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

March 6, 2021

Abstract: We study the MS game, a novel coordination game played between a manager and two subordinates. Unlike commonly studied coordination games, the MS game stresses asymmetric payoffs (subordinates have opposing preferences over outcomes) *and* asymmetric information (subordinates are better informed than managers). *Efficient* coordination requires coordinating subordinates' actions *and* utilizing their private information. We vary how subordinates' actions are chosen (managerial control versus delegation), the mode of communication (none, structured communication, or free-form chat), and the channels of communication (i.e. who can communicate with each other). Achieving coordination *per se* is not challenging, but total surplus only surpasses the safe outcome when managerial control is combined with three-way free-form chat. Unlike weak-link games, advice from managers to subordinates does not increase total surplus. The combination of managerial control and free-form chat works because subordinates rarely lie about their private information, making efficient coordination possible. This contrasts with findings from the experimental literature on lying.

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

JEL Classification Codes: C92, D23, L20

Acknowledgements: The authors thank the National Science Foundation (SES-0214310), the Spanish Ministry of Economy and Competitiveness (Grant: ECO2017-88130), the Severo Ochoa Program for Centers of Excellence in R&D (CEX2019-000915-S), and the *Generalitat de Catalunya* (Grant: 2017 SGR 1136). We thank Adrià Bronchal, Joe Ballard, Ellis Magee, Luke Ortolani, and Lavinia Piemontese for valuable help as research assistants, and seminar participants at Case Western Reserve, Copenhagen Business School, Durham, East Anglia, Edinburgh, Florida State, Lausanne, Paderborn, Paris School of Economics, Stavanger, UCSB, the Arne Ryde Workshop, and the London Experimental Workshop for useful feedback.

1. Introduction: There is a large experimental literature studying whether managers can use various instruments, notably communication, to coordinate subordinates' actions on an efficient outcome. This research focuses on cases like the weak-link game where subordinates share common and known objectives with each other and their manager. In settings with aligned interests, efficient symmetric outcomes, and symmetric information, it is well-established that communication among subordinates and advice from a manager to subordinates both increase the probability of efficient coordination. Allowing managers to directly control subordinates' actions makes efficient coordination trivial. 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) Although subordinates gain from coordination, they have differing preferences over which common course of action should be chosen. (3) The state of the world varies over time, changing which outcome is efficient in the sense of maximizing total surplus. (4) Subordinates know the state of the world, but the manager does not. The combination of Properties 2 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 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 equipment or software, there are beneficial synergies if middle managers 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 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.[1]

Can coordination on an efficient outcome be achieved in the face of these difficulties? If the manager imposes a decision on her subordinates ("managerial control"), can she get her subordinates to reveal their information even though it is not in their interest? Does her ability to discover the truth depend on what type of communication is possible with her subordinates? Is it better to delegate decision making to subordinates ("delegation"), giving up control in exchange for eliminating the need to extract information? Can the manager still play a useful leadership role while delegating authority by suggesting a course of action to her subordinates ("managerial advice")? The purpose of this paper is to address these questions.

We examine these issues using a novel coordination game, the manager-subordinate game ("MS game"). This is a three-player game with one player in the role of manager and two acting as her subordinates. The four properties listed above are all present: coordinating on a common action benefits all agents, subordinates have divergent preferences over possible outcomes, managers lack the necessary information to simply impose efficient coordination on their subordinates, and subordinates possess the relevant information but have little reason to truthfully reveal it. The MS game confronts subjects with a challenging coordination problem that accentuates the contrast between managerial control and delegation.

The experimental design features repeated play of the MS game in fixed groups. We vary how actions are chosen (delegation vs. managerial control) and what type of communication is available (none, structured communication with pre-specified messages, or free-form chat). The baseline treatment features delegation and no communication; this is expected to yield poor performance since there is no mechanism to address the challenging coordination problem faced by subordinates. Within each type of communication (structured communication or free-form chat) we consider three possible mechanisms for choosing actions: delegation with pre-play communication between subordinates, delegation with managerial advice, and managerial control with messages from subordinates to the manager.

Our analysis focuses on outperforming the "safe" outcome. This is the unique equilibrium under managerial control for both the one-shot and finitely repeated MS games; the manager receives no information from her subordinates and imposes coordination. The resulting babbling equilibrium is

[1] An interesting real world example is the adoption of standards for new technologies such as HDTV and wireless in the 90s. Europe used a more centralized process than the US. This was especially true for wireless, where the US largely delegated the problem of choosing a standard to firms. This made some sense, as firms are better informed about the merits of various technologies than a central regulator, but also created a thorny coordination problem. Both network externalities and IP issues gave firms reasons to prefer differing technologies. Indeed, the US market suffered through an extended period where firms failed to coordinate on a single technology and was widely seen as lagging behind Europe (HDTV: Farrell and Shapiro, 1992; wireless: Gandal, Salant, and Waverman, 2003). Other related examples from the field include software adoption (Brynjolfsson and Kemerer, 1996) and product line selection (Thomas, 2011).

generally not efficient in terms of maximizing total surplus; it provides a baseline for what successful coordination can achieve *without using subordinates' information*. Importantly, the safe outcome is the secure equilibrium under delegation (subordinates use their maxmin actions) and equalizes subordinates' payoffs on a round-by-round basis. As such, the safe outcome provides an easy, if inefficient, way of solving the coordination problem under delegation. Unlike the safe outcome, achieving efficient coordination requires use of the subordinates' information.

Regardless of the form of communication, we find that total surplus is lower with delegation, either with or without managerial advice, 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 higher than the safe outcome, achieving roughly half of the possible efficiency gains.

So why does the combination of free-form chat and managerial control outperform the safe outcome, while combining delegation and free-form chat, either with or without managerial advice, does not? The theory predicts that subordinates should transmit no information to managers, but instead lying by subordinates is almost non-existent when free-form chat and managerial control are combined yielding unambiguous transmission of information. This makes efficient coordination possible and explains why the combination of managerial control and chat outperforms the safe outcome. Information transmission is not an issue with delegation, and coordination is almost perfect. The problem is that subordinates opt for the safe outcome more often than efficient coordination. This is especially true when the subordinates do not reach an agreement. As noted previously, the safe outcome provides an easy way to coordinate and subordinates take advantage of this. Adding managerial advice has two effects; subordinates are more likely to agree on efficient coordination but less likely to reach any sort of agreement (and hence less likely to coordinate). These effects offset each other, leading to a negligible effect from managerial advice.

