# Direct Response and the Strategy Method in an Experimental Cheap Talk Game*

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September 14, 2018

**Abstract**

Equilibrium analysis of cheap talk models predicts extreme limits on the amount of information that can be transmitted when experts and decisionmakers have different goals. However, experimental analysis finds that senders overcommunicate. We propose that overcommunication may be due to incomplete counterfactual cognition, in which players fail to think through the potential consequences of their decisions and is related to level-$k$ thinking. Psychological research on counterfactual thinking suggests that different levels of engagement and control encourage different levels of counterfactual cognition. To test this mechanism, we compare two elicitation methods, direct response and the strategy method, holding fixed the incentives of a game while encouraging varying level of engagement and counterfactual thought. We expect that informed senders will transmit less information when they explicitly formulate strategies (strategy method) than when they only choose actions on the path of play (direct response). In contrast, we find the reverse: the strategy method reduced equilibrium play. Further examination suggests that this occurred because senders played more naïvely with the strategy method than with direct response.

**Keywords:** Strategic information transmission; Sender-receiver games; Strategy method; Laboratory experiment

**JEL Classifications:** C72, C92, D82, D83

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*Previous versions of this paper were presented at the Stanford Graduate School of Business and the 2018 Annual Meeting of the American Political Science Association. We thank Keith Schnakenberg for helpful comments and suggestions.

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# 1 Introduction

There is a sharp disconnect between equilibrium predictions for cheap talk games and the actual behavior of subjects recruited to play incentivized experimental models of these games. For example, Crawford and Sobel (1982) famously show that all equilibria of sender-receiver games have a partition structure, in which senders transmit garbled information about the hidden state information. Even the most informative equilibria break the state space into regions, with senders conveying to receivers only which of those includes the state. Yet such partition equilibria are conspicuously absent from the experimental evidence. While there is clear evidence for comparative static predictions (i.e., as preferences diverge, informativeness decreases; see e.g., Dickhaut, McCabe and Mukherji 1995), observed behavior is strikingly different from partition strategies. Instead, empirical observation reveals overcommunication and naïve exaggeration, with senders revealing more information than predicted in equilibrium (Blume et al. 2001, Cai and Wang 2006, Minozzi and Woon 2016, Wang, Spezio and Camerer 2010).[1]

We conjecture that subjects overcommunicate because they do not think carefully about what other players will do in response. Specifically, we explore whether *incomplete counterfactual thinking* leads subjects to engage in naïve exaggeration.[2] This argument draws from work both in psychology as well as experimental economics. In psychology, there is a broad area of research on counterfactual thinking (Byrne 2016), the conscious experience of imagining alternative scenarios for past and future events. Such imagining is a plausible mechanism for level-$k$ thinking (see, e.g., Camerer, Ho and Chong 2004), the behavioral game theory framework that models subjects as playing as if responding to an opponent who has engaged in $k$ levels of best response dynamics.

A key finding from psychological research on counterfactual thinking is that people are more

[1] For a comprehensive review, see Blume, Lai and Lim (2017).

[2] Exaggeration is naïve insofar as it does not conform to Nash equilibrium prescriptions for behavior. However, such exaggeration is consistent with best response dynamics when starting from truthful messages and credulous actions (Crawford 1998). If senders believe receivers will implement their messages exactly and their preferences are based on loss functions from linearly translated (i.e., shifted) ideal points, the best response is to exaggerate by the amount of the shift. And if receivers knew that senders exaggerated by some amount, they would simply subtract the same amount. In response, senders would exaggerate more, receivers would deduct more, and if the message space is bounded, eventually all messages would hit a boundary. The result would be babbling equilibrium. Hence, such exaggeration is ultimately naïve.

likely to imagine alternatives to events that seem to be under their control than those that do not (Girotto, Legrenzi and Rizzo 1991). Thus, providing people with more choices may deepen their propensity to think in counterfactual terms. Indeed, in discussing the strategy method used to study bargaining, Roth (1995; p. 323) argues that "having to submit entire strategies forces subjects to think about each information set in a different way than if they could primarily concentrate on those information sets that arise in the course of the game." Ironically, the explicit purpose of game theory is to help analysts reason carefully about counterfactual choices because doing so can be very difficult. Empirically observed behavior may sometimes suffers from the same deficiencies, and thus may diverge from game theoretic predictions.

