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Jordi Brandts
David J. Cooper

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Managerial Leadership, Truth-Telling and Efficient Coordination

by Jordi Brandts* and David J. Cooper**

* Instituto de Análisis Económico (CSIC) and Barcelona GSE

** Florida State University and University of East Anglia
Corresponding author: djcooper@fsu.edu

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Abstract: We study the tradeoffs between managerial control and delegation using a new experimental game, the manager-subordinate game. Actions for two subordinates are either chosen independently by the subordinates (delegation) or imposed by a manager (managerial control). The manager-subordinate game combines four properties: (1) All parties benefit if the subordinates coordinate their actions. (2) The state of the world varies, changing which outcome is efficient. (3) Subordinates have differing preferences over which common course of action should be chosen. (4) Subordinates know the state of the world, but the manager does not. *Efficient* coordination requires coordinating subordinates' action *and* utilizing their private information. We find that total efficiency is highest with a combination of managerial control *and* free-form chat between the three players. This combination works because subordinates rarely lie about their private information, making *efficient* coordination possible. The frequency of truth-telling contrasts with findings from the experimental literature on lying.

Keywords: Coordination, Experiments, Organizations, Communication, Truth-Telling

JEL Classification Codes: C92, D23, L20

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1. Introduction: Managers perform many functions within a firm. They gather and aggregate information, determine institutional structures, set priorities, give advice, and make and attempt to implement decisions.[1] Managers also lead, using a combination of authority and persuasion to shape the actions of their subordinates. In line with this, there is a large experimental literature studying whether managers can use various instruments, notably communication, to coordinate subordinates' actions on an efficient outcome.[2] This research focuses on cases like the weak-link game where subordinates share common and known objectives with each other and their manager, but the manager's task is far more difficult when the underlying problem is asymmetric. Specifically, we are interested in settings that have the following four properties: (1) All parties would be better off if the subordinates coordinate on a common course of action. (2) The state of the world varies over time, changing which outcome is efficient in the sense of maximizing total surplus. (3) Although subordinates gain from coordination, they have differing preferences over which common course of action should be chosen. These differences are independent from the state of the world. (4) Subordinates know the state of the world, but the manager does not. The combination of Properties 3 and 4 implies that subordinates have an incentive to lie to their manager. Ideally, a manager achieves efficient coordination, inducing her subordinates to coordinate on a common course of action *and* doing so in a way that uses their private information to reach the surplus-maximizing outcome. Achieving this is non-trivial given the subordinates' opposing objectives and the manager's lack of critical information.

Many problems like this arise within organizations. Managers and their subordinates must make choices about what inputs to use, what types of people to hire, what products to produce, and what strategies to pursue. There typically exist gains from coordination when these decisions are made. For example, costs are lower due to purchasing power if employees all use the same tools or software, there are beneficial synergies if everyone agrees to hire workers with complementary skills, and there are economies of scale if a firm's stores all sell the same products. But subordinates often have differing preferences over the available options that are independent from what is good for the organization as a whole. Workers like to use equipment and software with which they are already familiar, middle managers prefer to hire people for the group they manage (e.g. the people in charge of product design always want more people for the product design group even if the firm needs more help in marketing), and store managers want product types that conform to tastes in their specific location. It is natural that subordinates who are "in the field" will be better informed than their manager. Workers who actually use a piece of software are probably better informed about its merits than their boss. Store managers who interact with customers are more likely to know the latest trends in consumer demand than an upper level manager sitting in a glass tower. The

[1] See Gibbons and Henderson (2012) for a discussion of the role played by managers within a firm.

[2] See Cooper and Hamman (2020) for a summary of this literature.

problem is that these subordinates have little incentive to be truthful with their manager rather than trying to influence her into picking their preferred option. For a manager to effectively exercise control, she needs to get her subordinates to reveal what they know even though it is not in their interest. How can a manager be an effective leader, achieving efficient coordination in the face of these difficulties?

Whether a manager effectively leads her subordinates to coordinate at an efficient outcome presumably depends on both the process, specifically who has the ability to make decisions and what types of communication are possible, and the manager's actions within a chosen process. It is not obvious *ex ante* what process is best (and why). Is managerial intervention necessary, or can efficient coordination be achieved via sufficiently rich communication between subordinates? If subordinates choose their own course of action (henceforth referred to as "delegation"), can a manager play a useful role by suggesting a course of action to her subordinates? If the manager imposes a decision on her subordinates (henceforth referred to as "managerial control"), can she get her subordinates to reveal their information? Does her ability to discover the truth depend on how much communication is possible with her subordinates? The purpose of this paper is to address these questions.

We examine these issues in a demanding experimental environment, the manager-subordinate game (henceforth referred to as the "MS game"). This is a three player game with one player is the role of manager and two acting as her subordinates. The four properties listed above are all present: coordinating on a common choice benefits all agents, the two subordinates have divergent preferences over possible outcomes independent of the state of the world, managers lack the necessary information to simply impose efficient coordination on their subordinates, and subordinates have the necessary information but also have little reason to truthfully reveal it. The MS game is designed to make the contrast between managerial control and delegation as extreme as possible and to stress the importance of the manager as leaders.

Our experimental design varies how actions are chosen (delegation vs. managerial control) and what type of communication is available (none, structured communication with a pre-specified message space, or free-form chat). The baseline treatment features delegation and no communication; this is expected to perform poorly since there is no mechanism to address the challenging coordination problem faced by subordinates. Within each type of communication (structured communication or chat) we consider three possibilities: delegation with pre-play communication between subordinates, delegation with advice from the manager, and managerial control with messages from the subordinates to the manager.

In evaluating the total surplus for these various treatments, we focus on the babbling equilibrium with managerial control. In this equilibrium, the manager always imposes coordination but receives no information from her subordinates. This is the unique equilibrium outcome under managerial control and provides a baseline for what successful coordination can achieve without using subordinates' information. We compare total surplus in the various treatments with this benchmark as well as examining what fraction

of the possible gain between the babbling equilibrium and the efficient equilibrium is achieved by varying the decision rules and types of communication.

Regardless of the form of communication, we find that total surplus is lower with delegation than managerial control. With low levels of communication (no or structured communication), managerial control performs better than delegation because it solves the coordination problem. With rich communication (free-form chat), managerial control works well because it solves the coordination problem *and* makes good use of subordinates' information. Total surplus is maximized by combining managerial control with free-form chat between the manager and her subordinates. This is the only treatment where total surplus is significantly better than the babbling equilibrium, achieving roughly half of the possible gain between the babbling equilibrium and efficient equilibrium.

Underlying the preceding result, lying by subordinates is almost non-existent when free-form chat and managerial control are combined. This yields unambiguous transmission of information from subordinates to the manager, making efficient coordination possible. The unexpectedly good transmission of information to managers explains why the combination of managerial control and chat outperforms the babbling equilibrium. We conjecture that fact-checking plays a major role in this finding; lies are frequently contradicted in real time by the other subordinate, which presumably makes lying unattractive. Our results about truth-telling strongly contrast with typical findings from the experimental literature on lying.

Our work contributes to the existing body of research in multiple ways. There exists a large experimental literature about the effects of communication, advice, and leadership on coordination (see Section 2 for a summary of this literature as well as the others referenced in the following paragraphs). This research primarily focuses on order statistic games (e.g. weak-link games, stag-hunt games, or median games) where the interests of all individuals are aligned and there is no dispute about the most desirable outcome. Both advice and leadership are effective in these settings, but it is relatively easy to act as a coordination device when everyone has the same information and aligned interests. The underlying coordination game in our experiment is asymmetric, and much of the tension comes from agents' differing preferences over possible outcomes. The role that asymmetric information plays in our experiment is also not present in the existing literature on leadership, communication, and coordination. We find that managers who can freely communicate with their subordinates and have managerial control (rather than only providing advice) provide critical leadership in spite of their informational disadvantage and the differing objectives of subordinates.

Our work also relates to work, both theoretical and experimental, that compares centralization and decentralization. The recent literature sees this tradeoff in terms of a comparison between the benefits of coordination and the costs of distorted information that accompany centralization. These tradeoffs play a central role in our work as well, but we stress the role of active leadership in fostering coordination. A

manager can do more than just mechanically gather information and then impose decisions. She can suggest a course of action, persuade subordinates to reveal their information, and point to the long-run benefits of pursuing a mutually beneficial course of action. Information plays a role in our paper, but our focus is on the relationship between communication, managerial leadership, and efficient coordination.

Finally, there is a large and growing literature on whether and when individuals are willing to lie. The typical finding is that individuals lie less than is optimal, adjust the frequency of lies in response to changing incentives (including both their own and other's payoffs), and frequently use partial lies (neither telling the truth nor lying to the full extent that would maximize profits). When subordinates are limited to sending a bare message about the state of the world, our data exhibits all of these standard patterns. It is striking that none of these patterns are present in our treatment with managerial control and free-form chat. Subordinates almost never lie, the frequency of lying does respond to incentives, and partial lies are rare. We argue that "fact-checking" limits the willingness of subordinates to lie. In other words, they are reluctant to lie because they are afraid that the other subordinate (who knows they have lied) will call them on it and embarrass them. The unwillingness of subordinates to lie plays a critical role in generating efficient coordination. Our work therefore identifies a new channel by which pre-play communication enhances efficiency.

Our experiments take advantage of the strengths of laboratory experiments. Our control over payoffs allows us to make sharp theoretical predictions; specifically, in equilibrium, subordinates' information will *not* be used under managerial control. We also take advantage of the controlled environment to randomly assign decision rights (managerial control vs. delegation) and what type of communication is available. These basic features of organizations are typically endogenous and not easily manipulated by a field experiment or RCT (it is difficult to imagine an organization allowing researchers to randomly decide who got to make decisions). Finally, use of a laboratory experiment lets us observe the precise content of communication. The combination of managerial control and chat is effective because subordinates frequently share their information and almost never lie. We can observe this mechanism because we have access to process data, namely the content of chat, which is not typically available from field experiments or observational data

2. Related Literature: Experimental economists have studied the effect of having a leader in a variety of settings. Leaders are defined by a pair of features: (1) A leader is formally distinguished from the rest of the group and (2) A leader is able to take some action, typically unavailable to other players, that is visible to group members and plausibly affects their choices (Cooper and Weber, 2020). A number of papers have shown that leaders can increase contributions in public goods games, either leading by example (e.g. Moxnes and van der Heijden, 2003;; Güth, Levati, Sutter, and van der Heijden, 2007; Sutter and Rivas, 2011; Arbak and Villeval, 2013; Gächter, Nosenzo, Renner, and Sefton, 2014; Jack and Recalde 2015;

Brandts, Rott and Solà, 2016; Cappelen, Reme, Sørensen, and Tungodden, 2016) or by transmitting their superior information about the state of the world (e.g. Potters, Sefton, and Vesterlund, 2005 and 2007). More closely related to the work reported below, several experiments have shown that leaders can increase the likelihood of efficient coordination either by leading by example (e.g. Weber, Camerer, and Knez, 2004; Cartwright, Gillet, and van Vugt, 2013; Sahin, Eckel, and Komai, 2015) or by sending messages (Weber, Camerer, Rottenstreich, and Knez, 2001; Cooper, 2006; Brandts and Cooper, 2007; Brandts, Cooper, and Weber, 2015; Sahin et al., 2015; Cooper, Hamman, and Weber, 2020). Unlike our work, these papers study symmetric games, mainly weak-link games. In a weak-link game, there is no dispute over what equilibrium should be chosen. The primary role of a leader involves overcoming strategic uncertainty. Choosing the efficient equilibrium is risky, and leaders can help by establishing common beliefs that everyone will choose the efficient outcome. With the exception of Cooper et al. (2020), asymmetric information does not play an important role in the existing literature. Asymmetry and the resulting disputes are at the heart of the problem leaders face in our experiment, and asymmetric information exacerbates the difficulty.[3]

Closely related to work on leadership, several experiments have studied the effect of advice on efficient coordination. This includes papers that study either exogenous advice from the experimenter (e.g. Van Huyck, Gillette, and Battalio, 1992; Brandts and MacLeod (1995), Chaudhuri and Paichayontjivit, 2010) or endogenous advice from another subject (e.g. Kuang, Weber, and Dana, 2007; Chaudhuri, Schotter, and Sopher, 2009). Advice can be effective, particularly if it is common knowledge and the interests of advisors and advisees are aligned. As in the aforementioned leadership studies, these papers about advice focus on symmetric games where players have aligned interests. Our experiments confront advising managers with the more challenging problem of resolving the conflicting interests of their subordinates.

Not restricting ourselves to settings with a leader, there exist many papers showing that pre-play communication leads to greater efficiency in social dilemmas (e.g. Dawes, MacTavish, and Shaklee, 1977; Isaac and Walker, 1988; Ostrom, Walker and Gardner, 1992; Charness and Dufwenberg, 2006; Cason and Mui, 2007; Cooper and Kühn, 2014) and coordination games with Pareto-ranked equilibria (e.g. Cooper, DeJong, Forsythe, and Ross, 1992; Blume and Ortmann, 2007; Kriss, Blume, and Weber, 2016; Blume, Kriss, and Weber, 2017). Especially relevant for our work, Cooper DeJong, Forsythe, and Ross (1989) study the effect of communication on coordination in a battle-of-the-sexes game, the best-known example of a coordination game where the equilibria are *not* Pareto ranked. Communication is limited to pre-play announcements of intended play. Without communication, coordination is difficult due to the lack of a focal

[3] In Cooper et al. (forthcoming), the leader is better informed than the followers, and the primary problem created by asymmetric information is that the leader has an incentive to make the state of the world appear better than it is, but risks losing her credibility in the long run. In our paper, the problem is that the leader does not know which equilibrium maximizes total surplus and the well-informed followers have strong incentives to deceive her.

equilibrium. With one-way communication, coordination rates are high as the sender can call for her preferred equilibrium and the receiver generally follows. Two-way communication is less effective, although coordination rates improve somewhat with multiple rounds of pre-play communication (see Brandts, Cooper, and Rott, 2019).