Our work contributes to existing research in multiple ways. There is a large experimental literature about the effects of communication, advice, and leadership on efficient coordination. (See Section 2 for a full summary of related research.) This research focuses on settings like the weak-link game where the interests of all individuals are aligned and there is no dispute about the most desirable outcome. Communication from a leader, such as advice from the manager to subordinates, is effective in these settings, but it is relatively easy to act as a coordination device when everyone has the same information and aligned interests. Achieving efficiency via managerial control is trivial in a weak-link game, presumably explaining why this has not been studied.[2] Like a weak-link game (and unlike a battle-of-the-sexes game), the MS game has an inefficient symmetric equilibrium that makes it easy to coordinate. The challenge facing a leader is *not* to achieve coordination *per se*, but rather to achieve *efficient* coordination. Compared to weak-link games, efficient coordination is difficult in the MS game. Managers need to do more than just overcome strategic risk. They must either induce turn-taking through managerial advice or impose turn-taking via managerial control. Achieving efficient coordination via managerial control is non-trivial in the MS game due to asymmetric information; the manager has to acquire information that their subordinates have no incentive to provide. Managerial advice proves insufficient to outperform the safe outcome, unlike weak-link games, but the combination of managerial control and free-form chat performs surprisingly well.

Our work also relates to research, both theoretical and experimental, comparing centralization and decentralization. The recent literature sees this tradeoff in terms of a comparison between the benefits of coordination (meant in a somewhat different sense than here) and the costs of distorted information that accompany centralization. These tradeoffs play an important role in our work as well, but there are major differences. Unlike the games studied in papers like Alonso, Dessein, and Matouschek (2008a) and Rantakari (2008), the MS game with delegation is a true coordination game where the critical issue is selecting among multiple equilibria. We stress the role of active leaders using rich communication to achieve efficient coordination. The effects of rich communication are particularly relevant for the literature comparing centralization and decentralization. Performance with managerial control and free-form chat surpassed the safe outcome because subordinates revealed more information than was consistent with their financial incentives. Even though the games are significantly different, the same insight presumably applies to comparisons of centralization and decentralization – existing theories may systematically underestimate the benefits of centralization by overestimating the willingness of subordinates using rich communication to distort reports about their information for strategic purposes.

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 payoff maximizing, 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 the treatment with managerial control and free-form chat.

[2] There is little work on leadership in asymmetric games. The most relevant is the one-way communication treatment in Cooper, DeJong, Forsythe, and Ross's (1989) study of communication in the battle-of-the-sexes, but this is equivalent to communication between subordinates rather than managerial advice. See Section 2 for a detailed discussion. Managerial control is trivial in the battle-of-the-sexes due to the lack of asymmetric information.

Subordinates almost never lie, the frequency of lying does respond to incentives, and partial lies are rare. Fact-checking is common – when one subordinate lies, the other subordinate (who knows they have lied) often calls them on it. We suspect this motivates the rarity of lies, although more work is needed to work out why lies are not occurring. The unwillingness of subordinates to lie plays a critical role in generating efficient coordination with managerial control and free-form chat. Previous work has found that pre-play communications in the form of free-form chat is more effective than restricted communication at fostering efficiency and cooperation (Brandts, Cooper, and Rott, 2019), but our work identifies a new channel by which this occurs.

Our work provides several useful insights for the practice of management. First, the existing literature suggested that managers could be quite effective via persuasion, providing motivation and advice on the best course of action. This is no longer true when managers face the strong conflicts of interest in the MS game; managerial control is vital. Second, subordinates are more willing to share information than either their financial incentives or the existing literature on lying would suggest. This implies that principal-agent problems due to asymmetric information are not as severe as theory would predict, and managers may not need to resort to elaborate mechanisms to extract information from their subordinates.

2. Related Literature: There are a number of experiments showing 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).[3] 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 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. Asymmetric payoffs and the resulting disputes are at the heart of the problem managers face in our experiment, and asymmetric information exacerbates the difficulty.[4]

Closely related, several experiments study the effect of advice on efficient coordination. This includes papers that study advice from either the experimenter (e.g. Van Huyck, Gillette, and Battalio, 1992; Brandts

[3] It has also been shown that leaders can increase contributions in public goods games, either leading by example or by transmitting their superior information about the state of the world. See Cooper and Hamman (2021) for a survey of this literature.

[4] In Cooper et al. (2020), 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.

and MacLeod, 1995; Chaudhuri and Paichayontjivit, 2010) or from another subject who has previously played the game (Chaudhuri, Schotter, and Sopher, 2009). Advice can be effective, particularly if it is common knowledge and the interests of advisors and advisees are aligned. Once again, these papers about advice focus on symmetric games where players have aligned interests. We confront managers with the more challenging problem of resolving the conflicting interests of their subordinates.

Many papers show that pre-play communication among players (as opposed to an external leader) 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 symmetric 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 pre-play communication on coordination in a battle-of-the-sexes game, the best-known example of an asymmetric coordination game. Communication is limited to pre-play announcements of intended play. Without communication, coordination is difficult due to the lack of a focal equilibrium. With one-way communication, coordination rates are high as the sender can call for her preferred equilibrium and the receiver generally follows. This can be seen as an example of successful leadership in an asymmetric game. There are many differences between our set-up and the experiments of Cooper et al., but perhaps the most important is our focus on *efficient* coordination. Coordination is achieved in a number of our treatments, and we have little doubt that one-way communication would promote coordination as well. *Efficient* coordination is an entirely different matter. For Cooper et al., efficient coordination is a non-issue as the two pure-strategy equilibria in the battle-of-the-sexes game are not Pareto ranked.

Cooper et al. find that two-way communication is less effective, although coordination rates improve somewhat with multiple rounds of two-way communication. Our treatment combining structured communication between subordinates with delegation resembles the Cooper et al. treatment with multiple rounds of two-way communication, but, due to two important differences, we anticipated that pre-play communication would be more effective in the MS game. Unlike the battle-of-the-sexes game, the safe outcome in the MS game provides a simple, safe way of coordinating without asymmetric payoffs. Second, we use partners matching while Cooper et al. use strangers matching. This provides more opportunities for subordinates to reach an agreement, and also makes it possible to equalize (expected) payoffs while using asymmetric choices. In spite of our optimism, we too observed 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 mechanism underlying our result, specifically the shift to truth-telling by subordinates with free-form chat, differs from these previous studies.

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,[5] (2) the likelihood of lying is sensitive to incentives, and (3) partial lies (failing to either tell the truth or the payoff-maximizing lie) are common. In the treatment with structured communication and managerial control, where subordinates can only send 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 treatment with managerial control and 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. Both theorists and experimenters have made a great deal of progress in understanding why individuals tell partial lies, but we are unaware of any results that explain the differing results with structured communication and chat. The conclusion discusses some possibilities, but a full explanation is beyond the scope of this paper.

