in the context of directive leadership but not in the context of empowering leadership. The empirical analysis of the contribution decisions and of two-way leader follower communication content allows us to gather foundational evidence on how leadership styles and communication channels work together to reduce free-riding.

The next section presents the hypotheses, which is followed by sections on experimental design, results, and discussion.

2. Hypotheses

There is little research within experimental economics on the effects of leadership styles. Rather, the focus tends to be on leading by example. When leadership is voluntary, leading by example causes a marginally significant increase in contributions compared to a situation without such leadership (Haigner and Wakolbinger 2010; Rivas and Sutter 2011) and leaders are more effective when provided with exclusion rights (Güth et al. 2007). Potters et al. (2005) find that first movers who are informed about the value of the public good in the case of sequential donations cause more contributions than in the case of simultaneous donations. Normann and Rau (2015) find in a step-level public goods experiment that leadership by example improves public-good provision and payoffs. In a public bad game, Moxnes and van der Heijden (2003) find that followers invest 13% less in the public bad when there is a

leader setting a good example compared to when there is no leader. However, there are also instances in which leadership by example is found to be relatively inefficient. For example, Sutter et al. (2007) report that when group members are heterogeneously endowed and when this unequal endowment is common knowledge, the presence of a first mover increases average contribution levels but less so than in the case of homogeneous endowments. Arbak and Villeval (2013) find that voluntary leaders are not necessarily more influential than randomly-chosen leaders. Given these inconsistent results, the leading by example approach may not represent a wide enough view of leadership for experimental economics. Towards this end, the literature on leadership styles within organizational leadership research presents an opportunity to expand these horizons.

There is a long history of leadership research on comparing varying leadership styles and understanding the situational appropriateness of these different styles, e.g. initiating structure vs. consideration, task vs. relational, transformational vs. transactional (Bass & Bass, 2008). Leadership researchers are now investigating the way that leaders use power when guiding their teams by comparing the empowering and directive leadership approaches (Lorinkova, Pearsall, & Sims Jr., 2013; Martin, Liao, & Campbell, 2013; Sims Jr., Faraj, & Yun, 2009). The focus of this paper extends this recent interest on empowering and directive leadership. Empowering leadership provides followers with the locus of authority with regards to making decisions (Arnold, et al., 2000). Followers are granted a great deal of autonomy and responsibility, and the emphasis is on supporting and encouraging followers, helping them learn, and building their confidence. Empowering leadership differs from the classic participative leadership perspective in that participative leadership is more about joint decision-making and “involves leaders soliciting employee input” (Martin et al., 2013, p.1375) In contrast to empowering leadership, directive leadership accentuates the leader’s position of power and makes the leader the central focus of decision-making authority

(Lorinkova et al. 2013). Directive leadership is oriented much more towards obtaining compliance with regards to directives and goals. It places little emphasis on followers' autonomy. Consequently, directive leaders focus on giving guidance, advocating for goals, monitoring performance, and correcting mistakes. Because both empowering leadership and directive leadership pertain to role of power, they are not necessarily linked to a specific communication approach. Either approach can be executed in a high communication (in the presence of opportunity for two-way leader follower communication) or low communication (in the absence of opportunity for two-way leader follower communication) context. The combination of empowering leadership and directive leadership with different communication treatments is explained in more detail in the procedures section.

Previous findings from studies comparing empowering leadership and directive leadership demonstrate that the effectiveness of either approach depends on the context. In studying medical trauma teams, Sims et al. (2009) find that directive leadership is more effective when subordinates are not experienced and/or when the problem is critical. Consistent with this view, directive leadership yields better results in the initial performance of teams and when followers are highly satisfied with their leader. However, empowering leadership improves results when followers are less satisfied with the leader. While there are several reasons for the benefits of empowering leadership (e.g. learning, coordination, trust), one consistent effect of empowering leadership is the influence on motivating subordinates (Huang, et al., 2010; Lorinkova et al., 2013). Empowerment connects specifically to key aspects of intrinsic motivation that then drive individual behavior (Spreitzer, 1995). Chen, et al. (2011) report that "motivational states" are influenced by empowering leadership and that these psychological states impact innovation, teamwork, and turnover intentions. Zhang and Bartol (2010) conclude that empowering leadership positively affects psychological empowerment, which leads to higher motivation and engagement. Thus, in the No two-way leader follower

communication treatment, we hypothesize that the content of empowering leader messages tends to activate the motivational psychological states that are referred to in the literature.

H1 *In the absence of two-way leader follower communication, free-riding is lower in the empowering leadership treatment than in the directive leadership treatment.*

The experimental design allows us to study the impact of two-way leader follower communication by building on previous results of public goods experiments with communication. In particular, pre-play communication and communication between group members both tend to enhance contributions. Camerer and Weber (2012) and Kriss and Weber (2013) offer two surveys of the literature on communication in experimental organizational economics. Brandts et al. (2019) offer a recent survey on the literature on communication in laboratory experiments. Cooper et al. (1996), which follows Cooper et al. (1992), initiated the finding that pre-fabricated pre-play messages (cheap talk as in this design) are sufficient to induce participants to choose the payoff-dominant equilibrium in repeated prisoner's dilemma games.

The literature on intra-group communication in public good game experiments finds a positive effect of intra-group communication on contributions. Isaac et al. (1985), Isaac and Walker (1988), Isaac and Walker (1991), Ostrom and Walker (1997), Krishnamurthy (2001) and Bochet et al. (2006) report that communication causes an increase in cooperation. Brosig et al. (2003) investigate the impact of various pre-play communication media and find little variation across media and a positive effect of communication on cooperation.

The literature on announcements indicates positive effects on contributions. Bochet and Putterman (2009) find that letting subjects make non-binding numerical announcements about their "possible" contributions resulted in higher contributions. Masclet et al. (2013) report that communication in the form of pre-play threats to punish increases contributions

significantly. Denant-Boèmont et al. (2011) find that pre-play announcements significantly increase contributions. Levy et al. (2011) observe that the decisions of groups are influenced by non-binding contribution suggestions from human leaders, but not by those that originate from computers. Serra-Garcia et al. (2013) conclude that it is the promise component in messages about intended contributions that leads to less free-riding, which indicates that communication about contributions can help mitigate free-riding.

