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Delegation Using Forward Induction

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Delegation Using Forward Induction*

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Abstract

This paper explores a potentially important role of delegation: as a signal to sustain cooperation in coordination games. I consider a static principal-agent model with two tasks, one of which requires cooperation between the principal and the agent. If there is asymmetric information about the agent's type, the principal with a private belief that the agent is a good type can delegate the first task as a signal of his private belief. This equilibrium is supported by the forward induction argument. I conduct laboratory experiments to test these theoretical predictions and to examine the role of information in equilibrium selection. I find that delegation is used only sometimes to facilitate cooperation; however, when the subjects have information about past sessions, there is a statistically significant increase in the use of delegation. This evidence suggests that information matters in equilibrium selection in Bayesian games.

Keywords: Delegation, Forward Induction, Lab Experiment, Information

JEL Classification: C92, D23, D86, D82.

List of Tables

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1 Introduction

Inter-organizational delegation is an important issue in economics. Most of the existing literature explains delegation as emerging from either differences in information, cost, ability, or from credibility and commitment power (Bolton and Dewatripont, 2005 [6]). In this paper we explore another potentially important role of delegation if there is type uncertainty about the agent: as a signaling device to facilitate cooperation.

We first use a simple theoretical model to show that this unique use of delegation as a signal is sustained as an equilibrium, also that it is the only equilibrium that survives the forward induction logic.

Let us illustrate the central idea with an example: consider an inter-organizational relationship between an agent and a principal, where there are two separate tasks to perform. An example of such a relationship is the relation between a scientist (principal, *he*) and a research intern (agent, *she*). The first task (in the example, consider the setting up of the laboratory, filling out official forms etc.) is a simple one and any one of the scientist and the intern can do it, while the second task, the scientific experiment, requires cooperation from both of them. The intern may be one of two types: Unbiased or Biased. In this example, a scientifically motivated intern is be called *"Unbiased."* The scientist does not know the agent's true type, he only has access to a private signal about the intern's type. During the second task which has to be performed together, if the research intern is scientifically motivated, the task resembles a coordination game (like a stag-hunt game), hence it is beneficial to both the scientist and the intern to cooperate and exert high effort. However, if the intern is not motivated (Biased), she will always shirk. Thus, the scientist would benefit from cooperating with an unbiased intern but not a biased one, and also the unbiased intern would like to cooperate if she believes that the scientist will cooperate as well. Here, in absence of any other way of communication, there is a possibility of coordination failure. That is, it may happen that the scientist is actually matched with an unbiased intern but still both end up choosing low effort in Task 2. Here, the scientist can use delegation of the first task as a signalling device. He can let the intern go through the laboratory set up and official tasks to indicate that he has a high belief that the intern is scientifically motivated.

This Bayesian game has two Perfect Bayesian equilibria which can be Pareto-ranked. In one of the equilibria, delegation is used to signal the scientist's belief. If the scientist believes the intern to be unbiased, he delegates the first task to the intern to signal his trust. Observing this signal, the unbiased intern will infer that the scientist must have a higher belief about her type, and is likely to cooperate in the next task. In this equilibrium, delegation can bring about cooperation in the second task. This equilibrium is supported by forward induction logic. In another PBE, the scientist never uses delegation irrespective of his belief, and in the second task cooperation does not take place.

Because of the presence of multiple equilibria in this game, whether this equilibrium is actually chosen by decision makers is an empirical question. Therefore we take the next step: in a controlled laboratory experiment we simulate the exact environment postulated in the theoretical model. From the experimental data we can test the theoretical predictions and also get insights about how the subjects select equilibrium. This experimental study explores the possibility of using delegation as a signaling device, and at the same time, it helps us identify the factors behind equilibrium selection in this scenario.

From the experimental data we find that the subjects do not choose to delegate very often; the Pareto inferior pooling equilibrium where the principal never delegates is chosen most of the times. However, in one of the treatments, in each session we publicly announce some information about the observed behavior in the past sessions. Even though the information is not payoff relevant since it's not the data from the ongoing session, it significantly affects the results. In this treatment with information, we observe the theoretically postulated use of delegation significantly more often.

This paper's contribution is twofold. Firstly, it theoretically finds an alternative use of delegation as a signal in coordination games. The existing body of research, employing the standard principal-agent framework, explains delegation as emerging from either differences in information, cost, ability, or from credibility and commitment power due to handing of the decision-making authority (Bolton and Dewatripont, 2005 [6] includes an extensive survey). Schelling, 1980 [40] shows that delegation can also act as a commitment device. Delegation of control rights is often discussed as an important tool to provide incentives in the incomplete contract framework (Aghion and Tirole, 1997 [1]). Fershtman, Judd, and Kalai, 1991 [26] shows that delegation can be used to gain credibility. More recently, many experimental studies have also documented the use of delegation to serve other strategic purposes apart from efficiency. For example, Bartling and Fischbacher, 2011 [4], Oexl and Grossman, 2013 [38] find that delegation may happen because of the principal's desire to shift the responsibility to the delegate. They find that delegates are often punished less severely. Similarly, Hamman et.al., 2010 [32], Erat, 2013 [23] show that a principal may hire an agent to take self-interested or immoral actions that the principal would be reluctant to take more directly.

While these studies explore different reasons for delegation, the theoretical model developed in this paper proposes a novel alternative explanation of delegation, where delegation can be used as a signal to facilitate cooperation at a later stage. Here, we do not assume that the agent has superior skills or information about the task, nor we allow for repeated interaction. This present paper is thus aimed at complementing the existing literature on delegation.

The experimental study also complements the literature of equilibrium selection in Bayesian games: more specifically the predictive power of the forward induction argument. Bayesian games generally suffer from multiplicity of equilibria. To obtain predictive power, different refinements have been suggested theoretically. Mainly following Kohlberg and Mertens' (Kohlberg and Mertens, 1986 [37], later formalized by van Damme, 1989 [43], and Ben-Porath and Dekel, 1992 [5]) concept of stability, these refinements pick equilibria from the set of Perfect Bayesian Equilibria which satisfy the stability criteria; hence they are more likely to be chosen by a decision maker. In this paper, the theoretical prediction of the use of delegation as a signal is consistent with a forward induction argument.

The laboratory results can provide important insights to complement the theoretical debate about the predictive power of forward induction refinement. Since the early days of experimental economics, various studies have presented mixed evidence on the predictive power of the refinements (for an exhaustive review of these works, refer to Crawford, 1997 [21], Devetag and Ortmann, 2007 [22], and Friedman and Sunder, 1994 [29]). Cooper et.al., 1990 [14] find evidence supporting forward induction argument in coordination games, but only when the equilibrium chosen by the forward induction refinement coincides with the Pareto dominant equilibrium. Cachon and Camerer, 1996 [10] find support for forward induction when it is coupled with another selection criterion: loss avoidance. In the battle of sexes game, forward induction is shown to be effective along with a focal point argument (Cooper et. al., 1993 [18]). Another study by Cooper et. al., 1994 [17] show that preplay communication can increase the predictive power of forward induction and solve the coordination failure problem. Brandts and Holt, 1989 [7] find that in a signaling game with multiple equilibria, the Pareto dominant Nash equilibrium is often chosen, which supports the Intuitive Criterion; however, after gaining experience with different partners in a series of these signaling games, behavior closer to the unintuitive equilibrium outcome is observed. Such mixed predictions require us to further investigate the out-of-equilibrium adjustment process.

In general, it is found that the outcomes are often game-specific (see Banks et. al., 1994 [2], Brandts and Holt, 1992 [8]) and a small change in the parameter value can change the outcome even when the play followed equilibrium prediction before (Goeree and Holt, 2009 [30]) and even a small payoff asymmetry may lead to coordination failure (Crawford et. al., 2008 [20]).

In contrast to the existing literature, we find that the majority of the subjects choose the Pareto dominated equilibrium rather than the Pareto superior PBE supported by the forward induction argument. However, this refinement performs better if the subjects are publicly informed about the observed data in the past sessions.

