Endogenous role assignment and team performance[1]

[Running Head: Endogenous roles and teams]

David J. Cooper[#]

Florida State University and University of East Anglia

Matthias Sutter[†]

Max Planck Institute for Research into Collective Goods Bonn, University of Cologne and University of Innsbruck

Abstract: We study how the mechanism used for assigning roles within teams affects team performance. Subjects play the takeover game in buyer-seller teams. Understanding optimal play is demanding for buyers and trivial for sellers, so teams should perform better if the buyer is the abler teammate. When teammates are allowed to jointly choose their roles, abler teammates tend to become buyers, but this is more than offset by disruptions to the learning process. We examine two potential sources for the latter effect, and find that endogenous role assignment has a negative psychological and emotional effect on buyers.

JEL-Code: C91, C92

Keywords: Role assignment in teams, team performance, takeover game, communication, experiment, organizational economics

[1] We would like to thank Hal Arkes, Rachel Croson, Hanming Fang, Guillaume Frechette, Salar Jahedi, John Kagel, Peter Kriss, Scott Tindale, two anonymous referees, and seminar participants at Florida State, SJDM, EWEBE and the ASSA meetings for helpful comments. We thank Björn Brand, Phil Brookins, Brent Davis, Krista Jabs, Roland Jansky, Manuela Oberauer and Matthias Praxmarer for assistance in programming and running the experiments, Glenn Dutcher for help with preparing the text, and Fabienne Fier, Lucas Haiduck, Richard Krenndorfer and Alessandro de Spirito for coding the dialogues. Financial support from the Austrian Science Fund (FWF Project P22772-G11) and the NSF (SES – 0924772 and SES-1227298) is gratefully acknowledged.

[#] Department of Economics, Florida State University, Tallahassee, FL 32306-2180, USA. e-mail: djcooper@fsu.edu

[†] Max Planck Institute for Research into Collective Goods, Kurt-Schumacher-Str. 10, D-53113 Bonn, Germany; Department of Economics, University of Cologne, Albertus Magnus Platz, D-50923 Köln, Germany; and Department of Public Finance, University of Innsbruck, Universitaetsstrasse 15, A-6020 Innsbruck, Austria. e-mail: matthias.sutter@uni-koeln.de

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/iere.12313

1. Introduction

Motivated by the observation that many important economic decisions are made by teams rather than individuals, economics has recently witnessed a surge of interest in team decision making. Extending the existing psychology literature to domains of specific interest to economists, experimenters have established that team choices are generally more rational and more self-interested than individual choices (e.g., Bornstein and Yaniv, 1998; Cooper and Kagel, 2005; Blinder and Morgan, 2005; Kocher and Sutter, 2005; Charness and Jackson, 2007; Luhan, Kocher, and Sutter, 2009; Casari, Zhang, and Jackson, 2016; Charness and Sutter, 2012; Kugler, Kausel, and Kocher, 2012). An issue these studies place little emphasis upon is the internal organization of teams. More specifically, a universal feature of existing studies is that team members are all engaged in the same task. While appropriate for establishing basic observations about how teams perform relative to individuals, use of homogenous tasks departs significantly from the reality of many team environments. Team members in most environments are filling different roles and completing different tasks with different levels of difficulty. Not all team members are equally well suited for all tasks, so getting the right person assigned to the right role can be an important determinant of team success.

Our study focuses on how the process of assigning teammates to roles affects performance, comparing random role assignment with allowing team members to agree among themselves on role assignments. Giving team members input on the assignment of roles has clear informational benefits, since they are likely to know more about their abilities than any outside observer and therefore do better at getting the right person assigned to each role. Holding role assignments fixed, letting team members have a say in choosing roles could affect their performance in several additional ways. Conventional wisdom holds that increasing employee involvement improves performance by increasing intrinsic motivation.[2] This implies that giving team members input on the assignment of roles will have a positive

[2] See Ichniowski and Shaw (1999) for empirical evidence of the positive effect of employee involvement.

effect on performance. However, some roles may be more desirable than others. If having to agree to roles leads to open disagreement or unvoiced discomfort with the implied conflict of choosing winners and losers, the effect of allowing team members to have a say in team assignment might be negative rather than positive (controlling for role assignment). Even in the absence of conflict and emotional pressure, forcing team members to focus on assigning roles in addition may distract them from their tasks and therefore harm their performance.

We examine role assignment in a setting where one role is more demanding than the other, making proper role assignment crucial for the success of a team. We find that endogenous role assignment does *not* improve team performance relative to random role assignment. Underlying this are two effects of endogenous role assignment that almost perfectly counter-balance: the likelihood that the more able teammate is assigned the more demanding role increases with endogenous role assignment, reflecting the informational benefits of endogenous role assignment, but at the same time endogenous role assignment damages the performance of individuals assigned to the more demanding role due to negative psychological and emotional effects.

Getting into the details, our subjects play a simplified version of the takeover game (Samuelson and Bazerman, 1985). This game has a Buyer and a Seller. The Seller has a single item to sell. She knows the value of this item while the Buyer only knows the distribution of values and that the value of the item to the Buyer is always 150 percent of the value to the Seller. The Seller's payoff maximizing strategy is trivial: she should accept any bid greater than her value. Because of the asymmetric information between Buyers and Sellers concerning the item's value, the Buyer faces adverse selection. In choosing a bid he needs to understand that the expected value of the item *conditional on having his bid accepted* is less than the expected value *ex ante*. The adverse selection is sufficiently severe that submitting a bid equal to the lowest possible value is the Buyer's expected payoff maximizing strategy.

Previous work on the takeover game has focused on why the winner's curse (over-bidding) occurs, but we use the takeover game to understand how task assignment affects team performance. The takeover game has two features that make it valuable as a lab environment for studying role assignment. First, the

Buyer and Seller roles differ greatly in difficulty. The Seller's optimal strategy is trivial, but previous work has established that Buyers have a great deal of difficulty understanding that they need to bid low due to adverse selection (e.g., Grosskopf, Bereby-Meyer and Bazerman, 2007; Bereby-Meyer and Grosskopf, 2008; Charness and Levin, 2009). Second, performance in the takeover game is known to improve when the Buyer role is played by a group (Casari et al., 2016).[3] This allows us to study the relationship between the importance of role assignment and the degree of interaction between teammates, specifically whether the method of role assignment matters more when team members can work together than when they operate independently. In the four main treatments of our experimental design, subjects are matched into teams of two players each. One teammate plays exclusively as a Buyer and the other plays exclusively as a Seller. Each plays a series of takeover games against Buyers and Sellers from *other* teams and split their earnings evenly. Teammates *never* play against each other, so their interests are perfectly aligned. The four treatments with teams systematically vary along two dimensions: (1) the Buyer and Seller roles are either assigned randomly and exogenously or are endogenously agreed upon by the two teammates, and (2) teammates either play independently, only interacting through their shared payoffs, or are given periodic opportunities to chat about how to play the game. *Ex ante*, we expect either endogenous role assignment or chat between teammates to improve the Buyers' performance by lowering bids.

We find that chat leads to significantly lower bids as expected. Endogenous role assignment has little effect, raising (rather than lowering) bids by a small amount that is far from statistical significance. This is surprising since our data has all the necessary conditions for endogenous role assignment to lower bids. Bids from the initial phase should provide a clear measure of ability, and the data confirms that bids are significantly lower in the second phase when the more able teammate (i.e., the lower bidder in the first

[3] In Casari et al. (2016) groups consist of three members who are all in the role of buyers (while sellers were computerized). Their paper does not focus on role assignment and how it affects team performance. Our version of the takeover game resembles their easy task where teams outperform individuals.

phase) is assigned to the Buyer role. As expected, endogenous role assignment generates selection in favor of more able subjects taking the Buyer role, with subjects who bid lower than their teammates in the first phase being significantly more likely to be assigned the Buyer role in the second phase. The problem is that Buyers who are endogenously assigned this role bid significantly higher in the second phase, controlling for ability, than Buyers who are randomly assigned this role. This unexpected effect more than reverses the positive effects of selection in favor of more able subjects. The dialogues between teammates provide direct evidence that endogenous role assignment negatively affects the quality of the discussion between teammates on how to play the game.

The negative effect of endogenous role assignment on Buyers' performance, controlling for ability, is the primary result of our paper. In two follow-up treatments, we tried to gain insights into why endogenous role assignment had negative, rather than positive, effects. Our first hypothesis was that the negative effect of endogenous role assignment was due to cognitive load. The intuition is straight forward. Individuals only have a limited budget of cognitive resources available. Adding a task that requires use of these resources necessarily leaves less for other tasks, leading to less rational behavior (Johnson-Laird and Wason, 1970). To test this hypothesis, we ran a first follow-up treatment in which teammates were given two demanding logic puzzles to solve for a monetary award, thus increasing cognitive load. Subjects spent a large amount of time working on the puzzles and discussion of how to bid was reduced even more than with endogenous role assignment. As with endogenous role assignment, Buyers bid higher, controlling for ability, in the logic puzzle treatment. This effect, however, is less than half the effect of endogenous role assignment and is not statistically significant. Cognitive load may explain part of the effect of endogenous role assignment, but is unlikely to be the full explanation.

Our second conjecture was that endogenous role assignment triggers negative feelings on the part of Buyers, since they have been assigned the more demanding role, diminishing the perceived importance of thinking hard about how to bid. To test for negative psychological and emotional effects of endogenous role assignment, we ran a second follow-up treatment. Teams were able to chat and assign roles endogenously, but after the role selection we paused for almost half an hour to conduct several

questionnaires. These addressed two main sets of questions: First, does endogenous role selection generate selection into the Buyer role on individual characteristics beyond those related to bidding behavior in the first part of the experiment? We focus on psychological characteristics such as overconfidence, risk preferences, positive and negative reciprocity, a desire for control, and self-efficacy. Second, are there differences in the emotional state of Buyers and Sellers? For example, do Buyers feel happier with their role than Sellers? Do Buyers feel more pressure than Sellers or more responsible?

We find that subjects who select into the Buyer role are significantly more likely to want to punish people who have harmed them (negative reciprocity). The emotional states of the two roles also differ, with Buyers feeling less happy, less joyful, and more envious. Directly related to role selection, Buyers put less value than Sellers on their chosen role.

With endogenous role assignment, it is the Seller, not chance, who bears responsibility for Buyers getting the more demanding role. Even though we observe little open conflict when roles are being assigned, subjects assigned endogenously to the Buyer role are unhappy about it and inclined to punish people who have harmed them. While we don't think Buyers are purposefully sabotaging Sellers, it is easy to imagine that they aren't terribly motivated to try their hardest to figure out the best bidding strategy. Hence, we conclude that endogenous role assignment puts an emotional strain on Buyers which leads to worse bidding behavior.

We proceed as follows: Section 2 describes the takeover game, and section 3 introduces the experimental design. Section 4 presents our hypotheses, and section 5 the experimental results. Section 6 is devoted to our two follow-up treatments, and section 7 concludes the paper.