The literature in experimental economics on leadership in the form of one-way communication (communication by one individual to the group members) also finds positive effects of communication on contributions. As reviewed earlier, one-way communication leads to an increase in contributions (Koukoulis et al., 2012 and Brandts et al. 2016).

To summarize, contributions to a public good have been shown to increase in the presence of communication between group members, public announcements, and leader communications, which leads to our second hypothesis:

H2 *Free-riding is lower in the presence of two-way leader follower communication treatments than in its absence.*

The introduction of two-way leader follower communication, although motivated by the previously cited stream of literature in experimental economics, also allows us to explore the question of whether the impact of increased communication varies depending on the leadership style. Because the empowering leadership style is a more supportive and intrinsically motivating approach than the goal-driven directive style, directive leadership styles will likely benefit more from increased communication. Thus, there are reasons to believe that there may be an interaction between leader-follower communication and leadership styles, but we did not make any a priori predictions about these relationships.

3. Experimental Design and Implementation

a. The game

Subjects in the experiment were assigned to fixed groups of one leader and four followers who interacted for 16 periods in a finite horizon repeated public goods game, following the literature initiated by Marwell and Ames (1979), Kim and Walker (1984) and Ledyard (1995). The matching was fixed, and the finite horizon was common knowledge. Each follower (referred to as a “participant” in the instructions and interface) received an endowment of 10 tokens per round that could be either privately consumed or contributed to the group account. The contributions could range from 0 to 10 tokens. As in conventional public good games, the monetary payoff of a follower was determined by the amount kept from their endowment plus the return from the contributions of all group members to the group account in that round. Followers could earn \$0.10 per token kept and \$0.04 for each token contributed to the group account (by them or by other followers). A player who contributed nothing earned at least \$1 per round from the tokens kept. The highest payoff is achieved if all followers contribute everything. In that case, followers could earn at most \$1.60 per period (from their contributions and from the contributions of others). Leaders received no endowment and they could earn \$0.05 per token contributed by followers to the group account. This payoff scheme mimics the prevalent organizational features in which leaders receive a payoff based on the group’s performance as well as higher private benefits from groups’ productive output than the followers themselves. The instructions were embedded in the computerized interface. The comprehension of the payoff structure was checked using computerized practice questions.

b. Leadership

Leaders were provided with a set of nine messages, and they were able to send a single public message to all participants in the group at the beginning of each round. Prior to selecting this experimental procedure, a series of pilots were conducted with editable public messages. The

high heterogeneity of public messages led to the implementation of two non-editable pre-written message sets to guarantee the implementation of the leadership styles. This procedure allows control over leadership styles, while conferring some autonomy to leaders, as they had to choose public messages. The instructions naturally informed the followers that “the interface provides the leader with guidelines for the public message and it restricts what the leader can say.”

Each round started with the leader choice of a message and the followers’ acknowledgement of the reception of the message; the radio button stated “I acknowledge the leader message.” Only then could followers make their contribution decisions, which was done simultaneously and without communication with other followers. After all decisions were made, the interface released the contribution decisions and earnings for the round. Leaders saw the total number of tokens provided by followers in their group, and followers also saw the total, together with their own contribution in a manner that clarified explanations of earnings.

Subjects were assigned to one of four treatments in a between-subjects design with two treatment dimensions: the message types – empowering or directive – and the presence or absence of two-way leader follower communication.

c. First treatment dimension: The message types

The experiment implemented two core types of leadership messages, empowering and directive, where neither type of leadership message is designated as being more effective than the other. These message sets are similar in orientation to the “prescribed phrases” used by Lorinkova et al. (2013) in their training of empowering and directive leaders. The empowering leadership messages convey a willingness to share power and responsibility with the group. Within these messages, there is an emphasis on “we”, “together”, support,

encouragement, and understanding. In contrast, directive leadership messages convey a willingness to provide clear guidance and expectations to followers where there is a focus on “you”, “must”, “I”, telling, and instructing. While these message sets may not capture the full range of behaviors and components of empowering and directive leadership (e.g. Arnold et al., 2000), they are designed to have general alignment with the leadership style they represent. One limitation of this approach is these message sets are narrowly focused on interactions in public good games and may not apply to broader settings.

Table 1 shows the list of messages available to each leader type. For round 1, the interface offers an ‘introductory message’ to set the tone and expectations and describe the role of the leader. Then, all messages were associated with descriptions of when they may be appropriately used. The message descriptions ‘After investments have increased’, ‘After some increased and some decreased their investments’, ‘After high target investment levels have been reached’ and ‘Desire to Reward’ were positive in tone. The message descriptions ‘After investments have decreased’, ‘After investments have become stuck at a minimal, disappointing level’, ‘Desire to Punish’ and ‘Desire to Exclude’ were negative in tone. This balanced set of four positive and four negative messages was intended to provide for most possible situations encountered in this game.

Table 1 Message sets provided to leaders

Description of messages	Message set 1: Empowering message set	Message set 2: Directive message set
An initial message to set the tone and expectations	It is my role to suggest ways that, working together, we can achieve high levels of investments that will generate high earnings for all.	It is my role to tell you how you can achieve high levels of investments and earnings.
After investments have increased	Please keep it up, I'll do what I can to encourage everyone to continue	You must keep it up. We have been successful last round, and you should

	increasing investments. You really have done a good job, I am learning from you.	continue to follow the high investment path that I laid out.
After investments have decreased	We need to reverse this downward trend. My role is to support you so that we can all trust each other and switch to high investments that benefit us all.	You must reverse this downward trend. I have a clear vision of a strategy for achieving a better outcome if we all invest more.
After some increased and some decreased their investments	We are getting there, but we need for everyone to pitch in and invest so that we all benefit.	You haven't achieved as much as you should. You must follow the high-investment guidelines.
After high target investment levels have been reached	We can all take credit for reaching our goal of high investments and high earnings, which we should strive to sustain.	You have achieved my goal of high investments and high earnings, which you must sustain.
After investments have become stuck at a minimal, disappointing level	This situation allows us to learn from our mistakes and we must be sure not to repeat these mistakes in the future. Think about ways to increase your investments.	I have done my best to map out a way to achieve high earnings, but you are not following my advice to invest at high levels. Now is the time for everyone to change course.
Desire to Punish	Are you unclear on my instructions for you? We're trying to invest more tokens.	My instructions have been clear: you should invest more tokens.
Desire to Reward	You implemented a good strategy while investing. I congratulate you.	I am happy that you followed my instructions: this led us to success.
Desire to Exclude	We have to learn from our mistakes. Think about where your investment strategy went wrong.	We are a results-driven group. Unless you deliver, you are not part of the group.