The standard theories of Bayesian games define equilibria consistent with different beliefs, but do not explain how economic agents actually form their beliefs. In this study, the results from the information treatment indicate that the formation of second order belief depends on information. Thus, this study not only sheds light on the issue of equilibrium selection, but also seeks to identify the role of information in equilibrium selection. The results provide fresh insight and can be used in future to formulate behavioral models to show how belief formation in Bayesian games depends on the information environment.

This paper is organized as follows. First, we develop the theoretical model and state the equilibrium. In section 3, we describe in detail the experimental design, along with the description of the sessions. Sections 4 contains the analysis of the results. In section 5 we discuss the significance of the results and suggest possible explanations of the observed behavior. Section 6 contains some concluding remarks.

2 Theoretical Model

Consider a principal agent relationship: a principal (he) and an agent (she) are engaged in a project that involves two separate tasks where monetary transfers are not allowed.

The agent does not have any superior skill or knowledge relevant to the tasks compared to the principal, but her "type" $\theta \in \{\text{Biased } (B), \text{Unbiased } (U)\}$ is privately known.

A biased, or, untrustworthy agent does not care about the project's success whereas the unbiased or trustworthy agent has preferences completely aligned with the principal.

The prior belief about the agent's type: $\Pr(U) = \mu \in (0,1)$.

Let us describe the timeline of the game:

- At the beginning, Nature moves and chooses the agent's type $\theta \in \{U, B\}$. The principal can not observe the true type, he gets a private binary signal $s \in \{H, L\}$ about θ. The signal structure is given by:
$$\Pr(s = H|\theta) = p_\theta$$
- *Assumption 1:* The signal structure satisfies Monotone Likelihood Ratio Property (MLRP), i.e., $p_U > p_B$

  Thus the posterior belief about the true type becomes
$$\begin{aligned}
\mu_H &= \Pr(\theta = U|s = H) = \frac{\mu p_U}{\mu p_U + (1-\mu)p_B} \\
\mu_L &= \Pr(\theta = U|s = L) = \frac{\mu(1-p_U)}{\mu(1-p_U) + (1-\mu)(1-p_B)}; \\
&\Rightarrow \mu_H > \mu > \mu_L
\end{aligned}$$
- *Task 1:* The active player chooses effort $e_1 \in \{0, 1\}$. The payoffs of the players from this task are given in the following table:

Payoffs from Task 1

Payoff for	Principal	Unbiased Agent	Biased Agent
Effort $e_1 = 1$	2	2	0
Effort $e_1 = 0$	1	1	1

Thus, the unbiased agent's preferences are closely aligned with the principal's, unlike the biased agent. The principal and the Unbiased agent have a dominant strategy to choose $e_1 = 1$ but the Biased agent would choose $e_1 = 0$.

The effort choice in this task is not observable before the completion of task 2.

- *Task 2:* After task 1, both the principal and the agent have to choose efforts simultaneously to complete task 2, where efforts are complementary in nature. Task 2 involves simultaneous choice of effort $e_{2P}, e_{2A} \in \{0, 1\}$, which yields payoff according to the following 2×2 matrix.

  If the agent is Unbiased, the game becomes a coordination game:

P\AU	1	0
1	$(9, 9)$	$(1, 5)$
0	$(5, 1)$	$(5, 5)$

  If, however, the agent is biased, the game becomes:

P\AB	1	0
1	$(9, 1)$	$(1, 5)$
0	$(5, 1)$	$(5, 5)$

Thus, a Biased agent always has a dominant action in Task 2: to choose $e^B_{2A} = 0$, whereas if the Unbiased agent and principal chose with complete information, the coordination game will have two pure strategy Nash Equilibria: $(e_{2P}, e^U_{2A}) = (1, 1)$ and $(e_{2P}, e^U_{2A}) = (0, 0)$, with the former Pareto dominating the latter.

Total payoff of a player is the sum of his/ her payoffs obtained from both the tasks.

Note that, in the second task, the complementarity of effort choices implies that if the agent is unbiased then the principal would want him to choose higher effort in task 2. The unbiased agent's effort choice in task 2 in turn depends on his belief about the principal's private signal. Thus, if delegating the first task can serve as a signaling device, then the principal with a more favorable signal could use it to induce higher effort from the unbiased agent in task 2. we look for Perfect Bayesian Equilibria of this game that satisfy forward induction criterion.

Definition 1 (Forward Induction (van Damme, 1988 [43])) *A Perfect Bayesian Equilibrium satisfies Forward Induction if the following property is satisfied. In a generic 2 player game in which player i chooses between an outside option or to play a game G of which a* *unique and viable equilibrium e^* yields the player more than the outside option, only the outcome in which player i plays G and then e^* is played is plausible*[1].

Then, in the signaling game described above, the pure strategy Perfect Bayesian Equilibrium are:

Proposition 1 *If the prior belief is such that*

$$p_U < \frac{5}{9}, \mu_H > \frac{5}{9} > \mu_L$$

then there exist two pure strategy Perfect Bayesian Equilibria:

(A) a separating equilibrium: *principal with a high private signal chooses to delegate Task 1, and then chooses high effort in the coordination game, and the principal with low signal does not delegate the task 1 and chooses low effort in the coordination game; Unbiased agent chooses High effort in Task 2 whenever he is delegated Task 1 and chooses low effort in Task 2 whenever not delegated; Biased agent always chooses low effort in Task 2.*

(B) a pooling equilibrium: *Both high and low signal principals choose not to delegate; subsequently in Task 2, both the principal and the agent always choose low effort, so cooperation fails to occur.*

Under the parametric restriction, the separating equilibrium is the unique Perfect Bayesian Equilibrium satisfying the forward induction refinement.

Proof. Let us define the Unbiased Agent's belief as:

$$\begin{aligned}
\alpha_i^U &= \Pr(P \text{ got a High Signal}|\ \theta = U,\ P \text{ chose } i); \\
i &= \{Delegate, No\ Delegate\}
\end{aligned}$$

The strategies are:

$$\begin{aligned}
&for \text{ Principal:} \\
&\qquad \sigma_{2j} = \Pr(P \text{ chooses Task 2 effort=1}|\text{Signal=}\ j) \\
&\qquad \sigma_{Dj} = \Pr(P \text{ chooses to Delegate}|\text{Signal=}\ j) \\
&\qquad j = \{High, Low\} \\
&for \text{ Unbiased Agent:} \\
&\qquad \sigma_U^i = \Pr(A \text{ chooses Task 2 effort=1}|P \text{ chose } i) \\
&\qquad i = \{Delegate, No\ Delegate\}
\end{aligned}$$

[1]See also Govindan and Wilson, 2009b [31]

Then, a pooling Perfect Bayesian Equilibrium is given by:

$$\begin{aligned} &for\ \text{P:} \\ &\quad(\sigma_{2H} = \sigma_{2L} = 0; \sigma_{DH} = \sigma_{DL} = 0) \\ &for\ \text{Unbiased A:} \\ &\quad(\alpha_D^U < p_U, \alpha_{ND}^U = p_U; \sigma_U^{ND} = \sigma_U^D = 0) \end{aligned}$$

For all parameter range, such a Perfect Bayesian Equilibrium exists (call it *PBE* hereafter).

