Cheap, Easy or Connected: The Conditions for Creating Group Coordination

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Abstract: In both legal and political settings there has been a push towards adoption institutions that encourage consensus. The key feature of these institutions is that they bring interested parties together to communicate with each other. Existing research about the success or failure of particular institutions is ambiguous. Therefore, we turn our attention to understanding the general conditions when consensus is achievable, and we test experimentally three crucial factors that affect a group's ability to achieve consensus – the difficulty of the problem, the costs of communication, and the structure of communication. Using multiple experimental approaches we find that difficult problems impede consensus, costs make consensus far less likely (even relatively very small costs), and the structure of communication has significant effects and interacts with both problem difficulty and costs. In particular, the structure of communication can reduce the negative effect of costs and facilitate consensus. Together these results imply that consensus is only likely to occur if problems are easy, costs to communicate are low, or the communication structure helps overcome the other two problems. These findings can provide insight about the institutional designs that can be utilized to promote consensual outcomes.

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There has been a tremendous push in modern democracy to establish procedure that leads to more consensual lawmaking. One prominent example of this movement in modern democracy is negotiated rulemaking[2] (or "regneg"), which is defined as "a consensus-based process in which a proposed rule is initially developed by a committee composed of representatives of all those interests that will be affected by the rule, including those interests represented by the rulemaking agency." The Administrative Conference of the United States highlighted negotiated rulemaking as a method of lawmaking that could allow affected parties to have input in the legislative process[3]. The negotiated rulemaking procedure has been described as follows:

> "This technique permits affected interests to retain greater control over the content of agency rules, while ensuring fairness and balance. It also permits agencies to obtain a more accurate perception of the costs and benefits of policy alternatives than can be obtained from digesting voluminous records of testimonial and documentary evidence presented in adversarial hearings."[4]

This quote implies four things about negotiated rulemaking:

1) The agency itself has a built in set of "fire-alarms"[5] that prevent shirking.
2) Those affected by the policy are better off since legislation accounts for multiple points of view.
3) Negotiated rulemaking strips away unnecessary information without removing that which is useful or relevant.

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[2] "Texas Negotiated Rulemaking Deskbook" 1996 Center for Public Policy Dispute Resolution at the University of Texas School of Law.

[3] Negotiated Rulemaking Act

[4] "Negotiated Rulemaking and Administrative Law" 1986 Henry H. Perritt Jr.

[5] "Congressional Oversight Overlooked: Police Patrols and Fire Alarms" 1984 Mathew D. McCubbins and Thomas Schwartz

4) These things together allow for agencies operating under these parameters to be put on auto-pilot[6] to the point where Congressional intervention is all but unnecessary.

At the core of these arguments is the notion of achieving consensus from communication. Those involved in the negotiated rulemaking, as the name implies, must negotiate over the proper course of action to take.[7] The instinct underpinning negotiated rulemaking is that allowing the relevant parties to communicate will lead to both agreement among the actors and better decisions. Some have argued that negotiated rulemaking is successful at achieving this outcome.[8] Others have argued that negotiated rulemaking is slow and thus infeasible as a lawmaking procedure.[9] Coglianese, for example, argues that negotiated rulemaking does not reduce either the amount of time spent crafting legislation or the amount of litigation following a law's imposition. As he states, "Although this quest for consensus has held out the promise of a faster and less conflictual regulatory process, experience has so far shown otherwise."[10] Negotiated rulemaking establishes a process for communication among interested parties but it remains unclear whether, or under what conditions, communication can lead to consensual outcomes.

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[6] "Administrative Procedures as Instruments of Political Control" McNollgast 1987

[7] Administrative agencies have attempted to use electronic rulemaking to encourage greater public participation and to shift "participants from individual opinion to group choices and plans of action (Beierle 2003).

[8] Philip J. Harter, Assessing the Assessors: The Actual Performance of Negotiated Rulemaking, 9 N.Y.U. ENVTL. L.J. 32, 2000

[9] Cary Coglianese, Henry Perritt, Jerry Mashaw

[10] Coglianese, Cary, 1997. "Assessing Consensus: The Promise and Performance of Negotiated Rulemaking." 46 Duke Law Journal 6, 1997, pp 1255-1350

Therefore, in this paper we focus on the following question: “Under what conditions can communication lead to consensus?”

To shed light on communication and consensus we present the results of two different experiments that focus on the conditions under which groups of people can solve consensus problems. Although there are a huge number of factors we could examine we have chosen to focus on three factors particular important to legal and political settings: 1) the costs to participations of communication, 2) the difficulty of the problem the group must decide, and 3) the structure of communication among decision-makers, in other words, who talks to whom, and how does communication get passed throughout the group. Our results suggest that consensus is easiest to achieve when groups face relatively easy problems or when they can communicate relatively very cheaply. However, our results also indicate the structure of communication (who talks to whom) can encourage consensus even when problems are difficult or communication is costly. We turn now to a brief discussion of the three factors we study experimentally and then to a description of the experimental design and results.

2. Difficult Problems, Costly Communication, and Communication Structure

In settings where consensus is a desirable outcome the following three factors can affect whether a group will achieve the outcome: the difficulty of the task facing the group, the costliness of communicating or taking an action, and the structure of communication (who talks to whom). In this section we briefly discuss each factor and explain why it might affect the likelihood of successful consensus.

In both of our experimental approaches (described in more detail later) communication is sparse – basically a simple dichotomous choice[11] that all subjects in the experiment make. All subjects are connected to at least one other subject, and they all have the *same goal*. The connections between subjects allows their stated preference to be conveyed to either everyone else in the group or some subset of all the subjects. The costs associated with the conveyance of these choices can be varied within the experiment.[12] Thus, the settings we focus upon are a parsimonious framework for understanding how idealized communication can affect the ability of a group to achieve consensus. In neither experiment do we consider situations in which players lack an incentive to achieve consensus, although we know this may exist in legal and political settings. Rather, we focus on the conditions that affect consensus when there is an incentive for all individuals to agree. Our results demonstrate that simply having an incentive to agree is insufficient to guarantee a consensus outcome.