One of our treatments, combining structured communication between subordinates with delegation, resembles the Cooper et al. treatment with multiple rounds of two-way pre-play communication, but there are two important differences. The safe equilibrium in the MS game equalizes payoffs between the two subordinates in all states of the world. Unlike the battle-of-the-sexes game, this gives subjects a simple way of coordinating without asymmetric payoffs. Additionally, we use partners matching while Cooper et al. use strangers matching. This provides more opportunities for a pair of subordinates to reach an agreement, and also makes it possible to equalize (expected) payoffs while using asymmetric choices. These two differences made us anticipate a larger impact from two-way structured communication than observed by Cooper et al., but, as will be seen, we too observe little effect relative to no communication.

We find large differences between our structured communication treatments and the parallel chat treatments. These findings parallel existing evidence that the pro-efficiency effects of communication are greater with free-form chat than structured communication (e.g. Lundquist, Ellingsen, Gribbe, and Johannesson, 2009; Ben-Ner and Putterman, 2009; Charness and Dufwenberg, 2010; Cooper and Kühn, 2014; Brandts, Charness, and Ellman, 2016). The game studied in our paper and the mechanisms underlying the results differ from these previous studies, especially when we compare structured communication and chat under managerial control.

An extremely active experimental literature on subjects' willingness to lie has developed over the past fifteen years (e.g. Gneezy, 2005; Erat and Gneezy, 2012; Fischbacher and Föllmi-Heusi, 2013; Gneezy, Kajackaite, and Sobel, 2018; Abeler, Nosenzo, and Raymond, 2019). Several striking regularities have emerged: (1) Subjects often tell the truth even when lying would pay more,[4] (2) the likelihood of lying is sensitive to incentives, and (3) partial lying (failing to either tell the truth or tell the payoff-maximizing lie) is common. In the managerial control treatment with structure communication, where subordinates are limited to sending bare messages about the state of the world, all of these regularities are present in subordinates' messages. However, lying is *not* sensitive to incentives and partial lies are rare in the managerial control treatment with chat. Messages are observable in both cases and the message space in both cases is sufficient to communicate the full state of the world, yet the nature of truth-telling is quite different in the treatment with chat than in the existing literature. Theory has made a great deal of progress

[4] Studies of cheap talk games find a similar bias towards telling the truth (Cai and Wang, 2006; Sanchez-Pages and Vorsatz, 2007), which could stem from either an aversion to lying or a failure to grasp the strategic benefits of lying.

in understanding why individuals (at least partially) tell the truth and keep promises,[5] but we are unaware of any theory that explains the effect of chat with managerial control.

Beyond the general literature on aversion to lying, our treatment with structured communication and managerial control (SC-MC) resembles the work of Vespa and Wilson (2016). They study information transmission in variations of the multi-sender cheap-talk model proposed by Battaglini (2002). Although the MS game with managerial control is also a cheap talk game with multiple senders, Vespa and Wilson's experimental environment differs from ours in a critical aspect since; in keeping with Battaglini, they study games where messages should fully reveal the state of the world in equilibrium. We wanted to make the informational problems under managerial control as severe as possible, so we designed a game where messages are *not* fully revealing (or even informative) in equilibrium. Nonetheless, their experiments are related to ours. They study three different games. In the two where it is relatively difficult (but possible) to infer the state of the world from senders' messages, receivers perform poorly at extracting information. The failure to extract information is even more severe in our SC-MC treatment, as central managers make systematic errors even when the information extraction problem is rather simple.[6]

Our work is also related to the extensive literature comparing centralized and decentralized firm management. See Mookherjee (2006) for a survey of the older theoretical literature. Prominent recent examples in the theory literature include Hart and Moore (2008), Alonso, Dessein, and Matouschek (2008a, 2008b and 2015), Rantakari (2008), Hart and Holmstrom (2010), Dessein, Garicano, and Gertner (2010). Recent empirical studies using observational data include Thomas (2011) and McElheran (2014), and experiments by Evdokimov and Garfagnini (2019) and Hamman and Martínez-Carrasco (2018) compare centralization and decentralization. Evdokimov and Garfagnini find support for theoretical predictions for the models of Alonso et al. (2008a) and Rantakari (2008). Specifically, the quality of horizontal communication is significantly higher than that of vertical communication and divisions' actions are more coordinated when the importance of coordination is high. Hamman and Martínez-Carrasco (2018) examine decentralization in the context of a more complex environment involving task selection. Their results show a bias toward choosing centralization which they attribute to a desire for control by central managers.

Our work is not intended to test the predictions of any existing theory comparing centralization and decentralization, and our focus differs from the existing literature. Recent papers in this literature concentrate on the relationship between the parameters of the game and the quality of information flowing between the various agents in equilibrium. Our focus is on the interaction between different types of

[5] Beyond the papers cited above, also see Charness and Dufwenberg (2006) on guilt aversion and Dufwenberg and Dufwenberg (2018) for a theory of partial lying.

[6] See also Lai, Lim, and Wang, 2015, for related work.

communication and managerial control. What is the role of the manager as a leader? Can a manager help subordinates overcome coordination failure (which is not an equilibrium outcome)? Can a manager get subordinates to reveal their information (which is also not part of an equilibrium), making efficient coordination possible? The mechanism underlying our main result is that subordinates are surprisingly reluctant to lie when chat and managerial control are combined, making it possible for the manager to achieve efficient coordination. It is this, rather than a change in incentives, that makes it possible to outperform the babbling equilibrium.

3. The Manager-Subordinate Game: The MS game used in our experiments is not drawn from any specific model in the literature, but instead is intended to confront subjects with a challenging environment that accentuates the tradeoffs between having the manager make decisions for her subordinates and delegating decisions to the subordinates. As a simple example to illustrate the model, imagine that two engineers in a firm's R&D division (Mr. A and Mr. B) have to collaborate on a technical document. They must pick word-processing software, either MS Word or LaTeX, for this task. The two word-processing packages have differing strengths and which is the best choice varies from task to task. Making the problem thornier, suppose each engineer has primarily used one of the two packages in the past. Mr. A is familiar with the oddities and limitations of MS Word, and does not want to invest the time needed to master LaTeX. Mr. B feels much the same about having to switch to MS Word. Left to their own devices, the engineers may struggle to agree on a package, either settling on the wrong package for the task at hand, or, even worse, failing to agree. The manager overseeing the R&D division, Ms. C, might try to resolve matters by imposing a decision, but she faces a problem if the engineers are better informed than her about which word-processing package is best for the task at hand. They might even secretly agree on which package is best suited for creating their document, but neither wants to learn a new word-processing package. Ms. C could ask the engineers which word-processing package is best suited for their project, but Mr. A has a strong incentive to suggest use of MS Word, and Mr. B will always tout LaTeX. Ms. C wants to get the engineers to agree on one package, but she wants it to be the right one for the task at hand.

$$\pi_S = k_1 - k_2 * coordination\ loss - k_3 * adaptation\ loss - k_4 * state\ loss \quad \textbf{(Eq. 1)}$$

Like the preceding example, the MS game is played by two subordinates (S1 and S2) and a manager (M). Equation 1 summarizes the intuition underlying subordinates' payoffs, which equal a constant minus three types of losses. "Coordination losses" are losses from not choosing the same option as the other subordinate. In our simple example, it would be difficult to co-author a document if the two engineers used different software packages. Our model assumes that coordination is paramount, so the worst outcome is to have the subordinates fail to agree on an option. "Adaptation losses" are losses due to deviations from a

subordinate's most desired outcome (the subordinate has to "adapt" to the wants and needs of others). Adaption losses do ***not*** depend on the state of the world. In our simple example, Mr. A *always* prefers to use MS Word and Mr. B *always* prefers to use LaTeX. They agree that they ought to pick a single word-processing package, but both *always* prefer to pick the package that they know and regularly use. To maximize conflict, subordinates are assumed to have diametrically opposed tastes, with S1's most preferred option being S2's least preferred option (and vice versa). "State losses" ***are*** state dependent, capturing that some options are inherently more or less attractive depending on the state of the world. Returning to our example, it is inherently better to create some documents using MS Word while others are better suited to LaTeX. Suppose the task at hand is one that is well suited to LaTeX. Mr. A would still be happier if the engineers agree to use MS Word, but it costs him little if he has to use LaTeX. It would be far costlier for Mr. B if they agree to use MS Word. Not only does he not get to use his preferred word-processing package, he also has to use a package that is poorly suited to the task at hand. If coordination is the foremost concern *and* subordinates care more about getting their most preferred option than the option that is best for the task at hand, it follows that $k_2 > k_3 > k_4 > 0$. This assumption makes the games induced by any state of the world into coordination games where the two subordinates have diametrically opposed interests.

The manager's payoff is the sum of the subordinates' payoffs, implying that management seeks to minimize total costs. This represents a setting where the manager is rewarded for how her unit does as a whole, and should not be interpreted as benevolence on the part of the manager. Because the subordinates have directly opposed interests, adaption costs play no role in the manager's decisions under managerial control.[7] Anything that makes one subordinate happier will necessarily make the other subordinate less happy. In our example, Ms. C can please Mr. A by choosing MS Word, but that makes Mr. B less happy. What Ms. C should care about is having the engineers coordinate on a single word-processing package, preferably the one that best fits the task at hand. The misaligned incentives that play a central role in most principal-agent problems are also present in the MS game, because subordinates care about whether or not coordination occurs at their preferred option but the manager does not.

3.1. Stage Game Payoff Functions: This sub-section formally describes the MS game. There are three players in the game, a manager (M) and two subordinates (S1 and S2). G denotes the state of the world: $G \in \{1,2,3,4,5\}$. As standard nomenclature, we refer to the states of the world by the games they induce (e.g., Game 1 for G = 1). G is randomly determined before players take any actions. Draws of G are i.i.d. with each game equally likely. To ease comparisons across treatments, we used the same draw of games for all sessions (although different groups in a session faced different draws). Both subordinates know the draw

[7] To be precise, this assumes the manager enforces coordinated choices on her subordinates.

of G, but the manager only knows the *ex-ante* distribution over games. The subordinates choose (under delegation) or are assigned (under managerial control) an action from the space $A_i \in \{1,2,3,4,5\}$. Equations 2a, 2b, and 2c give the payoff functions for S1, S2, and M respectively.

$$\pi_{S1} = k_1 - k_2|A_1 - A_2| - k_3|A_1 - 5| - k_4|A_1 - G| \quad \textbf{(Eq. 2a)}$$
$$\pi_{S2} = k_1 - k_2|A_1 - A_2| - k_3|A_2 - 1| - k_4|A_2 - G| \quad \textbf{(Eq. 2b)}$$
$$\pi_M = \pi_{S1} + \pi_{S2} \quad \textbf{(Eq. 2c)}$$

For all treatments, $k_1 = 54$, $k_2 = 14$, $k_3 = 7$, and $k_4 = 4$. Table 1 displays the payoff tables for G = 1, 3, and 5, and copies of all five payoff tables can be found in Appendix A. The three numbers in each cell of Table 1 correspond to the payoffs, denominated in ECUs, of S1 (π_{S1}), S2 (π_{S2}), and M (π_M). The row and column are the actions chosen by S1 and S2 respectively (or chosen for them by M). The row (R) and column (C) numbers correspond to the actions chosen by the subordinates (e.g. R3 ≡ $A_1 = 3$; C4 ≡ $A_2 = 4$).

Table 1: Stage Game Payoffs ($k_1 = 54$, $k_2 = 14$, $k_3 = 7$, and $k_4 = 4$)

Note: Each cell contains the payoffs for S1 (π_{S1}), S2 (π_{S2}), and M (π_M).

Game 1

	C1	C2	C3	C4	C5
R1	26, 54, 80	12, 29, 41	-2, 4, 2	-16, -21,-37	-30,-46,-76
R2	15, 40, 55	29, 43, 72	15, 18, 33	1, -7, -6	-13, -32,-45
R3	4, 26, 30	18, 29, 47	32,32, 64	18, 7, 25	4, -18, -14
R4	-7, 12, 5	7, 15, 22	21, 18, 39	35, 21, 56	21, -4, 17
R5	-18, -2, -20	-4, 1,-3	10, 4, 14	24, 7, 31	38, 10, 48

Game 3

	C1	C2	C3	C4	C5
R1	18, 46, 64	4, 29, 33	-10,12, 2	-24, -13, -37	-38, -38, -76
R2	15, 32, 47	29, 43, 72	15, 26, 41	1, 1, 2	-13, -24,-37
R3	12, 18, 30	26, 29, 55	40, 40, 80	26, 15, 41	12, -10,2
R4	1, 4, 5	15, 15, 30	29,26, 55	43,29, 72	29, 4, 33
R5	-10, -10, -20	4,1, 5	18,12, 30	32, 15, 47	46, 18, 64

Game 5

	C1	C2	C3	C4	C5
R1	10, 38, 48	-4, 21, 17	-18, 4,-14	-32,-13,-45	-46,-30, -76
R2	7, 24, 31	21, 35, 56	7, 18, 25	-7, 1,-6	-21,-16,-37
R3	4, 10, 14	18, 21, 39	32, 32, 64	18, 15, 33	4, -2, 2
R4	1,-4,-3	15, 7, 22	29, 18, 47	43, 29, 72	29, 12, 41
R5	-2,-18,-20	12,-7, 5	26,4, 30	40, 15, 55	54, 26, 80

The MS game confronts managers and subordinates with a challenging environment. We are especially interested in communication between managers and subordinates as well as the leadership role played by the manager. A number of the game's features accentuate the importance of communication and leadership: (1) Managers supervising subordinates face pervasive asymmetric information. The MS game focuses on this issue. (2) Having a single common shock rather than two independent shocks accentuates the difference between managerial control and delegation. Under delegation, asymmetric information plays no role but subordinates' conflicting preferences make it difficult to coordinate. With managerial control, coordination is trivial but achieving efficiency requires the manager to overcome the asymmetric information between her and her subordinates. (3) The functional forms in Equations 1a and 1b use absolute values of differences, rather than squared differences, to emphasize the importance of coordination. A subordinate in the MS game maximizes his payoff by picking exactly the same action as the other subordinate.[8] (4) We use five possible actions and five states of the world rather than two (as in battle-of-the-sexes) or three. Going from two to three possible actions adds the safe equilibrium (defined below) which plays a critical role in subjects' choices. Going from three to five actions five product types makes it easier to distinguish whether play is consistent with an efficient or safe equilibrium, since the two are equivalent less frequently, and easier to detect partial lies. (5) To accentuate their differing preferences, subordinates are solely concerned with their own payoffs. Implicitly, this eliminates incentive schemes based on revenue or profit sharing. (6) Finally, we model the interaction between the manager and subordinates under managerial control as a cheap talk game rather than a problem of mechanism design. Implicitly, we assume that the manager cannot commit to a mechanism for eliciting information.