We conduct an experiment to explore whether subjects can be induced to think more about counterfactual play via the *strategy method* than they do in a baseline *direct response* elicitation. Using direct response, subjects play sequentially, just as they would in the encounters from which the game was originally abstracted. Thus, each subject only makes one decision at information sets along the path of play. In contrast, the strategy method requires subjects to specify a complete plan of action that determines their response for every possible information set. The equilibrium predictions in both games are identical, but the presentation and elicitation of choices differs.[3]

Surprisingly, we find that the strategy method backfired: behavior was more informative, and thus further from equilibrium play, with the strategy method than with direct response. Further examination suggests that senders were more likely to use naïve communication strategies when playing with the strategy method. Consequently, receivers earned increased payments in the latter. These results run counter to both the incomplete counterfactual thinking conjecture and, more indirectly, the level-$k$ thinking framework. The results are more consistent with an alternative account, in which subjects rely on heuristics rather than conceptualizing counterfactuals.

[3] For a review of strategy method versus direct response, see Brandts and Charness (2011). We can also think of our design as comparing behavior across equivalent representations of the game in its extensive form (direct response) versus its normal form (strategy method). Several previous experiments explicitly compare the normal and extensive form, finding differences between representations despite strategic invariance (Cooper, Van Huyck et al. 2003, McCabe, Smith and LePore 2000, Rapoport 1997, Schotter, Weigelt and Wilson 1994). Such findings suggest that the way people think about and understand games indeed depends on how they are presented (see also Cason and Plott 2014, Chou et al. 2009).

## 2 Experimental Game and Design

We implement a version of the experimental cheap talk setup used by Minozzi and Woon (2013; 2016; 2018), which features large state and action spaces. We tailored this environment to compare direct-response elicitation to the strategy method. As in a standard two-player signaling game, there is an unobserved state of the world, the first player $S$ (Sender) observes the state and sends a message, the second player $R$ (Receiver) does not know the state but observes the message and then chooses an action. In our experiment, we refer to the state as the *Target*, $t$, an integer randomly selected from $-100$ to $100$. Similarly, the *Action*, $a$, is an integer from $-100$ to $100$.

To facilitate comparison of direct-response and the strategy method, our design has a limited message space. Most sender-receiver experiments specify a set of possible messages that corresponds exactly to the sets of targets and actions. Here, in contrast, $S$ chooses a *Message*, $m$, from only two values: "High" or "Low." This restriction simplifies the specification of complete strategies for both players, imposing a partition structure on $S$'s strategy while reducing the number of information sets for $R$ to two. Without this restriction, each player's strategy would be a mapping from a large set of targets to a large set of actions.

Following Crawford and Sobel (1982), $S$ and $R$ have overlapping but differentiated incentives. Payoffs are denominated in points, calculated as $320-|t-a|$ for $R$ and $320-|t+s-a|$ for $S$, where $s$ denotes a *Shift* that parameterizes the preference divergence (i.e., bias) between $S$ and $R$. In our experiment, $s$ is either $30$ (the *Low Shift*) or $60$ (the *High Shift*). Uninformative babbling equilibria exist for both *Shift* values. For *Low Shift*, there is also a partition equilibrium. In this equilibrium, $S$ uses the cutpoint $-60$ (sending "Low" for $t < -60$ and "High" for $t \geq -60$), in which case the best response for $R$ would be $a = -80$ given $m$ is "Low," and $a = 20$ given $m$ is "High." $S$'s message strategy is a best response to these actions, satisfying equilibrium requirements.