2. The Takeover Game

Subjects in our experiment played a simplified version of the takeover game. This game involves two individuals, a Buyer and a Seller. The game begins with the Seller drawing a value, V, for an indivisible item. This is the amount the item is worth to her. The possible values are 90, 600, and 1200 experimental

points, with each value equally likely to be drawn. The Seller knows the value of the item while the Buyer only knows the distribution of values. The Buyer submits a bid, B, to purchase the item, where bids are restricted to the set of integers between 0 and 2000 (inclusive). The Seller observes the bid and chooses to either accept or reject it. If the bid is accepted, the Buyer's profit is 1.5*V – B and the Seller's profit is B – V. If the bid is rejected, both players' profits are zero.

The Seller's optimal strategy is simple – she should accept a bid if it is (weakly) greater than the value and reject otherwise. The Buyer's optimal bid is less obvious. If the Seller is behaving optimally, the Buyer's expected payoff maximizing bid is 90. This is also the optimal bid for a risk averse buyer. In evaluating the profitability of a bid, the Buyer has to consider the expected value of the item *subject to the bid being accepted.* In other words, the Buyer must account for adverse selection. Table 1 illustrates the basic features of the Buyer's problem. A bid of 1200 induces all Sellers to accept the bid, including those with low (V = 90) and medium (V = 600) values. Because the expected value of an item is only 630 points, even after a 50 percent mark-up it isn't worth enough to make the bid profitable. The expected loss is large, 255 points, and Buyers lose money for two thirds of their bids. Similar reasoning for a medium bid of 600 yields an expected loss of 82.5 points. Unlike a high bid, however, feedback isn't going to make it obvious that a bid of 600 is a bad idea, because bids make money as often as they lose money and the expected loss isn't enormous. Learning to bid 90 is going to be difficult unless the Buyer recognizes the adverse selection problem and realizes that the only way to avoid losing money is to bid at the lowest possible value.

Table 1 about here

3. Experimental Design

Our experiment consisted of two parts. The first part, covering Rounds 1 – 10, was identical in all treatments. The second part (Rounds 11 – 40) differed across treatments. The initial instructions explained

only Part 1, including three questions to check for understanding (see the appendix for the instructions). Instructions for Part 2 were distributed after the conclusion of Part 1.

In Part 1, all subjects were in the role of Buyers. Sellers were computerized and always sold the indivisible item if the Buyer's bid was equal to or larger than the item's value in a given period. Buyers knew about this rule. Each subject received starting capital of 12 Euros (3000 experimental points) for Part 1 from which possible losses could be covered.[4] After each round, subjects got feedback about the item's value, whether they had bought the item or not, and how large their profit was.

In Part 2 we introduced five different treatments which are explained in the following.

1) **Control**. In this treatment, Rounds 11 – 40 were identical in structure to Rounds 1 – 10. Hence, all subjects remained in the role of Buyers, and Sellers were computerized. This treatment serves as a control for the possible effects of forming pairs of Buyers and Sellers in the other treatments. Buyers received an additional 10 Euros (2500 experimental points) of capital at the start of Part 2.
2) **No Chat - Random**. Here – and in the other treatments remaining to be introduced – we randomly assigned pairs of subjects to be teammates at the beginning of Part 2. In the **No Chat - Random** treatment, one teammate was randomly assigned to the role of Buyer in Rounds 11 – 40, and the other was assigned to the role of Seller. Subjects were informed about their roles before Round 11, and roles were fixed throughout Part 2. In this treatment and in the others to follow, *a Buyer never played the takeover game against the Seller who was his teammate*. This was

[4] The 21 subjects who finished Part 1 with a negative balance, in spite of the starting capital, were allowed to continue to Part 2. These subjects were told that their Part 1 losses could be recouped in Part 2. Since all subjects received additional starting capital at the beginning of Part 2, only four Buyers started Part 2 with a net negative balance. If someone still had a loss after Part 2, it was not enforced. This was never mentioned in advance. There were 34 subjects (5.7 percent) who ended the experiment in the red. The majority of these subjects (21 of 33) come from the Control treatment. Note that excluding Buyers in the red from our main regression (Model 2 in Table 2) would not change any of the insights reported there.

common knowledge. Before Round 11 started, subjects in both roles were asked to enter some information about them that was then shown to their teammate (see Table A.1 in the online Appendix). This information included age, gender, field of study, population of the hometown, working status, experience in experiments, grades in math and German from high school exit exams ("Maturanoten"), and total profit in Part 1. They were not shown the bids and values that led to the Part 1 profits. Other than this exchange of information, there was no opportunity for communication within a team.

For Part 2, Buyers received 10 Euros (2500 experimental points) as additional starting capital, and Sellers received 2 Euros (500 experimental points). The total profits of a team's Buyer and Seller in Part 2, including the starting capital, were divided equally between the teammates at the end of Part 2. This feature was stressed in the instructions for Part 2.[5] Because teammates never played each other and shared payoffs, their incentives were aligned. The Buyers' feedback after each period in Part 2 was the same as in Part 1. Sellers got as feedback the bid of the Buyer with whom they were paired in a given period, the item's value, whether the Seller had sold the item, and the resulting profit. Subjects did not receive feedback about their teammate's outcome.

3) **Chat - Random**. This treatment is identical to **No Chat - Random**, except that before Rounds 11, 21, and 31, the Buyer and the Seller in a team were allowed to chat with each other through an instant messaging program. The chat was restricted to five minutes (before rounds 11, 21, and 31), which pilot sessions indicated was more than adequate time for a full discussion of the relevant issues such as which strategy to play.

4) **No Chat – Endogenous**. This treatment differs from **No Chat - Random** only in the way the roles within each team were determined, but is identical in every other respect. After seeing the information (age, gender, etc.) about the other member of the team, each member could make

[5] We, nevertheless, used the 10 Euros starting capital for Buyers (and 2 Euros for Sellers) in order to keep the conditions for Buyers identical across treatments, because in **Control** they also received 10 Euros for Part 2.

proposals about how to assign roles. Proposals could be accompanied by one of the following preset reasons: (i) because one member did better in Part 1, (ii) because a particular role was easier to play, (iii), because a particular role was more fun, and (iv) because a subject did not like to take risks. These four reasons were the most common justifications for wanting a particular role in the Chat-Endogenous treatment (see below). Subjects were free to send as many messages back and forth as they wanted within a two-minute window. The idea was to let subjects communicate about role assignment, as in **Chat-Endogenous**, but to eliminate any possibility of discussing how to bid. After the two minutes for communication were over, subjects had to simultaneously enter which role they wanted. If both teammates entered the same role, the role assignment was randomly determined. Otherwise, roles were assigned as requested by the teammates.

5) **Chat – Endogenous**. This treatment is identical to **Chat - Random**, except that roles were determined endogenously within each team, following the same procedure as in **No Chat - Endogenous**. Before role selection before Round 11, teammates could chat for five minutes as in **Chat – Random**.

The experiment was run with a total of 592 participants, all of them students at the University of Innsbruck. Recruitment was done using ORSEE (Greiner, 2015), and the sessions were computerized with zTree (Fischbacher, 2007). We had 112 participants in **Control**, and 120 in each of the other four treatments. No subject participated in more than one session. On average, an experimental session lasted about 90 minutes. The average earnings per subject were 17 Euros.

4. Hypotheses

A bid of 90 maximizes expected value assuming no errors on the part of Sellers. Only bids in the range $90 \leqslant B < 135$ have positive expected value and we define these bids as "optimal bids". Most optimal bids are in the lower part of this range; 93 percent of optimal bids are in the range 90 – 100.

Comparing the **Control** and **No Chat – Random** treatments, differences in bidding can occur because Buyers in the **No Chat – Random** treatment share their payoffs with a teammate or because computerized Sellers do not make errors while humans potentially do. The latter possibility can largely be dismissed, as documented in Section 5.2. Sharing payoffs could lead to more substantial differences in bidding. Suppose that the effort spent on figuring out how to bid optimally is costly. If we assume that our subjects are largely self-regarding (i.e., put little weight on the payoffs of others), the rewards from learning to bid optimally are larger when Buyers keep their entire payoff rather than sharing it with a teammate. Combined with effort costs, this implies that bids will be lower in the **Control** treatment than in **No Chat – Random**.

*Hypothesis 1: Bids will be lower in Rounds 11 – 40 of the **Control** treatment than in **No Chat – Random**.*

In treatments with chat, the Buyer and Seller in a team get multiple possibilities to discuss bidding. If the Seller has learned to bid optimally and understands why this is a good strategy (i.e., understands the adverse selection), she should communicate her insights to the Buyer since profits are shared. Even if the Buyer has not previously learned to bid optimally, he should recognize the optimal strategy when it is explained to him and bid optimally in the future. This is the essence of the "truth-wins" model of team decision making pioneered by Lorge and Solomon (1955). Although the truth-wins model is often too optimistic about the performance of teams, experimental studies by economists and psychologists universally find that teams outperform individuals at solving these types of problems since at least some useful sharing of insights takes place between teammates.[6] This implies that bids will be lower in treatments with chat (assuming that subjects use the opportunities of exchanging information and insights in the chat) than the corresponding treatments without chat.

[6] For summaries of the psychology literature, see Davis (1992) and Kerr and Tindale (2004). Evidence from economic experiments studying play of games includes Cooper and Kagel (2005, 2009, and 2012), Casari et al. (2016), and Charness et al. (2010). For surveys, see Charness and Sutter (2012) and Kugler et al. (2012).

Hypothesis 2: Bids will be lower in Rounds 11 – 40 in treatments with chat than in treatments without chat.

In the treatments with endogenous role assignment it is no longer random who receives the role of Buyer. If the goal is to make as much money as possible, the teammates should attempt to get the most able individual in the role of Buyer since the role of Seller is trivial and, as shall be seen, it matters little who fills this role. The teammates have access to an excellent indicator for who will do a better job as the Buyer – their earnings from the first ten rounds. There is high correlation between earnings in the first ten rounds and bidding low in the first ten rounds.[7] If teams systematically pick the individual who earned more in Rounds 1 – 10 to be the Buyer for Rounds 11 – 40, we expect that they will on average bid lower and earn more in Rounds 11 – 40 than teams with randomly selected roles.

Hypothesis 3: Bids will be lower in Rounds 11 – 40 in treatments with endogenous role assignment than in treatments with randomly assigned roles.

We have no clear prediction about how the effect of role assignment will vary when chat is or is not available. On the one hand, having chat may strengthen the selection effect. On the flip side, role assignment should be less important with endogenous role assignment in **Chat – Endogenous**. If the Seller is more insightful than the Buyer, she can pass her insights along to the Buyer. It therefore ought to matter less whether the more able individual becomes the Buyer. These two effects have opposite signs. Whether endogenous role assignment matters more with or without chat is an empirical question.