3.2: Equilibrium, Delegation: With delegation, each subordinate chooses an action and the manager is a passive bystander. Ignoring the payoff for M, all five games are coordination games with five pure-strategy Nash equilibria where the two subordinates choose the same action: ($A_1 = A_2 = 1$), ($A_1 = A_2 = 2$), ($A_1 = A_2 = 3$), ($A_1 = A_2 = 4$), and ($A_1 = A_2 = 5$). For convenience, we refer to these outcomes as Equilibrium 1, Equilibrium 2, etc.

In all five games, there is a tension similar to the battle-of-the-sexes game since S1 most prefers Equilibrium 5 and least prefers Equilibrium 1, the reverse is true for S2, and M prefers the equilibrium that maximizes total surplus. This implies that M always wants a different equilibrium than at least one of her subordinates and wants a different equilibrium than either S1 or S2 in Games 2, 3, and 4. Alternative

[8] With squared differences, used by the theoretical models of Alonso et al. and Rantakari, subordinates want to shade their choice away from their own preferred outcome and towards the other subordinate's action rather than matching the other subordinate's action. Using absolute values would be problematic for the purposes of the Alonso et al. and Rantakari models because it leads to multiple equilibria and non-differentiability.

principles for equilibrium selection, such as safety and efficiency, suggest different ways of resolving the tension stemming from subordinates' differing interests.

Unlike a battle-of-the-sexes game, the MS game offers a relatively easy way to coordinate and achieve equal payoffs since in all five games Equilibrium 3 yields the same payoff to both subordinates. Equilibrium 3 is also safe, in the sense that $A_i = 3$ is the maximin strategy for both subordinates in all five games. Except in Game 3, Equilibrium 3 does *not* maximize total surplus.

All five games have an equilibrium that maximizes total surplus. This is always equivalent to the game number (i.e., Equilibrium 1 in Game 1, Equilibrium 2 in Game 2, etc.). The "efficient" equilibrium, where the subordinates play the surplus-maximizing equilibrium in all states of the world, is procedurally fair (i.e., equalizes expected payoffs under the veil of ignorance about the state of the world; Bolton et al., 2005) but yields asymmetric payoffs for all games except Game 3 once the state of the world is known. The efficient equilibrium is relatively complex because the subordinates must change their actions as the state of the world changes.

If adaptation losses are higher than the sum of coordination and state losses ($k_3 > k_2 + k_4$), it is a dominant strategy for each subordinate to always pick its most preferred option (A_5 for S1, A_1 for S2). For less extreme cases where adaption losses are higher than coordination losses ($k_2 + k_4 > k_3 > k_2$), there are multiple equilibria but some choices are dominated implying that the subgames do not have five equilibria and in some cases have a unique equilibrium. If state losses are larger than adaptation losses ($k_4 > k_3$), the subordinates' preferences over equilibria are aligned and the coordination problem is eliminated.

3.3: Equilibrium, Managerial Control: The following discussion is based on the treatment with managerial control and structured communication, but extend in a straightforward manner to the managerial control treatment with chat. With managerial control, the two subordinates do not choose rows and columns directly. After being informed about the state of the world (i.e., Game 1, Game 2, etc.) each subordinate independently sends a message to the manager indicating which state of the world has been selected ($M_i \in \{1,2,3,4,5\}$). After receipt of the two messages, the manager chooses both a row and a column. She has no knowledge about which game has been selected beyond the initial distribution over states of the world and whatever information she gleans from the subordinates' messages.

Conditional on enforcing coordination, Equations 1a and 1b imply that the manager does not care about the adaption losses, but the subordinates do. Given their opposing interests, the subordinates have no incentive to be truthful with the manager. If both subordinates always report the game where the efficient outcome is best for them (Game 5 for S1, Game 1 for S2), the best the manager can do is to choose the safe

outcome ($A_1 = A_2 = 3$).[9] Any benefits from the subordinates' private information are lost and the manager generally will not choose the efficient outcome.

More formally, we can prove the following theorem. Given that the manager must choose the same row and column ($A_1 = A_2$) in any Perfect Bayesian equilibrium (PBE), we henceforth refer to the manager as choosing a single action in response to the subordinates' messages.

Theorem: There does not exist a pure-strategy PBE where the manager chooses different product types for two different states of the world. This implies that the only pure-strategy PBE are babbling equilibria where the safe outcome ($A_1 = A_2 = 3$) is always chosen.
Proof: See Appendix B.

The absence of an informative equilibrium does *not* reflect a generic property of cheap talk games with multiple senders; such games generically have an informative equilibrium when the state space is multidimensional (Battaglini, 2002). The MS game intentionally gives the two subordinates diametrically opposed interests over a unidimensional state space. The resulting lack of an informative equilibrium makes information transmission theoretically impossible with managerial control. This is in keeping with our goal of confronting subjects with a challenging environment that accentuates differences between the manager retaining control or delegating choices to her subordinates.[10]

The theory assumes messages are cheap talk, with subordinates incurring no costs, pecuniary or psychological, for sending false messages. If we add a psychological cost for sending false messages, as in Kartik (2009), it is trivial to construct cases where truthful revelation is consistent with an equilibrium. For example, let $c_L*|M_i - G|$ be subordinate i's psychological cost of lying. If $c_L > k_3 - k_4$, there exists an equilibrium in which both subordinates truthfully reveal their information.[11]

4. Experimental Design and Hypotheses:

4.1 Experimental Design and Procedures: Subjects played 18 rounds in all treatments. They were assigned the role of M, S1, or S2 at the beginning of the session and kept these roles throughout the session. Partners

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[9] Given that payoffs are linear, this isn't transparent. Define a manager's error as the difference between the action she chooses (assume $A_1 = A_2$) and the efficient choice. Choosing the safe equilibrium limits the size of manager errors. If she chooses the safe equilibrium, her average error is 1.2. If she chooses action 2 or 4, the average error rises to 1.4. Choosing 1 or 5, the average error goes up to 2.0.

[10] Finite repetition of this game does *not* expand the set of possible equilibria to include informative equilibria. There is a unique equilibrium payoff vector in the stage game. Doing backwards induction, the set of equilibrium payoffs only expands if you can take advantage of differing payoffs across stage game equilibria to prevent deviations.

[11] If both subordinates send the same message, the manager chooses the corresponding equilibrium. If $M_i = 1$ and $M_j = 2$, where $i, j \in \{1,2\}$ and $i \neq j$, the manager chooses Equilibrium 2. If $M_i = 4$ and $M_j = 5$, where $i, j \in \{1,2\}$ and $i \neq j$, the manager chooses Equilibrium 4. Otherwise, the manager chooses Equilibrium 3.

matching was used (i.e. participants were matched with the same two other subjects throughout the entire experiment). In treatments with delegation, the participants in the M role were pure observers. We did this to keep the possible influence of other-regarding preferences constant across treatments.

Subjects received feedback about the realized state of the world (i.e. the game being played) and the chosen actions after each round. In the treatments with managerial control, this made it possible for managers to know if a subordinate had lied about the game being played.

We report on seven different treatments, as described below, broken into three broad categories by the type of communication (no communication, structured communication, or chat). We used a between-subjects design, so each subject participated in just one of the treatments. There were three sessions per treatment and nine three-person groups per session, giving 27 subjects per session, 27 independent groups per treatment, and a total of 567 subjects in 189 independent groups.

No Communication – Delegation (NC – D): This was the baseline treatment where subjects played the MS game with delegation, as described in Section 3.2, without any additional communication.

Structured Communication, Subordinates – Delegation (SC/S – D): This treatment was identical to the **NC – D** treatment, except pre-play communication between subordinates was added. Prior to the subordinates' choices of actions, each game began with three rounds of messages. Within each round of messages, the subordinates simultaneously chose a pair of messages suggesting actions for themselves and the other subordinate. The message space is limited in structured communication treatments; in **SC/S – D**, for example, the subordinates choose messages by clicking on radio buttons labeled with the three available actions and had no possibility of sending any other messages. Subordinates observed each other's messages at the end of each round of messages. The purpose of having three rounds of messaging (rather than one) was to make it easier for subordinates to agree upon a course of action.

Structured Communication, Advice – Delegation (SC/A – D): This treatment was identical to the **NC – D** treatment, except the manager sent a message to the subordinates prior to each round of play. This message suggested actions for both subordinates in each of the five possible games. In other words, the manager advised a course of action contingent on the realized state of the world. The full message (a 5 x 2 matrix) was shown to both S1 and S2 prior to their choice of actions. The subordinates knew that both received identical messages.

Structured Communication – Managerial Control (SC – MC): In this treatment, subjects played the game with managerial control as described in Section 3.3. In each round, the two subordinates viewed the state of the world (i.e., Game 1, Game 2, etc.) and sent simultaneous messages to the manager reporting the state of the world ($M_i \in \{1,2,3,4,5\}$). There was no requirement that these messages be truthful, a point

emphasized in the instructions.[12] After receipt of the two messages, M chooses both a row and a column. There was no requirement that the row and column match.

Chat between Subordinates – Delegation (CH/S – D): This treatment was identical to the **NC – D** treatment, except pre-play chat between subordinates was added. The subordinates had two minutes to engage in free-form discussions via chat before choosing actions. They could discuss whatever they chose. In practice, discussions largely focused on the obvious topic, how to play the game. The manager saw the discussion but could not participate.

Chat, Advice – Delegation (CH/A – D): This treatment was identical to the **CH/S – D** treatment, except the manager could participate in the chat prior to her subordinates choosing actions. The manager could advise her subordinate, but had no control over their actions.

Chat – Managerial Control (CH – MC): This treatment was identical to the **SC – MC** treatment, except the structured messages about the state of the world were eliminated and replaced by free-form chat between the subordinates and their manager. The subordinates were not specifically instructed to share information about the state of the world, but this was a natural and typical topic of conversation, making the structured messages redundant. Again there was a two-minute time limit. Unlike **CH/A – D**, the manager had control over the outcome and the subordinates had reason to not truthfully reveal the state of the world.

The structured communication and chat treatments served different purposes. Structured communication tightly controlled what types of messages could be sent, allowing for clean identification of mechanisms by which communication affected outcomes. Chat was inherently less controlled than structured communication. However, as documented in Brandts et al. (2019), chat generally has more impact than structured communication because it is a more natural form of communication. Structured communication eliminates aspects of communication that can play a critical role in reaching good outcomes. In our experiment, chat allowed for extended bargaining, appeals to the better nature of the other players, and explanations of a proposed course of action. Important features of the chat, such as the rarity of lying by subordinates and the fact checking in **CH – MC**, would have been missed with structured communication. We valued both the control available with structured communication and the rich (and more realistic) environment with chat.

Each session began with instructions (see Appendix C). Participants had printed copies of the payoff tables for all five games. Sessions were run at the LINEEX lab at the University of Valencia, with undergraduate students from the university as participants. The payoffs were denominated in Experimental

[12] The instructions state: " … [S1 and S2] will separately send messages to [M] saying which game has been selected. This message can be truthful or not."

Currency Units, with 1 ECU = 0.2€. Participants received their cumulative earnings for all rounds. Including a 5€ show-up fee, average pay was 19.90€. Sessions lasted approximately an hour.

Beyond the seven treatments reported in this paper, we ran an additional four treatments. These were modifications of the **NC – D** and **SC – MC** treatments, and involved exploring how behavior changes either with use of a strangers matching or an increase in the size of state losses. The hypotheses we had about these treatments were not central to the main goals of this paper, and the results contain nothing that would alter our conclusions. To maintain a full record, Appendix D provides a full description of these four additional treatments as well as a summary of the results.

4.2. Hypotheses: The **NC – D** treatment was the baseline treatment. In theory, there exists an equilibrium that yields efficient coordination in all rounds, but, in practice, our expectations were quite low. The MS game with delegation resembles a battle-of-the-sexes game, as setting where it is known that coordination without communication is difficult (e.g. Cooper *et al*., 1989). We therefore doubted that subordinates could coordinate, let alone coordinate efficiently, in the absence of communication. For either structured communication or chat, the types of communication (between subordinates, managerial advice, or managerial control) emphasized different mechanisms by which communication might improve coordination, ideally yielding efficient coordination. Communication between subordinates gave them an opportunity to directly coordinate their choices prior to picking actions. The subordinates did not face any asymmetric information in **SC/S – D** or **CH/S – D**, but did not have an obvious mechanism for resolving conflicts due to their divergent interests. Managerial control made coordination trivial, and efficient coordination would also have been trivial *if the manager had known the state of the world.* The problem, of course, is that the manager did *not* know the state of the world. As the theory above suggests, we anticipated that managers would struggle to achieve efficient coordination because their subordinates would not communicate the state of the world in either **SC – MC** or **CH – MC**. *Ex ante*, we anticipated that the treatments with advice, **SC/A – D** and **CH/A – D**, would achieve the best of both worlds. The manager could provide leadership, acting as a coordination device by advising the efficient course of action subject to the state of the world. Because the power to choose actions still resides with the subordinates, we believed that asymmetric information would have a limited role. Thus, we anticipated that efficient coordination would be most likely with advice.

The preceding discussion is formalized by the following hypotheses. The first draws on the theory developed in Sections 3.2 and 3.3 to compare the **NC – D** and **SC – MC** treatments. The efficient equilibrium available in **NC – D** achieves the maximum possible total surplus. In **SC – MC**, only babbling equilibria, which make no use of the subordinates' information, exist. **H1** follows. This hypothesis was a straw man; there are *many* possible equilibria in **NC – D**, and existing evidence from related games like the

battle-of-the-sexes game suggested that achieving coordination, let alone the efficient equilibrium, might be difficult.