Each experimental session was assigned to either *Direct Response* or *Strategy Method*, and each subject participated in one session. At the beginning of a session, subjects were randomly assigned to roles, half to $S$ and half to $R$. They played $60$ rounds of the game, with the *Low Shift* parameter in the first $30$ rounds and the *High Shift* in the second $30$ rounds. Roles were fixed throughout the session, but subjects were randomly re-matched into pairs for each round.

In *Direct Response*, a round begins when $S$ sees the randomly drawn value of $t$ and selects $m$. Then $R$ observes $m$ and chooses $a$. At the end of each round, players see the results for their pair including the true value of $t$ and both payoffs. In *Strategy Method*, players make decisions simultaneously. $S$ specifies a strategy in terms of a *cutpoint*, $c$, an integer from $-100$ to $100$. Simultaneously, $R$ chooses two actions: $a_L$ for when the message is "Low" and $a_H$ for when the message is "High." After $S$ and $R$ have both entered their decisions, the realized value of $t$ is revealed, which then determines the message based on the sender's cutpoint $c$:

$$m(t) = \begin{cases} \text{“Low”} & \text{if } t < c \\ \text{“High”} & \text{if } t \geq c \end{cases}. \tag{1}$$

A value of $c$ characterizes a complete strategy for $S$ because it specifies a message for each information set (realized value of $t$). The value of $m$ then determines $R$'s action $a$:

$$a(m) = \begin{cases} a_L & \text{if } m = \text{“Low”} \\ a_H & \text{if } m = \text{“High”} \end{cases}. \tag{2}$$

To convey that the game is sequential—even though strategies are elicited simultaneously—we provide feedback similarly to *Direct Response*. First, we show $S$ (but not $R$) the value of $t$ and then the realized message $m$. Next, we show $m$ to $R$ (but not $S$) and then the realized action $a$. Finally, subjects view a feedback screen identical to that from *Direct Response*. Subjects never observe other players' strategies, only realized messages and actions.

In April 2018, we conducted $3$ sessions per treatment at the Pittsburgh Experimental Economics Laboratory, recruiting subjects through the lab's database ($48$ subjects in *Direct Response*, $44$ in *Strategy Method*). Most subjects were undergraduates at the University of Pittsburgh. Our experiment was conducted using $z$-Tree (Fischbacher 2007). Each session lasted under 2 hours. At the end of a session, one round was randomly selected to calculate payoffs. Points were converted to cash at the rate of $\$1$ per $20$ points. The average payoff was \$20.78, including a \$7 show-up fee.

# 3 Hypotheses

We predicted that subjects will play closer to equilibrium with the *Strategy Method* (SM) than with *Direct Response* (DR). Since the behavioral regularity in similar games is for senders to over-communicate (Blume et al. 2001, Cai and Wang 2006) and naïvely exaggerate (Minozzi and Woon 2016), play that is closer to equilibrium includes less information transmission. Thus, we test two main hypotheses.

**H1** Message behavior will be more like equilibrium predictions in SM than DR.

**H2** Receiver actions will be better informed in DR than in SM.

Throughout, play conforming to equilibrium theory would imply the null hypothesis of no difference between treatments.

# 4 Results

## 4.1 Equilibrium Messages

To test **H1** regarding equilibrium play, we analyze senders' messages separately for the *Low Shift* and *High Shift* regimes. For *Low Shift*, we focus on the most informative equilibrium. Regardless of elicitation method, the equilibrium message in this case is given in (1) with the cutpoint $c = -60$. Figure 1 shows the overall proportion of equilibrium messages in each treatment: from 77% in DR and 72% in SM. Contrary to our hypothesis, senders' messages are less likely to conform to equilibrium in SM than in DR. Of course, neither figure is close to 100%; indeed, both are closer to 80%, which would be consistent with random message selection. More rigorous analysis is provided in Table 1, which presents logistic regression estimates, including random intercepts for session- and subject-levels to accommodate the panel structure of the data. Consistent with the raw data, the coefficient is negative, albeit not statistically significant.