2.1 Problem difficulty

The difficulty of the problem that confronts a group will affect their ability to solve a consensus problem. Two common ways problems can become more difficult are by a reduction

[11] There are many decisions made in legal situations where the choice space is binary. For an example, see Mashaw 2001 p. 30 "Small Things Like Reasons" for a discussion about the Social Security Administration dealing with hard edge rules for disability benefits (i.e. you are disabled or you are not).

[12] The costs of communication can be borne by both "speakers" and "listeners" in this experiment. It may be similarly difficult for speakers in certain situations to push information through networks.

in the number of solutions (the classic needle in the haystack problem)[13] or making the problem one where fewer people in the population either know the correct answer or have a strategy for finding it (i.e., can a person tell the difference between the needle and just more hay).[14] Both types of problem difficulty occur in legal and political situations. For example, in deciding where and how to store radioactive waste there a great many ways and places to store the waste, and a regulatory body has to identify the best solutions, but at the same time there may be only a very few individuals who are competent to adjudicate if a proposed solution is actually a good one. If it is difficult to identify the correct answer it will be harder to achieve consensus on a solution than a task where there answers are relatively easy and understood.[15] In addition to directly manipulating the difficulty of a problem, one way to indirectly affect the difficulty of finding the correct solution is to change the decision-rule by which groups decide an answer to a problem. In political and legal settings, the decision rules often require either unanimity or majority for a decision to be reached. In our experiments (discussed later) we directly manipulate both the

[13] Enemark et al. (2011) demonstrate that reductions in the number of solutions can severely impede a group's ability to resolve a coordination problem.

[14] Page (2007) acknowledges that problem difficulty can affect solutions and argues that diversity in groups is useful, because the diversity of individuals makes it more likely that either someone will know the correct answer or have a strategy to find the correct answer.

[15] We assume here that the solutions to the problems do not have differential payoffs to the actors. Actors share a common preference in identifying and agreeing upon a solution, regardless of which one it is. If actors also disagree about which solutions should be adopted (or have a different ranking of their benefits and costs), then the consensus problem will be made more difficult because of conflict between individuals.

difficulty of the underlying problem (how many people know the answer) and the decision rule to understand how these factors affect group consensus.

2.2 Costs to Communicate or Take an Action

Costs to communicate can significantly impede both communication and the likelihood a group achieves consensus on the right answer (see Boudreau et al. 2010 for the results and a full discussion of how costs affect communication and consensus). Essentially, as it becomes more costly to acquire information then fewer people will choose to listen, which thereby induces fewer people to speak. The result of this process is that costs substantially eliminate communication. If it is costly to take an action this, too, can affect coordination or consensus. For example, it could be that it is costly to change one's mind about the right answer to a question (i.e., is a defendant guilty or how should we dispose of radioactive waste) or it could be that achieving consensus requires us to all take the same action (i.e., multiple agencies must agree on how to implement a policy and implementation is costly). In either situation, costly actions can impede coordination or consensus, because if achieving consensus requires that some actors pay a cost and the cost reduces ones overall payoffs, then each actor would prefer that the other actors pay the cost. In this environment a successful outcome may be less likely, because the guaranteed cost of taking an action exceeds the expected benefit of coordination. In essence, a coordination/consensus problem with costly actions contains elements of both coordination and cooperation and represents a common political and legal scenario.

2.3 Structure of Communication

In a group of decentralized actors there are many different ways to model the structure of communication -- that is, who talks to whom. Prior work in this vein has demonstrated that costs to communicate can impede coordination (McCubbins et al. 2010); having a group leader can improve coordination (Wilson and Rhodes 1997) and the presence of focal points (Schelling 1960) can encourage coordination. We model the communication environment using a network.[16] In the network model a node is an individual/actor and a link represents communication or information between them. Using a network approach we can model any pattern of information among nodes in a network. An example of some of the different communication structures that can exist among just four actors is shown in Figure 1. In our experiments a link is undirected and implies symmetric information (both nodes see each other) along that link, but in theory links could be directed (i.e. information would be asymmetric) so that only one node could observe the other node, which would increase the number of possible communication structures.[17] It is clear that even with only a small number of nodes and bilateral, undirected links there are many possible communication structures.

Insert Figure 1 here

3. Testing the effects of problem difficulty and costs on consensus

All of our experiments on consensus involve: multiple decision makers; a state of the world that individuals need to determine; the opportunity to communicate information about one's beliefs about the state of the world; the opportunity to receive information about others' beliefs; and a great incentive for individuals and groups to reach a consensus. Despite sharing

[16] We are not the first to use a network to model communication structure. For instance, see Calvo-Armengol (2001) and Choi et al. (2011) for examples of communication networks combined with standard economic games (i.e. bargaining, public goods).

[17] The number of possible structures explodes if either 1) links are directed/asymmetric between nodes or 2) positions in the network are not equivalent – that is in a line is the structure simply the connections or also which actors occupy a node. We opt for a simpler approach in this paper.

these similarities our experiments differ in the communication structure that connects individuals, the task facing subjects, and the structure of incentives.

In the first experimental design subjects are faced with the task of deciding the correct answer to math problems about which they are uncertain (that is, subjects may not know the correct answers to the math problems).[18] These math problems are drawn from an SAT II, level two math test, and we provide two possible answers for each question, one of which is correct and the other is incorrect. Subjects have 60 seconds to answer each math problem. They earn $1 if their final answer is correct, they lose $1 if their final answer is incorrect, and they neither earn nor lose money if they do not answer the problem. Consensus requires a correct answer by either a majority or unanimity (depending on the condition) of the subjects. If the group achieves consensus then each individual makes an additional $10. This payment structure creates common interests among all subjects in reaching consensus about the correct answer to the problem. The use of math problems allows us to focus on the core element of this experiment – the difficulty of the problem – and its relationship with successful consensus.