H1: *Total surplus will be greater in the NC – D treatment than in the SC – MC treatment.*

The theory implies that messages under managerial control, consistent with play of a babbling equilibrium, will contain no useful information. **H2** follows from this logic. Once again, there were good reasons to be skeptical. Our design differed from most existing experiments, especially since there was more than one subject sending messages, but the general finding that individuals are reluctant to tell lies seemed likely to apply.

H2: *In **SC – MC**, messages from the subordinates will contain no useful information about the state of the world. Total surplus will not exceed the expected payoff from a babbling equilibrium.*

Turning to the other two treatments with structured communication, neither type of pre-play communication changes the theoretical prediction. We nevertheless expected total surplus to increase relative to **NC – D** in both cases. Cooper et al. (1989) observe modest improvements from adding three rounds of bilateral pre-play structure communications to the battle-of-the-sexes game. Based on this evidence, we expected a modest increase in total surplus between the **NC – D** and **SC/S – D** treatments.[13] We were more optimistic about the **SC/A – D** treatment. Suggestions from the experimenter or an external leader can act as a coordination device in weak-link coordination games (e.g., Van Huyck, Gillette, and Battalio, 1992; Brandts and Cooper, 2007; Brandts, Cooper, and Weber, 2015), and we conjectured that the manager's messages would have a similar effect in the MS game. It is always in the manager's interest to promote the efficient equilibrium, and unlike the **SC/S – D**, subordinates in the **SC/A – D** treatment respond to a single, common piece of advice. It is always hard to overcome the opposing interests of players in asymmetric coordination games, but we hoped that the benefits of certain coordination would overcome reluctance to accept a less preferred common course of action. The preceding conjectures are summarized in **H3**. This hypothesis is stated relative to the **NC - D** treatment, as both limited message space treatments modify this treatment, but combining **H1** and **H3** yields a prediction that both treatments would also yield higher total surplus than the **SC - MC** treatment.

H3: *Total surplus will be greater in the SC/A – D treatment than the SC/S – D treatment, and greater in the SC/S – D treatment than the NC – D treatment.*

The final hypothesis covers the chat treatments. There exist many papers comparing the effects of structured communication versus chat. The general finding is that communication has a greater impact of

[13] There are differences in the structure of our experiment and game, described in Section 2 that increased our optimism about the relative performance of the **SC/S – D** treatment.

outcomes if chat is used rather than structured communication (Brandts et al., 2019). Particularly relevant to our current work, Cooper and Kühn (2014) find that free-form communication outperforms structured communication in a two period Bertrand game, *largely by improving coordination on an efficient equilibrium*. While the games are different, we expected that the ability to make unlimited asynchronous proposals along with the ability to explain proposals would similarly increase efficient coordination under decentralization. We therefore expected the chat treatments to yield higher total surplus than the parallel structured communication treatments. We also expected the order between chat treatments to match the order between structured communication treatments. Our conjectures are summarized in H4.

H4: *CH/S – D will yield higher total surplus than SC/S – D, CH/A – D will yield higher total surplus than SC/A – D, and CH – MC will yield higher total surplus that SC – MC. The addition of chat will not affect the ordering over treatments.*

5. Results: Section 5.1 gives an overview of the main treatment effects, and Section 5.2 digs into the process underlying the treatment effects.

5.1. Treatment Effects: Unless otherwise noted, statistical tests comparing treatments are Wilcoxon rank-sum tests and comparisons with the babbling equilibrium are Wilcoxon matched-pairs signed-rank tests. The unit of observation is a single group. Statistical comparisons are based on the second half of the experiment (Rounds 10 – 18) when play has settled down.[14] An observation is the average value of the variable in question over these rounds. Surpluses from the babbling equilibrium are based on what the total surplus would have been if the manager had always set $A_1 = A_2 = 3$ as predicted.

Table 2 summarizes outcomes by treatment, with the two sub-tables dividing the data between the first (Rounds 1 – 9) and second (Rounds 10 – 18) halves of the experiment. The first column shows average total surplus.[15] To better understand differences in total surplus, recall that there are two necessary conditions for achieving efficient coordination: the choices of the two subordinates need to be coordinated ($A_1 = A_2$) *and* these choices have to take advantage of the subordinates' information ($A_1 = A_2 = G$). The second and third columns of Table 2 measure performance along these two dimensions. The second column reports the percentage of games where the choices were coordinated and the third column reports the average "efficiency gain." The latter is defined as the difference between a group's total surplus for the nine round block and the total surplus that would have been achieved by playing the babbling equilibrium ($A_1 =$

[14] The average change in total surplus across Rounds 1 – 9 is more than ten times larger than the change across Rounds 10 – 18 (6.40 vs. 0.60).

[15] We define total surplus as the sum of the payoffs for S1 and S2. This is equivalent to the manager's payoff.

$A_2 = 3$) throughout, divided by the difference between the surplus from efficient coordination and the surplus from the babbling equilibrium. This is a measure of how well a group does relative to the babbling equilibrium; for treatments where coordination is high, it largely reflects making use of the subordinates' information. Playing the efficient equilibrium yields an efficiency gain of 100%, while the babbling equilibrium leads to an efficiency gain of 0%. Negative percentages reflect a failure to coordinate, let alone use the subordinates' information.

Table 2: Summary of Outcomes

Rounds 1 – 9

Treatment	Total Surplus	% Coordinate	Efficiency Gain
NC – D	53.5	46.1%	-190.8%
SC/S – D	62.7	72.8%	-89.0%
SC/A – D	57.9	55.1%	-141.3%
SC – MC	70.0	97.5%	-10.4%
CH/S – D	64.2	82.3%	-70.2%
CH/A – D	64.0	75.7%	-79.2%
CH – MC	71.3	98.4%	5.2%

Rounds 10 – 18

Treatment	Total Surplus	% Coordinate	Efficiency Gain
NC – D	61.4	69.5%	-108.3%
SC/S – D	65.7	77.8%	-57.5%
SC/A – D	64.4	69.5%	-77.4%
SC – MC	71.7	99.6%	6.5%
CH/S – D	72.2	97.5%	14.0%
CH/A – D	71.6	90.9%	2.8%
CH – MC	75.2	100.0%	44.3%

We begin by comparing total surplus across treatments. **H1** hypothesizes that total surplus would be greater in **NC – D** than **SC – MC**. This is a straw man, relying on the best case scenario of efficient coordination for **NC – D**, and indeed **H1** is strongly rejected as total surplus is significantly greater in **SC – MC** than **NC - D** ($n = 54$; $z = 3.89$; $p < .01$). It is not difficult to see the reason for this difference. Managers almost universally understand the importance of coordination, leading to a coordination rather of almost 100% in **SC – MC**. Lacking a coordination device, coordination is much rarer in **NC – D**. The difference in coordination rates between **NC – D** and **SC – MC** is large and significant across Rounds 10 – 18 ($n = 54$; $z = 4.82$; $p < .01$).

Result 1: *Total surplus is significantly higher in **SC – MC** than **NC – D.** The data are not consistent with **H1**. Significantly lower coordination rates largely explain the lower total surplus in **NC – D**.*

While performance is far stronger in **SC – MC** than **NC – D**, it does not follow that much use is made of the subordinates' information. The difference between total surplus in **SC – MC** and the babbling equilibrium is small – recall that the expected total surplus from the babbling equilibrium is 70.4 – and the efficiency gain is only 6%, indicating that little of the possible gain over the babbling equilibrium is achieved. The difference between total surplus in **SC – MC** and the babbling equilibrium is not statistically significant (n = 27; z = 0.78; p > .10).

Table 3: Types of Coordination

Rounds 1 – 9

Treatment	% Safe	% Efficient	% Other
NC – D	27.0%	9.0%	5.8%
SC/S – D	44.4%	20.1%	5.3%
SC/A – D	23.3%	23.8%	3.7%
SC – MC	28.6%	38.1%	31.7%
CH/S – D	36.5%	26.5%	16.9%
CH/A – D	28.0%	31.7%	15.3%
CH – MC	40.2%	33.3%	24.3%

Rounds 10 – 18

Treatment	% Safe	% Efficient	% Other
NC – D	48.1%	12.6%	4.9%
SC/S – D	36.1%	30.6%	8.2%
SC/A – D	32.8%	30.1%	4.4%
SC – MC	31.1%	36.1%	32.2%
CH/S – D	41.0%	36.1%	20.8%
CH/A – D	29.5%	44.8%	15.8%
CH – MC	34.4%	50.8%	14.8%

To help us better understand why performance varies across treatments, Table 3 summarizes the frequency of specific outcomes in Games 1, 2, 4, and 5. As defined previously, the safe outcome refers to mutual choice of 3 ($A_1 = A_2 = 3$) and the efficient outcome indicates choices matching the state of the world ($A_1 = A_2 = G$). "Other" refers to any other outcome where the subordinates actions are coordinated ($A_1 = A_2$), but neither at the safe nor the efficient outcome. Table 3 does not use data from Game 3 because the efficient and safe outcomes coincide in this case.

Table 3 makes it clear that failure to coordinate is *not* the only problem in **NC – D**. When the safe and efficient outcomes did not coincide ($G \neq 3$), even if the subordinates coordinated, it was usually at the safe outcome (69% subject to coordinating) rather than the efficient outcome is rare (18% subject to coordinating). Subordinates generally failed to take advantage of their information in NC – D, solving their difficult coordination problem by utilizing the safe equilibrium.

Matters were a bit more complex in **SC – MC**. A quick glance might suggest that performance was better than the babbling equilibrium. For $G \neq 3$, play of the efficient outcome is slightly more common than the safe outcome. The problem is that a third of the outcomes are in the "other" category, and this does *not* represent an intermediate case between play of efficient and safe outcomes. Total surplus for coordination at an "other" outcome was *lower* than could have been achieved via the babbling equilibrium (62.1 vs. 67.7). "Other" outcomes often do *not* involve shading the difference between safety and efficiency. For Games 1 and 5, 56% of "other" outcomes use actions that are *farther* away from the efficient outcome than the safe outcome. The managers attempted to use subordinates' information, but did so quite poorly.

Result 2: *When subordinates coordinate under delegation, play is generally consistent with the safe equilibrium in the* ***NC – D*** *treatment, implying a failure to use the subordinates' information. Total surplus in* ***SC – MC*** *is almost identical to the babbling equilibrium prediction, consistent with* ***H2****, but play is consistent with neither the babbling nor the efficient equilibrium. This, again, implies a failure to use the subordinates' information.*

The results in Table 2 provide little support for **H3**. Both **SC/S – D** and **SC/A – D** yield higher total surplus than NC - D across Rounds 10 – 18, but the differences are small and not statistically significant (**NC – D** vs. **SC/S – D**: $n = 54$; $z = 1.43$; $p > 0.10$; **NC – D** vs. **SC/A – D**: $n = 54$; $z = 0.81$; $p > 0.10$). Total surplus is slightly lower in **SC/A – D** than **SC/S – D**, rather than higher as predicted. Neither **SC/S – D** nor **SC/A – D** does as well as **SC – MC**, with both differences at least weakly significant across Rounds 10 – 18 (**SC – MC** vs. **SC/S – D**: $n = 54$; $z = 1.92$; $p < 0.10$. **SC – MC** vs. **SC/A – D**: $n = 54$; $z = 2.61$; $p < 0.01$).

The **SC/S – D** and **SC/A – D** treatments have little effect on total surplus because neither does much to improve the coordination rate relative to **NC – D** across Rounds 10 - 18 (**NC – D** vs. **SC/S – D**: $n = 54$; $z = 0.96$; $p > 0.10$; **NC – D** vs. **SC/A – D**: $n = 54$; $z = 0.07$; $p > 0.10$). To the limited extent that these treatments do better than NC – D, it is by making somewhat better use of the subordinates' information. Subject to coordinating in $G \neq 3$, the frequency of using the efficient equilibrium rises from 19% in NC – D to 41% and 45% in **SC/S – D** and **SC/A – D** respectively.

Result 3: The **SC/S – D** and **SC/A – D** treatments *do not yield significantly higher total surplus than* ***NC – D****, and do significantly worse than* ***SC - MC****. The data do not support* ***H3****.*

All three treatments with free-form chat yield higher average total surplus across Rounds 10 - 18 than **NC – D** (**NC - D** vs **CH/S – D**: n = 54; z = 4.14; p < .01; **NC - D** vs **CH/A – D**: n = 54; z = 3.93; p < .01; **NC - D** vs **CH – MC**: n = 54; z = 5.19; p < .01). Morever, consistent with **H4**, the chat treatments always yield significantly higher total surplus than the parallel structured communication treatments (**CH/S – D** vs. **SC/S – D**: n = 54; z = 2.30; p < .05; **CH/A – D** vs **SC/A – D**: n = 54; z = 2.78; p < .01; **CH – MC** vs **SC – MC**: n = 54; z = 2.94; p < .01).

Comparing the three chat treatments, performance is highest in **CH – MC**. Chat-Centralization yields significantly higher total surplus than either **SC – MC** (n = 54; z = 2.94; p < 0.01) or **CH/S - D** (n = 54; z = 2.45; p < 0.05). The former implies that the addition of free-form chat is improving performance and the latter that managerial control also improves performance. Strong performance in the **CH – MC** treatment is not due to chat *or* managerial control, but rather the conjunction of the two.[16]

Oddly, total surplus is not significantly higher in **CH – MC** than **CH/A – D** (n = 54; z = 1.41; p > .10) even though the average total surplus across Rounds 10 – 18 is *lower* in **CH/A – D** than **CH/S – D**. This reflects the high variance of outcomes in the **CH/A – D** treatment. The standard deviation of total surplus across Rounds 10 – 18 is more than double in **CH/A – D** (10.5) than the other two chat treatments (4.7 and 4.0 for **CH/S – D** and **CH – MC** respectively). If we look at the nine groups (out of 81 in the three chat treatments) that achieve a perfect total average surplus of 80, **CH/A – D** ties with **CH – MC** for the most at four apiece. But, if we flip the coin and look at the nine *worst* groups, **CH/A – D** leads as well with five while **CH – MC** has none. It would be a mistake to describe performance in **CH/A – D** as either good or bad; a more accurate adjective would be "erratic."