A separating equilibrium is given by:

$$\begin{aligned} for\ \text{P: } &(\sigma_{2H} = 1, \sigma_{2L} = 0; \sigma_{DH} = 1, \sigma_{DL} = 0) \\ for\ \text{Unbiased A: } &(\alpha_D^U = 1, \alpha_{ND}^U = 0; \sigma_U^{ND} = 0, \sigma_U^D = 1) \end{aligned}$$

Given $(\alpha_D^U = 1, \alpha_{ND}^U = 0; \sigma_{2H} = 1, \sigma_{2L} = 0)$, P delegates iff

$$\begin{aligned} V_j(Del) &\gtreqqless V_j(No\ Del) \\ &\Leftrightarrow \mu_j \geq \frac{5}{9} \end{aligned}$$

For $\mu_H \geq \frac{5}{9} > \mu_L$, $\sigma_{DH} = 1$ and $\sigma_{DL} = 0$. So, the only off the equilibrium belief consistent with the forward induction argument is:

$$\alpha_D^U = 1, \alpha_{ND}^U = 0$$

Thus, this separating equilibrium satisfies Forward Induction refinement (call it *FI* hereafter). It is easy to see that the off equilibrium belief $\alpha_D^U < p_U$ is never consistent with Forward Induction refinement, so the pooling PBE does not satisfy this refinement. ■

For conducting the experiments, we use a set of parameters to simulate the signal structure and the tasks:

$$\begin{aligned} \mu &= \frac{1}{2}, \mu_H = \frac{3}{5}, \mu_L = \frac{3}{7}; \\ p_U &= \frac{1}{2}, p_B = \frac{1}{3} \end{aligned}$$

The experiment is intended to test Proposition 1 under the given set of parameters, and reveal if the decision to delegate can be considered as a signaling device to facilitate cooperation, and how the decision to delegate depends on information.

3 Experimental Design

Nine experimental sessions are conducted in the Computer Laboratory in the Economics Department at the University of Texas, Austin, out of which eight sessions are used for the study (we omit one session in order to avoid inconsistency, as explained later). A total of 174 subjects participated in these 8 sessions, creating a dataset with 2784 observations. Four of the sessions feature the sequential game discussed above (we call this *Treatment B*), and five sessions were conducted where the subjects were given information about the behavioral trends observed in a past session (we call this *Treatment I*) (details later).

For the baseline treatment (*Treatment B*), there are three sessions with 24 participants each and one with 20 participants; for the treatment with information given to the subjects: *Treatment I*, two sessions have 22 participants, one has 20 and the other has 18 participants. zTree software [28] is used to design the interface and record the participants' responses. At the beginning of a session, each participant is assigned a random subject number generated by the computer. The experimental instructions are then given verbally to the participants along with some slides and a copy of the instructions are also distributed among them (the detailed instructions are attached as Appendix C.2).

At the beginning of each round, every participant receives a role: either a principal or an agent, with *role switching*[2] in every round. The agents are randomly assigned as biased or unbiased types (with equal probability) and randomly and anonymously matched to the subjects assigned as principals in that round. This random and anonymous matching retains the static structure of the game. The principals do not observe the type of the agent he/she is matched to in that round, but receive a randomly generated signal sent by the computer. The matching and signaling structures remain the same throughout the session. To avoid any positive or negative connotations, we call the types Green (for Unbiased) and Red (for Biased); the signals as Lime (high) and Pink (low).

Since the game consists of multiple tasks, it is imperative that the subjects are trained in each of these tasks and have sufficient experience with them before playing the sequential game. So, at the beginning, Stage One of Part One features four rounds of task 2 separately, where in each round the matched pair of a principal and an agent play the coordination game described above. After that, instructions about the sequential game are given and a short quiz is conducted to ensure the subjects' understanding of the task. Stage Two of Part One features six rounds of the entire game, where each matched pair of a principal and an agent play task 1 and task 2 sequentially, but without the option to delegate task 1. Thus, the data generated from Stage Two of Part One can be used as the Control. Part Two consists of ten rounds of the entire game, with the principals having the option to delegate task 1 to

[2]This role switching ensures that every subject is aware of the incentive faced by both principals and agents.

the agents; thus this stage provides the data from the Treatment.

In *Treatment B,* we use *within subjects design*, i.e., the same subjects first face the entire game without delegation (in Control rounds) and then with the delegation option (in Treatment rounds). The Control rounds are expected to make the subjects aware of the coordination problem. So when they are given the delegation option, the principals are expected to use this to try and obtain coordination in task 2. The possible order effect present in the design thus makes it more likely that the forward induction equilibrium will be chosen more often.

We use the binary lottery approach to induce *risk neutrality* (Roth and Malouf [39] and Cox et.al. [44][3]). At the end of each session, two lotteries are conducted, one for each Part. Every round the subjects receive payoff points. The lottery draws a random integer between 0 and the maximum payoff points each individual can possibly get, given his/her assigned role and type. If the sum of obtained payoff points is greater than this random integer, the individual wins the lottery and obtains the winning payoff. Each of the two lotteries pay $15 as a winning payoff. This payment scheme also ensures fairness since it takes into account the roles and types the subject is assigned to in each round.

Apart from conducting four sessions with the benchmark treatment *(Treatment B)*, we also conduct five sessions with information given to the subjects. In the first session with *Treatment I* , the information given is from the previous *Treatment B session.* The following *Treatment I sessions* are conducted using information from the last *Treatment I session.* Hence, in the first *Treatment I session*, the subjects are informed about behavioral trends of others who, in turn, were not given any information; whereas in the next Treatment I sessions, subjects observe the data generated from a session where information was given. To avoid any possible inconsistency due to this, we omit the data from the first *Treatment I session* and use the data from the remaining four sessions.

In these sessions, termed as the *Treatment I sessions*, Part One is conducted similar to the *Treatment B sessions.* However, before Part Two, the subjects are given information about

(a) the proportion of principals who chose high effort after delegating Task 1 and after not delegating, and

(b) the proportion of Red (Biased) and Green (Unbiased) agents who chose high effort after being delegated and after not being delegated[4].

When we compare the performance of the forward induction equilibrium with and

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[3]Even though there are crticisms against this approach (Selten et. al., 1999 [41]), this remains the most used approach to induce risk neutrality. The alternative approach of eliciting risk aversion also shares similar pitfalls as this approach.

[4]Appendix C contains **??**: the slide through which the historical information was given in one of the Treatment I sessions.

without information, we exploit *between subjects* design.

3.0.1 *Hypotheses:*

There are two central hypotheses: Forward Induction Hypothesis which examines if the subjects' choices are consistent with the forward induction predictions; and Information Hypothesis which seeks if there is a significant change in behavior in Treatment I.

Forward Induction Hypothesis *:*

In Part Two of Treatment B, FI will be chosen as predicted by Proposition 1.

This hypothesis can be broken into several components:

1. The principal with a high signal more frequently chooses to delegate the task 1 than the principal with a low signal.

2. After delegating task 1 to the matched agent, the principal is more likely to choose high effort in task 2 than when not delegating.

3. After observing delegation by the principal, the matched Unbiased agent chooses high effort more often than after observing no delegation.

Information Hypothesis *:*

In Part Two in *Treatment I sessions* , FI is chosen more often than in *Treatment B sessions.* Also, delegation is more frequently observed with *Treatment I.*

Apart from these two, the control stage of Treatment B checks for subjects' natural coordination behavior.

Hypothesis B:

In Part One of Treatment B, in Task 1 the principal will choose high effort and in Task 2, $(e_{2P}, e_{2A}) = (0, 0)$ will be played irrespective of the principal's signal or the agent's types, so the outcome will be consistent with the Pareto inferior outcome $(5, 5)$. Also, the choices should not significantly depend on which session or period the data is from, nor on the subject specific effects.

4 Results

4.1 *Treatment B*: Part One

First let us examine the results from the Part One , with 552 observations. Apart from showing if the subjects' play conforms to any equilibrium behavior, the results also shed light on the natural cooperative tendency in the subject pool.

1. *Observation 1:* The Unbiased agents choose high effort in Task 2 significantly more often (41.72% compared to 58.28%, t-stat: -8.3757). Biased agents almost always choose Low effort (98.23% of the times).

2. *Observation 2:* The principals almost always choose high effort in Task 1 (92.75% of the times), indicating the consistency of behavior in the subject pool.

3. *Observation 3:* The principals choose high effort in Task 2 significantly more often if the private signal is high (45.87% of the principals with High signal choose High effort, compared to 13.77%, t-stat: -6.3011).