Leaders who were provided with the empowering message set were told: “You begin the round by sending a message to all participants in your group. In general, you should project a collegial, helpful manner and avoid direct commands.” Leaders who were provided with the

directive message set were told: “You begin the round by sending a message to all participants in your group. In general, you should project a strong, decisive leadership posture, with a clear expectation that participants will follow your mandates”. These instructions were not read out loud and were only given to the leaders, in order to limit experimenter-demand effects.

The semantic analysis of the message sets reported in Table 2 shows that the empowering message set contains slightly longer messages, with more unique and difficult words. This feature is intended to capture the fact that empowering communication is less direct than directive communication. However, the estimated reading time for the leader is equivalent (about 1 minute for both), which keeps the burden of reading the messages constant across treatments.

Table 2 Message set semantics

Word statistics	Empowering message set	Directive message set
Syllables	294	252
Unique Words	105 (55%)	89 (52%)
Average Word Length	4.6	4.4
Average Sentence Length	10.6	9.4
Monosyllabic Words (1 syllable)	122	112
Polysyllabic Words (≥ 3 syllables)	29	22
Syllables per word	1.5	1.5
Difficult Words	49 (26%)	36 (21%)
Readability (Dale-Chall index)	8.2 (easily understood by an average 11th and 12th grade student)	7.4 (easily understood by an average 9th and 12th grade student)
Estimated Reading Time	1 min	1 min

d. Second treatment dimension: two-way leader follower communication

The opportunity for two-way leader follower communication was provided to allow for the studying of the impact of naturalistic communication. When opportunity for leader-follower communication was provided, subjects were given a two-minute period to communicate privately: leaders could talk to targeted followers individually, and followers could write to the leader. These two-way conversations were not limited in any way. Leaders could carry out personal conversations with followers in their group who were identified by their ID number in the leaders' two-way communication interface. As horizontal communication among followers was not possible; followers could only carry out conversations with the leader. To ensure that any outcome differences in treatments with or without two-way leader follower communication solely resulted from the ability to communicate privately and not to the time allocated to each decision, participants in the conditions without two-way leader follower communication were given a one minute period to record their thoughts in an introspection box. It was clearly stated that these personal notes would not be transmitted to any other players.

e. Experimental implementation

The experiments were conducted in a conventional economics laboratory setting in a large public university in the United States, using the Veconlab online software (<http://veconlab.econ.virginia.edu/admin.php>). Subjects were recruited from a large pool of undergraduate and graduate students. Subjects were randomly assigned to a role of leader or participant based on their time of login. The experimenters distributed the login information according to a random order that was scheduled prior to the session. The first subjects to receive the login information became the leaders. The randomization procedure was implemented at the same time that other documents were distributed in a manner to ensure that participants could not guess who the leaders were.

All subjects received a participation payoff of \$6. In addition, followers received an initial payment of \$2 and leaders received \$6. This payment guaranteed minimal earnings to the leaders in case followers' contribution decisions turned out to be very low. It also contributed to increasing the external validity of the experiment, as leaders are often paid more, but their salary is not known to the team members they manage. Subjects were assigned to be a "participant" or "leader" in ten different teams in each of the four treatments. The sessions lasted about 1 hour and 15 minutes. Followers earned \$28.40 on average and leaders earned \$26.80 on average. The experimenters read the instructions out loud, which all subjects could see on their screens. Subjects answered practice questions to check their understanding of the payoff structure. In total 160 participants were put into groups of size 4: ten different groups in each of the four treatments. In addition, 40 subjects were assigned to the leader role, one per group¹. Session treatments were randomized over morning and afternoon time slots and days of the week.

4. Results

i. Summary statistics on contributions

Table 3 shows the follower contributions in the presence and in the absence of two-way leader follower communication in each leadership style treatment². The "Follower contribution" entry is the average number of tokens allocated to the group account by

¹ The number of observations in this experiment is on the lower end of the spectrum of the number of observations typically retained for such experiments. Our experiment has 10 groups of 5 participants in each of 4 treatments. Bochet, Page, and Putterman (2006) have treatments ranging from 8 groups of 4 participants to 12 groups of 4 participants per treatment in 8 treatments. Brandts, Cooper, and Weber (2015) in a tournaroud game on legitimacy, communication and leadership have 9 to 10 groups of 5 participants per treatment in 6 treatments. Koukouvelis et al. (2012) have 18 groups of 4 participants in each of 3 treatments. Isaac and Walker (1988) have 12 groups of 4 participants and 12 groups of 10 participants. In a market experiment, Eckel and Füllbrunn (2015) have 7 groups of 9 participants in each of 2 treatments.

² Note that this analysis of the contributions by treatment is made possible by the fact that leaders choose a mix of public messages that is insensitive to the leadership style treatment. Implementation of leadership via a set of pre-written messages allows control for the selection of positively- or negatively-described messages (in the description of the message that is provided to the leader in the interface). No statistical difference in the choice of public messages made by leaders in the experiment is found across leadership styles, which shows that the proportion is not be affected by the message set.

followers, and earnings for each role are the average payoffs. Notice that contributions are higher in the presence of two-way leader follower communication for both leadership styles. The trends in contributions are shown in Figure 1. In the absence of two-way leader follower communication, contributions start at 40% of the endowment in the directive condition and at above 50% in the empowering one, but contributions end up being below 20% in both conditions. There is a declining trend, but contributions do not converge. In the presence of two-way leader follower communication, contributions start around at 60% of the endowment and remain above 35% of the endowment. There is no sharp decline in contributions. Notice that the contributions with the directive condition (lines with triangles in Figure 1) are lower than for the empowerment condition in the absence of two-way leader follower communication, but this is not the case with two-way leader follower communication.