CH – MC has by far the highest efficiency gain of any treatment (44.3%), and is the only treatment which significantly outperforms the babbling equilibrium (n = 27; z = 3.65; p < .01).[17] Efficient coordination has two components: the subordinates' choices must be coordinated and they must reflect the subordinates' information. **CH – MC** does well on both accounts. It is the only treatment where groups achieve 100% coordination across Rounds 10 – 18. **CH/S – D** does almost as well at achieving coordination, but **CH/A – D** has a distinctly lower coordination rate which largely explain its relatively low surplus. The average coordination rate for **CH/A – D** hides a great deal of heterogeneity; 19 of 27 groups achieve 100% coordination, but the other eight groups only have an average coordination rate of 69%. Not only is coordination 100% perfect across Rounds 10 – 18 in **CH – MC**, but play of the efficient equilibrium is increased relative to either **SC – MC** (n = 54; z = 2.20; p < 0.05) or **CH/S – D** (n = 54; z = 1.86; p < 0.10).

[16] Neither **CH/S – D** (n = 54; z = 0.44; p > .10) nor **CH/A – D** (n = 54; z = 1.12; p > .10) improve performance significantly over **SC – MC**.

[17] Equivalent test statistics for **CH/S – D** and **CH/A – D**, are (n = 27; z = 1.61; p > .10) and (n = 27; z = 1.63; p > .10).

The ability of **CH – MC** to outperform these two treatments reflects superior use of the subordinates' information. Note that this is *not* true for **CH/A – D**; subject to coordination, the rate of efficient coordination is only slightly lower in **CH/A – D** than **CH – MC**. The problem in **CH/A – D** is the subset of groups that struggle with coordination.

Result 4: *The data are largely consistent with **H4**. All three chat treatments produce significantly higher total surplus than the parallel structured communication treatments. As with structured communication, managerial control yields the best performance. This reflects both high levels of coordination and improved usage of the subordinates' information.*

The results strongly support picking a combination of managerial control and rich communication between managers and subordinates. Managerial control combined with chat yields significantly higher total surplus than either managerial control combined with structured communication or delegation combined with either structured communication or free-form chat. The only treatment that **CH – MC** fails to *significantly* outperform is **CH/A – D**, but this reflects the higher variance of outcomes in the latter treatment. Given that **CH – MC** offers higher average total surplus *and* significantly lower risk than **CH/A – D**, it is difficult to argue that **CH – MC** is not the preferred option.

The high performance of b is due to both high levels of coordination and a relatively strong ability to use the subordinates' information. The next section digs more deeply into the process underlying why this treatment does so well on both dimensions while others fail.

5.2. Process: This subsection examines the processes underlying the treatment effects described in Section 5.1 with a focus on information transmission in the treatments with managerial control (**SC – MC** and **CH – MC**). In both cases managers achieve almost perfect coordination, but only in **CH – MC** do managers take advantage of their subordinates' information to outperform the babbling equilibrium. We show that this reflects what information is communicated to managers and how they utilize it.

5.2.a. Structured Communication: Contrary to **H3**, neither treatment combining delegation with structured communication (**SC/S – D** and **SC/A - D**) has a significant impact on total surplus relative to **NC – D**. The fundamental problem in both cases is a failure to much improve the coordination rate.

SC/S - D creates a different coordination problem than **NC – D**. Rather than having to coordinate on actions, subordinates have to coordinate on messages. If the subordinates agree on a message by the third round of communication, they almost always coordinate their actions (96%). The problem is that the subordinates only reach an agreement in 63% of the observations. Experience helps little, with an agreement rate of only 66% in Rounds 10 – 18. Without an agreement, the coordination rate falls to 40%.

Making matters worse, agreements do not make efficient coordination more likely. Subject to coordinating, the rate of efficient coordination is 53% with an agreement versus 49% without. This follows from the nature of agreements. For games where the efficient and safe equilibria do not coincide (G ≠ 3), 62% of agreements call for play of the safe equilibrium. The safe equilibrium provides a straightforward way of solving the difficult coordination problem faced by subordinates, and they take advantage of it.

Turning to **SC/A – D**, two things have to happen for managers to exercise effective leadership: managers have to make useful suggestions and subordinates need to follow them. Unfortunately, neither step reliably occurs.

Managers often give poor advice. Consider games where the safe and efficient equilibrium do not coincide (G ≠ 3). Even in Rounds 10 – 18, when managers have gained some experience, 14% of messages do not call for coordination. Given that managers in **SC – MC** have a coordination rate over 99%, indicating that they understand the need to coordinate, it is hard to fathom why many managers give advice to *not* coordinate.[18] Even when coordination is advised, managers often take a conservative approach by calling for the safe equilibrium. In Rounds 10 – 18, the safe and efficient equilibria are almost equally likely to be proposed (38% vs. 39%).

The conservative approach of managers would make sense if suggesting the safe equilibrium led to coordination when none would occur otherwise, but this is not the case. Define the manager's "realized suggestion" as the suggestion made *for the realized game*. Once again, consider games where the efficient and safe equilibria can be distinguished (G ≠ 3). In Rounds 10 – 18, the probability that the subordinates coordinate is high when the realized suggestion calls for either the safe or the efficient equilibrium (72% and 76% respectively). These figures compare well with the 44% coordination rate for all other realized suggestions, but suggesting the safe equilibrium does *not* make coordination more likely than suggesting the efficient equilibrium. It does shift outcomes from the efficient equilibrium (68% when suggested) to the safe equilibrium (72% when suggested), harming manager payoffs and total surplus.[19] It isn't surprising that managers are too conservative, since suggesting the safe equilibrium is an obvious strategy and generally yields high coordination rates. Only by experimenting with suggesting the efficient equilibrium

[18] The best explanation is that failing to advise coordination reflects a misguided attempt to split the difference between the two subordinates. In 77% of the cases where coordination is *not* suggested, a higher number is suggested for S1 than S2. In other words, the suggestions are shaded towards the preferred outcome for each subordinate.

[19] Manager suggestions vary by game and lagged outcome. For example, a manager may suggest the safe equilibrium because she knows that her subordinates have previously coordinated on the safe equilibrium. Thus, the association between realized suggestions of the safe equilibrium and coordination may reflect the circumstances when such suggestions are made rather than a causal link. To check for this possibility, we have run probits with coordination as the dependent variable that control for the game and the lagged outcome. The estimated difference between having received a suggestion to choose the safe equilibrium versus the efficient equilibrium is negligible – the estimated marginal effect is -1.9% with a standard error, corrected for clustering, of 11.1%.

can they realize that suggesting the safe equilibrium does not help. It is probably unrealistic to expect managers to grasp this subtle point.

Result 5: *Performance in **SC/S – D** is limited by frequent failures to reach an agreement between the subordinates. In **SC/A – D**, little effect is observed due to poor advice by managers, especially since conservative advice fails to overcome coordination failure.*

Two things have to happen in **SC – MC** for a group to take advantage of the subordinates' information. The subordinates have to send messages that are informative about the state of the world, and the manager has to correctly interpret the information contained in a messages. The theory presented in Section 3 focuses on the first issue and concludes that information transmission will fail since the subordinates have no incentive to send informative messages. Built into the theory is an assumption that the messages would be interpreted correctly if informative. In reality, the messages sent by S1 and S2 contain useful information, but managers make frequent errors in using messages. Total surplus is about the same as predicted by the babbling equilibrium because the advantages from better than expected information transmission are wiped out by errors in using this information.

Table 4: Messages as a Function of Game

		Game (Mapped)				
		1	2	3	4	5
Message (Mapped)	1	18	1	1	1	1
	2	1	34	2	1	0
	3	11	9	79	3	3
	4	16	15	11	73	3
	5	41	37	27	18	80

Table 4 displays the messages sent in Rounds 10 – 18 of **SC – MC** as a function of the game. Data from S2 players has been remapped to be from an S1's point of view, allowing us to combine data for the two roles.[20] If messages are uninformative, as the theory predicts, there should be no correlation between messages and the game being played. Instead, there is strong positive correlation ($\rho = .33$).[21] Play of a babbling equilibrium implies that subordinates will only tell the truth in 20% of the observations, but the observed likelihood of truth-telling is 58%. Even when it is least beneficial to do so (Game 1 for S1 or Game 5 for S2), 21% of messages tell the truth. If truth-telling was solely due to a failure to grasp the

[20] Recall that Equilibrium 5 is the most desired outcome for S1 and Equilibrium 1 is the most desired outcome for S2. We remap games for S2: G' = 6 - G. Messages are remapped in an analogous fashion: M2' = 6 - M2.

[21] To show that this correlation is statistically significant, we regressed the (mapped) message on the (mapped) game. The only other right side variable was round dummies. The parameter estimate is .296 with a standard error, corrected for clustering at the group level, of .044.

strategic value of lying, we'd expect subordinates to lie more as they learn that lying pays. This is not the case, with 58% truth-telling in both Rounds 1 – 9 and Rounds 10 - 18. Purely self-interested subordinates should always send a message corresponding to their most preferred equilibrium. This is the most common type of lie in Rounds 10 – 18, but 34% of self-serving lies are partial lies (i.e. the message lies strictly between the true game and the subordinate's preferred equilibrium).[22] This resembles the partial lying observed in papers like Fischbacher and Föllmi-Heusi (2013).[23]

Result 6: *The messages sent by subordinates are informative. The data are not consistent with the first part of H2. Partial lies are common.*

On aggregate, managers respond to the information in their subordinates' messages. Table 5 shows the managers' average choices as a function of the messages sent by the two subordinates. To increase the size of the dataset, we use data from all eighteen rounds – there is little change in the relationship between messages and manager choices over the course of the experiment. Cells with five or fewer observations are left blank due to the small amount of data, and we delete the small number of observations (7/486) where the manager did not choose the same action for her two subordinates. When the two messages coincide, the M follows the messages closely (but not perfectly). When the two messages differ, the manager's choices generally increase in each subordinate's message (holding the other's message fixed). The response of managers to messages is both strong and statistically significant.[24]

Table 5: Manager Choices as a Function of Messages

		Message S2				
		1	2	3	4	5
Message S2	1	1.38	---	---	---	---
	2	1.57	2.25	---	---	---
	3	2.42	2.58	2.98	---	---
	4	2.72	3.00	3.67	3.71	4.00
	5	2.90	3.08	3.52	4.50	4.79

[22] Self-serving lies that are shaded away from the actual game towards the subordinates' preferred equilibrium. There is a small percentage of messages (5%) that are actually shaded towards the *other* subordinates' preferred equilibrium.

[23] There are a small number of observations (3.7% of all messages) where subordinates tell lies that are not self-serving (not shaded in the direction of the subordinate's preferred equilibrium). The proportion of such lies falls with experience (4.9% in Rounds 1 – 9 vs. 2.6% in Rounds 10 – 18), suggesting that these are primarily errors.

[24] To establish statistical significance, we ran a regression where the dependent variable is the common strategy chosen by the manager for her two subordinates, and the independent variables are the two messages. The parameter estimates are .361 and .392 with standard errors, corrected for clustering at the group level, of .051 and .049.

Given that subordinates send useful information and managers respond to their subordinates' messages, it is surprising that total surplus is no better than in the babbling equilibrium. The problem is that managers often make choices that seem to be clear errors. For example, in the frequent cases (31% of observations) where the two subordinates' messages match ($M_1 = M_2$), they are almost certainly telling the truth (98%). Not surprisingly, it is an empirical best response to assign both subordinates the action that corresponds to their messages ($A_1 = A_2 = M_1 = M_2$), but managers fail to do so in 18% of these observations. Managers making this type of error earn an average payoff of 66.6 ECUs, compared with 79.6 ECUs for those who play the best response.

Another common error occurs when S1 and S2 send diametrically opposed messages by choosing $M_1 = 5$ and $M_2 = 1$ (19% of all observations). Obviously at least one of the subordinates is lying and the safe outcome ($A_1 = A_2 = 3$) is the empirical best response to diametrically opposed messages, but only 35% of managers follow this course of action. This type of error reduces average total surplus (66.9 vs 63.3 ECUs), albeit by less than in our first example.

Making matters worse, managers do not learn to avoid these errors. The frequency of the first type of error falls a bit between the first and second halves of the experiment (19% vs. 16%), and the frequency of the second error type increases slightly from 59% to 70%.

Errors in using the information contained in subordinates' messages explain why managers in **SC - MC** do no better than the babbling equilibrium. To see how well managers could do just by avoiding obvious errors, suppose they adopt the following simple rule: If the subordinates' messages agree, choose the action that matches their messages; otherwise play the babbling equilibrium. Over Rounds 10 - 18, this rule yields an average total surplus of 73.3 compared to 71.1 for the babbling equilibrium and 71.7 for the average total surplus actually achieved by managers. The efficiency gain from the simple rule is 26.4% compared to the 6.5% actually achieved, and it yields significantly higher total surplus than either the babbling equilibrium ($z = 4.38$; $p < .01$) or the realized total surplus ($z = 2.32$; $p < .05$). Managers could easily outdo the babbling equilibrium, but fail as to effectively use the information transmitted by their subordinates.

Result 7: *Managers in* ***SC – MC*** *respond to subordinates' message but make frequent errors using the information contained in the messages. These mistakes cause their failure to beat the babbling equilibrium.*

There are three specific things to take away from the various structured communication treatments. First, in all three treatments there is room for improvement. Even in **SC – MC**, the one case where coordination is *not* a problem, little advantage is taken of subordinates' information. Second, managers are error prone. Whether giving poor advice, being excessively conservative, or failing to grasp obvious information from their subordinates' messages, managers consistently make mistakes that hold down total surplus. Finally, even though there is no incentive to reveal their information, subordinates frequently do

so. The manner in which they do so would not surprise anyone familiar with the literature on lie aversion; some subordinates tell the truth, but lying is common including the frequent use of partial lies.