Beyond the general literature on lie aversion, our treatment with structured communication and managerial control (SC-MC) is related to Vespa and Wilson (2016). They study information transmission in variations of the multi-sender cheap-talk model proposed by Battaglini (2002). In games where it is relatively difficult (but possible) to infer the state of the world from senders' messages, receivers perform poorly at extracting information. The MS game with structured messages and managerial control is also a cheap talk game with multiple senders, but differs along a critical dimension from the games studied by Vespa and Wilson. In keeping with Battaglini, they study games where messages fully reveal the state of the world in equilibrium. This contrasts with the MS game where messages are *not* fully revealing (or even informative) in equilibrium. We intentionally made the informational problems under managerial control as severe as possible. That said, we also observe receivers (managers) struggling to extract information from senders' (subordinates') messages. If anything, the problem is even more severe as managers make systematic errors even when information extraction is trivial.[6]

Our work has a clear relationship 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,

[5] 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.

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

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 (2020) compare centralization and decentralization.

Our work is not intended to test the predictions of any existing theory comparing centralization and decentralization, and our focus differs from the recent theoretical literature. Papers like Alonso et al. (2008a) and Rantikari (2008) concentrate on the relationship between the parameters of the game and the quality of information flowing between the various agents in equilibrium. The MS game with delegation is a true coordination game with multiple equilibria. Rather than focusing on how the equilibrium changes between organizational structures, we study the effect on the likelihood of efficient coordination with a stress on the roles of active leadership and rich communication. As noted above, our results have some relevance for the theoretical literature comparing centralization and decentralization, but interested readers should see Evdokimov and Garfagnini (2019) for experiments directly testing some of the recent theoretical models. They find support for theoretical predictions from the models of Alonso et al. (2008a) and Rantakari (2008).

3. The Manager-Subordinate Game: The MS game confronts subjects with a challenging environment that accentuates the tradeoffs between having the manager make decisions for her subordinates and delegating decisions to the subordinates. To illustrate the game, 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. The manager overseeing the R&D division, Ms. C, could resolve matters by imposing a decision, but she faces a problem if she doesn't know which word-processing package is best for the task at hand. Suppose she asks the engineers which word-processing package is best suited for their project. Even if both subordinates know that LaTeX is best for the project, Mr. A has a strong incentive to suggest use of MS Word. Along similar lines, Mr. B always has a strong incentive to tout LaTeX. Ms. C can force the engineers to agree on one package, but she will be hard pressed to get information about which is the right one for the task at hand. The MS game models problems like the one facing Mr. A, Mr. B and Ms. C.

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

The MS game is played by two subordinates (S1 and S2) and a manager (M). Equation 1 gives the basic structure of subordinates' payoffs. They face three types of losses: (1) "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. (2) "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). Adaptation 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 *always* prefer to pick their favored package. To maximize conflict, subordinates have diametrically opposed tastes in the MS game, with S1's most preferred option being S2's least preferred option (and vice versa). (3) "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 well suited to LaTeX. Mr. A still prefers that the engineers agree on using MS Word, but it costs him relatively little if they agree on LaTeX since at least they are using the right package for the task at hand. It would be far costlier for Mr. B if they agree to use MS Word. He does not get to use his preferred word-processing package, and 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 $k_2 > k_3 > k_4 > 0$. Imposing these inequalities makes the game induced by any state of the world into a coordination game 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, adaptation costs play no role in the manager's decisions under managerial control. 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

∈ {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 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 $A_i \in \{1,2,3,4,5\}$.

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

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

$$\pi_M = \pi_{S1} + \pi_{S2} \quad \textbf{(Eq. 2c)}$$

Equations 2a, 2b, and 2c give the payoff functions for S1, S2, and M respectively. For all treatments, $k_1 = 54$, $k_2 = 14$, $k_3 = 7$, and $k_4 = 4$.

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

Table 1 displays the payoff tables for G = 1, 3, and 5; 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 ≡ $A_2 = 4$).

A number of the MS game's features were chosen to accentuate specific aspects of the coordination problems facing managers and subordinates: (1) Without asymmetric information, the problem facing managers under managerial control is trivial as information transmission is a non-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 coordination difficult. With managerial control, coordination is trivial but achieving efficiency requires the manager to overcome the asymmetric information between her and her subordinates.[7] (3) The functional forms in Equations 1a and 1b use absolute values of differences, rather than squared differences as used by Alonso et al. (2008a) and Rantakari (2008). Because of this choice there are multiple equilibria in the MS game with delegation rather than a single equilibrium.[8] Multiplicity plays a central role in our paper, as the main problem facing managers is trying to achieve efficient coordination rather than defaulting to the safe outcome. (4) We use five possible actions and five states of the world rather than two (as in a battle-of-the-sexes game) or three. Going from two to three possible actions adds the safe outcome (defined below) as an equilibrium which plays a critical role in subjects' choices. Going from three to five actions makes it easier to distinguish whether play is consistent with the efficient or safe outcome, since the two are equivalent less frequently, and easier to detect partial lies. (5) To accentuate their differing preferences, subordinates are paid based solely on their own payoffs rather than a weighted average over the two subordinates' payoffs. Implicitly, this eliminates incentive schemes that include revenue or profit sharing components. (6) Finally, the interaction between the manager and subordinates under managerial control is modeled 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.

[7] Models like Alonso et al. (2008a) and Rantikari (2008) use two independent shocks. Using the terminology of our paper, this leads to a comparison of information flows between subordinates under delegation versus information flows from subordinates to managers under managerial control. Our paper focuses on the coordination problem with delegation and eliminates any issues due to asymmetric information between subordinates.

[8] With absolute values, a subordinate maximizes his payoff by picking exactly the same action as the other subordinate. With squared differences, 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.

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 ($A_1 = A_2 = 5$). We refer to these outcomes as Outcome 1, Outcome 2, etc.

In all five games, there is a tension similar to the battle-of-the-sexes game since S1 most prefers Outcome 5 as an equilibrium and least prefers Outcome 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 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, but similar to a weak-link game, the MS game with delegation offers an equilibrium that is safe, simple, and fair, but is not efficient in the sense of maximizing total surplus. Outcome 3 (the "safe" outcome) is safe because $A_i = 3$ is the maxmin strategy for both subordinates in all five games, is simple because subordinates use the same action in all states of the world, and fair because it yields the same payoff to both subordinates. Except in Game 3, the safe outcome does *not* maximize total surplus. In spite of this, the attractive features of the safe outcome give it drawing power in our data.

All five games have an equilibrium that maximizes total surplus. This is always equivalent to the game number (i.e., Outcome 1 in Game 1, Outcome 2 in Game 2, etc.). Efficient coordination, 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, Brandts, and Ockenfels, 2005) but yields asymmetric payoffs for all games except Game 3. Efficient coordination is also relatively complex because the subordinates must change their actions as the state of the world changes.

3.3: Equilibrium, Managerial Control: The following discussion is based on structured communication, but extends in a straightforward manner to free-form chat. With managerial control, 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 adaptation 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 actions 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.