5. Results

5.1 Rounds 1 – 10: The cluster of bars on the left side of Figure 1 shows the distribution of bids for Rounds 1 – 10 in which all subjects in all treatments played as a Buyer. Bids have been broken into the

[7] The correlation between an individual's average bid and average points earned in Rounds 1 – 10 is -0.599. This is statistically significant at the 1 percent level (t = 17.54).

same seven categories used in Table 1 to show the logic of bidding a low amount. There are four categories ($B < 90$, $135 \leqslant B < 600$, $900 \leqslant B < 1200$, and $B \geqslant 1800$) where the Buyer never earns money unless the Seller makes an error. Choices in these four categories are rare. The remaining three categories ($90 \leqslant B < 135$, $600 \leqslant B < 900$, and $1200 \leqslant B \leqslant 1800$) can make money if the right value is drawn, but only the first category ($90 \leqslant B < 135$) has positive expected value.

Figure 1 about here

A little less than half of the bids are optimal ($90 \leqslant B < 135$) in the first ten rounds. Many subjects immediately grasp the need to bid optimally, but many don't. This is a scenario in which team play with communication should help since there will be many matches between an individual who doesn't bid optimally with a subject who does. Of course, subjects don't fall neatly into categories of those who "get it" and those who don't. Only 10 percent of the subjects never bid optimally in Rounds 1 – 10 and only 17 percent always bid optimally. Looking at gender effects, we find that men bid significantly lower than women (average bids of 366 vs. 425; $p < 0.05$).

5.2 Sellers in Rounds 11 – 40: Underlying the hypotheses developed in Section 4 is an assumption that Sellers always behave optimally (in terms of maximizing monetary payoffs), accepting only bids that are at least as great as their value. In **Control** this happens by design, and suboptimal decisions by Sellers in the other four treatments are relatively rare. Define an error as rejecting a bid strictly greater than the item's value or accepting a bid strictly less than the item's value. Errors are observed for only 4 percent of observations in Rounds 11 – 40, with no difference across treatments with human sellers. Even with Sellers making this modest amount of errors it remains optimal to submit a bid in the range $90 \leqslant B < 135$.

5.3 Treatment Effects for Buyers: Figure 2a shows average bids by Buyers in all five treatments. The data is broken down into ten round blocks and data is included from Rounds 1 – 10, the rounds before the

treatments are in effect, to show the differing starting points for the treatments. The data for Rounds 1 – 10 is taken from all subjects, including those who became Sellers in Rounds 11 – 40.

Figure 2a and Figure 2b about here

In Rounds 11 – 40, allowing chat unambiguously reduces bids. Bids are lower in **Chat – Random** than in **No Chat – Random** and lower in **Chat – Endogenous** than in **No Chat - Endogenous**. The effect of endogenous role assignment in Rounds 11 – 40 is murkier. Bids are higher in **Chat – Endogenous** than in **Chat – Random**, except for Rounds 31 – 40, and lower in **No Chat – Endogenous** than in **No Chat – Random**, except for Rounds 31 – 40. In neither case are the differences especially large.

Using bids as our primary measure implies an assumption that lower bids are always better. We have chosen this approach because it relies directly on the choices of Buyers as well as being simple and intuitive. That said, we thank a referee for noting that expected profits are not monotonic in bids. For example, a bid of 550 has a lower expected profit than a bid of 650. The non-monotonicity should not have much impact on our conclusions since only 3 percent of bids in rounds 11 – 40 are in non-monotonic zones, and there is a very high correlation between bids and expected profits ($\rho = 0.9$). But for the sake of completeness, Figure 2b parallels Figure 2a, showing average expected profit for Buyers in each of the five treatments. Note that average expected profits are always negative, reflecting the frequency of overbidding. The differences between treatments parallel those shown in Figure 2a: higher expected profits with chat and a murky effect from endogenous role assignment.

Figures 3 and 4 illustrate two different ways in which endogenous role assignment could affect bids. First, endogenous role assignment is predicted to reduce bids relative to random role assignment because of selection. Teammates who are better at the difficult problem of bidding should get the more challenging role of Buyer. The best-case scenario is "perfect role assignment," where the most able individual is *always* assigned the more critical role of Buyer. Using bids in Rounds 1 – 10 as a proxy for ability as a Buyer, we simulate perfect role assignment by using data from the treatments with random role assignment and selecting only those teams where the low bidder in Rounds 1 – 10 is assigned the

Buyer role. This subsample provides a guide for how well endogenous role assignment would have performed if it had no effect on bidding (or learning about how to bid) and yielded perfect role assignment.

Figure 3 displays average bids from the two treatments with random role assignment (solid lines) along with average bids from the subset of teams in these treatments where the low bidder in Rounds 1 – 10 became the Buyer (dashed lines). Arrows have been added to make it easier to see the effect of perfect versus random role assignment. In both cases, perfect role assignment leads to far lower bids in Rounds 11 – 40 than random role assignment. If the only effect of endogenous role assignment was to always get the right teammate into the Buyer role (perfect role assignment), we should have seen a clear reduction in bids consistent with Hypothesis 3.

Figure 3 and Figure 4 about here

Perfect role assignment is probably too much to hope for, but, as shown in Section 5.4, the endogenous role assignment treatments led to significant selection in favor of the teammate who bid less in Rounds 1 – 10. The reason that the endogenous role assignment treatments do not reduce bids in Rounds 11 – 40 is because they also affect learning. The effect of endogenous role assignment on learning is illustrated by Figure 4. This figure is based on bids from all treatments, except **Control**, by subjects assigned the roles of Buyers in Rounds 11 – 40. Treatments are paired by whether or not chat is available (**No Chat – Random** vs **No Chat – Endogenous** and **Chat – Random** vs. **Chat – Endogenous**) to isolate effects due to endogenous role assignment. For the treatments with random role assignment the graph shows average bids. For the treatments with endogenous role assignment, the average bids in Rounds 1 – 10 are adjusted to equal those in the paired treatment with random role assignment. (The starting points for the two treatments with random role assignment were very similar, so it appears that the four treatments are starting at the same point.) In subsequent ten round blocks the average bids are changed as they did in the real data from the endogenous role assignment treatments. Figure 4 therefore shows how the data would evolve if endogenous role assignment had no effect on role assignment (yielding equal starting positions), leaving only the effect on learning. Arrows have again

been added to make it easier to see the negative effects of endogenous role assignment. Endogenous role assignment slows the learning process both with and without chat, counteracting the positive effect of better role assignment. This unexpected effect of endogenous role assignment drives the most surprising result of our paper, the failure of Hypothesis 3.

Table 2 about here

The regressions reported in Table 2 are designed to analyze the data in more detail. The dataset for these regressions includes all observations from our data. The dependent variable for Models 1, 2, 4, and 5 is the amount bid by the Buyer. To check whether our main results are robust to changing the measure of Buyers' performance, Models 3 and 6 use the Buyer's expected profits as the dependent variable. Robust standard errors are reported in parentheses.

An obvious feature of the data is strong individual effects. To correct for these, all of the models use a linear specification with fixed effects. The fixed effects are identified from choices in Rounds 1 – 10, before any of the treatments take effect. The first row of Table 2 identifies the unit being used for the fixed effects: Models 1 and 4 use fixed effects identified from early choices (Rounds 1 – 10) by both members of a team while Models 2, 3, 5, and 6 use fixed effects based only on early choices by the teammate who ended up in the Buyer role for Rounds 11 – 40. The different methods allow us to isolate how much of the observed treatment effects are due to changes in the learning process. If the fixed effects are at the team level (Models 1 and 4), the estimated effects of endogenous role assignment include the impact through selection (i.e., better role assignment) and the impact through changes in the learning process. The estimated differences in Models 1 and 4 parallel those observed in Figure 2a.

When the fixed effects are at the Buyer level (Models 2, 3, 5, and 6), the estimated treatment effects only reflect effects due to changes in the learning process since the regression now accounts for the differing behavior of Buyers and Sellers in Rounds 1 – 10 with endogenous role assignment. In other words, Models 2, 3, 5, and 6 control for improved role assignment. The estimated treatment effects in Models 2 and 5 are analogous to those shown in Figure 4.

Models 1, 2, and 3 are basic regressions checking whether the effects of chat and endogenous role assignment are significant. A dummy is included for Rounds 11 – 40 as well as interactions between the dummy for Rounds 11 – 40 and dummies for the **Control** treatment, the treatments with chat (**Chat – Random** and **Chat – Endogenous**), and the treatments with endogenous role assignment (**No Chat – Endogenous** and **Chat – Endogenous**). These interaction terms are the critical variables that allow us to test Hypotheses 1 – 3.[8]

The results of Models 1 and 2 provide little support for Hypothesis 1. Bids in Rounds 11 – 40 are lower in the **Control** treatment than in the **No Chat – Random** treatment, but the effect is weak and not statistically significant. Hypothesis 2 receives strong support from the data, as bids in Rounds 11 – 40 are significantly lower in the treatments with chat for both Models 1 and 2. The big surprise is how badly Hypothesis 3 does. If this hypothesis is correct, the estimate for "Rounds 11 – 40 * Endogenous Roles" should be negative and significant in Model 1 where the effects of selection work in favor of finding a reduction in bids due to endogenous role assignment. Instead, the estimated effect in Model 1 is small and positive. When effects due to selection are eliminated by having fixed effects at the Buyer level (Model 2), the effect of endogenous role assignment on bids for Rounds 11 – 40 becomes significant and *positive*. Combining the results from Models 1 and 2, the benefits of selection with endogenous role assignment are more than counter-balanced by the unexpected harmful effects on learning.[9] Model 3 tells a similar story to Model 2, showing a positive effect of chat and a negative effect of endogenous role assignment on expected profits. Hence, our conclusions do not depend critically on how the performance of Buyers is measured.

[8] The interaction with the dummy for Rounds 11 - 40 is necessary to avoid collinearity with the fixed effects.

[9] The floor on bids could distort our estimates since subjects who learn to bid optimally in Rounds 1 – 10 have nothing left to learn in Rounds 11 – 40. To control for this, we count the number of optimal bids per Buyer in Rounds 1 – 10 and rerun Model 2 with this added variable (interacted with a dummy for Rounds 11 – 40). The new control variable is significant, but the estimate for "Rounds 11 – 40 * Endogenous Roles" remains positive and significant at the 5 percent level as in Model 2. The floor on bids does not drive our main result.

Models 4, 5, and 6 modify Models 1, 2, and 3, respectively, by adding controls for the Buyers' demographic characteristics: gender (0 = male, 1 = female), age, math score, and German score. For the math and German scores, lower numbers indicate better grades. All of these variables are interacted with the dummy for Part 2 (Rounds 11 – 40) to avoid collinearity with the fixed effects. The results of Models 4 and 5 parallel those of Models 1 and 2 as far as Hypotheses 1 – 3 are concerned. Looking at the estimates for the demographic variables, gender is negative and significant. This doesn't mean that women bid lower than men in Rounds 11 – 40, but rather that women are catching up over time. Recall that women bid significantly higher than men in Rounds 1 – 10, but in Rounds 11 – 40, average bids are essentially identical for men and women (296 for men vs. 299 for women). None of the other demographic variables are statistically significant. The results in Model 6 are similar to those in Model 5. Of greatest interest, the effect of endogenous role assignment on expected profits is negative and significant. One difference is that the estimated effect of chat, while little changed in magnitude from Model 3, is not statistically significant.