Table 3 Summary statistics on contribution decisions and earnings by treatment and by round

			Without two-way leader follower communication -	With two-way leader follower communication-
		N	Mean (st.dev)	Mean (st.dev)
Empowering message set	Follower contribution	640	3.87 (3.39)	5.57 (4.23)
	Follower earnings	640	1.23 (.29)	1.33 (.33)
	Leader earnings	160	.77 (.44)	1.85 (1.11)
Directive message set	Follower contribution	640	2.74 (3.17)	6.35 (3.95)
	Follower earnings	640	1.16 (.27)	1.38 (0.32)
	Leader earnings	160	.55 (.42)	1.27 (.57)

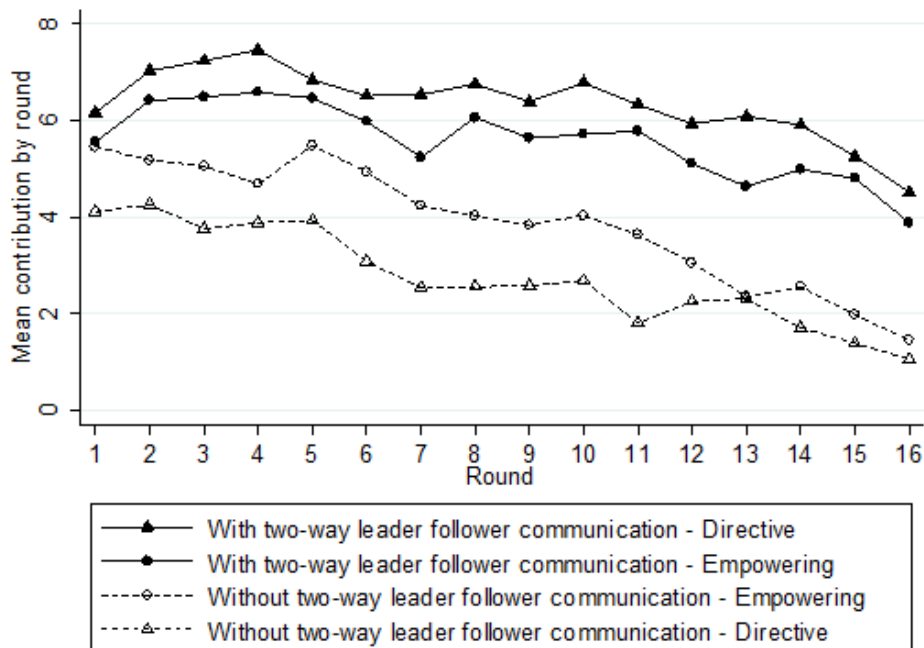


Figure 1 Mean contribution by round and by treatment

ii. Statistical results

Table 3 above shows the mean follower contributions (in tokens) for each of the four treatment combinations in the 2x2 design, along with standard deviations in parentheses. With our small sample sizes, the normality assumptions implicit in standard statistical tests are questionable, so we follow the common practice of using nonparametric tests, which are derived from permutations (Holt, 2019). Tables 4 reports permutation-based statistical tests³

³ Table 4 relies on nonparametric tests constructed from permutations. Permutation tests work as follows. E.g. in the analysis of two-way leader follower communication, we permute the presence of two-way leader follower communication and absence of two-way leader follower communication labels for all sessions with the empowerment style, and at the same time, we permute the presence of two-way leader follower communication and absence of two-way leader follower communication labels of the treatment averages for sessions done with the directive style. In this sense, we hold the leadership style constant by doing the permutations. For each permutation, we compare the difference in treatment means (With – Without two-way leader follower communication) with the difference that was observed in the experiment (2.66) tokens. The p-value is the proportion of the permutations that yield differences in mean token contributions that are greater than 2.66 in absolute value.

over group-level independent observations, with to 10 or 20 group observations per treatment, depending on whether some of the data is pooled given the 2*2 design for the tests.

Table 4. Results of permutation tests using average follower contributions by group

	Number of Observations	<i>p</i> -value (2-tailed test)
<i>Effects of leadership style on follower contributions</i>		
Empowering vs Directive (stratified by two-way leader follower communication treatment)	40	0.80
Difference in Means (Empowering – Directive) = 0.177		
Empowering vs Directive (without two-way leader follower communication)	20	0.09*
Difference in Means (Empowering – Directive) = 1.13		
Empowering vs Directive (with two-way leader follower communication)	20	0.54
Difference in Means (Empowering – Directive) = -0.775		
<i>Effects of two-way leader follower communication on follower contributions</i>		
With vs without two-way leader follower communication (stratified by leadership style)	40	0.008***
Difference in Means (With – Without two-way leader follower communication) = 2.66		
With vs without two-way leader follower communication (empowering treatments only)	20	0.13
Difference in Means (With – Without two-way leader follower communication) = 1.17		

With vs. Without two-way leader follower communication	20	0.0014***
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(directive treatments only)

Difference in Means (With – Without two-way leader follower communication) = 3.61

Key: * indicates significance at the 10% level, *** indicates significance at the 1% level.

The top section of Table 4 reports the statistical tests over group-level independent observations on the effect of leadership style on follower contributions based on permutation tests using average follower contributions by group. The results show that the difference in mean follower contributions between Empowering and Directive sessions is only 0.177 tokens, which is, of course, not significant. Indeed, about 80 percent of all permutations of the leadership style labels yield a treatment difference greater than the 0.177 amount observed, which explains the p value of 0.8 in the top row.⁴ If attention is restricted to sessions without two-way leader follower communication, the difference in means is 1.13 tokens, which is relatively small (out of 10 tokens) and only significant at the 10% level ($p = 0.09$), as shown in the second row. This result is aligned with H1: in the absence of two-way leader follower communication, empowering messages lead to higher contributions and thus less free-riding. With two-way leader follower communication, the significant difference across leadership styles disappears. This result is aligned with H2: in the presence of two-way leader follower communication, directive leadership leads to high contributions, and the gap between directive leadership and empowering leadership is closed.

Result 1 *In the absence of two-way leader follower communication, free-riding is marginally statistically lower in the empowering treatment than in the directive treatment.*

⁴ The test reported is a permutation test done by permuting the empowerment and directive labels on the group average contribution amounts. With stratification, this permutation is done separately for contribution measures in each treatment with two-way leader follower communication (see Holt, 2019, Chapter 13 for motivation and examples). The p value is the proportion of observations that yields a treatment difference that is as great or greater in absolute value than what is observed (2-tailed test).