4. *Observation 4:* The inefficient outcome $(5,5)$ is chosen significantly more often than the Pareto dominant outcome $(9,9)$ in Task 2.

Equilibrium Chosen	Frequency	Percent
Outcome $(9,9)$	22	7.97%
Outcome $(5,5)$	203	73.55%
Total Play	276	100%

Also, the subjects' behavior mostly conforms to an equilibrium prediction; only 18% of the times the behavior observed is different than predicted by an equilibrium. Together, these four observations show support for Hypothesis B[5].

Next, with the help of logistic regressions, we seek to understand the factors that affect the Task 2 effort choices by the principals and agents (the regression results are summarized in Table A1 in Appendix A). Exploiting the panel structure of the data, we estimate a random effects logistic regression. The principals' choice of Task 2 effort depends only on the private signal, while the agents' choice mainly depends on the type. Overall, these results support Hypothesis B.

4.2 *Treatment B*: Part Two

From the data collected from Part Two, analyzing the 920 observations, we observe the following trends.

1. Principals with high signal delegate more often than with low signal (t-stat: -4.1037), as posited in Forward Induction Hypothesis. A logistic regression with random effects supports this as well (Table A3).

[5] In Appendix A, Table A2 shows the results of a t-test to check if the proportion of coordination equilibrium play (outcome $(9,9)$) is significantly different from the proportion of the Pareto dominated equilibrium play (outcome $(5,5)$). The evidence suggests that the majority of the participants chose not to coordinate on the "better" equilibrium in Part One.

Signal\Delegation	Delegate	No Delegate	Total
High	55 (28.65%)	137 (71.35%)	192
Low	36 (13.43%)	232 (86.57%)	268
Total	91	369	460

2. After Delegation, principals more often follow up with high effort choice in Task 2 (t-stat: -5.0013).

Delegation\Task 2 Effort	High	Low	Total
After Delegation	33 (36.26%)	58 (63.74%)	91
After No Delegation	52 (14.09%)	317 (85.91%)	369
Total	85	375	460

3. After observing Delegation, Unbiased agents are more likely to respond by choosing High Effort in task 2, as posited in Hypothesis B3 (t-stat: -3.3962).

Delegation\Task 2 Effort	High	Low	Total
After Delegation	24 (42.11%)	33 (57.89%)	57
After No Delegation	35 (20%)	140 (80%)	175
Total	59	173	232

   Biased agents almost never choose high effort (only 2 instances out of 228).

   Table A3 shows that agents' effort choice depends only on own type and principal's delegation decision, and principal's effort choice depends only on own signal and delegation.

4. After a delegation occurs, the proportion of plays choosing (High, High) in Task 2 is significantly greater than after no delegation. The following table shows that after delegation it is ten times more likely to end up at $(9, 9)$ in Task 2.

Delegation\Task 2 Outcome	Task 2 payoff : $(9, 9)$	Total
After Delegation	11 (12.09%)	91
After No Delegation	6 (1.63%)	369
Total	17	460

4.2.1 Forward Induction Hypothesis

Now we turn to our central question: whether delegation is used in equilibrium as a signal to obtain coordination. First, note that both the Perfect Bayesian Equilibria mentioned in Proposition 1 predict a similar outcome if the Principal observes a low signal: in both equilibria the Principal does not delegate Task 1 and subsequently chooses low effort in Task

2, and the matched Agent responds by choosing low effort in Task 2, irrespective of her own type. So, we have to focus on the behavior observed after a High signal.

If a High Signal is observed, FI is chosen significantly less often than the Pareto-inferior PBE. Table 1 shows that FI has been chosen significantly less often.

Equilibrium Chosen \ Signal	High	Low	Total
FI	19 (9.90%)	212 (79.10%)	231
PBE	105 (54.69%)	212 (79.10%)	317
PBE-FI	86(44.79%)	0	86(18.7%)
t-stat (p-value)	10.664(0.00)	0	5.88(0.00)
Total Equilibrium Play	124 (64.58%)	212 (79.10%)	336(73.04%)

Table 1: Equilibrium Selection in Treatment B

Since t-tests use the normality assumption, we also use a non-parametric test, viz. Mann-Whitney U test and obtain similar results (z-stat: 7.72, significant at 1% level).

This result clearly shows that the proportion of plays conforming to the Pareto dominated PBE is significantly greater than the proportion conforming to FI. This result contradicts *FI Hypothesis*.

Also, the proportion of plays conforming to an equilibrium prediction is significantly lower (Table 1) compared to the same if a Low signal is observed (only 64.58% compared to 79.10% with Low signal, t-stat 3.40, p-value 0.0007).

To sum up the results from this treatment, we observe that:

(a) The observed play mostly conforms to one of the Perfect Bayesian Equilibria.

(b) *After* a delegation decision, the choices made by the principal and the agent supports the theoretical prediction of forward induction.

(c) However, FI is seldom chosen. Principals do not delegate often. The Pareto inferior PBE is chosen significantly more frequently, indicating that forward induction fails to predict the outcome in this context. To gain more insight into this result, and to know the role of information in this context, we use the next set of treatments.

4.3 *Treatment I*

The main question in this set of treatments is if the delegation choices depend on the information given to the participants? Theoretically, since the sessions are completely independent of each other, the information describing summary statistics of one session should not impact any decision in another.

We use the data from the last four sessions of *Treatment I*, containing 1312 observations. In each session, before Part Two, the participants were given summary statistics about the past Treatment I session[6]. The observations from these four sessions are listed below:

1. *Observation 1:* The data from the Part One in *Treatment I sessions* is similar to the Part One data observed in *Treatment B sessions*.

   The Unbiased agents choose Task 2 effort in a similar way (t-statistic for comparing the Task 2 effort between *Treatment B* and *Treatment I* is 1.63, insignificant at 10% level), similar for the Biased agents (t-stat: -0.7303). The principals choose Task 2 effort similarly (for low-signal principals, t-stat: 1.53, for high-signal, t-stat: 1.35). The coordination achieved in Task 2 is also similar (t-stat: 0.31). This just proves that the sessions are otherwise very similar to the Treatment B sessions. The tables and the logistic regressions are given in Appendix A (Table A4).

2. *Observation 2:* The principals observing high signals delegate more often in *Treatment I* than in *Treatment B* (Table 2) Logistic regressions with random effects shows us that

Treatment\Delegation	Delegation	Total
Treatment I	65 (42.76%)	152
Treatment B	55 (28.65%)	192
Difference	10(14.11%)	
t-stat (p-val)	2.7503(0.0063)	
Total	120	344

Table 2: Higher Delegation Frequency with Information

   only delegation decision depends on information, not the effort choices for principals or agents (Table 3).

3. *Observation 3:* The proportion of times the observed play conforms to FI is significantly higher in *Treatment I* compared to *Treatment B*. after High signal (Table 4). Both t-test and Mann-Whitney test show that while FI is chosen more frequently in *Treatment I* than *Treatment I* (t-stat: -2.45, z-stat: -2.75), the pooling PBE is chosen with similar frequency across the treatments (t-stat: 0.49). The test results and a random effects logistic regression are given in Appendix A (Table A5 and 7).

We also observe that the proportion of plays conforming to an equilibrium prediction is significantly higher in Treatment I (mean: 78.78%) vs in Treatment B (mean: 73.04%) at 5% level (t-stat: -1.97).

[6] In all of these sessions, the summary statistics given was from the previous session conducted with similar informational environment. For the sake of consistency, we do not use the first session where the data given was from a session which was conducted without information. Also, by not giving them a single session's statistics, we can explore any possible trend and have more insight if the subjects are "sticking to the norm".