5.2.b: Free-form Chat: To evaluate the impact of specific message types in the three chat treatments, we developed a systematic scheme for coding message content. The goal was to quantify communication that might be relevant for the play of the game, avoiding prejudgments about which sorts of messages were important. We employed the methods developed by Cooper and Kagel (2005). After reading a random sample of conversations, we developed a coding scheme. Two research assistants then independently coded the content of all chat conversations. No effort was made to force agreement among coders. For several categories (marked with asterisks on Table 6), the initial two coders had a Cohen's kappa of less than .5, indicating relatively low agreement. These categories were all recoded by a third coder who was given extensive training in an attempt to improve the quality of the coding. The research assistants were not informed about any hypotheses the co-authors had about the messages. They were told that their job was to simply capture what had been said without concern to the possible effects of what had been said. Coding was binary – a message line was coded as a 1 if it was deemed to contain the relevant category of content and zero otherwise. We had no requirement on the number of codings for a message line – a coder could check as many or few categories as he or she deemed appropriate. A number of the categories also had sub-categories. For example, the coding scheme has a category for suggesting what product types should be chosen and sub-categories for specific suggestions (e.g. suggesting play of the efficient equilibrium). A coder was free to check whatever sub-categories they deemed appropriate when the corresponding category was checked off. Our analysis of the coding uses averages across coders unless otherwise noted.

Table 6 reports the frequency of the coding categories across all rounds, broken down by treatment. Statistics in this subsection are based on all rounds unless otherwise noted. Some of the categories are not relevant in **CH/S – D** since the manager cannot send messages, and hence no figures are reported. "Contradict" is not a category per se, but instead is a combination of the preceding two categories that accounts for cases where one subordinate truthfully reported what game was being played and the other lied. Table E1 in Appendix E provides a fuller description of the categories. The unit of observation is the entire conversation prior to play in a single round rather than a single message line within that conversation or messages from only one individual in the conversation. So, for example, in 93.1% of the pre-play dialogues in **CH/S - D**, at least one subordinate suggested what actions should be chosen.

Before discussing the content of messages, the first two lines of Table 6 report the average number of messages sent per round, broken down by role. Managers send significantly more messages in **CH – MC** than **CH/A – D** (n = 54; z = 2.40; $p < 0.05$), and subordinates send significantly more messages in **CH –**

MC than either **CH/S – D** (n = 54; z = 1.88; p < 0.10) or **CH/A – D** (n = 54; z = 2.76; p < 0.01).[25] We noted earlier that total surplus has high variance in the **CH/A – D** treatment, and the same goes for the behavior of managers. The three most *and* the three least talkative managers come from **CH/A – D**, and, more generally, the variance in the frequency of messages is higher in **CH/A – D** than **CH – MD** (StDev = 3.17 vs. StDev = 1.99).[26] Our prediction of relatively high performance in **CH/A – D** depended on leadership by managers, but a surprisingly large fraction of managers fail to provide any sort of leadership.

Table 6: Frequency of Coding Categories

Coding Category	**CH/S – D**	**CH/A - D**	**CH - MC**
# Messages (Manager)	n/a	3.33	4.56
# Messages (Subordinate)	4.46	3.72	5.31
Any Suggestion	93.1%	73.3%	90.7%
Suggest Safe Equilibrium	54.1%	37.6%	60.6%
Suggest Efficient Equilibrium	48.4%	41.0%	57.7%
Agreement to Suggestion	78.9%	54.0%	67.9%
Discuss Need to Coordinate *	6.4%	3.5%	4.0%
Discuss Fairness *	31.8%	34.6%	43.9%
Discuss Efficiency	39.4%	16.0%	37.7%
Questions About Rules of the Experiment *	11.7%	8.8%	15.0%
Questions About How to Play *	10.9%	6.0%	14.2%
Explanation *	21.7%	39.3%	32.3%
Ask What Game Is Being Played (M)	n/a	14.9%	19.4%
Truthfully Reveal Game	n/a	28.8%	68.4%
Lie About Game	n/a	0.0%	3.4%
Contradict (One tells truth, other lies)	n/a	0.0%	2.5%

Turning to message content, recall that **CH/S – D** significantly improves total surplus relative to **SC/S – D**, the parallel treatment with structured communication. Performance in **SC/S - D** is limited by failures to reach an agreement as well as a tendency not agree on the efficient equilibrium. Agreements are more frequent in **CH/S – D** (63% agreement in **SC/S – D** vs. 79% in **CH/S – D**). Given that subordinates almost always coordinate their actions if an agreement is reached (95%), the higher agreement rate translates into improved coordination and, by extension, higher total surplus. **CH/S – D** does not solve the second problem that plagued **SC/S – D**. In cases where the safe and efficient equilibria do not coincide ($G \neq 3$), only 34%

[25] For subordinates, an observation for the statistical test is the average number of messages sent by the *pair* of subordinates in a group. The difference between **CH/S – D** and **CH/A – D** is not statistically significant (n = 54; z = 1.03; p > .10).

[26] There are no significant differences across treatments in the variance of message frequency for subordinates.

of agreements call for play of the efficient equilibrium. This is differs little from the 32% figure for **SC/S – D**. When subordinates agree on efficient coordination, they usually follow through (96%), but **CH/S - D** does no better than the babbling equilibrium because such agreements occur too rarely.

Result 8: *Total surplus is higher in CH/S – D than SC/S – D because agreements are much more common in CH/S – D. This promotes coordination, but does improve the likelihood of the efficient equilibrium.*

Total surplus is basically equal in **CH/A – D** and **CH/S – D**, but the factors driving performance differ. Subject to reaching an agreement when G ≠ 3, agreements for play of the efficient equilibrium are more frequent in **CH/A – D** (43%) than **CH/S – D**. Such agreements are usually followed (90%), but the problem is that agreements of any kind are much *less* frequent in **CH/A – D** than **CH/S – D** (54% vs. 79%).[27] This problem doesn't go away with experience, as the agreement rate falls slightly from 58% to 50% between the first and second halves of the experiment. Failing to reach an agreement is associated with a lower coordination rate (71% vs. 94%). Thus, the coordination rate is lower in **CH/A – D** than **CH/S – D**, leading to the odd combination of lower total surplus and more play of the efficient equilibrium.

In **CH - MC**, coordinating the subordinates' choices is trivial; the question is whether the manager can achieve an efficient outcome given that she cannot observe G. A key insight of our work is that managers get remarkably good information about what game is being played, making efficient coordination possible. In most cases (68%), at least one subordinate truthfully reveals the game being played and only in 3% of observations does a subordinate lie about the game. These figures improve with experience from 65% and 5% in Rounds 1 – 9 to 72% and 2% in Rounds 10 – 18. Information transmission is far more efficient in **CH – MC** than in **SC – MC** where managers usually receive conflicting reports (69%). They get information, but it is difficult to interpret and, as documented in Section 5.2.a, the managers struggle with extracting information from the subordinates' messages. In **CH – MC**, extracting information is simple for managers. They receive some report about the game in 69% of the observations. For 95% of these cases, they receive a truthful report without contradiction. Almost always, a manager either has no information and therefore doesn't face an information extraction problem or has unambiguous information that makes information extraction trivial.

The high quality of information transmission is enormously important for efficiency. In games where the safe and efficient equilibria do not coincide (G ≠ 3), the frequency of efficient coordination rises from

[27] Consistent with the high variance of total surplus, there is more variance in groups' ability to reach agreements for **CH/A – D** than **CH/S – D**. Looking at the number of periods (out of 18) that a group reaches an agreement, the standard deviation is 4.53 for **CH/A – D** vs. 2.87 for **CH/S – D**.

18% when neither subordinate truthfully reveals the game to 52% when at least one tells the truth.[28] The frequency of efficient coordination is almost unaffected when one subordinate tells the truth and the other lies (53%), albeit based on a very small number of observations. Unlike politics, the truth wins in this environment.

Result 9: *Better transmission of the subordinates' information occurs in* ***CH – MC*** *than in* ***SC - MC****. This happens because subordinates frequently tell the truth, almost never lie, and rarely confront managers with conflicting reports. Truth-telling is strongly associated with play of the efficient equilibrium.*

Accurate transmission also takes place in **CH/A – D**, albeit less frequently than in **CH – MC**. Subordinates are far less likely to report what game is being played in **CH/A – D** than **CH – MC**, but always tell the truth when they do so. The lack of lies is less surprising here than for **CH – MC**; there is little incentive to lie since the manager does not control what actions are chosen. Like **CH – MC**, accurate transmission promotes efficient coordination in **CH/A – D**. The frequency of efficient coordination is 51% when the game is truthfully reported (and G ≠ 3), compared with 33% otherwise.

Table 7: Frequency of Truth-Telling and Lying

Game (Remapped)	SC – MC		CH – MC	
	Truth	Lie	Truth	Lie
1	24.9%	75.1%	46.6%	2.5%
2	36.4%	63.6%	42.8%	3.1%
3	68.0%	32.0%	43.0%	2.2%
4	73.3%	26.7%	50.1%	1.9%
5	87.6%	12.4%	47.1%	0.3%

The nature of truth-telling strongly differs between **CH - MC** and **SC - MC**. Most subordinates in **SC – MC** mix between telling the truth and lying; 69% both tell the truth in at least a third of the rounds and lie in at least a third of the rounds. There are only two subordinates that never lie and none that never tell the truth. As noted previously, partial lying is common. Subordinates are strategic when choosing to tell the truth, doing so more often when it is to their benefit to be believed. This can be seen in Table 7. The games have been remapped for the S2 role so all observations are from the point of view of S1 (i.e. Equilibrium 1 is the worst equilibrium and Equilibrium 5 is the best).[29] Subordinates are least likely to tell

[28] It may be surprising that the coordination rate is not close to zero when there isn't a truthful report and G ≠ 3. In 87% of these cases, there is a suggestion that the efficient equilibrium should be played. A possible interpretation is that these suggestions serve as an indirect method of revealing the game, making a direct report unnecessary.

[29] Remapping the games allows us to pool data for the two subordinates into a single table. Game 1 for a D2 is mapped to Game 5, Game 2 for a D2 is mapped to Game 4, etc.

the truth and most likely to tell a lie when the efficient equilibrium would be worst for them (Game 1). This flips when the efficient equilibrium would be best for them (Game 5).

These patterns change in **CH – MC**. Mixing between truth-telling and lying is largely non-existent. There are 47 subjects in the subordinate role who send at least one message reporting what game is being played, averaging 9.8 reports over the course of 18 rounds. 35 of 47 reporting subordinates never lie and another 6 of 47 only lie once. None lie in more than 40% of their reports. Unlike **SC – MC**, there are *no* subordinates that both tell the truth in at least a third of the rounds and lie in at least a third of the rounds. Subjects mix, but it is almost entirely between telling the truth and not reporting. Subject to lying, partial lies are common (40% of lies), but in absolute terms partial lies are necessarily rare given the low overall rate of lying. Returning to Table 7, truth-telling is not sensitive to incentives.[30] Telling the truth is about as likely when it is most advantageous for a subordinate to lie (46.6% in Game 1) as when it is most advantageous to tell the truth (47.1% in Game 5).

Result 10: *The frequency of truth-telling, lying, and non-reports in **CH – MC** is *not* sensitive to what game is being played. Unlike **SC – MC**, the patterns of truth-telling in **CH – MC** do *not* parallel what is typically reported in the literature on lying.*

The different pattern of truth-telling in **CH – MC** suggests that the psychological mechanism underlying truth-telling is altered by the real-time, asynchronous communication available in this treatment. One possible reason for infrequent lying in **CH – MC** is that subordinates feel guiltier about lying to the manager when they have been directly asked for a report. However, it is surprisingly rare for the manager to request reports about what game is being played (19%), and the fraction of lies increases from 2% to 10% when a report is requested. Another possibility is that subordinates avoid lying because they are concerned about being "fact-checked." In both **SC – MC** and **CH – MC**, the manager knows *ex post* when a subordinate has lied, but in **CH – MC** it is possible for the other subordinate to call out a liar in real time. Indeed, in 40% of the observations where a subordinate lies, the other subordinate corrects them.[31] It may be more embarrassing to be actively called out as a liar than to merely be revealed as a liar.[32]

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[30] Table 7 reports the frequency that an individual subordinate reports truthfully at some point during the pre-play communication. This is different from the figure reported in Table 6, which shows the frequency that at least one of the two subordinates' reports truthfully at some point during the pre-play communication.

[31] This is different from the figure reported as "Contradict" in Table 6, which measures cases where one subordinate reported truthfully and the other lied. The 40% figure refers to "fact-checking" where one subordinate explicitly corrects a false report by the other. (e.g. "It is Game 3." "No, it is really Game 2.")

[32] Fact-checking partially explains why the frequency of the efficient equilibrium is the same when one subordinate tells the truth and is not contradicted versus when one subordinate tells the truth and the other contradicts them by lying, since fact-checking often gives the M guidance about which subordinate to believe.

Failing to report what game is being played could be considered a “soft” lie. However, subordinates that don’t report the game usually have little reason to do so. If one subordinate has truthfully revealed the game, there is little need for the other to reiterate this information. In line with this, the other subordinate has reported truthfully in 44% of the cases where a subordinate does not make a report. It is also pointless to report what game is being played if the safe equilibrium is going to be chosen regardless. Consider cases where the safe and efficient equilibria could be distinguished in the *previous* round ($G \neq 3$). If the safe equilibrium was previously played, *neither* subordinate reports what game is being played in the current round in 44% of the observations; this makes sense if subordinates expect the manager to choose the safe equilibrium regardless of any new information. By contrast, if subordinates expect the efficient equilibrium to be played then they have an incentive to guide the manager’s decision by reporting the current game. Indeed, when the efficient equilibrium was played in the previous round ($G \neq 3$), *neither* subordinate reports for only 17% of the observations. Overall, 78% of non-reports occur in cases where either the other subordinate has told the truth or the safe equilibrium is played. Non-reports largely do not appear to be a form of deception.

5.2.c: The Effect of Chat Content: None of the preceding establishes a causal relationship between the content of pre-play communication and outcomes. Establishing causality is tricky because outcomes and the content of communication may both depend on lagged outcomes. Table 8 shows the results of probit regressions that control for lagged outcomes. Separate regressions are shown for each of the three treatments with chat. The dependent variable is either a dummy for coordination (the two subordinates’ actions match) or efficient coordination (the subordinates’ action match the game being played). First round data are dropped to allow the use of lagged variables. There is no regression for coordination in **CH – MC** because there was 100% coordination following Round 1.