Finite repetition of the MS game with managerial control 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.

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. In the quest for efficient coordination, managerial control exchanges the problem of having multiple equilibria for the problem of needing to get subordinates to reveal information against their interests.

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.[10]

---

[9] Given that payoffs are linear, this isn't transparent. Define a manager's error as the difference between the action she chooses (assuming $A_1 = A_2$) and her payoff maximizing 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] 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.

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 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, 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 was limited in structured communication treatments; in **SC/S – D**, for example, the subordinates chose messages by clicking on radio buttons labeled with the three available actions and could not send 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. After receipt of the two messages, M chose 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.[11] 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

[11] The treatments with structured communication separately identify the effects of pre-play communication between subordinates and managerial advice. Given that neither had much effect in isolation, it seems safe to assume that the combination, paralleling **CH/A – D**, would also have little effect.

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 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 the main text, we ran an additional four treatments. These were modifications of the **NC – D** and **SC – MC** treatments to examine secondary issues. The main experimental design holds incentives fixed to focus on the effects of changing decision making rights and the types of available communication. The **HSL – D** and **HSL – MC** treatments examine the effect of changing incentives by increasing state losses ($k_4 = 6$ vs. $k_4 = 4$). This reduces the tension between subordinates, making the efficient outcome more attractive relative to the safe outcome. Play shifts towards efficient coordination, consistent with the change in incentives, but our qualitative conclusions are unaffected. In particular, lowering state losses does not significantly increase efficiency gains relative to **SC – MC** and efficiency gains remain significantly lower than in **CH – MC**. In other words, a strong increase in incentives to play the efficient equilibrium has significantly less impact than allowing rich communication. The **STR – D** and **STR – MC** treatments used strangers matching rather than partners matching. This was expected to make efficient coordination harder. Performance is indeed worse with strangers matching, but the effects are not significant and our qualitative conclusions are unaffected. Appendix D provides more description of these four additional treatments and the results.

4.2. Hypotheses: **H1** draws on the theory developed in Section 3 to compare **NC – D** and **SC – MC**. Efficient coordination, which is an equilibrium in **NC – D,** uses subordinates' information to achieve the maximum possible total surplus. In **SC – MC**, only inefficient babbling equilibria exist. **H1** follows. This hypothesis was a straw man. The MS game with delegation resembles a battle-of-the-sexes game, a setting where coordination is known to be difficult in the absence of communication (Cooper et al., 1989). Even though the presence of a safe equilibrium should make coordination easier, we still doubted that subordinates could coordinate, let alone coordinate efficiently, in the absence of communication.

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

The theory predicts play of a babbling equilibrium in **SC - MC**, implying that subordinates' messages will be uninformative. **H2** follows. Once again, there were good reasons to be skeptical. Our design differed from most existing experiments, especially since more than one subject sent messages, but the general finding that individuals are reluctant to lie seemed likely to apply.

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

Turning to the treatments with structured communication and delegation, **SC/S – D** and **SC/A – D**, neither type of pre-play communication changes the theoretical prediction. We nevertheless expected total surplus to increase relative to **NC – D** in both cases. The different types of communication (between subordinates vs. managerial advice) emphasized different mechanisms by which communication might yield 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**, but lacked an obvious mechanism for resolving conflicts due to their divergent interests. 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.[12] With managerial advice, we expected managers to act as a coordination device promoting efficient coordination. Because the power to choose actions resides with the subordinates, asymmetric information should not be an issue in **SC/A – D**. It is always in the manager's interest to promote efficient coordination, and unlike **SC/S – D**, subordinates in the **SC/A – D** treatment have a single, common source of guidance on how to play. We hoped that the benefits of certain coordination would overcome reluctance to accept a less preferred outcome. Thus, we anticipated that efficient coordination would be more likely with managerial advice than communication between subordinates. The preceding conjectures are summarized in **H3**. This hypothesis is stated relative to **NC – D**, as the structured communication treatments with delegation modify **NC – D**, but combining **H1** and **H3** yields a prediction that both treatments will also yield higher total surplus than **SC - MC**.

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

The final hypothesis covers the chat treatments. Many papers have compared the effects of structured communication versus chat. The general finding is that communication has a greater impact on outcomes with chat 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 delegation. We therefore expected the chat treatments to yield higher total surplus than the parallel structured communication

[12] 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.

treatments. We also expected the order between chat treatments to match the order between structured communication treatments. Specifically, as noted above, we did not anticipate efficient coordination with managerial control. Managerial control would make efficient coordination trivial *if the manager knew the state of the world,* but, of course, the manager did *not* know the state of the world. Consistent with the theory above, we anticipated that subordinates would not truthfully communicate the state of the world in **CH – MC** leading to play of the safe outcome. Our conjectures are summarized in H4.

H4: ***CH/S – D*** *will yield higher total surplus than* ***SC/S – D*** *and* ***CH/A – D*** *will yield higher total surplus than* ***SC/A – D****. No difference is predicted between* ***SC – MC*** *and* ***CH – 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 examines the process underlying these treatment effects.

5.1. Treatment Effects: Unless otherwise noted, statistical tests comparing treatments are Wilcoxon rank-sum tests and comparisons with total surplus from play of the safe outcome 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.[13] An observation is the average value of the variable in question over these rounds. Total surpluses from the safe outcome are adjusted for the random draw of games.

Table 2 summarizes outcomes by treatment, subdivided between the first (Rounds 1 – 9) and second (Rounds 10 – 18) halves of the experiment. The first column of Table 2 shows average total surplus.[14] To maximize total surplus, 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 ($A_1 = A_2 = 3$) throughout, divided by the difference between the total surplus from efficient coordination and the total 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'

[13] 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).

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

information. Playing the efficient equilibrium yields an efficiency gain of 100%, while the babbling equilibrium leads to an efficiency gain of 0%. Negative efficiency gains reflect failures to coordinate.

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%

H1 hypothesized that total surplus would be greater in **NC – D** than **SC – MC**. This was 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 understand the importance of coordination, leading to a coordination rate of almost 100% in **SC – MC**. Lacking a coordination device, coordination is significantly lower in **NC – D** ($n = 54$; $z = 4.82$; $p < .01$).

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 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 coordinated 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 at neither 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 coordination failure is *not* the only problem in **NC – D**. When subordinates coordinate and the safe and efficient outcomes do not coincide, they usually coordinate at the safe outcome (69% subject to coordinating) rather than the efficient outcome (18% subject to coordinating). The safe outcome provides a relatively easy route to coordination in the challenging environment of **NC – D**, and subordinates take advantage of this even though it means *not* using their information.