We summarize the results up to this point by revisiting our initial hypotheses. The following conclusions refer to bids and expected profits in Rounds 11 – 40.

*Conclusion 1: Bids are lower and expected profits higher in the **Control** treatment than in the **No Chat – Random** treatment, but the differences are generally small and not statistically significant. We find little support for Hypothesis 1.*

Conclusion 2: Bids are lower and expected profits higher in treatments with chat than in the corresponding treatments without chat. This result is stronger from a statistical point of view for bids than expected profits. The data supports Hypothesis 2.

Conclusion 3: Bids are higher and expected profits lower in treatments with endogenous role assignment than in the corresponding treatments with random role assignment. This difference is significant when effects due to changes in the learning process are isolated. The data provides no support for Hypothesis 3, and instead indicates that endogenous role assignment harms the ability of Buyers to learn the optimal bidding strategy.

5.4 Comparing Buyers to Sellers in the Endogenous Role Assignment Treatments: This subsection examines more closely how roles are assigned in the two treatments with endogenous role assignment. Table 3 compares Buyers and Sellers by showing the median values of individual characteristics (except for gender where we report the proportion of women) broken down by role and treatment. Wilcoxon signed rank tests are used to test the significance of differences between Buyers and Sellers. The demographic characteristics do not differ significantly between Buyers and Sellers with one exception: women are less likely to become Buyers in **No Chat – Endogenous** with the difference being weakly significant. The final two rows of Table 3 show average bids and expected profits in Rounds 1 – 10. Endogenous role assignment systematically puts the teammate who did a better job of bidding in Rounds 1 – 10 into the Buyer role. For 41 of 58 pairs (71 percent) in **No Chat – Endogenous** and 39 of 60 pairs (65 percent) in **Chat – Endogenous**, the subject who bid less in Rounds 1 – 10 became the Buyer.[10] The results are weaker for expected profits, as expected profits are higher for Buyers in both treatments but the difference is not significant for **Chat – Endogenous**. Hypothesis 3 is based on an assumption that endogenous role assignment leads to more able individuals being selected into the Buyer role. This underlying assumption holds for both treatments with endogenous role assignment, but more strongly for **No Chat – Endogenous** than **Chat - Endogenous**. In Section 4 we predicted that chat improves role assignment, but this is not true.

Table 3 about here

Conclusion 4: In both treatments with endogenous role assignment, Buyers bid less and have higher expected profits in Rounds 1 – 10 than the Sellers they are paired with. Selection into roles is stronger in the absence of chat.

[10] There were two pairs in No Chat – Endogenous where the average bids were identical for both teammates in Rounds 1 – 10.

5.5 Does It Matter Who Becomes the Buyer? It would matter little whether Buyers bid less than Sellers for Rounds 1 – 10 if teams performed the same regardless of which teammate took which role. Figure 5 shows otherwise. This figure compares the average bid in Rounds 11 – 40 for teams where the teammate who bid (strictly) lower on average in Rounds 1 – 10 becomes the Buyer with teams where the teammate who bid lower becomes the Seller.

Figure 5 about here

The average bid for Rounds 11 – 40 is lower when the teammate who bid lower in Rounds 1 – 10 is given the role of Buyer. The effect is stronger in the treatments without chat (left-hand side of Figure 5) than in those with chat (right-hand side), consistent with our prediction from Section 4 that role assignment should be less important with chat since a Seller who understands the benefits of bidding low can pass this understanding on to the Buyer.

Table 4 about here

The regressions shown in Table 4 put the preceding observations on a firm statistical footing. Both models include data from all four treatments with teams. The dependent variable is a team's average bid for Rounds 11 – 40 in Model 1 and a team's average expected profit for Rounds 11 – 40 in Model 2, yielding a single observation per team.[11] The independent variables are a dummy for the treatments with chat, an interaction between a dummy for treatments *without* chat and a dummy for teams where the Buyer is the teammate with lower average bids (higher average expected profits) in Rounds 1 – 10, and an interaction between a dummy for treatments *with* chat and a dummy for teams where the Buyer is the teammate with lower average bids (higher average expected profits) in Rounds 1 – 10. The parameter estimate for the first interaction term is large and significant at the 1 percent level in both models. Not

[11] The fixed effect approach used in Table 2 isn't feasible here, since the fixed effects would be collinear with the independent variables.

surprisingly, bids and expected profits in Rounds 11 – 40 are very sensitive to the Buyer's identity when the teammates cannot communicate. The parameter estimate for the second interaction term is smaller, but still significant. Consistent with our impression from Figure 5, who becomes the Buyer is less important when teammates can chat, but still matters.

Conclusion 5: Both without and with chat, teams where the Buyer bid lower (had higher expected profits) than the Seller in Rounds 1 – 10 have lower bids in Rounds 11 – 40.

5.6 Content of Conversations: When Buyers are randomly selected, chat improves the quality of bidding, albeit less than the truth wins model would suggest. Given that the more able teammate, as measured by bids in Rounds 1 – 10, generally ends up as the Buyer in the **Chat – Endogenous** treatment, we would expect that bids would be even lower in this treatment than in the **Chat – Random** treatment. The fact that bids are *higher* in the **Chat – Endogenous** treatment, significantly so if we control for selection into the Buyer role, suggests that something must be going wrong in the interaction between teammates. To determine what exactly causes the problem, we turn to the content of the conversation between teammates.

We focus on the conversations that took place between Round 10 and Round 11. As can be seen in Figure 4, this is where the major divergence between the two chat treatments occurs. Recall that subjects were given five minutes to discuss how to bid and (when relevant) role assignment. They could not move on to the next stage of the experiment until the five minutes had elapsed. We coded every team for whether they discussed how to bid and, as a subcategory of this, if they specifically discussed the benefits of optimal bids. The coding was initially done independently by two research assistants. We then had the two coders discuss all the discrepancies in the coding and agree on a single decision for coding. Using a

single coding simplifies our discussion of the chat content but has little effect on our conclusions since there was a high degree of agreement between the two initial codings.[12]

Subjects indeed chatted extensively, with the average team sending 25.0 messages during the five minutes. There is no significant difference in the quantity of messages between **Chat – Random** (26.2 messages) and **Chat – Endogenous** (23.8). Looking at what teams said, however, we see significant differences between the two chat treatments. More teams discussed how to bid in **Chat – Random** than **Chat – Endogenous** (78 percent vs. 61 percent; $p < 0.05$), and, even stronger, more teams specifically discussed optimal bidding in **Chat – Random** than in **Chat – Endogenous** (63 percent vs. 35 percent; $p < 0.01$).

The relative failure of teams in the **Chat – Endogenous** treatment to discuss bidding, especially bidding low, provides a partial explanation for why bids are significantly higher than in the **Chat – Random** treatment after controlling for selection into the Buyer role. With Buyer fixed effects, the estimated difference between the two chat treatments in Rounds 11 – 40 is 89.22 with a robust standard error of 45.80 (see Table A.2 in the online appendix). If this regression is modified to include a control for whether the team discussed optimal bidding, the estimated difference drops to 46.90 with a robust standard error of 44.76. The difference between the treatments is halved and is no longer statistically significant. This crude control for what is said between Rounds 10 and 11 accounts for a large fraction of the higher bids in **Chat – Endogenous** relative to **Chat – Random**.

*Conclusion 6: Teams in **Chat – Endogenous** are significantly less likely to discuss bidding, and are significantly less likely to discuss optimal bids than teams in **Chat – Random**. Controlling for differences in chat content explains a large fraction of why bids are significantly higher in **Chat – Endogenous** than in **Chat – Random** after controlling for selection.*

[12] The cross-coder correlation was 0.55 for the category "discussed how to bid" and 0.49 for "bidding low", both significant at the 5 percent level.

The teammate who bid lower in Rounds 1 – 10 was more likely to become the Buyer in **Chat - Endogenous** (39 of 60 teams), but this was far from universal. The message content helps explain why the low bidder did not always become the Buyer. Almost all of the teams (54/60) in **Chat – Endogenous** discussed which teammate should be the Buyer, but the discussions of role assignment are typically brief and often miss basic points. Few teams (9/60) discussed performance in Rounds 1 – 10 as a reason for assigning roles. Not only did endogenous role assignment harm teams' discussion of how to bid, but they also had low quality discussions about who should be the Buyer.

6. Explaining Poor Performance with Endogenous Role Assignment

The most surprising result in our initial set of experiments was the poor performance of Buyers with endogenous role assignment. The remainder of the paper explores possible reasons for this result by presenting two additional treatments. Cognitive load provides one plausible explanation for this effect. Buyers face a challenging intellectual problem. Having subjects responsible for assigning roles increases their cognitive load. With less cognitive resources available to think about bidding, Buyers might do a poor job of learning to bid optimally. The reduced discussion of optimal bidding in **Chat - Endogenous** is consistent with this explanation.

Therefore, we ran a first additional treatment testing the hypothesis that cognitive load drives the negative effect of endogenous role assignment. The **Nonogram** treatment was identical to the **Chat – Random** treatment except for one detail. After Round 10 and prior to the start of chat, subjects were told that they would be given two nonograms (a type of logic puzzle) to solve and that they could work on them during the chat period of five minutes. Subjects were paid one euro for each puzzle solved correctly.

Figures 6 and 7 about here

Nonograms are a type of grid-based logic puzzle. They serve as a good task to induce cognitive load as they are challenging, but with rules simple enough to be learned quickly. Figure 6 shows a 6 x 6 nonogram. Initially, subjects only see the blank cells inside the 6 x 6 grid. The task is to mark each cell with an "X" or leave it unmarked. For reference, since teammates could talk about the puzzles, rows are indexed by Roman numerals and columns are indexed by letters. Labels with Arabic numerals indicate the length of each run of consecutive marked cells, according to the solution, in each row and column. The "X"s inside the 6 x 6 grid show the correctly solved puzzle. As in **Chat – Endogenous**, the task presumed to increase cognitive load takes place at the same time team members are chatting with each other and serves as an alternate topic of discussion to discussing the bidding strategy.

Figure 7 about here

Six sessions were run of **Nonogram**, with twenty subjects per session, none of whom had participated in any of the other treatments. We hypothesized that, controlling for Buyer fixed effects, bids in Rounds 11 - 40 would be higher in **Nonogram** than **Chat – Random**. More importantly, we hypothesized that bids would be at least as high as in **Chat – Endogenous**. Nonograms are a challenging intellectual task. If having to choose roles affects bidding primarily by reducing the cognitive resources available to think about and discuss bidding, solving nonograms should have a similar effect. We predicted a negative effect on discussion of bidding, paralleling the effect documented for **Chat – Endogenous**, and a similar delay in learning relative to **Chat – Random**.