Subjects have the opportunity to exchange information during the experiment. In the experiment we break the information process in two steps – sending information and receiving information. After subjects see the math question and the two possible answers they have an opportunity to choose if they want to send a recommended answer about the problem. They also choose simultaneously if they would like to receive any recommended answers about the math

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[18] Math problems are a good problem to give to subjects because we can easily observe whether or not subjects converge to the correct consensus. In addition, subjects are unlikely to have ideological attachments to the answer that might make them unwilling to learn from others. For a longer discussion of why math problems are useful in such experiments see Boudreau (2007).

problem. After subjects make these two decisions the experimenters aggregate the number of subjects (if any) who suggest answer A and B, and they then distribute this information to the subjects that chose to receive information. If a subject chose to receive information he or she will receive a signal that tells them that some number of subjects recommended answer A and some number of subjects recommended answer B. This communication set up is analogous to the Delphi method and is represented by Figure 2.[19] The figure demonstrates that we can model this structure of connections between individuals as a network, in which each node can connect to the central node (the Delphi box) at a cost. The core function of this central Delphi box is to assure the anonymity of subjects and to provide information about the others' choices – how many others choose A or B as the correct answer.[20]

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[19] The Delphi method is one way to implement the model DeGroot (1974) proposed for how a group could achieve consensus.

[20] The Delphi method has been used in government and business applications as a way to facilitate consensus among decision makers. The Delphi method has been implemented in a number of different ways, but generally the technique involves experts answering survey questions, a central person aggregating the experts' answers and distributing the aggregated responses to the experts, and then experts again answering all or a subset of the survey questions. This process may then be repeated for some number of iterations, depending on the actual Delphi method utilized. For more about Delphi see: Sackman, H. 1974. "Delphi Assessment: Expert Opinion, Forecasting, and Group Process." A Report prepared for United States Air Force Project RAND and Rowe, Gene and George Wright. 1999. The Delphi Technique as a Forecasting Tool: Issues and Analysis." *International Journal of Forecasting*. 15, 353-375

Insert Figure 2 here

We do not provide any information in our standard experiment about characteristics of those who suggested answers because we do not want to affect what people know about the group or individuals, as that is not the focus of the experiment. The significant bonus for consensus creates the conditions for trust among subjects (Crawford and Sobel 1982; Lupia and McCubbins 1998) so that only those who know the correct answer should provide information and they should only suggest the correct answer because there is no benefit from deceiving subjects in this experiment. After subjects receive the signal about recommended answers they must decide how to answer the math question. In the experiment subjects do not receive any feedback after each problem about whether they answered a question correctly or if the group achieved the bonus. We design the experiment in this fashion to reduce the opportunity for subjects to learn about the others in the group. We also utilize dividers between subjects and all actions taking during the experiment are done anonymously to reduce learning within the experiment and make each question as close as possible to a one-shot trial as in the model. All of the protocols are read aloud to subjects to ensure common knowledge, and subjects are quizzed on the various instructions throughout the experiment.

Boudreau et al. (2010) demonstrate that costs to communicate significantly reduce the likelihood of groups achieving consensus. This effect occurs for two reasons. First, if speaking is costly then fewer subjects will choose to do so because they may not believe their choice to speak will lead the group to achieve coordination and therefore they pay the cost without receiving a benefit. Second, if listening is costly then subjects are less likely to listen, which also implies that it is less useful for subjects to suggest an answer, because no one is listening and therefore speaking is without any value. These results suggest that consensus may not be easy to achieve if communication is costly.

3.1 Effects of Problem Difficulty and Costs on Consensus

In the tables below we examine the proportion of times that groups of eight subjects were able to achieve consensus on the correct answer to a math problem, based on the difficulty level of the problem. These results combine a variety of different costs for communication, but in all of these trials it was possible for subjects to communicate with one another. We measured difficulty in a separate set of experiments in which we gave the math problems to randomly selected undergraduate students and paid them to solve math problems, where they earned $1 for a right answer. This table combines the various communication conditions (free, cost to speak, cost to listen, and cost to speak and listen). It is clear that there is a considerable main effect of the difficulty of a problem on the likelihood a group reaches consensus on the correct solution. For the very easiest problems groups almost always reach consensus, but the proportion steadily decline until consensus almost never occurs. Therefore, even if there is a significant advantage to achieving consensus (the large bonus) and communication is possible, groups may fail to do so if problems are difficult.

Insert Table 1

We also expect that majority rule will lead to an increase in the probability that a group achieves consensus compared to unanimity, because only five subjects must answer correctly instead of all eight. We test these predictions in Table 2 and 3 where we examine how changing from unanimity to majority affects both communication and the ability to achieve consensus. The results in Table 2 demonstrate that majority rule does not affect the decision of subjects to send or receive information in the experiment. However, as shown in Table 3 we do find that majority rule is associated with a positive, significant increase in the probability that a group achieves consensus. These two results together suggest that the greater success in achieving consensus is because fewer people must agree under majority rule and NOT because individuals are more likely to communicate. The results in Table 3 indicate that both cost to receive and costs to send and receive are associated with a lower probability of achieving consensus, as we demonstrated in prior work. The cost parameter is insignificant, suggesting that increasing costs does not decrease the probability of consensus and the implication from this is that even a small cost has the same impact on achieving consensus as a large cost (which was also reported in Boudreau et al. 2010). In addition, the results in both Tables 2 and 3 show that easier problems are associated with both more communication and a higher probability of achieving consensus. Together these results demonstrate that changing the decision rule can lead to greater consensus, but it does not engender greater communication in the process.

Insert Tables 2 and 3

4. Communication Structure and Costly Coordination

In a separate set of experiments we have studied how the structure of communication (modeled as a network) affects group consensus. These experiments model the network explicitly by treating individuals as nodes and a link between two nodes allows them to communicate during the experiment. The task facing subjects in these experiments is deceptively simple – they must choose a color for their node that either makes them the same or different than all of their neighbors (depending on the experiment). If every node in the network successfully solves their local problem, then the entire group earns a payoff. If nodes are not connected then they do not observe each other, and subjects do not have any information about the global properties of the network other than the number of nodes.