Matters are a bit more complex in **SC – MC**. In some ways performance is better than the babbling equilibrium. For $G \neq 3$, the efficient outcome is slightly more common than the safe outcome. The problem is the 32% of outcomes in the "other" category. Average total surplus for coordination in the "other" category is *lower* than could have been achieved via the babbling equilibrium (62.1 vs. 67.7). Underlying this, "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. Managers are attempting to use their subordinates' information, but do so quite poorly.

Result 2: *In **NC – D,** subordinates generally coordinate by playing the safe outcome, implying a failure to use their 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 equilibrium (repeated play of the safe outcome) nor efficient coordination. 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 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).

SC/S – D and **SC/A – D** have little effect on total surplus in Rounds 10 - 18 because neither increases the coordination rate much relative to **NC – D** (**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 better use of subordinates' information. Subject to coordinating in G ≠ 3, the frequency of the efficient outcome rises from 19% in **NC – D** to 41% and 45% in **SC/S – D** and **SC/A – D** respectively.

Result 3: **SC/S – D** and **SC/A – D** *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). Consistent with **H4**, the chat treatments with delegation 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). Contrary to **H4**, total surplus is significantly higher in **CH – MC** than **SC – MC** (n = 54; z = 2.94; p < .01).

Comparing the three chat treatments, performance is highest in **CH – MC**. **CH – MC** yields significantly higher total surplus in Rounds 10 – 18 than either **SC – MC** (n = 54; z = 2.94; p < 0.01) or **CH/S – D** (n = 54; z = 2.45; p < 0.05). Strong performance in the **CH – MC** treatment is not due to chat *or* managerial control, but rather the conjunction of the two.[15]

[15] 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**.

Oddly, total surplus is not significantly higher in **CH – MC** than **CH/A – D** ($n = 54$; $z = 1.41$; $p > .10$) even though total surplus across Rounds 10 – 18 is *lower* on average 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 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). Looking at the nine groups in the 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 look at the nine *worst* groups, **CH/A – D** leads again 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 repeated play of the safe outcome ($n = 27$; $z = 3.65$; $p < .01$).[16] Efficient coordination has two components: subordinates' choices must be coordinated and must reflect their information. **CH – MC** does well on both accounts. It is the only treatment where groups achieve 100% coordination in Rounds 10 – 18. **CH/S – D** does almost as well at achieving coordination, but **CH/A – D** has a lower coordination rate which largely explains its relatively low total surplus.[17] Not only is coordination 100% perfect 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** ($n = 54$; $z = 1.86$; $p < 0.10$). 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**.

Result 4: *The data are only partially 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 with chat. This reflects both high levels of coordination and improved usage of the subordinates' information in* ***CH – MC***.

To summarize, either managerial control or rich communication improves performance, but only the combination of both beats repeated play of the safe outcome. 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 doing better. The high performance of **CH – MC** reflects both high coordination rates and a relatively strong ability to use the subordinates' information. The next

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

[17] The average coordination rate in **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%.

section digs into why this treatment does well on both dimensions relative to the other treatments, focusing on how well information is transmitted from subordinates to managers.

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 significantly 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. When the efficient and safe outcomes do not coincide ($G \neq 3$), 62% of agreements call for play of the safe outcome. The safe outcome 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 be effective: they have to make useful suggestions and subordinates need to follow them. Unfortunately, neither step occurs reliably.

Managers often give poor advice. Consider Rounds 10 – 18 for games where the safe and efficient outcomes do not coincide ($G \neq 3$). Even with experience, 14% of messages do *not* call for coordination. The high coordination rate in **SC – MC** (99%) indicates that managers understand the benefits of coordination, making it hard to fathom why they give advice to *not* coordinate.[18] When coordination is advised, managers often take a conservative approach by calling for the safe outcome (38%) rather than efficient coordination (39%).

[18] Failures to advise coordination may reflect misguided attempts at fairness. 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.

The conservative approach of managers would make sense if suggesting the safe outcome 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*, and consider games where the efficient and safe outcomes can be distinguished ($G \neq 3$) in Rounds 10 – 18. The probability of successful coordination is equally high when the realized suggestion calls for either the safe outcome or efficient coordination (72% and 76% respectively). These figures are both better than the 44% coordination rate for all other realized suggestions, but suggesting the safe outcome does *not* make coordination more likely than suggesting the efficient outcome.[19] Instead, it shifts outcomes from efficient coordination (68% when suggested) to the safe outcome (72% when suggested), harming manager payoffs and total surplus. It isn't surprising that managers are too conservative, since suggesting the safe outcome is an obvious strategy and generally yields high coordination rates.

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 their 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 (repeated play of the safe outcome) because the advantages from better than expected information transmission are wiped out by errors in using this information.

Table 4 displays the messages sent in Rounds 10 – 18 of **SC – MC** as a function of the game. The data from S2 players have 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

[19] Manager suggestions vary by game and lagged outcome. For example, a manager may suggest the safe outcome because she knows that her subordinates have previously coordinated on the safe outcome. Thus, the association between realized suggestions of the safe outcome 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, including controls for the game and the lagged outcome. The estimated difference between having received a suggestion to choose the safe outcome versus the efficient outcome is negligible – the estimated marginal effect is -1.9% with a standard error, corrected for clustering, of 11.1%.

[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: $M2' = 6 - M2$.

messages and the game being played. Instead, there is strong positive correlation (ρ = .33).[21] Play of a babbling equilibrium implies that subordinates 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 is solely due to a failure to grasp the strategic value of lying, subordinates should 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 outcome. 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 outcome).[22]

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

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, Table 5 reports 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 manager follows the messages closely (but not perfectly). When the two messages differ, the

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

[22] Self-serving lies are shaded away from the actual game towards the subordinates' preferred outcome. There are a small number of messages (3.7%) that are shaded in the direction of the *other* subordinate's preferred outcome. 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.

manager's choices generally increase in each subordinate's message (holding the other's message fixed). The response of managers to messages is strong and statistically significant.[23]

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

Given that subordinates send useful information and managers respond to their subordinates' messages, why is total surplus no better than in the babbling equilibrium? The problem is that managers often make choices that seem to be clear errors. For example, when 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 $M_2 = 1$. Obviously at least one of the subordinates is lying. The safe outcome is the empirical best response to diametrically opposed messages, but only 35% of managers follow this course of action. This type of error also reduces average total surplus (66.9 vs 63.3 ECUs). 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%.

Managers' errors explain why total surplus in **SC - MC** is no better than repeated play of the safe outcome. 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 safe outcome. 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 repeated play of the safe outcome ($z = 4.38$; $p < .01$)

[23] To establish statistical significance, we ran a regression where the dependent variable is the common action 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.

or the realized total surplus (z = 2.32; p < .05). Managers could easily outdo the babbling equilibrium, but fail 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, causing their failure to beat repeated play of the safe outcome.*

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 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 0 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 actions should be chosen and sub-categories for specific suggestions (e.g. suggesting play of the efficient outcome). 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.