	Principal	Agent	Delegation
Task 2 Effort	b/se	b/se	b/se
Information	0.04(0.40)	$-0.46(0.43)$	$0.68^{*}(0.40)$
If Principal Delegated	$2.91^{***}(0.35)$	$2.64^{***}(0.38)$	-
Type	$-$	$5.55^{***}(0.90)$	-
Signal	$2.44^{***}(0.32)$	$-$	$1.93^{***}(0.26)$
Period	0.01(0.04)	$-0.12^{*}(0.06)$	$-0.31(0.04)$
Constant	$-4.59^{***}(0.91)$	$-5.84^{***}(1.29)$	$-2.69^{***}(0.77)$
	* $p < 0.05,^{**}$ $p < 0.01,^{***}$ $p < 0.001$		
	Random-effects logistic regression		

Table 3: *Effect of Information in Effort Choice and Delegation*

Equilibrium Outcome\Treatment	I	B	Total
FI	29 (19.08%)	19 (9.90%)	48
PBE	79 (51.97%)	105 (54.69%)	184
Total No of Equilibrium Plays	108 (71.05%)	124 (64.58%)	232 (67.44%)

Table 4: Equilibrium Selection After High Signal

The three observations support the Information Hypothesis and indicate that the treatment of giving information about past session is more conducive to forward induction reasoning.

5 Discussion

5.0.1 On Forward Induction

In this paper, we find that in general, the participants choose the pooling Perfect Bayesian Equilibrium. Delegation is not used often and later in Task 2 (Low, Low) effort choice is observed. Thus, the forward induction logic breaks down here. This finding is consistent with the existing studies (e.g.: Cooper et.al., 1992 [16]) which discuss the limitations of forward induction reasoning. It has been found that, especially in coordination games with multiple Pareto ranked equilibria, forward induction refinement does not have much predictive power. Forward induction relies essentially on the common belief of rationality assumption. So, if the players are unsure of other players' rationality, they can choose the "safe" option of playing low effort and this can lead to the observed results.

5.0.2 Information and Second Order Belief

The public announcement of the information may have helped the subjects in forming the second order beliefs about the other subjects. Although we do not elicit beliefs in this study, from the behavioral trends one can form this conjecture. Here, we see that the effect of information is more pronounced among the principals: after choosing to delegate, in Treatment B, they choose High effort only 36.26% of times. In Treatment I, this proportion rises drastically (66.34% compared to 36.26% in Treatment B, t-stat −4.34. See Table 5). This happens because the principals, initially unsure about whether the agents can interpret the delegation decision as intended, now know that the agents also have the same information available. This increases their second order belief and makes them coordinate towards the FI equilibrium. On the other hand, as for the Unbiased agents, effort choice after observing delegation increases, but not so much (62.71% in Treatment I compared to 42.11% in Treatment B, t-stat −2.25), suggesting that the provision of information works mostly through the second order beliefs, not the first order beliefs.

High Effort	Principal	Unbiased Agent	Total
Treatment B	33 (36.26%)	24 (42.11%)	48
Treatment I	67 (66.34%)	37 (62.71%)	184
t-stat (p-value)	−4.34 (0.00)	−2.25 (0.03)	232 (67.44%)

Table 5: Effect of Information Among Principals and Unbiased Agents

Of course, to confirm that information does affect the second order belief, we need further studies to elicit the beliefs and use the strategy method to observe more data. Also, it will be instructive to see if the same information given privately has the same impact on equilibrium selection.

5.1 Informational Content or Information Itself?

In *Treatment I*, the information about the past session significantly increases the proportion of coordination. This clearly indicates that this information has a role to play in formation of belief and equilibrium selection. An important observation regarding this is: it seems that the availability of this information is what matters, not the information itself. In the data, we find that the proportion of times the "coordination" outcome[7] was chosen in these Treatment I sessions does not significantly differ across sessions. The following figure (Figure

[7]By "Coordination", I refer to the outcome where principals delegate and then in Task 2 end up with (High, High) effort choice.

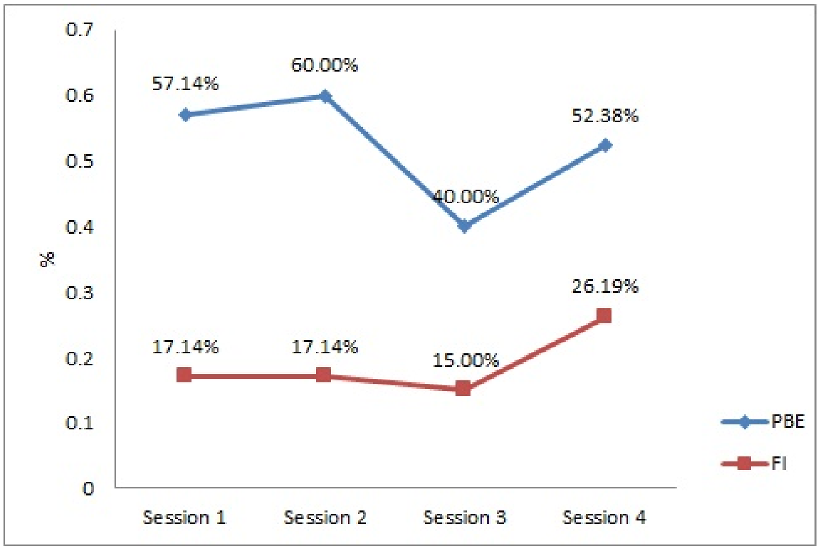

Figure 1: Proportion of Coordination by Sesseions in Treatment I

1) depicts the proportion of plays where coordination happens. This graph shows that the proportion of coordination does not exhibit any trend over time.

Also, in a regression (Table 6) to explain the equilibrium selection, we find that session is not statistically statistically significant.

	FI
	b/se
Signal	5.29***(1.21)
Information	7.39*(4.34)
Period	0.11(0.11)
Session	−0.42(0.38)
Subject	0.011(0.07)
Constant	−8.17(5.04)
	$^{*}\ p < 0.05;^{**}\ p < 0.01;^{***}\ p < 0.001$
	Random-effects Logistic Regression

Table 6: *Equilibrium Selection Does not Depend on Session*

Clearly, the coordination proportion does not show any significant cumulative growth pattern over the sessions. Given that each subsequent session were given data from a previous session which already had information, this lack of pattern is all the more stark. These results suggest that while the given information induces the subjects to revise their priors upwards, the amount of revision is insensitive towards the exact quality of information given, i.e. just the availability of information is what creates a significant difference.

5.1.1 Reluctance for Delegation

In both the treatments we observe that the subjects are quite reluctant to delegate Task 1, even when they have a high private belief about the matched agents' unbiasedness. The reluctance for delegation even though delegation is beneficial has been noted in some earlier studies as well. Fehr et.al.[25], and Bartling et.al.[3] find that in an authority-delegation game, individuals often retain authority even when its delegation is in their material interest; suggesting that authority has non-pecuniary consequences for utility. It has been found that individuals often intrinsically value decision rights beyond their instrumental benefit. This intrinsic valuation of decision rights has potentially important consequences for corporate governance, human resource management, and optimal job design. In that light, the finding that subjects use delegation seldom possibly because of this reluctance to give up authority is of note. In this paper we are only exploring delegation as a signal, it would be interesting to see if subjects delegate in other circumstances involving differential information or cost between the principal or agent, or in situations of repeated interaction where trust and reciprocity are prominent concerns.

6 Conclusion

In this study we have shown that theoretically it is possible to explain the delegation phenomenon in various real life contexts as a signal of private belief, in order to achieve cooperation in a later phase. However, the experimental data show that the subjects do not often choose this equilibrium. Providing more information about past play increases the proportion of subjects choosing this equilibrium, hence using delegation to achieve coordination.

On one hand, this paper sheds light on the determinants of coordination in many real life scenarios. In inter-organization partnerships, it is often crucial to sustain cooperation among the employer and the employee in order to enhance the value of the relationship. In absence of repeated interaction and monetary payments, this study shows how the use of delegation can be used to signal the employer's private signal about the employee's type and bring about cooperation. It also underlines the importance of factors like the workplace environment and past information in forming new employee's belief and consequently in equilibrium selection.