The bottom section of Table 4 reports the statistical tests over group-level independent observations on the effect of two-way leader follower communication on follower contributions. When both leadership styles are combined, the difference in treatment means with and without two-way leader follower communication is 2.66 tokens, and less than 1% of all permutations of treatment labels would yield a treatment difference this large or larger in absolute value ($p < 0.01$). Thus two-way leader follower communication has a highly significant effect when stratified by leadership style. When taking the leadership styles separately, the effect is significant for the directive treatments at the 1% level, but not for the empowering treatments.

Result 2 *Overall, free-riding is lower in the presence of two-way leader follower communication than in its absence.*

Observation 1 *Result 2 holds true in the directive treatments but not in the empowering treatments.*

We further investigate the structure and content of two-way leader follower communication messages.

iii. Exploratory analysis of two-way leader follower communication

Following a procedure similar to the one used by Brandts and Cooper (2007), the content of messages sent in the two-way leader follower communication is analyzed using a methodology similar to the one reported in Cooper and Kagel (2004). The coding procedure that is detailed in Appendix A3 allows us to unfold the impact that types of statements have on free-riding. Messages were coded to quantify communication that might be relevant for the play of the game, avoiding prejudgments about which sorts of messages were important and which were not.

Table 5 reports the categories that were found to have been used more than 10% of the time in the leaders' two-way leader follower communication, for both treatments combined as well as for each two-way leader follower communication treatment. Table A3a in the Appendix lists all the categories found in the two-way leader follower communication analysis for the leaders. Additional exploratory analysis of the categories found in the two-way leader follower communication of the followers can be found in Table A3b.

Table 5. Summary of leader codings.

Description	Empowering	Directive	Difference (p-value)
<i>No difference between empowering and directive</i>			
Ask for effort	0.579	0.597	0.5366
Ask for effort - Specific effort level	0.517	0.479	0.2139
Positive response (praise, thanks, appreciation, etc.)	0.169	0.182	0.5777
Soliciting feedback from followers	0.127	0.097	0.1190
Giving feedback to followers (involves responding to messages from followers)	0.131	0.127	0.8456
<i>Higher occurrence in the empowering treatment than in the directive treatment</i>			
Ask for effort - Polite	0.245	0.099	0.0000
Encouragement (should not specifically refer to effort)	0.245	0.191	0.0332
<i>Higher occurrence in the directive treatment than in the empowering treatment</i>			
Negative response	0.052	0.152	0.0000
Discuss monetary benefit of high effort	0.239	0.35	0.0001

Discuss monetary benefit of high effort - Mutual benefits	0.209	0.304	0.0004
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Mann-Whitney tests show there is no difference across leadership styles in the categories referring to effort, positive responses, and feedback. This exploratory evidence further shows differences across leadership styles. In the empowering treatment, leaders are more likely to ask for effort in a polite fashion and to use encouragement than leaders in the directive treatment. In the directive treatment, leaders are more likely to use negative responses, to discuss monetary benefit and mutual benefits than in the empowering treatment. The statistical differences across leadership styles show that leaders' use of two-way leader follower communication corresponds to the focus of their respective message set, i.e. politeness and encouragement in the empowering condition and negative responses and benefit of high effort in the directive condition.

Observation 2 *The content of two-way leader follower communication messages sent by leaders relates to the benefits of effort in this task. The differences in content of two-way leader follower communication messages across empowering and directive treatments are aligned with the main focus in their respective message sets.*

The estimation of the impact of the content of the messages in the two-way leader follower communication on contributions in the public good game is precluded by the endogenous nature of communication in repeated interactions in the partner setting that was used in this experiment to observe the treatment effects over time. Thus, the exploratory analysis of the effect of the most frequent two-way leader follower communication on the average group contribution is reported in Table A4. The proportion of the variance explained by specific messages in the two-way leader follower communication is very limited, and it remains so

when all leader codings as reported in Table 3a are used to predict the average group contribution.

5. Discussion

This paper shows that, in the absence of two-way leader follower communication, contributions are higher in the empowering treatment than in the directive treatment. Overall, contributions in the two-way leader follower communication treatments are higher than in its absence. At the leadership style level, this result holds true in the directive treatments. The combination of a directive message set with two-way leader follower communication allows leaders to have a more interactive and engaging form of directive leadership, which leads to an increase in contributions, notably of those who contribute little initially. The analysis of the content of two-way leader follower communication shows that there is no difference in the quantity of messages across treatments. Moreover, the content of messages sent by leaders generally relates to the benefits of effort in this task. The differences in content of two-way leader follower messages across empowering and directive treatments correspond to the focus in the assigned message set. In other words, leaders tend to use a similar communication style in their two-way messages as the style in their assigned message sets.

Our findings provide important theoretical contributions to both the leadership and experimental economics literatures. First, although there is a literature on leadership with communication in economics – reviewed in Section 2 – leadership has been implemented mainly *by example* in the experimental economics literature, using experiments in which the leader is the first one to make a contribution that is visible to followers. Yet, the results from this approach are mixed (Güth et al. 2007; Haigner and Wakolbinger 2010; Moxnes and van der Heijden, 2003, Normann and Rau, 2015, Rivas and Sutter 2011; Sutter et al., 2007). Our

paper adds to this research by focusing on how leaders can reduce free riding outside of leading by example. Because of the restrictions of the experiment, leader style (empowering vs. directive) and two-way leader follower communication were the main devices by which leaders could attempt to reduce free riding. The results uniquely demonstrate within experimental economics that leaders are able to reduce free riding solely through their leadership style and channel of communication.

Second, our laboratory study contributes to leadership research by demonstrating a different experimental paradigm. Whereas a great deal of leadership research relies on perceptual dependent variables, Antonakis (2017) recommends greater creativity and rigor in leadership studies (including experiments). In this vein, experimental economics focuses exclusively on behavior, and our study follows this path by analyzing the free-riding behavior of followers. Although free-riding in public goods games is not the typical topic of leadership research, we hope that leadership scholars will be stimulated at the possibility of using experimental methods where behavior is the primary outcome. Another core principle of experimental economics research is avoiding deception. Research on leadership styles often relies on approaches using fictitious leaders or vignette scenarios that can limit the generalizability of the results. Deception is avoided in our study, since we manipulate leadership styles by limiting leaders to the use of pre-written message sets that reflect either a directive or empowering style. This approach represents a novel way to consider manipulating leadership styles within experiments and one that may inspire methodological creativity for future leadership experimental research.