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 Outcome	54.1%	37.6%	60.6%
Suggest Efficient Outcome	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%

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** ($n = 54$; $z = 2.76$; $p < 0.01$).[24] Recall that total surplus has high variance in **CH/A – D**. Underlying this, managers' behavior also has high variance in **CH/A – D**. 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 =

[24] 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 ($n = 54$; $z = 1.03$; $p > .10$).

3.17 vs. StDev = 1.99).[25] 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* leadership.

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 agree on what actions should be used as well as a tendency to not agree on efficient coordination. Agreements are more frequent in **CH/S – D** than **SC/S – D** (79% vs. 63%). 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 outcomes do not coincide (G ≠ 3), only 34% of agreements in **CH/S – D** call for play of the efficient outcome. This 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 safe outcome 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 not improve the likelihood of efficient coordination.*

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 on efficient coordination are more frequent in **CH/A – D** than **CH/S – D** (43% vs. 34%) and are usually followed (90%). The problem is that agreements of *any* kind are much less frequent in **CH/A – D** than **CH/S – D** (54% vs. 79%),[26] and failing to reach an agreement is associated with lower coordination rates (71% vs. 94%). This 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. The result is an odd combination of lower total surplus and more efficient coordination.

In **CH - MC**, coordination *per se* is trivial; the question is whether the manager can achieve *efficient* coordination given that she cannot observe the state of the world. A central finding of our work is that managers in **CH - MC** 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 rarely (3%) does a subordinate lie about the game. Rather than falling, these figures improve slightly with experience from 65% and 5% in Rounds 1 – 9 to 72% and 2% in Rounds 10 – 18. Information transmission is far cleaner in **CH – MC** than **SC – MC.** Managers get some useful information in **SC – MC** (see Section 5.2.a), but it often involves conflicting reports (69%) that are difficult to interpret.

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

[26] 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**.

On top of this, managers in **SC – MC** often make mistakes extracting information from subordinates' messages. In **CH – MC**, managers receive some report about the game in 69% of observations. For 95% of these cases, they receive a truthful report without contradiction. Almost always, managers in **CH - MC** either have no information, and therefore do not face an information extraction problem, or have unambiguous information that makes information extraction trivial.

The high quality of information transmission in **CH - MC** is enormously important for efficiency. When the safe and efficient outcomes do not coincide ($G \neq 3$), the frequency of efficient coordination rises from 18% when neither subordinate truthfully reveals the game to 52% if at least one tells the truth.[27] The frequency of efficient coordination changes little when one subordinate tells the truth and the other lies (53%), albeit based on a very few 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 efficient coordination.*

Accurate transmission also takes place in **CH/A – D**. Subordinates are far less likely to report what game is being played than in **CH – MC**, but always tell the truth when they do so. The lack of lies is less surprising for **CH/A - D** than **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 $G \neq 3$), 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

[27] It may seem surprising that the rate of efficient coordination is not close to zero when there is not a truthful report and $G \neq 3$. In 87% of these cases, there is a suggestion that the efficient equilibrium should be played. These suggestions may serve as an indirect method of revealing the game, making a direct report unnecessary.

lie in at least a third of the rounds. There are only two subordinates that never lie and none that never tell the truth. Partial lying is common and subordinates are strategic about telling 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. Outcome 1 is the worst outcome and Outcome 5 is the best).[28] Subordinates are most likely to lie when the efficient outcome would be worst for them (G = 1), and most likely to be truthful when it would be best for them (G = 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.[29] 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 their manager when they have been directly asked for a report. However, it is surprisingly rare for managers 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.

[28] 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.

[29] Table 7 reports the frequency that an individual subordinate reports truthfully at some point during the pre-play communication. This differs from the figure reported under "Truthfully Reveal Game" 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.

Indeed, in 40% of the observations where a subordinate lies, the other subordinate corrects them.[30] It may be more embarrassing to be actively called out as a liar than to merely be revealed as a liar.[31]

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 outcome will be chosen regardless. Consider cases where the safe and efficient outcomes could be distinguished in the *previous* round ($G \neq 3$). If the safe outcome was played in the previous round, *neither* subordinate makes a report for the current round in 44% of the observations; this makes sense if subordinates expect the manager to choose the safe outcome regardless of any new information. By contrast, if subordinates expect the efficient outcome to be played then they have an incentive to guide the manager's decision by reporting the current game. Indeed, when the efficient outcome was chosen in a previous round with $G \neq 3$, *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 outcome is used. 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 ($A_1 = A_2$) or efficient coordination ($A_1 = A_2 = G$). 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

[30] 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.").

[31] Fact-checking helps explain why the frequency of efficient coordination remains high when one subordinate tells the truth and the other lies, since fact-checking gives the manager guidance about which subordinate to believe.

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. Standard errors (in parentheses) are 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 achieving coordination in **CH/S – D** and **CH/A – D**, and the regressions provide additional evidence of this. In 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. 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 control. Managers can impose efficient coordination 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. Perhaps it is difficult to argue persuasively that the safe outcome is fair when it harms the manager (and the manager has a voice).

6. Concluding Remarks: This paper studies coordination in a demanding experimental environment, the MS game. It 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. Unlike the frequently studied weak-link game, the MS game stresses asymmetries; the manager doesn't know what game is being played, and the subordinates' interests are misaligned. Achieving coordination in the MS game is not difficult, but achieving efficient coordination that uses subordinates' information is a challenge. It is well-established that either communication among players or external leadership (like managerial advice) increases efficient coordination in symmetric coordination games. Managerial control has not been previously studied as its likely effect in symmetric coordination games, unlike the MS game, is obvious. Our primary goal is to study the roles of communication and managerial control in achieving efficient coordination in the difficult environment of the MS game.

Achieving efficient coordination in the MS game 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. 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 use the subordinates' information sufficiently well to outperform the babbling equilibrium, gaining almost half of the possible gains over the babbling equilibrium. Free-form chat can seem like a magic bullet in experimental economics, solving all problems with coordination and/or cooperation. In the MS game, neither rich communication nor managerial advice is sufficient. Even though managers lack critical information, managerial control plays a valuable role in enabling groups to make effective use of subordinates' information.

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 their resulting good information to frequently impose 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 corrected by the other subordinate (fact-checked) in real time. When lies are told, fact-checking is common. 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. That said, the rarity of lies in **CH – MC** could reflect other factors such as increased group identity.[32] The lack of lies in **CH - MC** was an unanticipated feature of our data and experiments specifically designed to study this phenomenon are needed to identify the mechanism underlying increased truthfulness with rich communication.

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, Irlenbusch, and Sutter, 2010).

[32] The political science literature refers to the type of open multi-lateral chat featured in **CH/A – D** and **CH – MC** as "deliberation." 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. 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 **CH/A – D** and **CH – MC** may reflect subordinates putting more weight on the interests of the group as a whole.