Subjects spent substantial effort on the puzzles, averaging 1.28 puzzles solved, and many teams (40 percent) used the chat to talk about the puzzles. As predicted, teams discussed their bidding strategy less frequently than in either **Chat – Random** or **Chat - Endogenous**. In **Chat – Random**, 78 percent of teams discussed bidding with 63 percent specifically mentioning optimal bidding. These figures dropped to 61 percent and 35 percent in **Chat – Endogenous**. The decrease is even more precipitous in **Nonogram**, as only 48 percent of teams discuss bids and only 30 percent bring up optimal bidding. If reduced discussion of bidding can be taken as a good proxy for the amount of thought devoted to bidding,

this suggests that the effect of solving nonograms *due to increased cognitive load* should be at least as large as the effect of endogenous role assignment *due to increased cognitive load*.

Figure 7 compares bids from **Nonogram** with bids in the other two treatments with chat. The construction of Figure 7 parallels that of Figure 4. It shows average bids of subjects assigned the Buyer role for Rounds 11 – 40. The average bids in Rounds 1 – 10 are adjusted to equal those in **Chat – Random**. In subsequent ten round blocks the average bids are changed as they did in the real data. Figure 7 therefore shows how the data would have evolved if the treatments had no effect on role assignment (yielding equal starting positions), leaving only the effect on learning. Both **Chat – Endogenous** and **Nonogram** increase bids relative to **Chat – Random**, and in both cases the effect narrows somewhat over time. However, the effect of **Nonogram** (relative to **Chat – Random**) is less than half the effect of **Chat – Endogenous**.

Formal statistical analysis yields similar conclusions. We modify Model 2 from Table 2 in two ways, adding the data from **Nonogram** and adding an interaction between Rounds 11 – 40 and **Nonogram** as an independent variable. The parameter estimate for this new interaction term is 31.50 with a robust standard error of 44.49. This is less than half of the estimate for endogenous roles and nowhere close to statistical significance.[13]

We would hesitate to suggest that *none* of the effect of endogenous role assignment is due to increased cognitive load. **Nonogram** does have a positive effect on bids, even if it is weak, and the impact on messages about bidding in **Nonogram** and **Chat – Endogenous** is consistent with an effect due to increased cognitive load. But it is difficult to argue that solving nonograms should increase cognitive load less than choosing roles.

[13] The difference between the estimates for "Rounds 11 – 40 x **Nonogram**" and "Rounds 11 – 40 x **Endogenous Roles**" is also not statistically significant ($p = 0.340$). If we use expected profits as the dependent variable, the estimate for the interaction term is -10.32 with a standard error of 16.02. This is not statistically significant.

A likely difference between the **Nonogram** treatment and the treatments with endogenous role selection is that role selection is freighted with emotional baggage which is absent in **Nonogram**. Our second follow-up treatment, **Emotion**, addresses this by studying two questions. First, does endogenous role selection generate selection into the Buyer role on individual characteristics beyond those documented in Table 3? We focus on psychological characteristics such as overconfidence, risk preferences, positive and negative reciprocity, a desire for control, and self-efficacy. Second, are there differences in the emotional state of Buyers and Sellers? For example, do Buyers feel happier with their role than Sellers? Do Buyers feel more pressure than Sellers or more responsible?

Rounds 1 – 10 of the **Emotion** treatment were the same as in the other treatments. Prior to role selection, we paused the experiment to ask subjects, "Compared to other buyers in this session how much money do you think you earned in [Rounds 1 – 10]?"[14] Subjects were asked to pick a quartile of the distribution and were paid an additional euro if they correctly identified their quartile. They were not told if they had correctly identified their quartile until the conclusion of the experiment. We use the difference between a subject's guess about their performance and their actual performance as our measure of overconfidence.

Selection of roles in the **Emotion** treatment was identical to the **Chat – Endogenous** treatment. *After* role selection was finished and before Rounds 11 – 40, we paused the session to conduct a number of questionnaires (see the online appendix for full details of all questionnaires). Subjects were not told in advance that this pause would occur.

The first block of questions dealt with subjects' emotional state of mind. We began by asking them whether they felt responsible for their teammates' earnings in Rounds 11 – 40 and whether they felt pressure to earn a high amount of money. We then asked them about "how you felt when you were told what role (Buyer or Seller) you would be assigned." They were asked to fill out a seven point Likert

[14] We intentionally avoided asking about their bids as we did not wish to suggest that lower bids were better.

scale ranging from "Not at all" to "Very intense" for eleven emotions: fear, envy, anger, sadness, happiness, shame, irritation, contempt, joy, jealousy, and surprise.

The next segment of the questionnaires gathered information about subjects' personal characteristics, including locus of control, self-efficacy, risk preferences, trust, and positive and negative reciprocity. The questionnaire for locus of control (Levenson, 1981) measures how much control individuals feel over what happens to them. Self-efficacy captures an individual's belief that they are (or are not) capable of accomplishing tasks across a broad variety of settings (Chen et al., 2001). Self-efficacy and locus of control do not measure the same trait but are related to each other, and indeed are correlated in our sample.

Our measures of risk preferences, trust, and positive and negative reciprocity were all drawn from Falk et al. (2016). In all cases, we used a qualitative question (see appendix for details) and a hypothetical choice in an experimental game to measure a specific trait.[15] We present only the latter here for reasons of succinctness, but adding the qualitative questions would not change any of our conclusions. For risk preferences, we elicited subjects' certainty equivalent for a gamble with a 50 percent chance of paying 300 euros and a 50 percent chance of getting zero. Trust was measured by asking how much a subject would be willing to send as the first player in a trust game, with amounts ranging from 0 to 20 euros. Positive reciprocity was measured by asking subjects about their behavior as second mover in a trust game, conditional on the first mover having sent 5, 10, 15, or 20 euros. Negative reciprocity was measured via a hypothetical question about a subject's minimum acceptable offer (MAO) in an ultimatum game with a 100 euro pie.

The final item in the survey elicited a subject's willingness to pay for their assigned role. Possible values ranged from -1.60 to 1.60 euro. Payments were framed as the amount a subject would have to be paid to switch roles, with a negative number indicating that the subject would be willing to pay in order to

[15] Falk et al. (2016) document that these are good predictors of behavior in incentivized choice experiments.

switch roles. Higher numbers mean that the subject has a higher preference for their role over the other role.

After the survey, the session concluded with Rounds 11 – 40, conducted in the same manner as **Chat – Endogenous**. The **Emotion** treatment was run with 114 new subjects (in six sessions) to see how endogenous role selection affected Sellers and Buyers with respect to their emotions, overconfidence, economic preferences, and feelings of responsibility. Rounds 11-40 play no role in generating these insights, but we played out Rounds 11 – 40 to avoid deceiving the subjects (instructions were identical to the **Chat – Endogenous** treatment, so subjects were told there would be an additional 30 rounds after selection of roles). The resulting data cannot be directly compared to the other treatments due to the presence of multiple confounds. Not only was there a long delay for the questionnaires (20 – 25 minutes) that was not present for the other treatments, but a number of the questions ask specifically about subjects' emotions and how they feel about their assigned role in the game. It is easy to imagine that the long delay gave subjects an additional opportunity to think about the takeover game as well as affecting their emotional state, and that the questions about subjects' emotions affected their emotional states. As such we largely dispense with a discussion of these data.

Table 5 about here

Table 5 summarizes the results of the survey. We have a number of redundant measures (e.g., two measures of risk preferences, two measures of negative reciprocity, etc.). In the interest of brevity, in all cases we report the measure that corresponds to choices in a laboratory experiment rather than the qualitative measures. However, our conclusions about differences (or the lack thereof) between Buyers and Sellers would be identical using the qualitative measures. To boil down the measures of locus of control and self-efficacy, we have run factor analysis. In both cases there was only a single factor with an eigenvalue greater than one, providing the variable reported in Table 5. We took a similar approach with the eleven questions about a subject's emotional state when they learned their role. In this case there were two factors with eigenvalues greater than 1, substantially so in both cases, so we report results for both factors in Table 5. For all variables we report the average values for Sellers and Buyers. The final

column of Table 5 reports the z-scores, first from a Wilcoxon signed rank test of the null hypothesis that the median difference between the Buyer and Seller in a pair equals zero, and second a Wilcoxon rank-sum test, because for some of the variables, particularly those dealing with emotions, the paired tests (with signed ranks) are not obviously appropriate. For this reason, we present the z-scores from both tests (paired and unpaired), which actually yield very similar results.

Looking at the variables that examine selection by personal characteristics, the only significant difference is on negative reciprocity as measured by the subject's MAO in an ultimatum game. The MAO is significantly lower for Buyers than Sellers, indicating greater negative reciprocity. This is the single strongest result in the survey. None of the other personal characteristics (risk preferences, trust, positive reciprocity, locus of control, and self-efficacy) even come close to showing a significant difference between Buyers and Sellers.

Turning to measures relating to subjects' emotions, there are significant differences between Buyers and Sellers on the second factor for the emotions and willingness to pay. To better interpret the result about Emotion 2, we need to look at the factor loadings. The three items getting the largest factor loadings are happiness and joy, which are highly correlated with each other and receive positive weight in this factor, and envy which receives negative weight. We have broken out these individual emotions below Emotion 2. Buyers are less happy and joyful than Sellers (albeit not significantly) and more envious. The other place where there is a significant difference is willingness to pay to keep one's role, where Buyers are significantly less willing to pay for their role. One additional point deserves mention – Buyers feel less responsibility than Sellers. This difference misses significance for the signed rank test but comes up weakly significant on a simple t-test for paired differences.

Combining the various results from Table 5, the data tells a straightforward story. Subjects assigned endogenously to the Buyer role are, for lack of a better term, relatively grumpy about it. Subjects who select into the Buyer role are significantly more likely to want to punish people who have harmed them (negative reciprocity). With endogenous role assignment, it is the Seller, not chance, who is responsible for them getting the Buyer role. While we don't think Buyers are purposefully sabotaging Sellers, it is

easy to imagine that they aren't terribly motivated to try their hardest to figure out the best bidding strategy, which is also reflected in a lower level of feeling responsible.[16]

Conclusion 7: Our two additional treatments reveal that cognitive load is most likely only of minor importance, but endogenous role assignment has a negative psychological and emotional effect on Buyers.

7. Conclusion

The primary purpose of our study was to investigate the relationship between how roles are assigned within a work team and team performance when teams consist of pairs where one member has a considerably more difficult task than the other member. We found that teams perform better when team members can communicate with each other and share information and discuss strategies. When team members are also allowed to assign roles endogenously, this feature has a positive effect on role assignment, leading to assigning the more able persons to the more difficult Buyer role. However, controlling for this selection, we find that endogenous role assignment increases Buyers' bids, completely counteracting the helpful effects of selection.