On the other hand, this study provides fresh evidence on equilibrium selection in a Bayesian game. The results suggest that equilibrium selection and belief formation depend on the informational environment of the game. In this particular Bayesian game, the information about past play increased the predictive power of forward induction refinement. These results thus stress the need of a fully formulated behavioral model of equilibrium selection in Bayesian games.

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Appendix A: Results

	Principal	Agent	
Task 2 Effort	b/se	b/se	
Signal	2.45^{***} (0.49)	-	
Period	$-0.52(0.11)$	$-0.28^{*}(0.12)$	
Type	-	$5.12^{***}(0.98)$	
Constant	$-2.12(1.23)$	$-2.67(1.55)$	
	* $p < 0.05$,** $p < 0.01$,*** $p < 0.001$		
	Random-effects logistic regression		

Table A1: *Task 2 Effort Choices in Part One of Treatment B*

Variable	Mean	Std. Error
Outcome $(9,9)$	7.971014%	0.1865
Outcome $(5,5)$	73.5507%	0.2665
Diff	-65.5797%	0.4295
Mean(Diff)	$H_o : mean(diff) = 0$	
	$P(\lvert T\rvert > \lvert t\rvert) = 0.00 = P(T < t)$	$P(T > t) = 1.00$

Table A2: *Lack of Coordination in Treatment B Part One*

	Principal	Agent	Delegation
Task 2 Effort	b/se	b/se	b/se
If Principal Delegated	$1.43^{***}(0.48)$	$4.57^{***}(0.88)$	
Type		$1.27^{***}(0.44)$	
Signal	$2.48^{***}(0.43)$	$-$	$1.20^{***}(0.36)$
Constant	$-4.12^{***}(0.54)$	$-6.52^{***}(0.99)$	$-3.04^{***}(0.44)$
	* $p < 0.05$,** $p < 0.01$,*** $p < 0.001$		
	Random-effects logistic regression		

Table A3: *Task 2 Effort Choices in Part Two of Treatment B*

	Principal	Agent
Task 2 Effort	b/se	b/se
Signal	$2.45^{**}(0.54)$	
Type		$3.07^{***}(0.67)$
Constant	$-3.14^{***}(0.54)$	$-4.02^{***}(0.71)$
	* $p < 0.05$,** $p < 0.01$,*** $p < 0.001$	
	Random-effects logistic regression	

Table A4: *Task 2 Effort Choices in Part One of Treatment I*

Two-sample test with equal variance					
Group	Obs	Mean	Std Er	95% Conf. Interval	
Treatment B	192	0.2864583	.0327133	.2219327	.350984
Treatment I	152	.4276316	.040261	.348084	.5071792
Combined	344	.3488372	.0257341	.2982207	.3994537
diff		$t = -2.7503$	d.f. = 342		
Ho: diff= 0					
Ha: diff < 0		Ha: diff != 0			Ha: diff > 0
$Pr(T < t) = 0.0031$		$Pr(\|T\| > \|t\|) = 0.0063$			$Pr(T > t) = 0.9969$

Table A5: *Higher Delegation Frequency with Information*

Behavior Trends of *Treatment I* (Part Two):

1. High signal principals delegate more often than low signal principals (t-stat: −6.8925).

Signal\Delegation	Delegate	No Delegate	Total
High	65 (42.76%)	87 (57.24%)	152
Low	36 (13.95%)	222 (86.05%)	258
Total	101	309	410

2. After Delegation, principals more often follow it up with high effort choice in Task 2 (t-stat: −17.8545).

Delegation\Task 2 Effort	High	Low	Total
After Delegation	67 (66.34%)	34 (33.66%)	101
After No Delegation	15 (4.85%)	294 (95.15%)	309
Total	82	328	410

3. After observing Delegation, Unbiased agents are more likely to respond by choosing High Effort in task 2 (t-stat: −11.2993).

Delegation\Task 2 Effort	High	Low	Total
After Delegation	37 (62.71%)	22 (37.29%)	59
After No Delegation	9 (5.96%)	142 (94.04%)	151
Total	46	164	210

Biased agents never choose high effort.

Delegation\Task 2 Effort	High	Low	Total
After Delegation	0 (0%)	42 (100%)	42
After No Delegation	0 (0%)	158 (100%)	158
Total	0	200	200

4. *Hypothesis H :* The coordination rate is higher with delegation.

Delegation\Task 2 Outcome	Task 2: $(9, 9)$	Task 2: $(5, 5)$	Total
After Delegation	28 (27.72%)	34 (33.66%)	62
After No Delegation	0 (0%)	294 (95.15%)	294
Total	28	328	356

Two-sample test with equal variance					
Group	Obs	Mean	Std Er	95% Conf. Interval	
Treatment B	192	.0989583	.0216064	.0563406	.1415761
Treatment I	152	.1907895	.0319757	.127612	.2539669
Combined	344	.1395349	.0187094	.1027352	.1763346
diff		$t = -2.4553$	d.f. $= 342$		
Ho: diff= 0					
Ha: diff $<$ 0		Ha: diff != 0		Ha: diff $>$ 0	
$Pr(T < t) = 0.0073$		$Pr(\|T\| > \|t\|) = 0.0146$		$Pr(T > t) = 0.9927$	

Table A5: FI Chosen More Often With Information (After High Signal): t-test

Equilibrium Outcome\Treatment	I	B	Total
FI	244 (59.51%)	231 (50.22%)	475 (54.6%)
PBE	294 (71.71%)	317 (68.91%)	611(70.23%)
Total No of Equilibrium Plays	323 (78.78%)	336 (73.04%)	659 (75.75%)

Overall Equilibrium Selection

Two-sample Wilcoxon rank-sum (Mann-Whitney) test			
Treatment	Obs.	Rank-sum	Expected
B	460	191565	200330
I	410	187320	178555
Combined	870	378885	378885
unadjusted variance	13689217		
adjustment for ties	-3509103		
adjusted variance	10180114		
$H_0 : d(NH) - d(H)$			
$z = -2.747$			
$\Pr ob > \|z\|$	$= 0.0060$		

Table A6: Overall FI Chosen More Often in Treatment I: Mann-Whitney Test

	FI Chosen
	b/se
Information	$2.80^{***}(1.02)$
Period	$0.10(0.11)$
Signal	$5.25^{***}(1.20)$
Constant	$-13.29^{***}(3.04)$
	$^{*}\ p < 0.10,^{**}\ p < 0.05,^{***}\ p < 0.01$
	Random-effects logistic regression

Table 7: *Effect of Information on Equilibrium Selection*

Appendix B: Instructions

Instructions (PI's Copy)

Comments and explanations of actions have been included in italics.

Part One

Thank you for participating in this experiment on economic decision making. Please pay attention to this instruction and also the accompanying slides. If you follow these instructions carefully and make careful decisions you might earn a considerable amount of money which will be paid to you in cash and in private at the end of the experiment.

(show them wads of cash)

The experiment will consist of two parts and last about one and a half hours. The amount of money you make will depend on the decisions you and all other participants make during the experiment.

Your computer will assign you an ID number, and at the end of the session you will be given an envelope with that ID number on it containing your monetary earnings. The person handing you your envelope will not know how much money is in the envelope. Thus, absolute anonymity and privacy will be maintained.

Please remain silent during the experiment. If you have any questions, or need assistance of any kind, raise your hand; one of the experiment administrators will come to you and you may whisper your question to him. Please do not talk, laugh, or exclaim out loud. We expect and appreciate your adherence to these rules.

You will be making choices using the computer mouse and keyboard. You may reposition the mouse pad so it is comfortable for you. Do NOT click the mouse buttons until told to do so.

(Please look up at the first slide)

This experiment will consist of two Parts, in each Part there will be several Stages. Each stage will feature a decision problem, which you will face for several "rounds". At the beginning of each stage, instructions about that stage will be given verbally and also will be displayed on the screen in front of the room. A copy of the instructions for Stage One of Part One are already handed out to you, for each stage fresh instructions will be distributed.