REFERENCES

Abeler, Johannes, Daniele Nosenzo, and Collin Raymond (2019), "Preferences for Truth-Telling," *Econometrica*, 87(4), 1115-1153.

Alonso, Ricardo, Wouter Dessein, and Niko Matouschek (2008a), "When Does Coordination Require Centralization?" *American Economic Review*, 98(1), 145-179.

Alonso, Ricardo, Wouter Dessein, and Niko Matouschek (2008b), "Centralization versus Decentralization: An Application to Price Setting by a Multi-Market Firm," *Journal of the European Economic Association*, 6 (2-3), 457-467.

Alonso, Ricardo, Wouter Dessein, and Niko Matouschek (2015), "Organizing to Adapt and Compete," *American Economic Journal: Microeconomics*, 7(2), 158-187.

Battaglini, Marco (2002), "Multiple Referrals and Multidimensional Cheap Talk," *Econometrica*, 70(4), 1379–1401.

Ben-Ner, Avner, and Louis Putterman (2009), "Trust, communication and contracts: An experiment," *Journal of Economic Behavior & Organization*, 70(1-2), 106-121.

Blume, Andreas and Andreas Ortmann (2007), "The Effects of Costless Pre-play Communication: Experimental Evidence from Games with Pareto-ranked Equilibria," *Journal of Economic Theory*, 132, 274–290.

Blume, Andreas, Peter H. Kriss, and Roberto A. Weber (2017), "Pre-play communication with forgone costly messages: experimental evidence on forward induction," *Experimental Economics*, 20(2), 368-395.

Bolton, Gary, Jordi Brandts, and Axel Ockenfels (2005), "Fair Procedures: Evidence from Games Involving Lotteries," *Economic Journal*, 115, 1054-1076.

Brandts, Jordi, Gary Charness, and Matthew Ellman (2016), "Let's Talk: How Communication Affects Contract Design," *Journal of the European Economic Association,* 14(4), 943-974.

Brandts, Jordi and David J. Cooper (2007), "It's What You Say Not What You Pay: An Experimental Study of Manager-employee Relationships in Overcoming Coordination Failure," *Journal of the European Economic Association*, 5(6), 1223-1268.

Brandts, Jordi, David J. Cooper and Christina Rott (2019), "Communication in Laboratory Experiments", in *Handbook of Research Methods and Applications in Experimental Economics*, edited by Arthur Schram and Aljaz Ule,, Edward Elgar Publishing.

Brandts, Jordi, David J. Cooper, and Roberto A. Weber (2015), "Legitimacy, Communication, and Leadership in the Turnaround Game," *Management Science*, 61(11), 2627-2645.

Brandts, Jordi and Bentley MacLeod (1995), "Equilibrium Selection in Experimental Games with Recommended Play." *Games and Economic Behavior*, 11(1), 36-63.

Cai, Hongbin, and Joseph Tao-Yi Wang (2006), "Overcommunication in strategic information transmission games," *Games and Economic Behavior*, 56(1), 7-36.

Cartwright, Edward, Joris Gillet and Mark van Vugt (2013), "Leadership by Example in the Weak-Link Game," *Economic Inquiry*, 51(4), 2028-2043.

Cason, Timothy N., and Vai-Lam Mui (2007), "Communication and coordination in the laboratory collective resistance game," *Experimental Economics*, 10(3), 251-267.

Charness, Gary and Martin Dufwenberg (2006), "Promises and Partnership," *Econometrica*, 74, 1579-1601.

Charness, Gary, and Martin Dufwenberg (2010), "Bare promises: An experiment," *Economics Letters*, 107(2), 281-283.

Chaudhuri, Ananish and Tirnud Paichayontvijit (2010), "Recommended play and performance bonuses in the minimum effort coordination game," *Experimental Economics*, 13, 346-363.

Chaudhuri, Ananish, Andrew Schotter and Barry Sopher (2009), "Talking Ourselves to Efficiency: Coordination in Inter-generational Minimum Effort Games with Private, Almost Common, and Common Knowledge of Advice," *The Economic Journal*, 119, 91-122.

Cooper, David J. (2006), "Are Experienced Managers Experts at Overcoming Coordination Failure?" *Advances in Economic Analysis & Policy*, 6(2), Article 6.

Cooper, David J. and John R. Hamman (2020)"Leadership and Delegation of Authority," in Marie-Claire Villeval and Klaus Zimmermann (eds.), The Handbook of Labor, Human Resources and Population Economics, forthcoming, Berline, Springer Verlag.

Cooper, David J., John R. Hamman and Roberto Weber (2020), "Fool Me Once: An Experiment on Credibility and Leadership," *The Economic Journal,* 130, 631, pp. 2105 - 2133.

Cooper, David J., and John H. Kagel (2005), "Are two heads better than one? Team versus individual play in signaling games," *American Economic Review,* 95(3), 477-509.

Cooper, David and Kai-Uwe Kühn (2014), "Communication, Renegotiation, and the Scope for Collusion," *American Economic Journal: Microeconomics*, 6, 247-278.

Cooper, Russell, Douglas DeJong, Robert Forsythe, and Thomas Ross (1989), "Communication in the Battle of the Sexes Game: Some Experimental Results," *RAND Journal of Economics,* 20, 568-587.

Cooper, Russell, Douglas DeJong, Robert Forsythe, and Thomas Ross (1992), "Communication in Coordination Games," *The Quarterly Journal of Economics,* 107(2), 739-771.

Dawes, Robyn M., Jeanne McTavish, and Harriet Shaklee (1977), "Behavior, communication, and assumptions about other people's behavior in a commons dilemma situation," *Journal of Personality and Social Psychology*, 35(1), 1.

Dawes, Robyn M., Alphons J.C. van de Kragt, and John M. Orbell (1990), "Cooperation for the benefit of us—Not me, or my conscience," in J. J. Mansbridge (ed.), *Beyond self-interest* (pp. 97-110), Chicago: University of Chicago Press.

Dessein, Wouter, Luis Garicano and Robert Gertner (2010), "Organizing for Synergies," *American Economic Journal: Microeconomics*, 2, 77-114.

Dryzek, John and Christian List (2003), "Social Choice Theory and Deliberative Democracy: A Reconciliation," *British Journal of Political Science*, 33(1), 1-28.

Erat, Sanjiv and Uri Gneezy (2012), "White Lies," *Management Science*, 58(4) 723-733.

Evdokimov, Piotr and Umberto Garfagnini (2019), "Communication and Behavior in Organizations: An Experiment," *Quantitative Economics*, 10(2), 775-801.

Feri, Francesco, Bernd Irlenbusch, and Matthias Sutter (2010), "Efficiency Gains from Team-based Coordination – Large-scale Experimental Evidence," *American Economic Review*, 100(4), 1892-1912.