It is common wisdom that more employee involvement is better, and there is certainly some truth to these assertions (see Ichniowski and Shaw, 1999), but our results suggest that employee involvement in role assignment can be counter-productive. Involving employees makes it possible to take advantage of their private information about co-workers, consistent with improved role assignment in our experiment, but also increases the number of tasks that the employees need to perform. If there is interference between

[16] Running regressions analogous to the models used in Table 2, the relationship between bids (expected profits) and willingness to pay is negative (positive) and significant (estimated parameters are -77.57 for bids and 25.95 for expected profits with standard errors of 35.79 and 9.12, respectively). The measures of emotions are not predictive for bids or expected profits. These regression results should be interpreted cautiously given the long delay between the end of role assignment and the start of Rounds 11 – 40.

tasks, processes for assigning roles that make less use of employees' input may improve performance by allowing them to focus on more critical tasks. Our point is not that we have identified the ideal way to assign roles – this is a topic for future research – but rather that the process used to assign roles matters *beyond getting the most able individuals assigned to the most critical roles.* Ideally, the process used for assignment of roles would assign the right person to the right role without disrupting performance at the employees' primary task.

A final question is why endogenous role assignment has a negative effect on Buyers' performance. This effect was unexpected, so our initial experiments weren't designed to answer this question per se. We therefore ran two new treatments. First, we conjectured that increased cognitive load could be driving the negative effect of endogenous role assignment. When we tested this conjecture with a follow-up treatment where subjects solved puzzles while discussing how to bid, the effect was in the predicted direction but modest. Cognitive load may play some role, but our data do not suggest it is primarily responsible for explaining the negative effect of endogenous role assignment on Buyers' performance. A second conjecture was that endogenous role assignment affected subjects' emotional state in a way that affected Buyers' choices. The data from our second follow-up treatment supports this conjecture. Endogenous role assignment selects for subjects who have a relatively high tendency towards negative reciprocity. Buyers are relatively unhappy with their role and feel less responsible. It is easy to see how this could lead to Buyers being less inclined to engage in discussion of the game (in the treatment with chat) and less willing to expend effort thinking about how best to bid.

Tables and Figures

Table 1: Bidding Strategies and Their Profitability

Bid	Value			1.5 * Expected Value if Accepted	Ever Profitable?
	90	600	1200		
Bid < 90	Reject	Reject	Reject	N/A	No
90 ⩽ Bid < 135	Accept	Reject	Reject	135	Yes
135 ⩽ Bid < 600	Accept	Reject	Reject	135	No
600 ⩽ Bid < 900	Accept	Accept	Reject	517.5	Yes
900 ⩽ Bid < 1200	Accept	Accept	Reject	517.5	No

1200 ⩽ Bid < 1800	Accept	Accept	Accept	945	Yes
Bid ⩾ 1800	Accept	Accept	Accept	945	No

Table 2: Regressions for Treatment Effects

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Dependent Variable	Bid	Bid	E(Profit)	Bid	Bid	E(Profit)
Fixed Effects	Team	Buyer	Buyer	Team	Buyer	Buyer
Rounds 11 - 40	-69.40***	-95.30***	25.21***	-24.07	-41.67	0.043
	(22.63)	(24.07)	(8.93)	(46.37)	(47.68)	(15.99)
Rounds 11 – 40 * Control	-31.99	-6.094	1.96	-34.34	-8.74	3.22
	(29.65)	(30.76)	(10.51)	(29.70)	(30.47)	(10.23)
Rounds 11 – 40 * Chat	-69.63***	-68.87**	16.16*	-65.50**	-64.08**	13.70
	(26.59)	(29.19)	(9.76)	(26.32)	(28.60)	(9.28)
Rounds 11 – 40 * Endogenous Roles	12.50	72.91**	-23.86**	2.48	60.74**	-18.49**
	(26.59)	(29.19)	(9.58)	(25.91)	(28.41)	(9.20)
Rounds 11 – 40 * Gender				-64.25***	-76.60***	35.67***
				(22.92)	(24.07)	(7.95)
Rounds 11 – 40 * Age				1.05	-0.23	0.30
				(5.29)	(5.49)	(1.83)
Rounds 11 – 40 * Math Score				-1.07	-8.16	0.33
				(11.01)	(11.59)	(3.21)
Rounds 11 – 40 * German Score				-9.89	1.18	2.78
				(13.25)	(13.04)	(4.29)

Notes: All regressions include 16,480 observations from 592 individuals (352 teams). To identify the fixed effects, we are using data from all 40 rounds. Robust standard errors are reported in parentheses. Three (***), two (**), and one (*) stars indicate statistical significance at the 1%, 5%, and 10% levels respectively.

Table 3: Median Characteristics of Buyers and Sellers when Roles are Endogenously Assigned

	No Chat – Endogenous			**Chat – Endogenous**		
	Buyer	Seller	|z-score|	Buyer	Seller	|z-score|
Age (in categories)[a]	5.0	5.0	0.94	5.0	4.0	1.03

Gender[b]	.317	.483	1.83*	.533	.467	0.69
Math Score[c]	2.0	2.0	0.62	2.0	2.0	0.41
German Score[c]	2.0	2.0	0.58	2.0	2.5	1.40
Earnings Rounds 1 – 10[d]	67.0	-642.5	4.13***	-17.5	-137.5	0.19
Expected Profits	-20.1	-49.1	2.70***	-22.3	-40.5	1.16
Bid, Rounds. 1 - 10	318.5	447.2	2.63**	306.7	400.5	1.79*

Notes: Three (***), two (**), and one (*) stars indicate statistical significance at the 1%, 5%, and 10% levels respectively (Wilcoxon signed ranks tests).

[a] Age was coded as follows: 0=18 years or younger; 1=19 years; 2=20 years; 3=21 years; 4=22 years; 5=23 years; 6=24 years; 7=25 years; 8=26 years or older.

[b] Gender was coded as follows: 0 = Male; 1 = Female.

[c] Lower grades are better in the Austrian school system. Grades were coded from 1 to 5.

[d] Earnings do not include the starting capital of 3000 experimental points.

Table 4: Does the Buyer's Identity Matter?

Dependent Variable	Model 1 Average Bid Rounds 11 – 40	Model 2 Expected Profits Rounds 11 – 40
Chat	-83.71*** (26.63)	23.03* (12.05)
No Chat * Buyer Low Bidder / High Expected Profit	-106.85*** (19.92)	33.98*** (11.77)
Chat * Buyer Low Bidder / High Expected Profit	-35.87** (18.19)	17.30* (10.36)

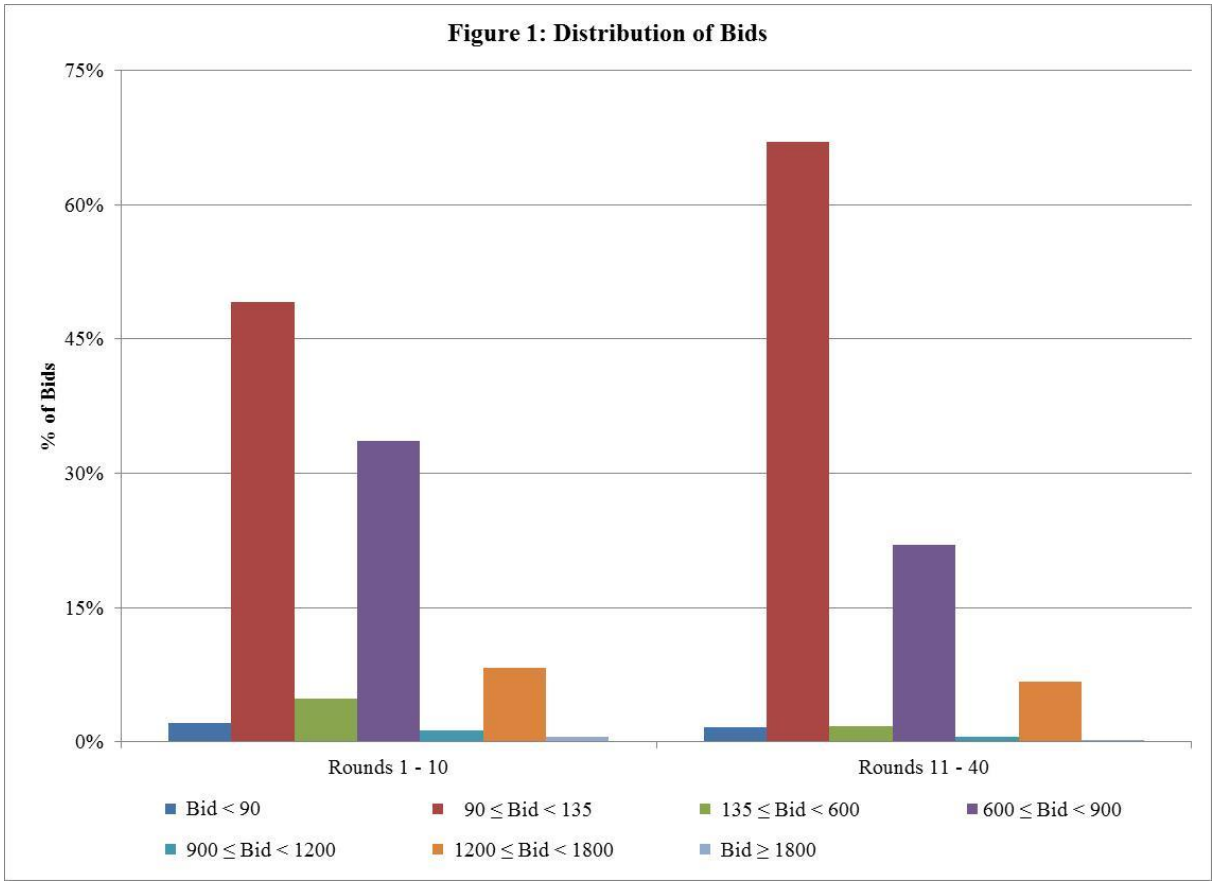
Notes: The dependent variable is a Buyer's average bid for Rounds 11 – 40, yielding a single observation per Buyer. Robust standard errors are reported in parentheses. Three (***), two (**), and one (*) stars indicate statistical significance at the 1%, 5%, and 10% levels respectively.