Third, our design allows us to investigate whether directive versus empowering leadership styles have different causal effects with and without communication. Research on directive and empowering leadership has yielded a mixture of contingent results concluding that both

empowering and directive leadership styles can be effective (Judge, Piccolo, & Ilies, 2004; Lorinkova et al., 2013; Martin et al., 2013). Our result adds to these contingent findings by demonstrating the role of two-way leader follower communication in reducing free riding. Although in the absence of two-way leader follower communication empowering leadership is more effective than directive leadership, both leadership styles benefit with the inclusion of two-way leader follower communication with no significant difference in results between the two styles. It seems that two-way leader follower communication provides an interpersonal connection within the leader-follower dyad. While leadership styles are often emphasized in leadership research, there is also importance placed on the dyadic connection between leaders and followers (Graen & Uhl-Bien, 1995). It seems probable that the two-way leader follower communication condition creates a leader-follower connection that enables both leadership styles to reduce free-riding. Moreover, it is likely that two-way leader follower communication also allows followers to feel that they have an enhanced sense of voice in the process. The experience of voice among followers is often connected to perceptions of procedural fairness, which can build trust in leaders (Dirks & Ferrin, 2002; Tyler, Rasinski, & Spodick, 1985). Although two-way leader follower communication benefited both leadership styles, these results are especially important with regards to directive leadership. Without two-way leader follower communication, directive leadership was less effective in reducing free riding. Directive leadership is more top-down and less follower-centric, yet two-way leader follower communication allows directive leaders to add an interpersonal connection that helps directive leaders be more effective. This finding builds on Peterson (1997), who found that directive leaders can be more effective in decision-making contexts if they encourage follower involvement (i.e. “voice”). Similarly, we show that, in the context of free riding, increased interactions with followers can enhance followers’ responses to directive leadership.

Our results also have practical implications for leaders and organizations. Reducing free riding and motivating followers toward contributing to organizational goals is an important leadership challenge. In dealing with this problem, the typical advice from the perspective of experimental economics is to lead by example and to properly incentivize followers. While there is definite value in these approaches, our study suggests that there are additional options at the disposal of leaders. To begin, leaders should understand their communication context. In contexts where there is less opportunity for leaders to connect with followers (e.g. virtual teams), empowering leadership is likely to yield better results than directive leadership. Yet, beyond styles, leaders should also think about ways that they can increase the interpersonal connection with followers. Both empowering and directive leadership are enhanced by being able to communicate directly with followers and, as a result, strengthen the leader-follower relationship. This connection is most important for directive leaders, as they may be at an even greater disadvantage in efforts to reduce free riding without this interpersonal connection. While leaders may consider this advice on their own, organizations may also have a direct role by offering leadership training that encourages leaders to build employee engagement by both considering their styles as well as ways to strengthen communication with followers.

The principal limitations of this study are threefold. Although we focus on two important leadership styles that are commonly discussed in the leadership literature, empowering and directive, there are other leadership styles (e.g. transformational) that could be considered. Second, the selected task, a finite public good game, although core and central in experimental economics, remains limited in its ability to document some important aspects of the impact of leadership communication, such as the leader's ability to engage in explicit negotiation, to enhance creativity, or to create identity, as argued by Zehnder et al. (2017). Third, it is possible that the results could be sensitive to the fact that the task is, as in all

controlled experiments, limited in time and contextual richness. Leadership communication as it happens in organizations interacts with pay schemes, macro-economic changes and a myriad of other environmental changes that are not studied in our context. Clearly, our method does not allow us to evaluate leadership communication effectiveness in more complex environments, and there is a need to test these results in field settings.

Based on our results, we see a continuing opportunity to explore leadership from an economic perspective. First, our exploratory analysis of two-way leader follower communication (see Table 5) finds that leaders in the directive condition stress the monetary as well as mutual benefits of high effort. These directive leaders seem to be emphasizing the value of an exchange (i.e. money for contributions). Given this effect, a natural candidate would be to study how transactional leadership performs in cooperative settings. As explained by Zehnder et al. (2017), leadership may help overcome inefficiencies in settings in which formal contracting is not available. Because our results suggest that transactional aspects of the leader-follower dyadic interaction are used by leaders in the directive treatment, a careful test of the impact of transactional leadership in cooperative settings could help study the impact of transactional communication in such settings. In addition to transactional leadership, other well-known leadership styles (e.g. transformational leadership) are natural candidates for a research agenda. For instance, with regards to charismatic leadership, Antonakis et al. (2019), specify the conditions under which speeches lead to increases in contributions in public good games. Further studies of the impact of other leadership styles in incentivized experiments could be used to continue the efforts to validate findings obtained with other methodologies in leadership studies and to document processes such as the ones we have identified in our specific study. Furthermore, it would be interesting to study the validity of our results in environments in which followers have more leeway to change the rules of the game they face. Such research could be engaged in a broader effort to

import from leadership studies settings of interest that would help economists diversify the types of situations they consider and to combine economics and leadership studies in a productive way.

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Appendix:

Table A1. Average follower contribution for ten groups of each treatment

Group	1	2	3	4	5	6	7	8	9	10
Without opportunities for two-way leader follower communication – Empowering	3.9	6.3	3.4	4.0	5.2	3.3	2.6	2.8	2.1	4.7
Without opportunities for two-way leader follower communication – Directive	1.4	2.9	5.5	1.5	4.8	2.2	0.7	3.4	2.6	1.8
With opportunities for two-way leader follower communication – Empowering	9.7	8.9	9.8	6.9	5.0	4.4	5.1	2.0	1.9	1.6
With opportunities for two-way leader follower communication – Directive	7.0	4.2	7.4	8.9	9.8	7.8	6.4	6.1	2.5	3.0

A2 Quantity of two-way leader follower communication messages

Table A2 reports that there is no difference across treatments in terms of quantity of two-way leader follower communication messages. Panel a) reports that the quantity and length of messages sent by leaders and followers are not statistical differences across leadership styles treatments at the group level. Panel b) reports that there are no statistical differences in terms of the number of bilateral conversations i.e. communication involving a leader and a follower across leadership styles treatments at the group level. Panel c) reports whether the leaders sent non-personalized, personalized messages or a combination of both to followers. Non-personalized messages report the instances in which the leader sent the same message to all followers; such messages were probably written by the leader in a two-way leader follower communication box and then copied and pasted in all two-way leader follower communication boxes. Personalized messages capture instances in which leader wrote a message that was unique and sent to a follower. When considering data at the group level, there are no differences in the use of these types of messages. In sum, about 60% of the

messages are not personalized and about 40% of the messages are at least in part personalized.