Fischbacher, Urs and Franziska Föllmi-Heusi (2013), "Lies in Disguise – An Experimental Study on Cheating," *Journal of the European Economic Association*, 11(3):525–547.

Fréchette, Guillaume R. (2015), "Laboratory Experiments: Professionals versus Students", in G. Fréchette and A. Schotter (eds.), *Handbook of Experimental Economic Methodology*, Oxford: Oxford University Press.

Gneezy, Uri (2005), "Deception: The Role of Consequences," *American Economic Review*, 95(1), 384-394.

Gneezy, Uri, Agne Kajackaite, and Joel Sobel (2018), "Lying Aversion and the Size of the Lie," *American Economic Review*, 108(2), 419-453.

Hamman, John and Miguel A. Martínez-Carrasco (2020), "Delegation and Team Selection in Organizations: An Experimental Study," Working Paper.

Hart, Oliver and John Moore (2008), "Contracts as Reference Points," *Quarterly Journal of Economics*, 123, 1-48.

Hart, Oliver and Bengt Holmstrom (2010), "A Theory of Firm Scope," *Quarterly Journal of Economics*, *125*(2), 483-513.

Isaac, R. Mark, and James M. Walker (1988), "Communication and free-riding behavior: The voluntary

Karpowitz, Christopher and Tali Mendelberg (2011), "An Experimental Approach to Citizen Deliberation," in Druckman, J. N., D. P. Green, J. H. Kuklinski, and A. Lupia (eds), *Cambridge Handbook of Experimental Political Science*, Cambridge: Cambridge University Press.

Kartik, Navin (2009), "Strategic Communication with Lying Costs," *Review of Economic Studies,* 76, 1359-1395.

Kriss, Peter H., Andreas Blume, and Roberto A. Weber (2016), "Coordination with decentralized costly communication," *Journal of Economic Behavior & Organization*, 130, 225-241.

Lai, Ernest K, Wooyoung Lim and Joseph Tao-yi Wang (2015), "An experimental analysis of multidimensional cheap talk," *Games and Economic Behavior*, 91, 114-144.

Lundquist, Tobias, Tore Ellingsen, Erik Gribbe, and Magnus Johannesson (2009), "The aversion to lying," *Journal of Economic Behavior & Organization*, 70(1-2), 81-92.

McElheran, Kristina (2014), "Delegation in Multi-Establishment Firms: The Organizational Structure of I.T. Purchasing Authority," *Journal of Economics and Management Strategy*, 23(2), 225-257.

Mookherjee, Dilip (2006), "Decentralization, Hierarchies and Incentives: A Mechanism Design Perspective," *Journal of Economic Literature*, 44(2), 367-390.

Myers, Daniel and Tali Mendelberg (2013), Oxford Handbook of Political Psychology. Oxford University Press, Ch. Political Deliberation, 699-734.

Orbell, John, Alphons J. C. van de Kragt, Robyn M. Dawes (1988), "Explaining Discussion-Induced Cooperation," *Journal of Personality and Social Psychology*, 54(5), 811-819.

Ostrom, Elinor, James Walker, and Roy Gardner (1992), "Covenants with and without a sword: Self-governance is possible," *American Political Science Review*, 86(2), 404-417.

Rantakari, Heikki (2008), "Governing Adaptation," *The Review of Economic Studies*, 75, 1257-1285.

Sahin, Selhan Garip, Catherine Eckel and Mana Komai (2015), "An experimental study of leadership institutions in collective action games," *Journal of the Economic Science Association*, 1, 100-113.

Thomas, Catherine (2011), "Too Many Products: Decentralized Decision Making in Multinational Firms," *American Economic Journal: Microeconomics*, 3, 280-306.

Van Huyck, John, Ann Gillette, and Raymond Battalio (1992), "Credible assignments in coordination games," *Games and Economic Behavior*, 4(4), 606-626.

Vespa, Emanuel and Alistair J. Wilson (2016), "Communication With Multiple Senders: An Experiment," *Quantitative Economics*, 7(1), 1-36.

Weber, Roberto A., Colin Camerer and Marc Knez (2004), "Timing and virtual observability in ultimatum bargaining and 'weak-link' coordination games." *Experimental Economics*, 7(1). 25-48.

Weber, Roberto A., Yuval Rottenstreich, Colin Camerer and Marc Knez (2001*),* The illusion of leadership: Misattribution of cause in coordination games," *Organization Science*, 12(5), 582-598.

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: Translated Instructions

We include instructions for two of the treatments, **NC – D** and **SC – MC**. The rest of the instructions are available from the authors upon request. The Spanish words for row and column are "fila" and "columna". We have kept the original abbreviations, F and C, in the text and payoff tables.

INSTRUCTIONS (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 composition of each group is randomly determined at the beginning of the nine periods and stays constant during the nine periods. During the nine periods you will be with the same two persons. 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 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 sent 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 not 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.

[Block 2] The rules will not change for the second block of nine periods. The persons you play with are the same as the first nine periods.

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 composition of each group is randomly determined at the beginning of the nine periods and stays constant during the nine periods. During the nine periods you will be with the same two persons. 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 not 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.

[Block 2] The rules will not change for the second block of nine periods. The persons you play with are the same as the first nine periods.

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 state losses.

*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 since taking turns was more direct and improving information transmission by strengthening the reputational reasons to tell the truth with managerial control (although the babbling equilibrium with play of the safe outcome is the unique equilibrium for both types of matching). 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 ($k_4 = 6$ vs. $k_4 = 4$). Increasing k_4 does not affect the theoretical predictions for the game under either delegation or managerial control since it remains true that adaptation losses are greater than state losses ($k_3 > k_4$), but the difference between adaptation and state losses is minimized. This reduces the tension between subordinates since the gain for moving from the efficient outcome to a subordinate's most preferred outcome is tiny. For example, moving from Outcome 1 to Outcome 5 in Game 1 gains S1 12 ECUs in **NC - D**, but only 4 ECUs in **HSL – D**.

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 efficient coordination, will be challenging with delegation. Even if coordination occurs, the tension between subordinates makes the safe outcome 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, making the safe outcome less attractive. This lets 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.[33] 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 ($n = 54$; $z = 1.32$; $p > .10$). Efficiency gains are significantly lower in **HSL – MC** than for **CH – MC** ($n = 54$; $z = 1.84$; $p < .10$). In other words, a strong increase in incentives to play the efficient equilibrium has significantly less impact than allowing rich communication.

[33] 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 the 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 outcome
    b. Suggest efficient outcome
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 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) (**CH/A – D** and **CH – MC** Only) M Asks What Game is Being Played.
9) (**CH/A – D** and **CH – MC** 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. "S1: It is Game 3." "S2: 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.