As independent variables, all regressions include dummies for lagged outcomes (coordination failure, safe coordination, and efficient coordination with other coordination as the omitted category), game dummies, and a dummy for late rounds (Rounds 10 – 18). These are not reported to save space in the table. All regressions include the average coding for the categories reported in Table 6 with the following exceptions. The categories for “Lie About Game” and “Contradict” are highly collinear, so we only include the latter (we felt this was the more interesting of the two). There were no cases of contradicting reports in **CD/A – D**, so this variable is dropped. Including suggestions about what actions to play makes the regressions circular (subjects do what they say they should do), so these categories are omitted. We report marginal effects. Standard errors are corrected for clustering at the group level.

Table 8: Probit Regressions, Effects of Chat on Play

Treatment	CH/S – D		CH/A – D		CH – MC
Dependent Variable	Coordination	Efficient Coordination	Coordination	Efficient Coordination	Efficient Coordination
Agreement	0.106*** (0.021)	0.217*** (0.060)	0.114*** (0.024)	0.184** (0.082)	0.051 (0.078)
Discuss Need to Coordinate	-0.031 (0.046)	0.231 (0.180)	0.032 (0.068)	0.080 (0.231)	-0.157 (0.199)
Discuss Fairness	0.010 (0.023)	-0.264*** (0.076)	-0.004 (0.024)	-0.088 (0.088)	-0.107 (0.105)
Discuss Efficiency	0.008 (0.026)	0.272*** (0.063)	0.050 (0.038)	0.262*** (0.098)	0.111 (0.090)
Questions About Rules	-0.053* (0.030)	-0.045 (0.148)	0.218*** (0.057)	0.112 (0.114)	-0.168 (0.104)
Questions About Play	0.036 (0.033)	-0.130 (0.148)	-0.061 (0.052)	0.159 (0.166)	-0.099 (0.149)
Explanation	-0.039 (0.031)	0.061 (0.125)	-0.076** (0.031)	-0.165* (0.086)	0.012 (0.098)
Ask What Game			-0.054** (0.024)	-0.121 (0.085)	0.127 (0.081)
Truthfully Reveal Game			0.022 (0.029)	0.202* (0.118)	0.294*** (0.094)
Contradict					-0.045 (0.234)

Notes: All models include 459 observations. Marginal effects are reported. In parentheses, we report standard errors corrected for clustering at the group level. All regressions include controls for the game being played, three-round block, and lagged outcomes. Coefficients for these variables are not reported to save space. Three (***), two (**), and one (*) stars indicate significance at the 1%, 5%, and 10% levels using two-tailed tests.

We have stressed the importance of agreements for coordination in **CH/S – D** and **CH/A – D**, and the regressions provide additional evidence of this. For both treatments, there is a strong positive relationship between reaching an agreement and either coordination or efficient coordination. Agreements play little role in **CH – MC**. The manager is a dictator in this treatment and does not need the subordinates to agree on a course of action.[33] The regressions also support our observation that efficient coordination is likelier in both **CH/A – D** and **CH – MC** when at least one subordinate reports truthfully, with the effect being stronger in the latter case. Contradictions have little effect in **CH – MC**; as noted previously, the truth typically wins in this environment. It is interesting to note that discussing efficiency has a strong positive effect in **CH/S – D** and **CH/A – D**, but not in **CH – MC**. Once again, this illustrates the importance of

[33] Being dictatorial might make subordinates less willing to share information, but the regression captures this directly through the effect of truthfully revealing the game.

control. Managers can impose efficiency in **CH – MC** without needing buy-in from their subordinates. Discussion of fairness plays an important role in **CH/S – D**, moving play towards the safe equilibrium, but plays surprisingly little role in the other two treatments. It is difficult to argue that the safe equilibrium is the fair thing when it harms the manager (and the manager has a voice).

6. Concluding Remarks: This paper studied the roles of leadership and communication in a demanding experimental environment, the MS game. This game combines four properties that characterize many organizational settings: coordinating on a common course of action benefits everyone, subordinates have divergent preferences over possible outcomes, managers lack the necessary information to simply impose efficient coordination on their subordinates, and subordinates have the necessary information but also have little reason to truthfully reveal it. The MS game stresses asymmetries; the manager doesn't know what game is being played, and the interests of the subordinates are misaligned.

Achieving efficient coordination requires two things: (1) The choices of the subordinates have to be coordinated and (2) the subordinates' information must be incorporated into the choice of action at achieve efficiency. Either rich communication (chat) or managerial control are sufficient in isolation to solve the coordination problem, but a combination of chat *and* managerial control is necessary to outperform the babbling equilibrium, gaining almost half of the possible gains over the babbling equilibrium. Free-form chat can seem like the magic bullet in experimental economics, solving all problems with coordination and/or cooperation. This is not the case in our experiment. Even with chat, the assignment of decision rights plays an important role in determining how the group fares.

The key feature that allows the combination of chat and managerial control to function so well is that information transmittal is remarkably good. The MS game with managerial control gives subordinates strong incentives to lie, and with structured communication, subordinates often do so. Managers receive only limited information and struggle to use it effectively. When rich communication is used, subordinates generally reveal what game is being played and rarely lie. Managers take advantage of the good information they receive to make substantial progress towards achieving efficient coordination.

The patterns of communication about the state of the world (i.e. what game is being played) in **CH – MC** are quite different from what is typically observed in experiments on truth-telling. This could reflect a difference between free-form and pre-formulated messages, but the results of Lundquist *et al.* suggest otherwise since they frequently observe deceptive lies (40%) with free-form messages. We speculate that having two identically informed subordinates together with the asynchronous nature of messages plays a major role in this finding by making it possible that a lie will be contradicted (fact checked) in real time. When lies are told, we often (40%) see fact-checking. We speculate that the psychic costs of being called out as a liar are enough to overcome the pecuniary benefits of lying to the manager. It is one thing to have

the manager find out after the fact that you have lied, but it is presumably much more embarrassing to be called out mid-conversation.

In **CH/A – D** and **CH – MC,** the manager and subordinates can freely discuss the available options. The political science literature refers to this type of open multi-lateral chat as "deliberation."[34] It has been suggested (Dawes et al.; 1990, Orbell et al., 1988; Dryzek and List, 2003) that deliberation makes group members more willing to take into account the interests of the whole group, perhaps by increasing group identity. Along similar lines, the reluctance to lie in these two treatments may in part reflect subordinates putting more weight on the interests of the group as a whole.

We study an intentionally simple game designed to capture a set of features that are present in many organizations. A natural goal for follow-up work is abandoning some of that simplicity in exchange for greater verisimilitude. One possible approach is using subjects with real-world managerial experience as subjects in the manager role. Existing evidence suggests that using managers would *not* affect our results (for coordination games with leaders, see Cooper, 2006; for games in general, see Fréchette, 2015), but it would still be interesting to see how real-world managers approach the MS game. Another possibility is looking at decision making by groups. Many decisions within organizations are made by groups, and there is an extensive literature suggesting that groups and individuals do not make identical decisions either for games generally or coordination games specifically (Feri et al., 2010).

The unwillingness of subordinates to lie when managerial control and chat are combined is striking and merits further exploration. We conjecture that this is due to fear of being fact checked, but it could reflect other factors such as increased group identity or some other feature chat such as receiving direct requests from the manager. More work is needed to identify the mechanism underlying increased truthfulness.

[34] See Myers and Mendelberg (2013) and Karpowitz and Mendelberg (2011) for overviews of research on political deliberation and of experimental work on the topic, respectively.

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Appendix A: Payoff Table

Table A1: Stage Game Payoffs (k1 = 54, k2 = 7, k3 = 4, and k4 = 14)
Note: Each cell contains the payoffs for S1 (π_{S1}), S2 (π_{S2}), and M (π_M).

Game 1

	C1	C2	C3	C4	C5
R1	26, 54, 80	12, 29, 41	-2, 4, 2	-16, -21,-37	-30,-46,-76
R2	15, 40, 55	29, 43, 72	15, 18, 33	1, -7, -6	-13, -32,-45
R3	4, 26, 30	18, 29, 47	32,32, 64	18, 7, 25	4, -18, -14
R4	-7, 12, 5	7, 15, 22	21, 18, 39	35, 21, 56	21, -4, 17
R5	-18, -2, -20	-4, 1,-3	10, 4, 14	24, 7, 31	38, 10, 48

Game 2

	C1	C2	C3	C4	C5
R1	22, 50, 72	8, 33, 41	-6, 8, 2	-20, -17, -37	-34,-42,-76
R2	19, 36, 55	33, 47, 80	19, 22, 41	5, -3, 2	-9, -28,-37
R3	8, 22, 30	22,33, 55	36, 36, 72	22, 11, 33	8, -14, -6
R4	-3,8, 5	11,19,30	25, 22, 47	39, 25, 64	25, 0, 25
R5	-14,-6,-20	0,5,5	14, 8, 22	28, 11, 39	42, 14, 56

Game 3

	C1	C2	C3	C4	C5
R1	18, 46, 64	4, 29, 33	-10,12, 2	-24, -13, -37	-38, -38, -76
R2	15, 32, 47	29, 43, 72	15, 26, 41	1, 1, 2	-13, -24,-37
R3	12, 18, 30	26, 29, 55	40, 40, 80	26, 15, 41	12, -10,2
R4	1,4, 5	15, 15, 30	29,26, 55	43,29, 72	29, 4, 33
R5	-10,-10,-20	4,1, 5	18,12, 30	32, 15, 47	46, 18, 64

Game 4

	C1	C2	C3	C4	C5
R1	14, 42, 56	0, 25, 25	-14, 8,-6	-28, -9, -37	-42, -34, -76
R2	11, 28, 39	25, 39, 64	11, 22, 33	-3, 5, 2	-17,-20,-37
R3	8, 14, 22	22, 25, 47	36, 36, 72	22, 19, 41	8, -6, 2
R4	5, 0, 5	19, 11, 30	33, 22, 55	47, 33, 80	33, 8, 41
R5	-6,-14,-20	8, -3, 5	22, 8, 30	36, 19, 55	50, 22, 72

Game 5

	C1	C2	C3	C4	C5
R1	10, 38, 48	-4, 21, 17	-18, 4,-14	-32,-13,-45	-46,-30, -76
R2	7, 24, 31	21, 35, 56	7, 18, 25	-7, 1,-6	-21,-16,-37
R3	4, 10, 14	18, 21, 39	32, 32, 64	18, 15, 33	4, -2, 2
R4	1,-4,-3	15, 7, 22	29, 18, 47	43, 29, 72	29, 12, 41
R5	-2,-18,-20	12,-7, 5	26,4, 30	40, 15, 55	54, 26, 80

Appendix B: Proof of Theorem

Lemma: For any beliefs, the manager will choose the same actions for the two subordinates (S1 and S2).

Proof: Suppose not. This implies that the manager is choosing an outcome that is not a Nash equilibrium if the two subordinates are allowed to choose their own actions. Either of the subordinates could improve its payoff by switching to the action chosen by the other subordinate. Moreover, the other subordinate's payoff is also increased by this change. Since the manager's payoff equals the sum of the two subordinates' payoffs, the manager's payoff also increases. This implies that the manager's initial choice could not have been optimal.

Given the preceding lemma, we can refer to the manager as choosing a single action in response to the subordinates' messages.

Theorem: There does not exist a pure-strategy PBE where the manager chooses different actions for two different states of the world.

Proof: Suppose that such an equilibrium existed. Let Σ1 and Σ2 be two states where different actions are chosen. Let A1 and A2 be the actions chosen by the manager in equilibrium in Σ1 and Σ2 respectively, where A1 ≠ A2. Without loss of generality, assume that S1 prefers the outcome in Σ1 and S2 prefers the outcome in Σ2. Let M_i^j be the message sent by Si in Σj.

It cannot be the case that $M_1^1 = M_1^2$. Proof is by contradiction. Suppose $M_1^1 = M_1^2$. This implies that the manager's choice is determined solely by S2's message. Since S2 prefers A2, it should always send M_2^2 whether the true state of the world is Σ1 or Σ2. But then the manager would choose A2 in both Σ1 and Σ2. A contradiction follows. By the same logic, $M_2^1 \neq M_2^2$.

Suppose that S1 deviates by sending M_1^1 in Σ2. The resulting pair of messages (M_1^1, M_2^2) cannot make S1 better off than A2 or a profitable deviation from equilibrium exists. It follows that (M_1^1, M_2^2) leads to an outcome that makes S1 worse off (weakly) than A2. However, because the two subordinates' preferences over possible outcomes are diametrically opposed, this implies that S2 can gain by sending M_2^2 in Σ1, giving S2 a profitable deviation from equilibrium. A contradiction follows. **Q.E.D.**

Appendix C: INSTRUCTIONS[35]

NC – D

Thanks for coming to the experiment. You will receive 5 euros for participation in the experiment. Also, you will earn additional money during the experiment.

Participants have been randomly assigned to one of three roles: F, C and A. This role will be the same throughout the experiment.

There will be 18 separate periods. We will now present the instructions for the first block of nine periods. Later you will receive further instructions. In each period, you will be in a group of three participants, one in each role. The persons that you are matched with will change from period to period. During the nine periods you will never meet another person twice. Also, at no time will you know the identity of who you are matched with.

Each period is independent from the others and develops in the following way. At the beginning of the period, the computer will randomly determine which of the following five games will be played.

In each of the cells the first number shown in yellow is the payoff that the person in the F role will receive, the second number shown in green is the payoff that the person in the C role will receive and the third number shown in red is the payoff for the person in the A role. As you can see all five games have five rows: f1, f2, f3, f4 and f5 [Note: The Spanish word for row is "fila". We have kept the original abbreviations in the payoff tables.], and five columns; c1, c2, c3, c4 and c5. [Note: The Spanish word for row is "fila". We have kept the original abbreviations in the payoff tables shown below.] Observe also that the numbers in the different cells differ between the games.

Game 1

	c1	c2	c3	c4	c5
f1	26, 54, 80	12, 29, 41	-2, 4, 2	-16, -21,-37	-30,-46,-76
f2	15, 40, 55	29, 43, 72	15, 18, 33	1, -7, -6	-13, -32,-45
f3	4, 26, 30	18, 29, 47	32,32, 64	18, 7, 25	4, -18, -14
f4	-7, 12, 5	7, 15, 22	21, 18, 39	35, 21, 56	21, -4, 17
f5	-18, -2, -20	-4, 1,-3	10, 4, 14	24, 7, 31	38, 10, 48

[35] We include the instructions for two of the treatments. The rest of the instructions are available from the authors upon request.