Table A2 Quantity of two-way leader follower communication messages

Message sender		Treatment	Number of rounds with messages	Mean (st. dev.) number of words per round with messages
a) Number and length	Leader	Empowering	503	21.83 (12.67)
	Leader	Directive	566	24.46 (17.77)
	Follower	Empowering	333	14.2 (12.13)
	Follower	Directive	349	16.16 (12.04)
b) Quantity of bilateral conversations			Number of rounds with 0 to 3 conversations	Number of rounds with 4 conversations
	Leader & Follower	Empowering	46	114
	Leader & Follower	Directive	38	122
c) Types of messages sent by leaders			Number of rounds with only personalized messages / only non-personalized messages	Number of rounds with personalized messages and non-personalized messages
	Leader	Empowering	56 / 329	118
	Leader	Directive	109 / 353	104

Appendix A3

Five groups in each treatment were selected. One co-author and a native English-speaking research assistant independently developed coding schemes using the coding schemes used in Brandts and Cooper (2007) as a benchmark. The research assistant independently coded all messages sent by leaders and followers. The research assistant was told the structure of the public goods game but was neither informed of the research question nor of the existence of treatments. As in Brandts and Cooper (2007), coding was binary: a message was coded as a 1 if it was deemed to contain the relevant category of content and zero otherwise. There was no requirement on the number of codings for a message: the coder could check as many or few categories as he deemed appropriate. As in Brandts and Cooper (2007), a number of the

categories had sub-categories. For example, category 1 for leader is “Ask for effort” and there were three associated subcategories: “Polite,” “Rude,” and “Specific effort level.” The coder was free to check as many or few sub-categories as he desired when the corresponding category was checked off.

Table A3a. Summary of leader codings.

Category	Description	Both		
		(combined)	Empowering	Directive
1	Ask for effort	0.588	0.579	0.597
1a	Polite	0.167	0.245	0.099
1b	Rude	0.035	0	0.065
1c	Specific effort level	0.497	0.517	0.479
2	Negative response	0.105	0.052	0.152
2a	Encouraging	0.033	0.038	0.028
2b	Hostile	0.032	0.01	0.051
2c	“Singling” out a follower	0.047	0.016	0.074
3	Positive response (praise, thanks, appreciation, etc.)	0.176	0.169	0.182
4	Discuss monetary benefits of high effort	0.297	0.239	0.35
4a	Benefits for leader	0.008	0.008	0.009
4b	Benefits for followers	0.034	0.026	0.041
4c	Mutual benefits	0.259	0.209	0.304
5	Laying out a plan	0.02	0.032	0.009
5a	Alternating plan	0.007	0.016	0
5b	Ratcheting up effort	0.012	0.016	0.009

	Encouragement (should not specifically			
6	refer to effort)	0.216	0.245	0.191
7	Use of humor	0.066	0.058	0.074
8	Comments about time	0.033	0.004	0.058
8a	Need to hurry to get finished	0.012	0.004	0.019
8b	Will be able to leave sooner if cooperate	0.011	0	0.021
9	Explicit reference to fairness	0.049	0.068	0.032
10	Explicit references to trust	0.078	0.103	0.055
11	Explicit references to reciprocity	0.017	0.03	0.005
12	Attempts by leader to appear sympathetic	0.013	0.024	0.004
13	Expressing confusion about the rules	0.011	0.006	0.016
14	Clarifying the rules	0.018	0.024	0.012
15	Soliciting feedback from followers	0.111	0.127	0.097
	Giving feedback to followers (involves			
16	responding to messages from followers)	0.129	0.131	0.127
	Establishing common knowledge (passing			
17	on a message from one follower to others)	0.05	0.083	0.019
18	Misunderstanding rules	0.004	0	0.007
19	Express own effort to follower	0.004	0.008	0
20	Uncertainty about how to lead	0.023	0.032	0.016
21	Unrelated discussion	0.014	0.002	0.025

Table A3b. Summary of follower codings.

Category	Description	Both (combined)	Empowering	Directive
1	Generic response to leader's comments	0.33	0.318	0.341
1a	Positive	0.218	0.174	0.261
1b	Negative	0.057	0.057	0.057
1c	Asking for clarification	0.06	0.093	0.029
2	Agreeing to leader's plan	0.183	0.258	0.112
3	Disagreeing with leader's plan	0.029	0.018	0.04
4	Giving leader advice	0.202	0.231	0.175
5	Discuss monetary benefits of high effort	0.103	0.078	0.126
5a	Benefits for leader	0.016	0.012	0.02
5b	Benefits for followers	0.013	0.006	0.02
5c	Mutual benefits	0.075	0.06	0.089
6	Attempting to start a dialogue/soliciting feedback from the leader	0.391	0.318	0.461
7	Negotiating with the leader	0.035	0.03	0.04
8	Explicit reference to fairness	0.003	0.006	0
9	Explicit references to trust	0.025	0.027	0.023
10	Explicit references to reciprocity	0	0	0
11	Rules	0.034	0.042	0.026
11a	Expressing confusion about the rules	0.001	0.003	0
11b	Requesting clarification of the rules	0.003	0.006	0
11c	Clarifying the rules	0.028	0.03	0.026
12	Comments about time	0.001	0	0.003

12a	Need to hurry to get finished	0.001	0	0.003
12b	Will be able to leave sooner if cooperate	0	0	0
13	Misunderstanding rules	0.001	0.003	0
14	Unrelated comments	0.021	0.015	0.026
15	Asking what other followers are going to do	0.053	0.066	0.04

Table A4. Linear regression clustered at the group level of the most frequent categories of messages sent by leaders in the two-way leader follower communication on group average contributions by treatment.