Table 5: Survey Results by Role

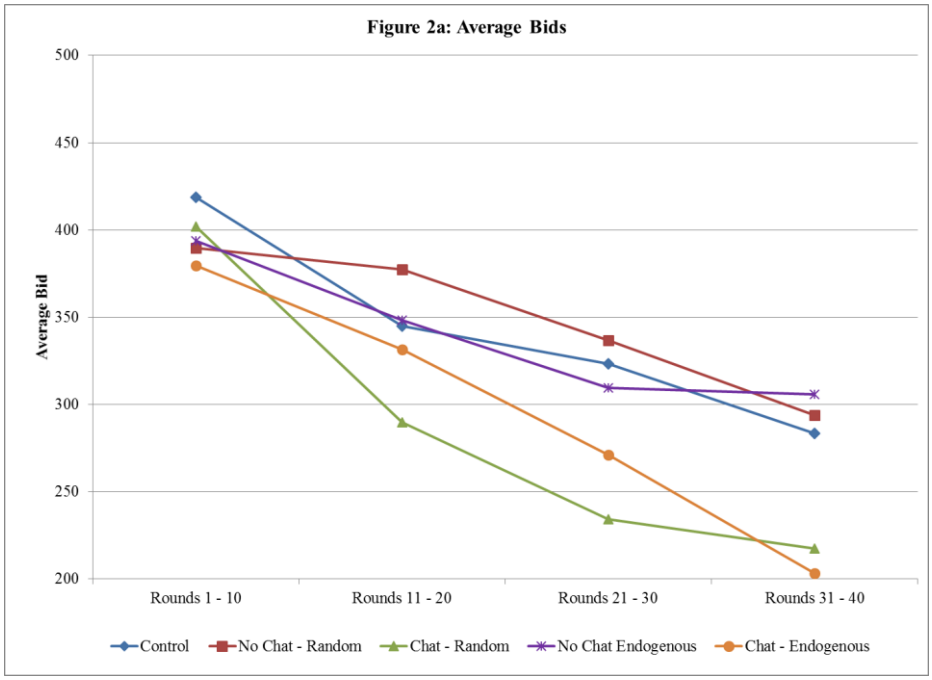
Variable	Sellers	Buyers	Wilcoxon Signed-Ranks Test	Wilcoxon Rank-Sum Test

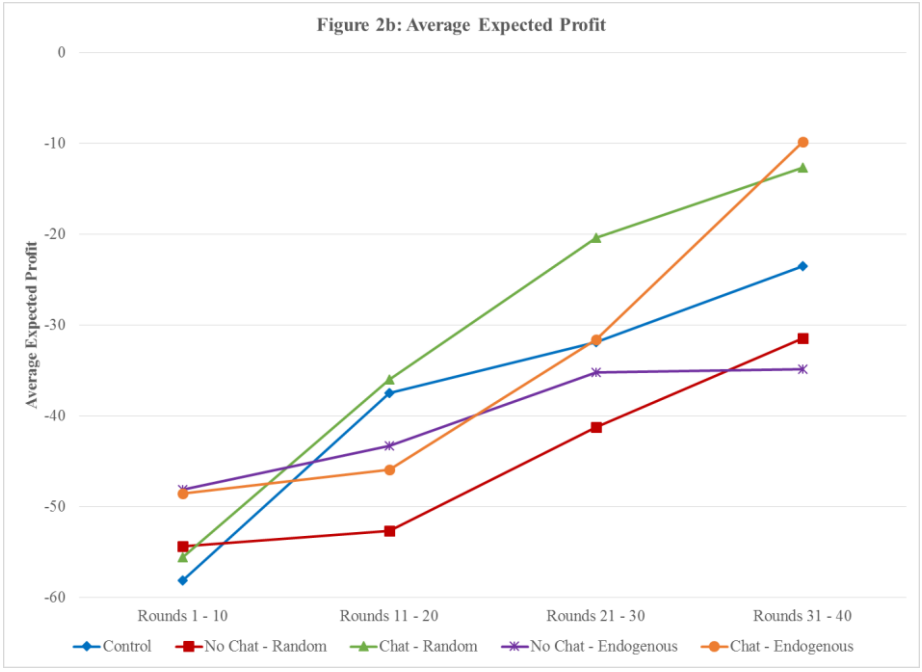
Overconfidence	0.018	-0.228	1.09	1.00
Responsible	3.95	3.65	1.42	1.42
Pressure	3.32	3.33	0.12	0.28
Emotion 1	-0.053	0.053	0.39	0.29
Emotion 2	0.173	-0.173	1.71*	1.99**
Happy	3.44	2.89	1.39	1.61
Joy	3.61	3.16	1.22	1.45
Envy	1.18	1.67	2.60***	2.46**
Self-efficacy	-0.076	0.076	0.97	1.26
Locus of Control	0.022	-0.022	0.12	0.33
Risk (Lotteries)	1.10 €	1.06 €	0.61	0.96
Ultimatum (MAO)	31.90 €	24.00 €	2.88***	3.16***
Trust Game (Send)	10.4 €	10.4 €	0.87	0.82
Trust Game Return (High - Low)	24.6 €	23.6 €	0.80	0.09
Willingness to Pay to Keep Role	1.00 €	0.72 €	1.83*	2.01**

*/**/*** indicates significance at 10% / 5% / 1%-level.

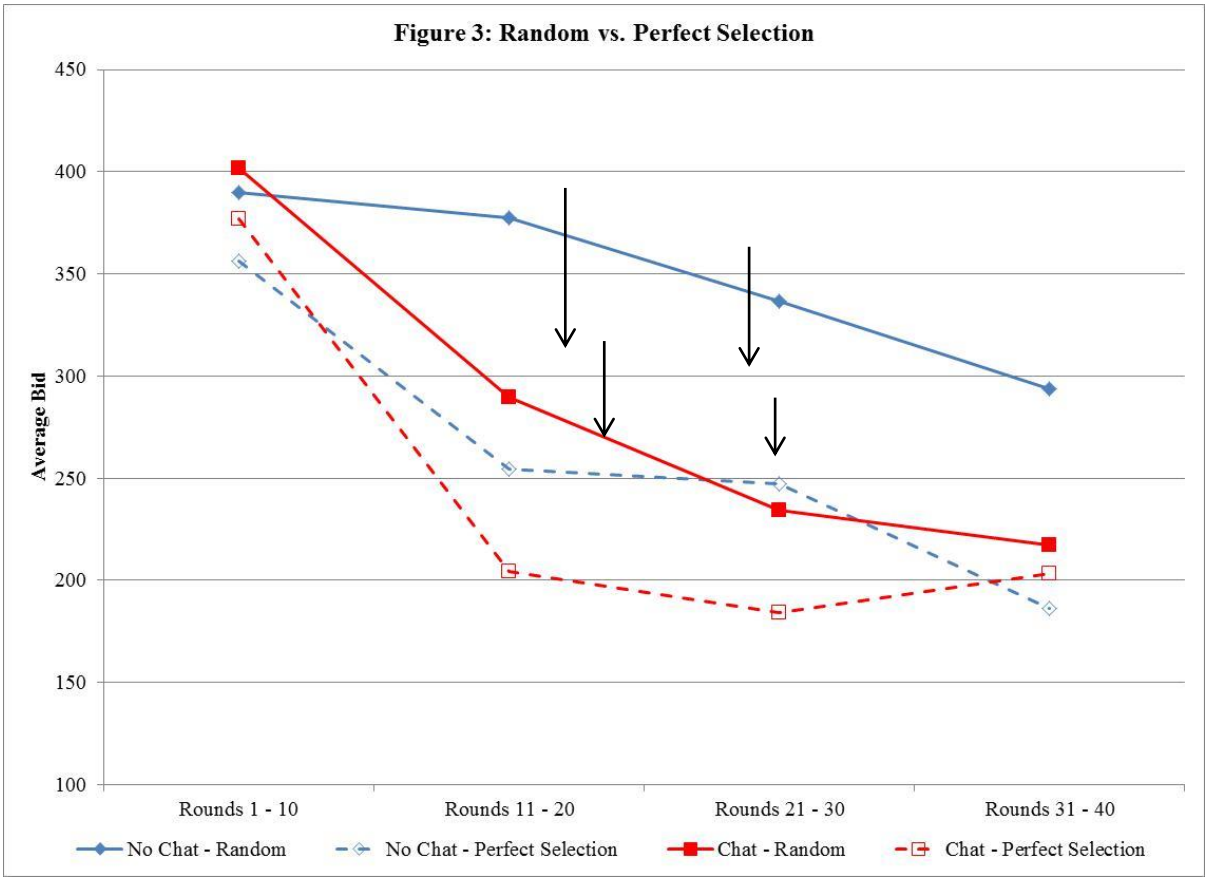


Notes: The bins are taken from Table 1. Both in the left and the right panel the three most frequent bins are those that can ever be profitable.

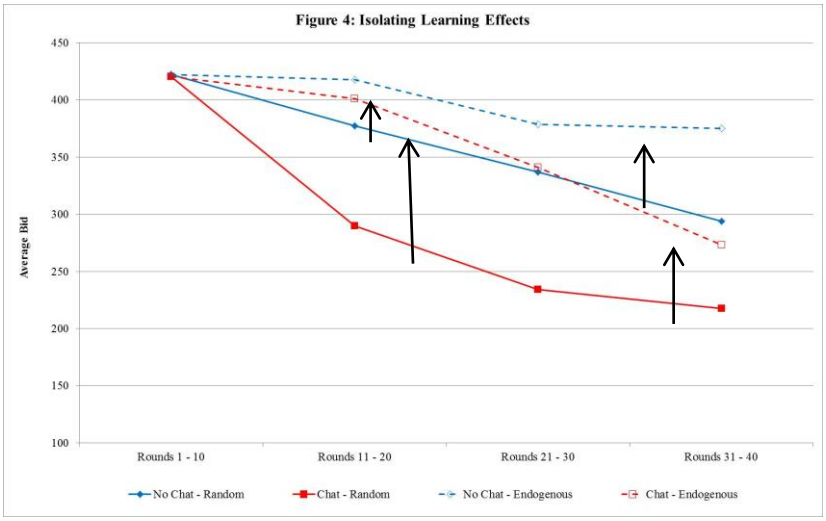




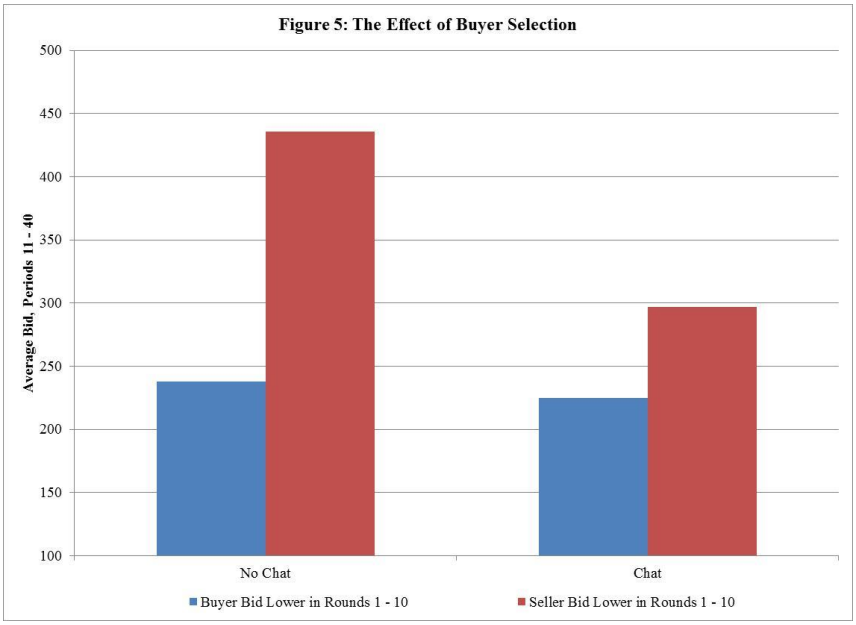
Notes: In Rounds 1 – 10 all subjects are included (because all subjects played in the role of Buyer against computerized Sellers), while in rounds 11 – 40 only the Buyers in each team are included (except for the **Control** treatment where all participating subjects were in the role of Buyers in Rounds 11 - 40).