Subjects were recruited from large public and private universities via email and flyers throughout campus. Interested subjects were then emailed to sign up for an experimental session and on the day of the experiment we chose 16 of the people who showed up to participate. The sixteen subjects were escorted to a computer lab where they sat at computer terminal with partitions between them to ensure they could not observe each other's behavior. We read aloud instructions to all the subjects to describe the game and ensure they had common knowledge of the game's rules. We also quizzed the subjects throughout the session to ensure they understood the rules at any time where we changed the experimental treatment. Subjects were always given two colors to choose from during a trial, but the colors varied for each trial and the colors differed for each subject to make the development of a focal color difficult. If the trial was solved successfully each subject earned $1, and if choosing a color was costly then the costs were subtracted from the earnings for that session. If consensus was unsuccessful and actions were costly, then subjects simply lost money for each move. Subjects had three minutes to successfully solve the coordination task, and once the session began subjects could make choices at any time and choices were immediately visible to others (if they share an edge). This makes the game dynamic and asynchronous, not a stage or single-shot game.

This experimental framework begins with a basic consensus game in which all actors try to take the same action, and then we modify this by adding a cost that is imposed each time an actor chooses a color (similar to communicating about the correct solution to a problem). The addition of costs creates an element of potential conflict between the individuals in the game, which is common in legal and political situations. The addition of costs changes the consensus game as illustrated in the following two scenarios. First, consider the situation in which no one has taken an action. If taking an action is costly, then players will only pay the cost to take an initial action if they believe that the group can solve the coordination problem (which requires all players to pay at least an initial cost to take an action). If players believe the group cannot reach a solution, then they will not pay the cost to make an initial choice. If the initial costly choice leads to consensus, then no one has an incentive to deviate. However, if the initial costly choice(s) do not lead to consensus, then at least some players must pay an additional cost to take another action for consensus to occur. In this scenario each player would prefer if the other player(s) paid the cost to change color. However, if everyone waits for someone else to act then the group will not achieve consensus. The most important point is that the simple addition of costs infuses the basic consensus game with an element of conflict regarding who will pay the costs to change color.

Insert Figure 3

In Figure 3 we present the modified version of the Delphi mechanism that functions in this experiment. In these experiments every actor is connected to the computer server (which acts as the Delphi mechanism) to maintain the anonymity of subjects and also lets subjects know how much time remains in a particular experimental trial, from which subjects can deduce if they solve the consensus problem before time expires. In addition, subjects have direct connections to others in the network. These connections comprise the communication structure and the networks we utilize in the experiment are displayed in Figure 4.

Insert Figure 4

During the actual experiment subjects know the following information, which is displayed in the sample screen shot in Figure 5:

Number and Degree of Neighbors: subjects can observe the other nodes to which they are connected and the color of those nodes at all times. They also know how many connections each neighbor has, which is displayed in the center of the node.

Time Elapsed: A bar displays how long until the session expires

Cost to move: We implement a cost for each choice a player makes, including his first choice and the cost per move is displayed on the screen.

Insert Figure 5

In addition, subjects can determine if the trial was solved successfully because if so the trial will end before the time elapsed bar runs out. They do not know the structure of the entire network at any point during these experiments. We utilize both within and between subject designs. During each experimental session (consisting of 30 to 50 trials) subjects play the coordination game with a variety of different costs to take an action. This allows us to observe, within a single group, how changes in costs affect coordination. At the same time, to achieve enough observations we pool results from experiments that involved different groups.

4.1 Effects of Communication Structure on Costly Consensus

To study communication structure and costly coordination we have subjects play a consensus game in which it is costly to choose a color for one's node. For instance, subjects might complete ten trials with no cost to move, 12 trials with a 10-cent cost, 16 trials with a 30-cent cost and 16 trials with a 50-cent cost. The reason to group trials based on cost is to ensure that subjects fully understand the costs for each set of trials because we can remind and quiz them before we change the cost to move. Given that the order of the costs may matter we also vary the order between different groups, but always begin with the no cost treatment to ensure that subjects believe the game is solvable and therefore attend to the coordination task to earn money. The addition of costs to consensus game significantly increases the amount of time it takes for the group to solve the problem ($p<0.01$, two-tailed test). Therefore, there is an overall main effect of costs on the time it takes for a group to reach agreement about how to solve this experimental task.

To examine the effect of communication structure on the time it takes to complete a costly consensus game we focus on the mixture and no leader networks, which feature no variance in degree. The mixture network has 56 edges and the leader network has only 24. Consistent with this, the mixture network is completed more quickly than the no leader network when we examine all the network trials across the various cost conditions (two-tailed t-test, $p< 0.01$). In Figure 4 we display the average time to solve the consensus problem in the mixture and no leader networks for each different cost level. We can see that although costs increase the time to solution in the mixture network the increase is much less than it is in the no leader network. These results clearly suggest that even when it is very costly to take an action it is possible to create a structure of communication that facilitates consensus.

Insert Figures 5 and 6 here

The moderating effect of communication structure on the time to achieve can provide guidance about the design of institutions, because it is through institutional design that we often build the structure of communication in legal and political situations. To put it another way, legal and political environments are often intentionally designed, which means that it may be possible to build a structure of communication that encourages agreement.

5. Discussion and Conclusion

In a variety of legal settings there is a focus on creating consensus among affected parties. Scholars are divided on whether or not these attempts, such as in the case of negotiated rulemaking, will actually lead to greater agreement. We demonstrate experimentally the conditions under which groups can, in fact, achieve consensus. Our experimental results demonstrate that achieving consensus is more likely when the underlying problem is relatively easy or when it is free (or very cheap) to take an action or communicate. In settings where communication is costly, however, our results indicate that that the structure of communication can facilitate or defeat consensus. This last point implies that institutions which create communication between actors can be a valuable part of encouraging consensus, even when it is costly to communicate or take an action.

Our experiments all involve situations where the actors have a common interest in solving the problem, even though they may not agree on how to solve it (i.e. should you or I pay the costs to reach a solution), therefore we have intentionally and explicitly stacked the deck towards finding that consensus is achievable. Clearly, if individuals in a group do not have an incentive to agree (or have an incentive to delay a decision), then it will be even more difficult to reach a consensus.