Treatment	Empowering	Directive
Ask for effort	-3.024*** (0.731)	0.134 (1.357)
Ask for effort - Specific effort level	2.281*** (0.688)	-0.200 (1.385)
Positive response (praise, thanks, appreciation, etc)	-0.533 (0.620)	2.169** (0.776)
Soliciting feedback from followers	-1.645** (0.703)	-1.179 (0.741)
Giving feedback to followers (involves responding to messages from followers)	0.0997 (0.516)	0.845 (0.798)
Ask for effort - Polite	2.477** (1.042)	-0.321 (0.711)
Encouragement (should not specifically refer to effort)	-0.0709 (0.551)	-0.146 (0.703)
Negative response	-1.119 (1.252)	-1.107 (0.814)
Discuss monetary benefit of high effort	0.536 (2.062)	0.317 (0.776)
Discuss monetary benefit of high effort - Mutual benefits	-1.082 (1.673)	0.432 (0.971)
Constant (Group average contribution)	5.278*** (0.706)	6.014*** (1.112)
Observations	503	566
R-squared	0.174	0.132

Robust standard errors in parentheses

Key: ** indicates significance at the 5% level, *** indicates significance at the 1% level

Note For simplicity, the order of the most frequent messages as reported in Table 5 is used in Table A4. When including all leader codings as reported in Table A3a, the R-squared increases to R-squared that remain low: 0.269 in the case of the Empowering treatment and to 0.286 in the case of the Directive treatment.

Instructions (ID =), Page 1 of 6

- **Matchings:** The experiment consists of a series of **rounds**. In each round, you will be matched with the **same** group consisting of 5 participants, i.e. you and 4 other people.
- **Roles:** Each group consists of one person who has been designated as a leader, and 4 people have been designated as participants. Please note, the leader is a real person in your group, not a simulated player.
- **Investments:** Participants begin each round with a number of "tokens," which may either be kept or invested. You will not learn anything about the total number of tokens invested by others until after your investment decision is submitted.
- **Participant Earnings:** The earnings for each participant will be:
\$0.10 for each token they keep,
\$0.04 for each token they invest, and
\$0.04 for each token invested by the others in their group.
- **Leader Earnings:** The leader in the group has no endowment of tokens, so the leader cannot earn money by keeping or investing tokens. The leader's earnings will be:
\$0.05 for each token invested by the 4 participants in their group.
- **Subsequent Rounds:** The groups of 5 people will remain unchanged in all rounds, and leader and participant roles will also stay the same. Your role is that of a (**leader or participant**).
- **Recording Your Thoughts:** At the start of each round, you will have a **1 minute period** in which you will be able to record your thoughts about the leader, about the

other people in your group, and about the factors that affect your investment decision. These thoughts will NOT be communicated to any of the others or to the leader.

- **Initial Leader Announcement:** In addition, the leader will be able to send a single public message to all participants in the group, prior to the beginning of the 1 minute period for recording your thoughts. The interface provides the leader with guidelines for the public message and it restricts what the leader can say. You will have to read the leader's message before proceeding.

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Example: Consider a Participant with only two tokens for the round, and the earnings from tokens kept, invested, and invested by the others are **\$0.10**, **\$0.04**, and **\$0.04** respectively. In particular:

- If both tokens are kept, then the earnings will be: **$\$0.10 \times 2 = \0.20** from the tokens kept, plus **\$0.04** times the number of tokens invested by the others in your group.
- If both tokens are invested, then earnings will be: **$\$0.04 \times 2 = \0.08** from the tokens invested, plus **\$0.04** times the number of tokens invested by the others in your group.
- If one token is kept and one is invested, then earnings will be:
 $\$0.10 \times 1 = \0.10 from the token kept, plus
 $\$0.04 \times 1 = \0.04 for the token invested, plus
\$0.04 times the number of tokens invested by the others in your group.

Note: In each of the 3 above cases, what is earned from the others' investments is: **\$0.00** if the others invest 0 tokens, **\$0.04** if the other people invest 1 token (in total) and keep the rest, **\$0.08** if the other people invest 2 tokens (in total), etc.

□ **Leader Earnings:** The leader has no token endowment, but would earn a higher amount, **\$0.05**, for each token invested by the 4 participants in the group.

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- There will be **16 rounds** in this part of the experiment. In all rounds, participants begin with a new endowment of **10 tokens** that can be kept or invested, but the leader receives no token endowments and earns money on the basis of the numbers of tokens invested by participants in the round.
- The participant endowments are fixed and do not depend on prior decisions. Participants are free to change the numbers of tokens kept and invested from round to round.
- **Note:** You will be matched with the **same** 4 other people in all rounds.
- Your role will be that of (**Leader** or **Participant**) in all rounds.

Instructions (ID =), Page 4 of 6

(Note added by the authors: same as Page 5 of 6 but without the corrections)

Instructions (ID =), Page 5 of 6

Question 1: Suppose a participant invests X tokens and the total number invested by the 4 other people is Y tokens.



(a) Then the participant earns $(10 - X) \cdot \$0.10 + X \cdot \0.04 .



(b) Then the participant's earnings will be at least as high as $(10 - X) \cdot \$0.10 + X \cdot \0.04 .

Your answer, (b) is **Correct**, and how much more you earn depends on the **others'**

investments.

Question 2: Which is true?

- (a) A participant may divide their 10 tokens any way in each round, keeping some and investing some, or either keeping or investing them all.
- (b) The more tokens that a person invests in one round, the less there is to invest in later rounds.

Your answer, (a) is **Correct**; the only requirement is that the number kept and the number invested sum to 10 in each round.

Instructions Summary (ID =), Page 6 of 6

- You will be matched with the **same** group of 5 people in each round (one leader and 4 participants). There will be a total of **16 rounds** in this part of the experiment.
- Each round begins with a **public announcement** made by the leader. This message is followed by a **1 minute period for recording your thoughts** about your strategy, about the leader, or about the others in your group. These notes are for your own records and are not communicated to the leader or to any of the others.
- In each round, participants each receive an endowment of **10 tokens** which they may keep (and earn **\$0.10** each) or invest (and earn **\$0.04** each), knowing that they will also earn **\$0.04** for each token invested by other people in the group.
- In each round, the earnings for the leader in the group will be **\$0.05** for each token invested by the participants in the group.

- Endowments in subsequent rounds remain the same, irrespective of how many tokens are kept or invested in previous rounds.
- The leader can observe the total number of tokens invested by the 4 participants in the group, but nobody can observe the investment decisions of specific individual participants.
- There will be a total of **16 rounds** in this part of the experiment. Your earnings for each round will be calculated for you and added to previous earnings, as will be shown in the total earnings column of the record form that you will see next.
- There will be an initial cash payment that may depend on your role, (leader or participant). Your initial payment will be \$*.**;

Finished with Instructions