Game 2

	c1	c2	c3	c4	c5
f1	22, 50, 72	8, 33, 41	-6, 8, 2	-20, -17, -37	-34,-42,-76
f2	19, 36, 55	33, 47,80	19, 22, 41	5, -3, 2	-9, -28,-37
f3	8, 22, 30	22,33, 55	36, 36, 72	22, 11, 33	8, -14, -6
f4	-3,8, 5	11,19,30	25, 22, 47	39, 25, 64	25, 0, 25
f5	-14,-6,-20	0,5,5	14, 8, 22	28, 11, 39	42, 14, 56

Game 3

	c1	c2	c3	c4	c5
f1	18, 46,64	4, 29, 33	-10,12, 2	-24, -13, -37	-38, -38, -76
f2	15, 32, 47	29, 43, 72	15, 26, 41	1, 1, 2	-13, -24,-37
f3	12, 18, 30	26, 29, 55	40, 40, 80	26, 15, 41	12, -10,2
f4	1,4, 5	15, 15, 30	29,26, 55	43,29, 72	29, 4, 33
f5	-10,-10,-20	4,1, 5	18,12, 30	32, 15, 47	46, 18, 64

Game 4

	c1	c2	c3	c4	c5
f1	14, 42, 56	0, 25, 25	-14, 8,-6	-28, -9, -37	-42, -34, -76
f2	11, 28, 39	25, 39, 64	11, 22, 33	-3, 5, 2	-17,-20,-37
f3	8, 14, 22	22, 25, 47	36, 36, 72	22, 19, 41	8, -6, 2
f4	5, 0, 5	19, 11, 30	33, 22, 55	47, 33, 80	33, 8, 41
f5	-6,-14,-20	8, -3, 5	22, 8, 30	36, 19, 55	50, 22, 72

Game 5

	c1	c2	c3	c4	c5
f1	10, 38, 48	-4, 21, 17	-18, 4,-14	-32,-13,-45	-46,-30, -76
f2	7, 24, 31	21, 35, 56	7, 18, 25	-7, 1,-6	-21,-16,-37
f3	4, 10, 14	18, 21, 39	32, 32, 64	18, 15, 33	4, -2, 2
f4	1,-4,-3	15, 7, 22	29, 18, 47	43, 29, 72	29, 12, 41
f5	-2,-18,-20	12,-7, 5	26,4, 30	40, 15, 55	54, 26, 80

Each of the five games has the same chance of being chosen in each period separately. That is in each period, each of the games will be chosen with 20%probability. Player F and player C will be informed of which game has been chosen, but player A will not be informed of which game has been chosen.

After having seen which game has been selected by the random draw, players F and player C will separately make decisions. Player F will choose between f1, f2, f3, f4 and f5 and player C will choose between columns c1, c2, c3, c4 and c5. Player A will not make any decisions.

The payoffs of players F, C and A will be the ones in the cell determined by the row chosen by F and the column chosen by C for the game selected by the random draw. Remember that players F and C will make their decisions independently from each other.

After each period everybody will be informed about what row was chosen by F and what column was chosen by C and about which game was randomly selected.

After this, a new period will start which will develop in the same way until reaching period 9. Remember that the persons you play with will change from period to period.

Each ECU is worth 0,02 euros. At the end of the session you will receive 5 euros plus what you will have earned in all 18 rounds of the experiment.

You can ask questions at any time. If you have a question, please raise your hand and one of us will come to your place to answer it.

INSTRUCTIONS

SC – MC

Thanks for coming to the experiment. You will receive 5 euros for participation in the experiment. Also, you will earn additional money during the experiment.

Participants have been randomly assigned to one of three roles: F, C and A. This role will be the same throughout the experiment.

There will be 18 separate periods. We will now present the instructions for the first block of nine periods. Later you will receive further instructions. In each period, you will be in a group of three participants, one in each role. The persons that you are matched with will change from period to period. During the nine periods you will never meet another person twice. Also, at no time will you know the identity of who you are matched with.

Each period is independent from the others and develops in the following way. At the beginning of the period, the computer will randomly determine which of the following five games will be played.

In each of the cells the first number shown in yellow is the payoff that the person in the F role will receive, the second number shown in green is the payoff that the person in the C role will receive and the third number shown in red is the payoff for the person in the A role. As you can see all five games have five rows: f1, f2, f3, f4 and f5, and five columns; c1, c2, c3, c4 and c5. Observe also that the numbers in the different cells differ between the games.

Game 1

	c1	c2	c3	c4	c5
f1	26, 54, 80	12, 29, 41	-2, 4, 2	-16, -21, -37	-30, -46, -76
f2	15, 40, 55	29, 43, 72	15, 18, 33	1, -7, -6	-13, -32, -45
f3	4, 26, 30	18, 29, 47	32, 32, 64	18, 7, 25	4, -18, -14
f4	-7, 12, 5	7, 15, 22	21, 18, 39	35, 21, 56	21, -4, 17
f5	-18, -2, -20	-4, 1, -3	10, 4, 14	24, 7, 31	38, 10, 48

Game 2

	c1	c2	c3	c4	c5
f1	22, 50, 72	8, 33, 41	-6, 8, 2	-20, -17, -37	-34,-42,-76
f2	19, 36, 55	33, 47, 80	19, 22, 41	5, -3, 2	-9, -28,-37
f3	8, 22, 30	22,33, 55	36, 36, 72	22, 11, 33	8, -14, -6
f4	-3,8, 5	11,19,30	25, 22, 47	39, 25, 64	25, 0, 25
f5	-14,-6,-20	0,5,5	14, 8, 22	28, 11, 39	42, 14, 56

Game 3

	c1	c2	c3	c4	c5
f1	18, 46, 64	4, 29, 33	-10,12, 2	-24, -13, -37	-38, -38, -76
f2	15, 32, 47	29, 43, 72	15, 26, 41	1, 1, 2	-13, -24,-37
f3	12, 18, 30	26, 29, 55	40, 40, 80	26, 15, 41	12, -10,2
f4	1,4, 5	15, 15, 30	29,26, 55	43,29, 72	29, 4, 33
f5	-10,-10,-20	4,1, 5	18,12, 30	32, 15, 47	46, 18, 64

Game 4

	c1	c2	c3	c4	c5
f1	14, 42, 56	0, 25, 25	-14, 8,-6	-28, -9, -37	-42, -34, -76
f2	11, 28, 39	25, 39, 64	11, 22, 33	-3, 5, 2	-17,-20,-37
f3	8, 14, 22	22, 25, 47	36, 36, 72	22, 19, 41	8, -6, 2
f4	5, 0, 5	19, 11, 30	33, 22, 55	47, 33, 80	33, 8, 41
f5	-6,-14,-20	8, -3, 5	22, 8, 30	36, 19, 55	50, 22, 72

Game 5

	c1	c2	c3	c4	c5
f1	10, 38, 48	-4, 21, 17	-18, 4,-14	-32,-13,-45	-46,-30, -76
f2	7, 24, 31	21, 35, 56	7, 18, 25	-7, 1,-6	-21,-16,-37
f3	4, 10, 14	18, 21, 39	32, 32, 64	18, 15, 33	4, -2, 2
f4	1,-4,-3	15, 7, 22	29, 18, 47	43, 29, 72	29, 12, 41
f5	-2,-18,-20	12,-7, 5	26,4, 30	40, 15, 55	54, 26, 80

Each of the five games has the same chance of being chosen in each period separately. That is in each period, each of the games will be chosen with 20%probability. Player F and player C will be informed of which game has been chosen, but player A will not be informed of which game has been chosen.

After having seen which game has been selected by the random draw, players F and player C will separately send messages to player A saying which game has been selected. This message can be truthful or not. Once player A has received the messages he will choose a row and column without knowing which game was selected.

The payoffs of players F, C and A will be the ones in the cell determined by the row and the column chosen by A for the game selected by the random draw. Remember that players F and C will send their messages independently from each other.

After each period everybody will be informed about what row and what column was chosen by A and about which game was randomly selected.

After this, a new period will start which will develop in the same way until reaching period 9. Remember that the persons you play with will change from period to period.

Each ECU is worth 0,02 euros. At the end of the session you will receive 5 euros plus what you will have earned in all 18 rounds of the experiment.

You can ask questions at any time. If you have a question, please raise your hand and one of us will come to your place to answer it.

Appendix D: Information About Additional Treatments

Beyond the seven treatments reported in the main text, we ran an additional four treatments. These were modifications of the **NC – D** and **SC – MC** treatments, and involved exploring how behavior changes either with use of a strangers matching or an increase in the value of k_4, the parameter governing the size of state losses. The hypotheses we had about these treatments are not particularly central to the main goals of this paper, and the results contain nothing that would alter our conclusions. We therefore decided to streamline the manuscript by not including these treatments in the main text, instead summarizing the design and results for these additional treatments in this appendix.

*Strangers (**STR – D** and **STR – MC**):* These treatments were identical to **NC – D** and **SC – MC** except for use of strangers matching; that is, groups changed from round to round. The matching was constructed so no participant met another person twice in a nine-round block (a point which the instructions stressed). At no time were participants informed about the identities of the other two people in their group. Because groups were not independent within a session, we conducted five sessions per treatment rather than three. There were 27 subjects in each session.

Our design focused on partners matching as the natural case since we are interested in the effect of organizational structure within long-lasting organizations. We conjectured that the repeated interactions helped groups, making it easier to coordinate on efficient coordination and possibly improving information transmission. The Strangers treatments are a robustness check, testing whether the results of **NC – D** and **SC – MC** were sensitive to what type of matching was used, specifically whether surplus would be lower with strangers matching.

*High State Losses (**HSL – D** and **HSL – MC**):* These treatments were identical to **NC – D** and **SC – MC** except we increased state losses ($k_3 = 6$ vs. $k_3 = 4$). Increasing k_3 does not affect the theoretical predictions for the game under either delegation or managerial control, but minimizes the difference between adaptation and state losses. This reduces the tension between subordinates since the gain for moving from the efficient equilibrium to a subordinate's most preferred equilibrium is tiny. For example, moving from Equilibrium 1 to Equilibrium 5 in Game 1 gains D1 12 ECUs in the Baseline treatment, but only 4 ECUs in the High State Losses treatment.

The High State Losses treatments are a second robustness check. Previous experiments with asymmetric coordination games (e.g. the battle-of-the-sexes game) suggest that achieving coordination, let alone efficiency, will be challenging with delegation. Even if coordination occurs, the tension between subordinates makes the safe equilibrium attractive, sacrificing efficiency in order to achieve coordination. Under managerial control, achieving efficiency is difficult because the tension between subordinates

provides a strong incentive to deceive the manager. The High State Losses treatments weaken tension between the subordinates, letting us explore how the results change when the environment is less challenging.

Table D.1: Summary of Outcomes, Additional Treatments

Rounds 1 – 9

Treatment	Total Surplus	% Coordinate	Efficiency Gain
NC – D	53.5	46.1%	-190.8%
STR – D	50.0	38.3%	-226.8%
HSL – D	49.2	43.6%	-127.3%
SC – MC	70.0	97.5%	-10.4%
STR – MC	69.3	97.8%	-16.9%
HSL – MC	66.5	95.9%	2.3%

Rounds 10 – 18

Treatment	Total Surplus	% Coordinate	Efficiency Gain
NC – D	61.4	69.5%	-108.3%
STR – D	55.0	46.7%	-181.4%
HSL – D	60.0	59.3%	-58.6%
SC – MC	71.7	99.6%	6.5%
STR – MC	70.3	99.5%	-9.1%
HSL – MC	68.2	97.5%	13.5%

Table D.1 summarizes the results for the additional treatments, paralleling Table 2 in the main text. The results from **NC – D** and **SC – MC** are included as points of comparison. Focusing on the later rounds when play has had a chance to settle down (Rounds 10 – 18), performance is somewhat weaker in the two strangers treatments than the parallel partners treatments. The differences are not large and are not significant for either delegation ($n = 32$; $z = 1.48$; $p > .10$) or managerial control ($n = 32$; $z = 1.09$; $p > .10$). High State Losses should make matters easier, and efficiency gains are better with either delegation or managerial control.[36] This effect looks large with delegation, but the improvement is not significant for either delegation ($n = 54$; $z = 1.17$; $p > .10$) or managerial control ($n = 54$; $z = 1.32$; $p > .10$).

[36] The expected surplus from the babbling equilibrium is lower with High State Losses. Thus, lower surplus in the two HSL treatments doesn't imply weaker performance. Comparing efficiency gains puts these two treatments on equal footing.

Appendix E

Table E1: Detailed Description of Coding

1) Make a suggestion about what row/column should be chosen. (Coder always recorded the specific suggestion that was made.)
    a. Suggest safe equilibrium
    b. Suggest efficient equilibrium
2) Agree to proposal about what row/column should be chosen.
3) Discussion about what row/column should be chosen.
    a. Discuss need for coordination (pick same row & column). This requires more than making a suggestion that involves coordination. The message needs to indicate that the two players should be choosing the same thing (e.g. "We'll do better if we make the same choices" is coded. "Let's choose row 4 and column 4" is not coded.)
    b. Discuss fairness. This category includes any message that discusses the distribution of pay over the three players
4) Discuss Efficiency: This includes discussion of maximizing total pay as well as explaining how and why rotation between players works.
5) Questions About Rules of the Experiment: This includes questions about either the rules of the experiment (e.g. "Do I choose a row or does [the central manager] choose for me?") or the game (e.g. "Is the third number my payoff?").
6) Questions About How to Play: This was for conceptual questions rather than the frequent generic request that somebody suggest a row and column.
7) Explanation: This included explanations about the rules of the experiment or game, as well as explanations of a suggested way of playing the game.
8) (Chat-Centralization Only) M Asks What Game is Being Played.
9) (Chat-Centralization Only) Subordinates Report What Game is Being Played.
    a. Truthfully Reveal Game
    b. Lie About Game
    c. Conflict: This is used for cases where there was "fact-checking". (e.g. "D1: It is Game 3." "D2: No, it is Game 2.") This category is different from the "Contradict" category reported in Table 6, which is a combination of 9a and 9b. This category is the basis for the discussion of fact-checking in the text.