These experimental results have important implications for both empirical research and the design of legal and political institutions. First, our results identify three important dimensions that can affect group consensus, and in so doing provide a path for future research about group decision making. Additional experiments and observational research can help clarify and further refine the various ways that problem difficulty, costs to communicate, and communication structure work to either facilitate or impede the formation of a consensus. Our results demonstrate that each factor matters, but there is much more work to understand fully how these factors affect outcomes. Second, our results can provide some guidance about how institutions can be designed to facilitate consensus. Institutions have a particular role to play in creating the communication structure with which decision makers interact. This design structure, the structure of connections between decision makers can go a long way to establishing the conditions for consensus, although they will not naturally emerge just by putting people into a room and having them make their cases, rather, a communication network needs to be established, one that reduces the adverse effects of costly communication and eases the burden of tough decisions.

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Table 1: Effect of Problem Difficulty on Consensus

Problem difficulty (% students answering correctly in pretest)	Hardest (6-15%)	Hard (16-36%)	Easier (37-56%)	Easiest (57-90%)
Successful consensus	2/104 1.9%	4/42 9.5%	25/68 36.7%	43/74 58.1%

Table 2: Majority Rule Does Not Lead to More Communication

	DV: Sending information	DV: Receiving information
Pay to send and receive	-2.40 (0.57)**	-7.48 (1.18)**
Majority rule for consensus	0.02 (0.82)	-0.64 (0.66)
SAT math score	0.007 (0.002)**	0.0008 (0.002)
GPA	0.86 (0.52)	-0.66 (0.40)
Group average SAT math score	-0.01 (0.02)	-0.04 (x0.2)**
Ease of problem	0.03 (0.008)**	-0.01 (0.008)
Constant	0.45 (12.08)	33.45 (12.8)**
N	531	531
Num of Groups	15	15
Random Effect Parameter		
Group	0.63 (0.27)**	0.47 (0.27)**
LR test vs. standard logistic regression (chi2)	4.09*	1.98*

** = significant at 0.01 level

Analysis includes only the free communication and cost to send and receive condition with a $2 cost to send and receive information. We exclude the experiments run with SAT scores and reasons.

Table 3: Majority Rule and Easier Problems Facilitate Consensus

	DV: Consensus
Cost for taking an action, either speaking or receiving	-0.31 (0.63)
Pay to send condition, receive for free	-0.48 (0.77)
Pay to receive condition, send for free	-3.15 (0.94)**
Pay to send and receive condition	-2.98 (0.91)**
Group's Average SAT math score	0.042 (0.01)**
Group's Average GPA	-0.07 (1.91)
Ease of problem	0.10 (0.02)**
Majority rule	3.77 (1.44)**
Constant	-29.69 (10.8)*
N	258
Num of Groups	25
Random Effect Parameter	
Group effect	0.84 (0.56)
LR test vs. standard logistic regression (chi2)	0.97