Notes: The figure displays average bids from the two treatments with random role assignment (i.e., **Chat – Random** and **No Chat – Random**; see solid lines) along with average bids from the subset of teams in these treatments where the low bidder in Rounds 1 – 10 became the Buyer (dashed lines). The latter subset of teams is denoted as perfect selection.



Notes: For the treatments with endogenous role assignment, the average bids in Rounds 1 – 10 are adjusted to equal those in the paired treatment with random role assignment. In subsequent ten round blocks the average bids are changed as they did in the real data from the endogenous role assignment treatments. The figure therefore shows how the data would evolve if endogenous role assignment had no effect on role assignment (yielding equal starting positions), leaving only the effect on learning.

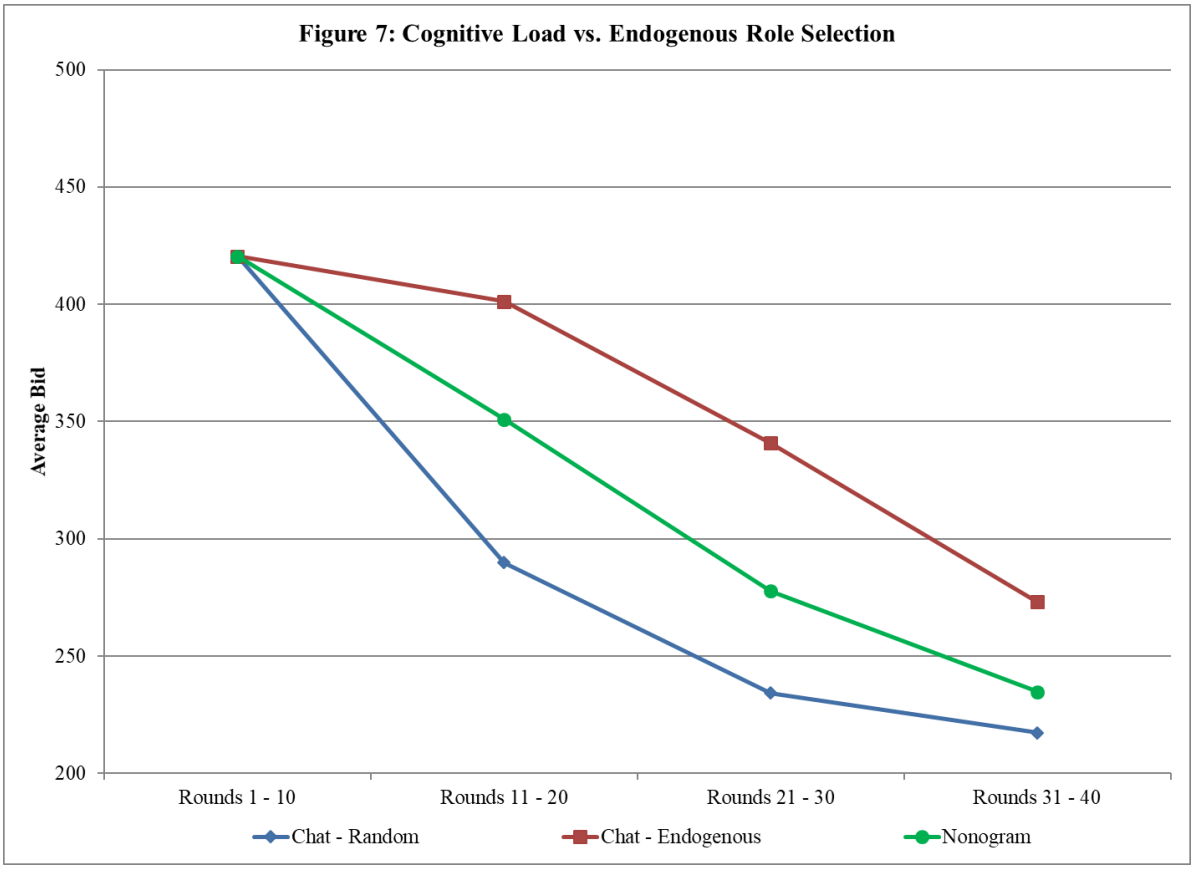


Notes: This figure compares the average bid in Rounds 11 – 40 for teams where the teammate who bid (strictly) lower on average in rounds 1 – 10 becomes the Buyer with teams where the teammate who bid lower becomes the Seller. Note that panel "No Chat" includes treatments **No Chat – Endogenous** and **No Chat – Random**, and that panel "Chat" includes treatments **Chat – Endogenous** and **Chat – Random**.

Figure 6: 6 x 6 Nonogram

		A	B	C	D	E	F
		4	2 2	2 3	3	4 1	1 4
I	1 2			x		x	x
II	4		x	x	x	x	
III	2 3	x	x		x	x	x
IV	1 4	x		x	x	x	x
V	3 1	x	x	x			x
VI	3 2	x	x	x		x	x

Notes: Subjects got an empty Nonogram (inside the 6 x 6 grid) and had to mark the correct cells with an "X". The figure shows the correct solution.



Notes: The construction of Figure 7 parallels that of Figure 4. It shows average bids of subjects assigned the Buyer role for Rounds 11 – 40 broken down by ten round blocks. The average bids in Rounds 1 – 10 are adjusted to equal those in **Chat – Random**. In subsequent ten round blocks the average bids are changed as they did in the real data.

References

Bereby-Meyer, Y. and Grosskopf, B., "Overcoming the Winner's Curse: An Adaptive Learning Perspective," *Journal of Behavioral Decision Making* 21(1) (2007), 15-27.

Blinder, A. S. and Morgan, J., "Are Two Heads Better Than One? Monetary Policy by Committee," *Journal of Money, Credit and Banking* 37(5) (2005), 789-811.

Bornstein, G. and Yaniv, I., "Individual and Group Behavior in Ultimatum Games: Are Groups More "Rational" Players?" *Experimental Economics* 1(1) (1998), 101-108.

Casari, M., Zhang, J. and Jackson, C., "Same process, different outcomes: group performance in an acquiring a company experiment," *Experimental Economics* 19(4) (2016), 764-791.

Charness, G. and Jackson, M. O., "Group Play in Games and the Role of Consent in Network Formation," *Journal of Economic Theory* 136(1) (2007), 417-445.

Charness, G., Karni, E., and Levin, D., "On the conjunction fallacy in probability judgment: New experimental evidence regarding Linda," *Games and Economic Behavior* 68(2) (2010), 551–556.

Charness, G. and Levin, D., "The Origin of the Winner's Curse: An Experimental Study," *American Economic Journal: Microeconomics* 1(1) (2009), 207-236.

Charness, G. and Sutter, M., "Groups make better self-interested decisions," *Journal of Economic Perspectives* 26(3) (2012), 157-176.

Chen, G., Gully, S. and Eden, D., "Validation of a New General Self-Efficacy Scale," *Organizational Research Methods* 4(1) (2001), 62-83.

Cooper, D. J. and Kagel, J. H., "Are Two Heads Better Than One? Team versus Individual Play in Signaling Games," *American Economic Review* 95(3) (2005), 477-509.

Cooper, D. J. and Kagel, J. H., "The Role of Context and Team Play in Cross-Game Learning," *Journal of the European Economic Association* 7(5) (2009), 1101-1139.

Cooper, D. J. and Kagel, J. H., "A Failure to Communicate: An Experimental Investigation of the Effects of Advice on Strategic Play?" Florida State University Working Paper, 2012.

Davis, J.H., "Some Compelling Intuitions about Group Consensus Decisions. Theoretical and Empirical Research and Interpersonal Aggregation Phenomena: Selected Examples 1950 – 1990," *Organizational Behavior and Human Decision Processes* 52 (1992), 3-38.

Falk, A., Becker, A., Dohmen, T., Huffman, D. and Sunde, U., "The Preference Survey Module: A Validated Instrument for Measuring Risk, Time, and Social Preferences," IZA Discussion Paper 9674, 2016.

Fischbacher, U., "z-Tree: Zurich Toolbox for Readymade Economic Experiments," *Experimental Economics* 10(2) (2007), 171-178.

Greiner, B., "Subject Pool Recruitment Procedures: Organizing Experiments with ORSEE," *Journal of the Economic Science Association* 1 (2015), 114-125.

Grosskopf, B., Bereby-Meyer, Y. and Bazerman, M., "On the Robustness of the Winner's Curse Phenomenon," *Theory and Decision* 63(4) (2007) 389-418.

Ichniowski, C. and Shaw, K., "The Effects of Human Resource Management Systems on Economic Performance: An International Comparison of U.S. and Japanese Plants," *Management Science* 45(5) (1999), 704-721.

Johnson-Laird, P. N., and Wason, P. C., "Insight into a Logical Relation," *The Quarterly Journal of Experimental Psychology* 22(1) (1970), 49-61.

Kerr, N. L., and Tindale, R. S., "Group Performance and Decision Making," *Annual Review of Psychology* 55 (2004), 623-655.

Kocher, M. G. and Sutter, M., "The Decision Maker Matters: Individual versus Group Behavior in Experimental Beauty-Contest Games," *Economic Journal* 115(500) (2005), 200-223.

Kugler, T., Kausel, E., Kocher, M., "Are Groups More Rational Than Individuals? A Review of Interactive Decision Making in Groups," *WILEY Reviews in Cognitive Science* 3 (2012), 471-482.

Levenson, H., "Differentiating among internality, powerful others, and chance," in H. Lefcourt, ed., *Research with the Locus of Control Construct* (New York, NY: Academic Press, 1981), Volume 1, 15-63.

Lorge, I. and Solomon, H., "Two Models of Group Behavior in Eureka-Type Problems," *Psychometrika* 20(2) (1955), 139-148.

Luhan, W. J., Kocker, M. G. and Sutter, M., "Group Polarization in the Team Dictator Game Reconsidered," *Experimental Economics* 12(1) (2009), 26-41.

Samuelson, W.F. and Bazerman, M. H., "The Winner's Curse in Bilateral Negotiations," in V. Smith, ed., *Research in Experimental Economics* (Greenwich, CT: JAI Press, 1985), Volume 3, 105-137.