Throughout the experiment, at the beginning of each round, you will be assigned one of the two roles: PRINCIPAL or AGENT. You will be assigned to a role randomly at the beginning of the experiment. After that, in each round, the roles will be switched, i.e. if you are a PRINCIPAL in round 1, you will be an AGENT in round 2 and so on. There will be an equal number of PRINCIPALS and AGENTS in each round. At the beginning of each round, each participant will be randomly and anonymously matched with another participant of the other role, thus a matched pair will stay matched for at most one round.

The AGENTS can be one of two types: GREEN or RED. The AGENT's type will be randomly assigned at the beginning of EVERY round.

AGENT's type will be GREEN or RED with equal probability in every round, i.e., with probability (1/2) it will be GREEN, with probability 1/2 it will be RED. The AGENT will be informed of his or her type at the beginning of each round, but the PRINCIPAL will not know the type of the AGENT he or she is matched to.

However, the PRINCIPAL will privately observe a signal about his/her matched AGENT'S type. This signal is randomly drawn by the COMPUTER; AGENTS have no control over it, and will not be able to observe it.

(Next slide shows the signals distribution.)

The signal can be LIME or PINK. On average, for 1 out of 2 GREEN AGENTs, a LIME signal is observed, and for 2 out of 3 RED AGENTS a PINK signal is observed.

For example, if there are 24 participants in a session, in each round 12 of them are assigned as PRINCIPALS and the other 12 as AGENTS. Out of the 12 AGENTS in each round, on average 1/2 (or 6) of them will be GREEN and 6 will be RED. Out of the 6 GREEN agents, on average a LIME signal will be sent to the PRINCIPAL for 3 AGENTs,

	GREEN	RED	
LIME	3	2	5
PINK	3	4	7
	6	6	12

If Signal=LIME, Prob(AGENT is GREEN)= 3/5
=60%
If Signal=PINK, Prob(AGENT is RED)=4/7
=57.1%

Figure 2: Signal Structure

and a PINK signal will be sent for the other 3 of the 6 GREEN AGENTs. Look now at the RED column: out of the 6 RED agents, on average a LIME signal is sent for 2 of the 6, and a PINK signal is sent for the other 4 RED AGENTs.

So, in any round, if you are a PRINCIPAL and observe a LIME signal, it means that your matched AGENT is GREEN with probability 3/(3+2)=3/5, or 60%. If you are a PRINCIPAL and observe a PINK signal, it means that your matched AGENT is RED with probability 4/(4+3)=4/7 or 57.1%. This matching and signaling structure will be followed throughout the experiment.

(please look up at the next slide)

In each round, depending on the decisions you and the participant matched to you make, you will earn some payoff points.

(next slide discusses how your cash rewards from Part One will be calculated.)

The computer will calculate the sum of payoff points you earned from all the rounds in Part One. Also, in each round, given the role and type assigned to you in that round, there is a maximum number of payoff points that you can earn. The computer will keep track of these maximum payoff points for each participant. The sum of your earned payoff points relative to the sum of maximum payoff points you could earn will determine your cash rewards for Part One as follows.

At the end of the experimental session, for each participant the computer will draw a random integer between 0 and the maximum number of points the participant can get in Part One, given the assigned roles and types in each round. If your earned payoff points total is greater than that random integer, you will win a prize of $15, otherwise you will

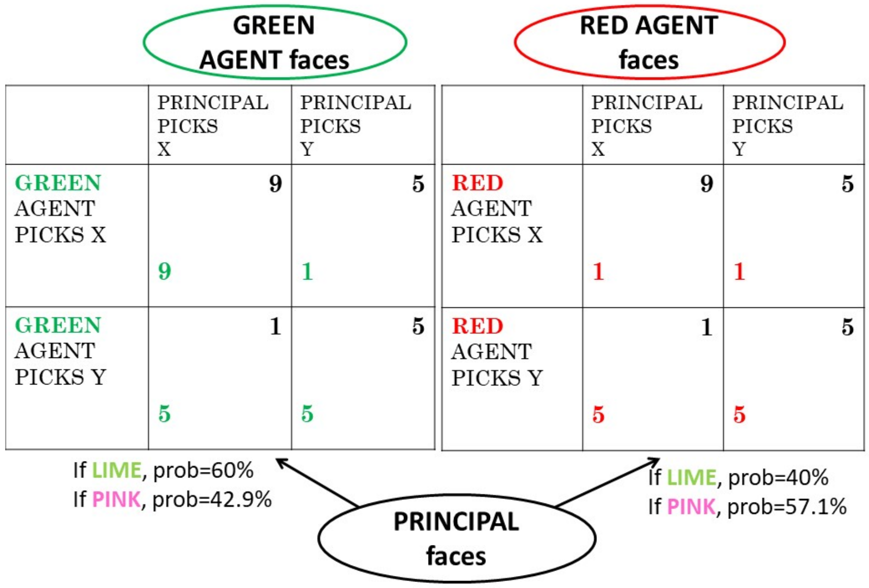

Figure 3: Task 2

receive $2 from Part One. A similar lottery will be conducted for Part Two, to be discussed later.

(Please look up at the next slide)

Stage One

In Part One of this experiment, there will be two Tasks or decision problems. To gain experience, we will first start with a decision task which we will call Task 2.

In each round, the PRINCIPAL and the AGENT of a matched pair will make a choice in the following scenario. There are two possible choices: X and Y. You will not know your matched participant's choice until after you make your own choice, and the participant matched to you will not know your choice until after he or she has made it. In other words, you both make your decisions simultaneously without knowing the choice that the other person is making.

(next slide shows the payoff table)

The payoff consequences depend on the choice the PRINCIPAL and the AGENT make, and the AGENT's type.

You must choose either "X" or "Y" by clicking on your choice displayed above in the game table. The left table is for GREEN agents, so if a GREEN AGENT chooses "X" and the matched PRINCIPAL chooses "X" *(point with laser)*, each receives 9 payoff points, as indicated in the upper left cell. In each cell the lower left corner entry (which is colored according to the AGENT's type) is the payoff for the AGENT and the upper-right corner black entry is for the PRINCIPAL. If a GREEN AGENT chooses "X" and the matched

PRINCIPAL chooses "Y," the AGENT receives 1 points and the PRINCIPAL receives 5 points (upper right-hand cell). If the GREEN AGENT chooses "Y" and the PRINCIPAL chooses "X", the AGENT receives 5 points and the PRINCIPAL receives 1 points (lower left-hand cell). If the GREEN AGENT and the PRINCIPAL both choose "Y", each receives 5 points (lower right-hand cell). Similarly, if the AGENT is RED, the AGENT's and the matched PRINCIPAL's payoff consequences are given by table on the right. For example, if a RED AGENT chooses "X" and the matched PRINCIPAL chooses "X", the AGENT receives 1 points and PRINCIPAL receives 9 points.

However, remember that a PRINCIPAL does not know the matched AGENT's type before making a choice. (point with laser) The PRINCIPAL will only receive a LIME or a PINK signal.

A PRINCIPAL who receives a LIME signal, knows only that with 60% (3/5) probability the AGENT is GREEN and the relevant payoff table is the one on the LEFT, and with 40% (2/5) probability the AGENT is RED and the relevant payoffs is the one on the RIGHT.

A PRINCIPAL who receives a PINK signal knows only that the AGENT is RED with 57.1% (4/7) probability and the relevant payoff table is the one on the RIGHT, and with 42.9% (3/7) probability, the AGENT is GREEN and the relevant payoff table is the one on the LEFT.

After all the participants have entered a valid choice, the AGENT's type and the choices made by you and the participant you were matched with for this round will be displayed on your monitor along with the resulting payoff points you earned in this round.

Before we begin, we will have a short quiz. Please turn to the next page and answer the short questions. We will discuss the answers in five minutes.

(quiz.

while they do quiz, the screen with payoff tables displayed.

change slide after quiz.)

Anyone needs more time to finish the quiz?