Figure 1: Possible Information Structures with Four Actors

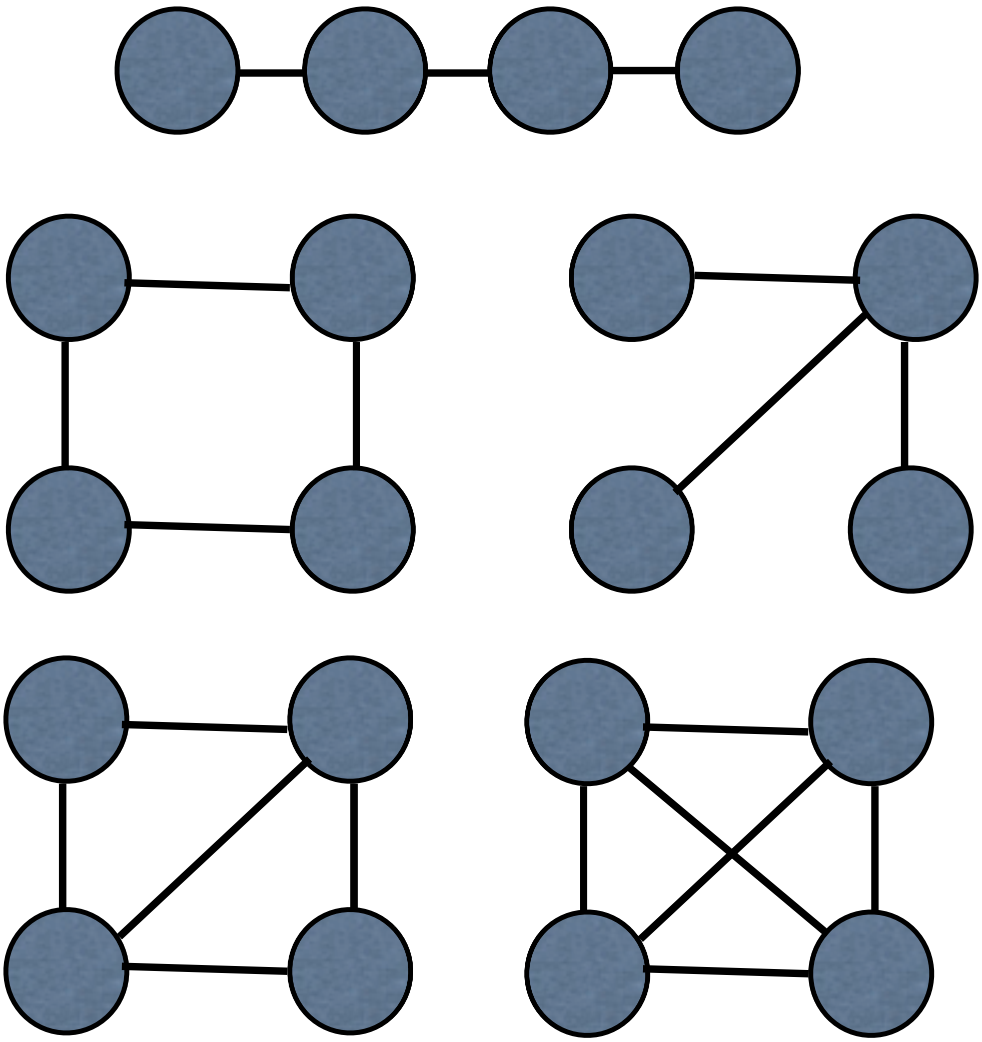


Figure 2: Delphi Mechanism

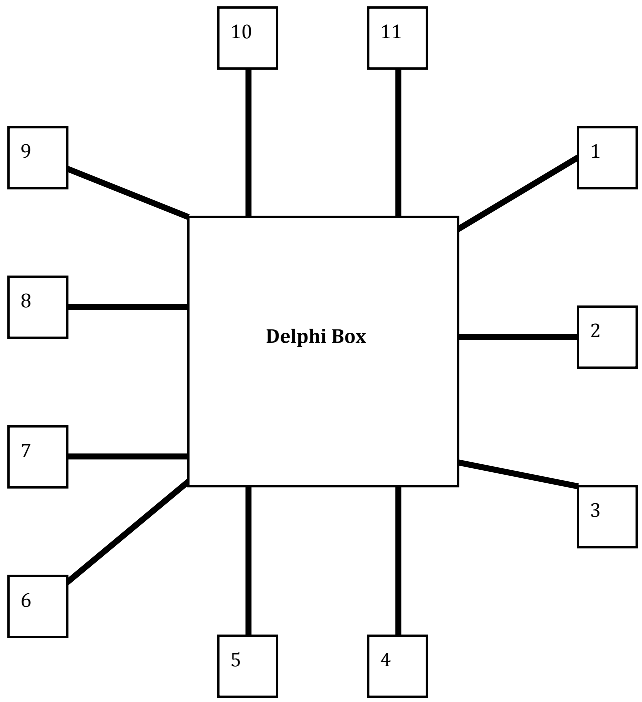


Figure 3: Delphi Mechanism Modified so Subjects Can Directly Observe Others' Actions

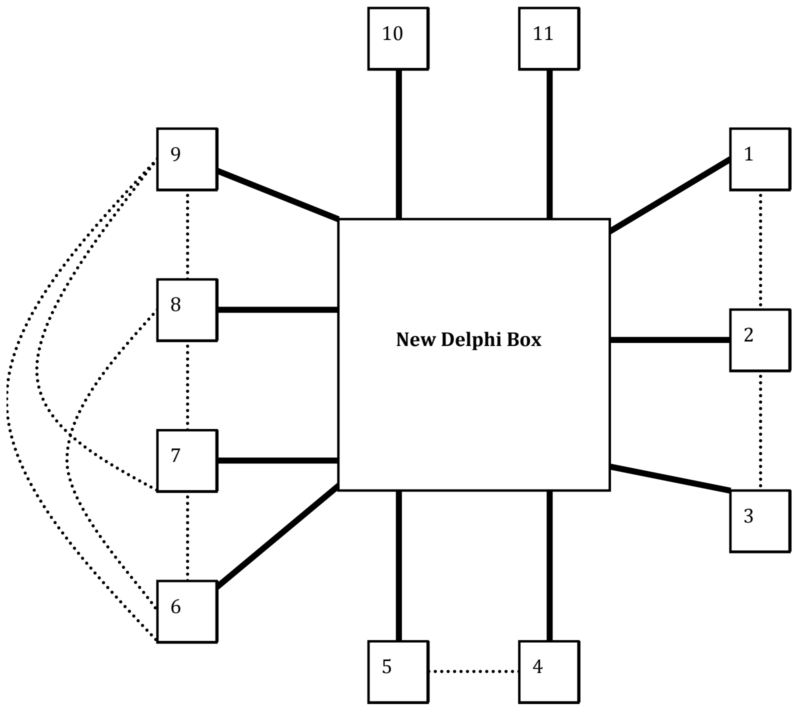


Figure 4: Networks used in Experiments

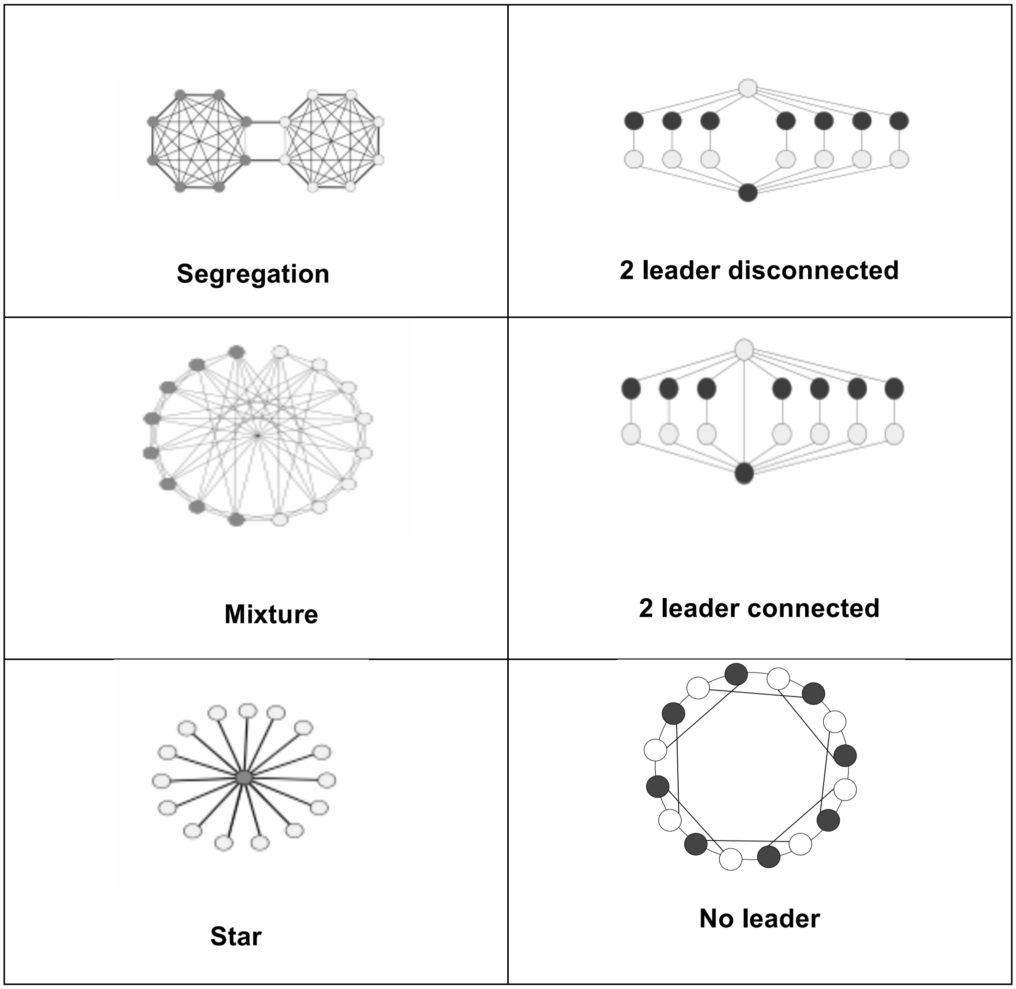


Figure 5: Interface Used During Network Consensus Experiments

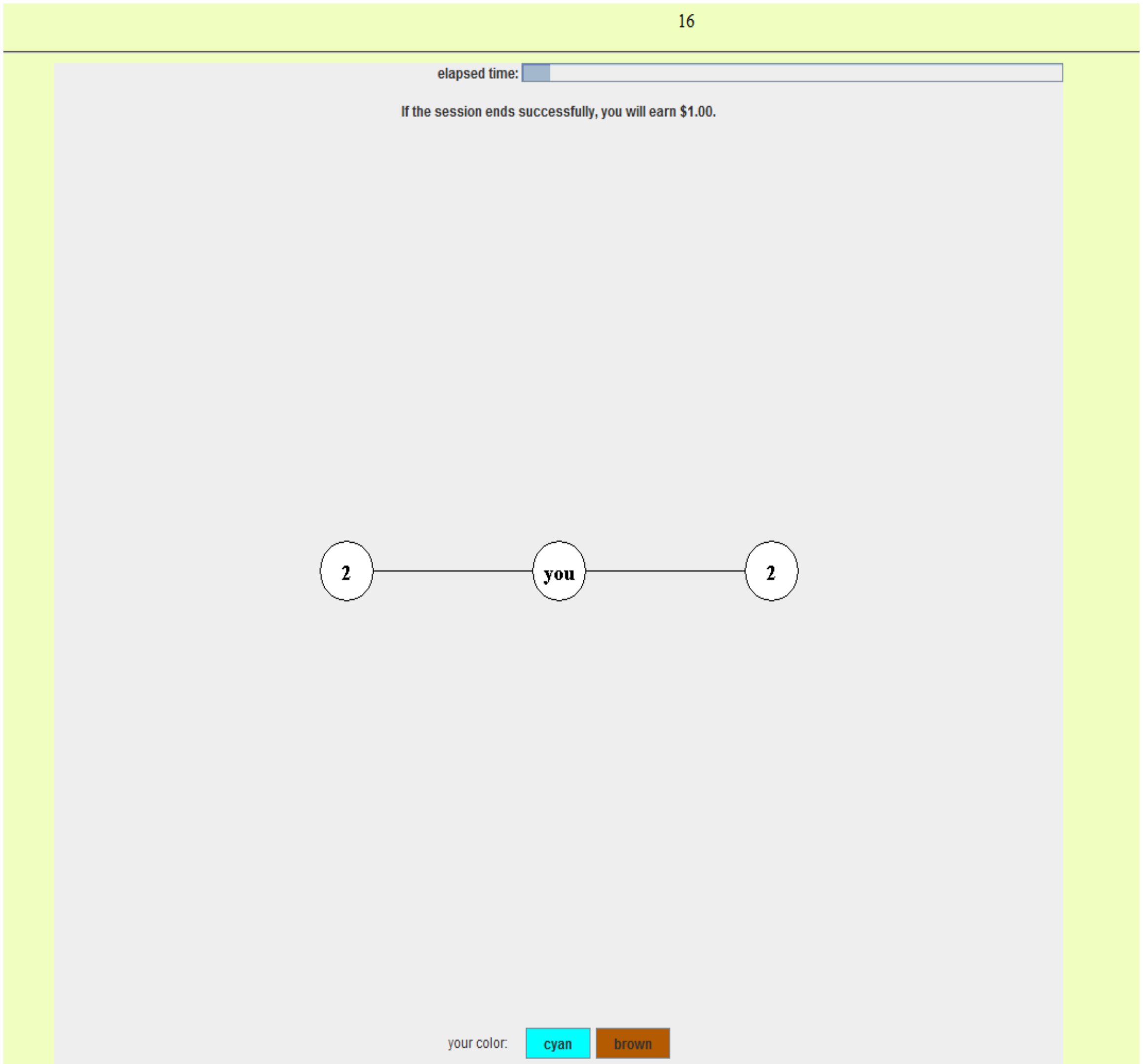


Figure 6: Costs Slow Network Consensus

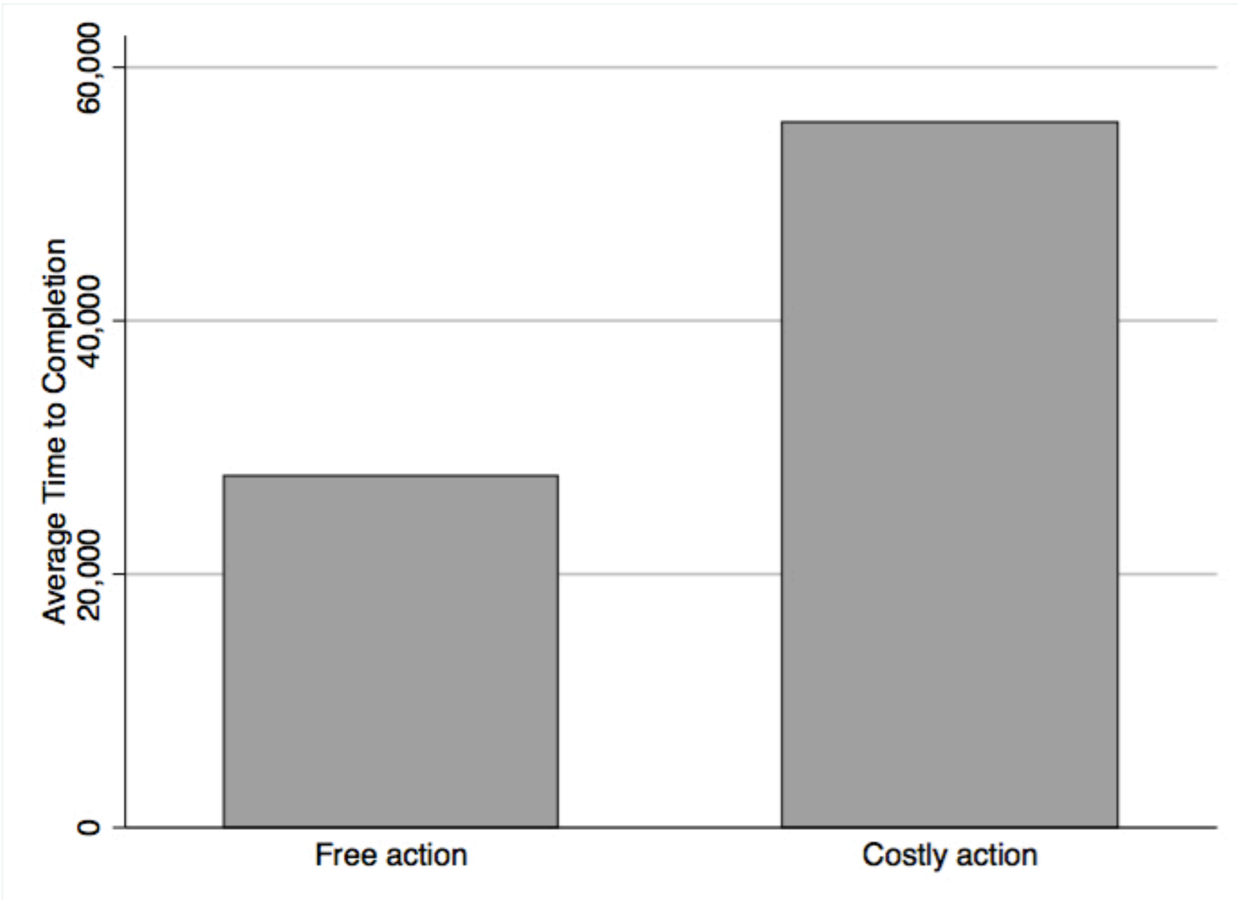