Okay, now we will discuss the answers to the Quiz. *(please look up at the next slide)*

Answer to Quiz:

1. You are assigned as a GREEN type AGENT in a particular round and randomly and anonymously matched with a PRINCIPAL. If you choose X and the PRINCIPAL chooses Y, what will be your payoff in this round?

Ans: 1.

(change slide)

Since you are assigned as a GREEN AGENT, the payoff table on the left is relevant to you. If you pick X, the green shaded cells give the possible payoffs. The PRINCIPAL chooses Y, which gives the grey shaded cells. The resulting payoffs are displayed in the dark shaded cell and YOUR payoffs are on the left corner.

(change slide)

2. You are assigned as a PRINCIPAL in a particular round and randomly and anonymously matched with an AGENT. You observe a LIME signal in this round. If you choose X, what are the possible payoffs you can get?

Ans: 9 or 1.

If the matched AGENT is GREEN and picks X, you get 9. If the matched AGENT is RED and picks X, you get 9. If the matched AGENT picks Y, you get 1 irrespective of which Type the AGENT is.

(slide change)

In the table, since the PRINCIPAL chooses X, the blue shaded cells give possible payoffs, but the PRINCIPAL does not know which table is relevant. Since he has received LIME signal, AGENT is GREEN and the left table is relevant with 60% probability. So all four payoffs that are possible are: 9, 1, 9 and 1.

(change slide)

3. In Task 2, what is the maximum payoff you can expect to earn if you are assigned as:

a. GREEN AGENT: Ans: 9 (if you and the matched PRINCIPAL both choose X)

b. PRINCIPAL matched to a GREEN AGENT: Ans: 9 (both PRINCIPAL and AGENT choose X)

c. RED AGENT: Ans: 5 (if you choose Y, no matter what the PRINCIPAL chooses)

d. PRINCIPAL matched to a RED AGENT: Ans: 9 (you and RED AGENT choose X)

(change slide and keep it at T2 table)

We will now begin interaction with the computers. If you have any questions before we begin the experiment, please RAISE YOUR HAND and a moderator will be with you shortly.

We will now begin the experiment. Please pay attention to your monitor and click the mouse when prompted to do so. Please click on the Continue button on each screen after you have read the information and/or made the choice. There are four rounds in this stage, once we have finished all the rounds, we will direct your attention to the screen in the front of the room again for the instructions for Stage Two.

Stage Two

Before starting Stage Two, we will discuss Task 1. Task 1 involves one of each matched pair (either the PRINCIPAL or the AGENT) choosing LEFT or RIGHT, where the payoff points each participant gets are given by this table:

Please look at your computer screen and take the quiz on this task.

(quiz on personal computer screen)

Choice	LEFT	RIGHT
PRINCIPAL gets	1	2
GREEN AGENT gets	1	2
RED AGENT gets	1	0

Figure 4: Task 1

(slide change after done with quiz)

We will now begin Stage Two of Part One, which contains six rounds. In this stage, you will do Task 1 and Task 2 sequentially. The sequence of actions is as follows:

- You will be assigned as PRINCIPAL or AGENT, with roles switching in every round as before. The AGENTs will receive their types (GREEN or RED) and the PRINCIPALs will not know the types but observe PINK or LIME signals. The matching and signaling will be exactly same as before.
- First, each matched pair will do Task 1. In this stage, the PRINCIPALs will be choosing LEFT or RIGHT and the AGENTs will have to wait for the PRINCIPAL to make the decision. The payoff points are as before. AGENTs will observe the PRINCIPAL's choice only after the entire round is completed.
- After completing Task 1, you will do Task 2 with the participant you are matched with. Task 2 is identical to what you did in Stage One. In each pair, both of you will simultaneously choose X or Y, as in Stage One. The instructions for AGENTs and PRINCIPALs will be displayed on your monitor.

Please turn to your monitors now.

(blank displayed while they play.)

Part Two

We are about to begin Part Two of the experiment. This part will consist of only one stage, which will contain ten rounds.

In each round, depending on the decisions you and the participant matched to you make, you will earn some payoff points. The computer will calculate the sum of payoff points you earned from all the rounds in Part Two. Also, in each round, given the role and type assigned to you in that round, there is a maximum number of payoff points that you can earn. The computer will keep track of these maximum payoff points as well. The sum of your earned payoff points relative to the sum of maximum payoff points you could earn in Part Two will determine your cash rewards for Part Two as follows.

At the end of the experimental session, for each participant the computer will draw a random integer between 0 and the maximum number of points the participant can get in Part Two, given the assigned roles and types in each round. If your earned total payoff points is greater than that random integer, you will win a prize of \$15, otherwise you will receive \$4 from Part Two.

((please look up at the next slide)

Stage One

In Stage One of Part Two, you will do Task 1 and Task 2 sequentially. The sequence of actions is as follows:

You will be assigned as PRINCIPAL or AGENT, with roles switching in every round as before. The AGENTs will receive their Types (GREEN or RED) and the PRINCIPALs will not know the Types but observe PINK or LIME signals. The matching and signaling will be exactly same as before.

(please look up to the next slide)

First you will do Task 1 with the participant you are matched with in this round. In this task, as before, the possible choices are LEFT or RIGHT, but there is one important difference.

If you are a PRINCIPAL in a round, you can choose whether to delegate the task to your matched AGENT, i.e. let him/her choose between LEFT or RIGHT. If you are an AGENT, you will observe if your matched PRINCIPAL has chosen to delegate the task to you. If the PRINCIPAL does NOT delegate, he/she will be making the choice on his/her own. If the PRINCIPAL DELEGATES the task, the matched AGENT will be choosing. The payoff consequences are given as before.

(slide change)

If the PRINCIPAL delegates Task 1, AGENT's choices will not be visible to the PRINCIPAL right after Task 1, but only after the completion of Task 2. After the entire round is completed, the choice made in the tasks, consequent payoffs and AGENT's type will be revealed.

(please look up to the next slide)

After completing Task 1, each matched pair will do Task 2 as before. Both of you will simultaneously choose X or Y.

(slide change and keep it blank)

Now, please turn to your computer to make choices in this Part. The instructions for AGENTs and PRINCIPALs and the payoffs will be displayed on your monitors.

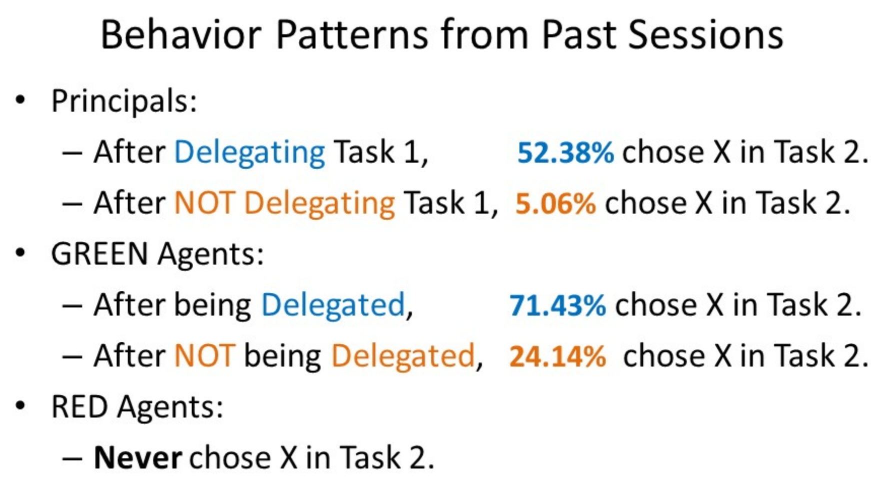

Figure 5: Information Screen

After the ten rounds of this stage, the COMPUTER will conduct the lotteries for the two Parts to determine your cash rewards.

Please turn to your monitors now.

(later)

Please complete the questionnaire displayed on your screen. To preserve your privacy, type xxx when asked for name; do not write your own name. While you give us your valuable feedback, we will be putting your winning amounts in the respective envelopes. Please fill out the receipt with your winning amount as well. Thanks for participating in this experiment!