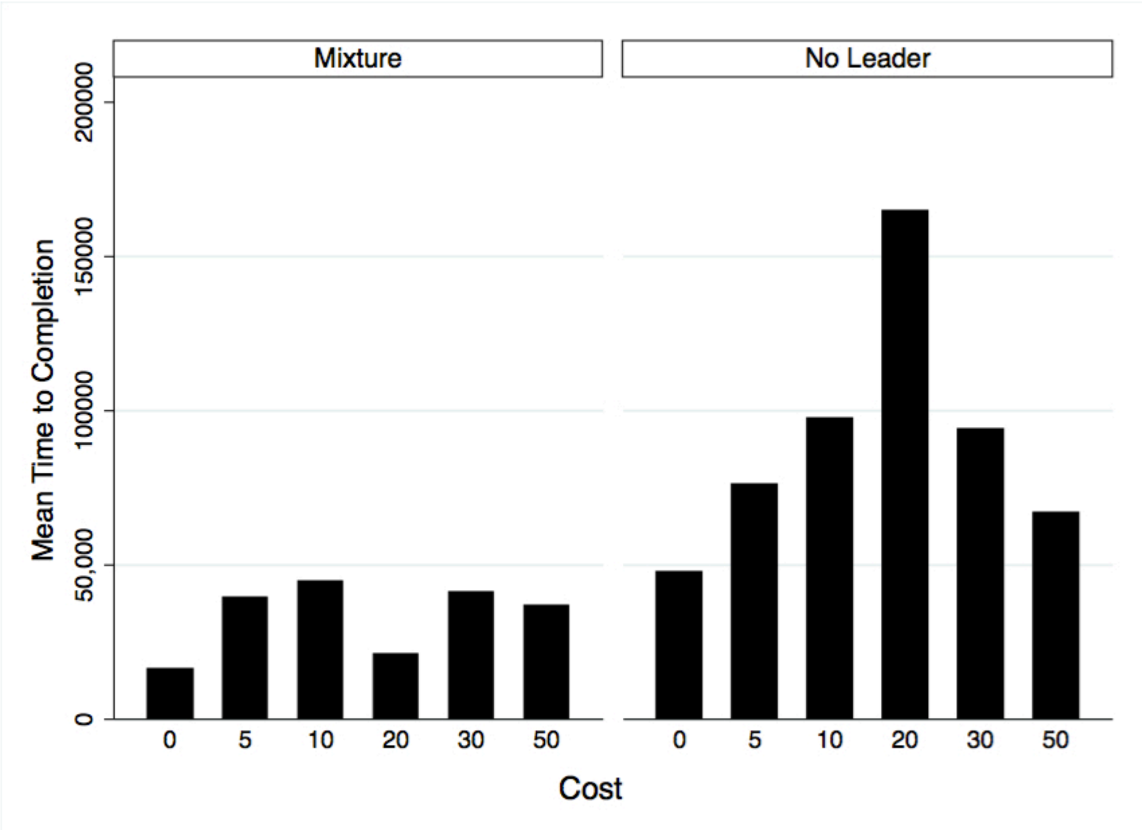


Figure 7: More Edges Reduce the Effect of Costs



Outcome is the average number of miliseconds to achieve coordination among all the trials in which taking an action was costly. Any failed trials are right-censored at 180,000 miliseconds