For the *High Shift* regime, the only equilibrium is babbling. In DR, there are several strategies consistent with uninformative babbling behavior. Subjects could choose only the low message,

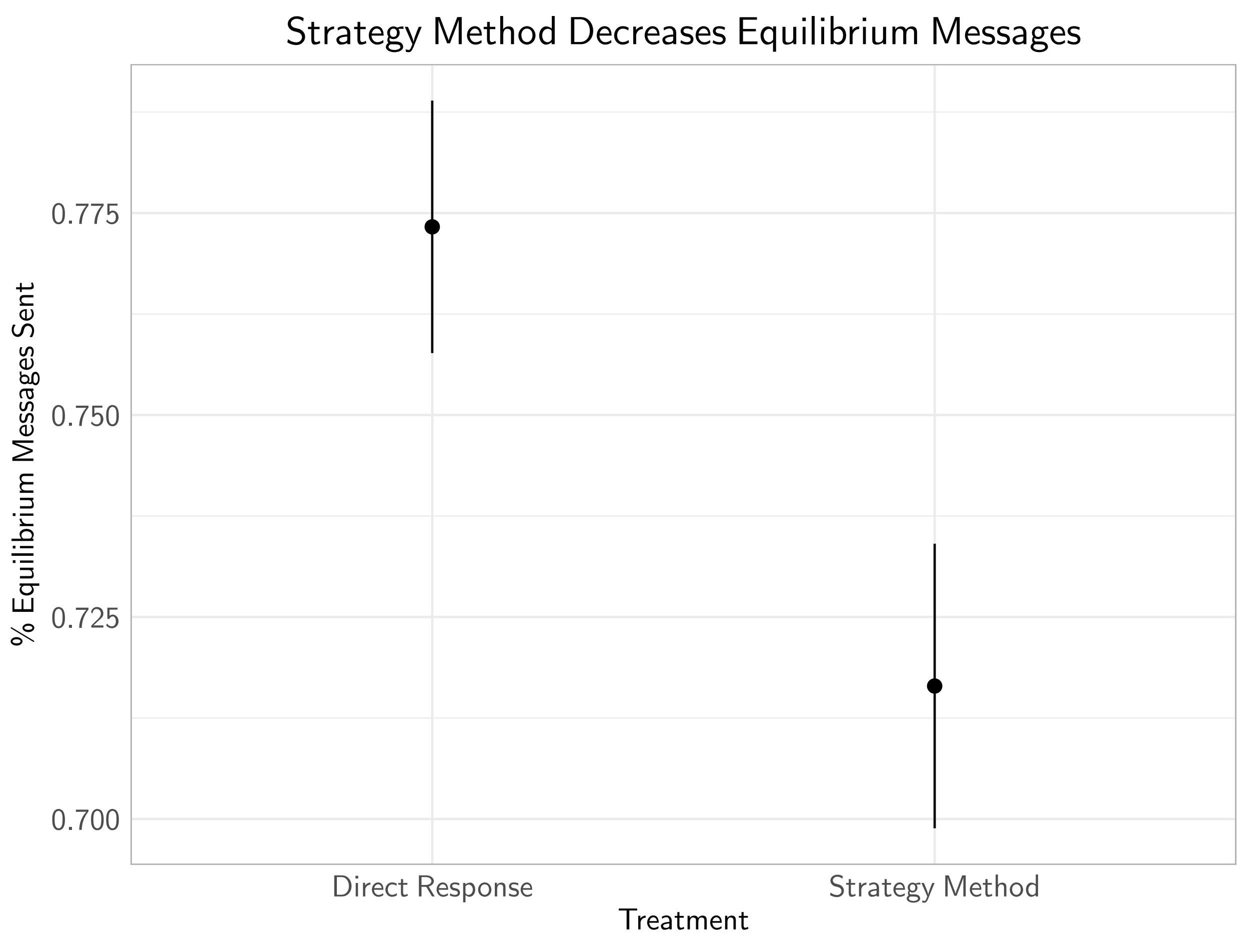


Figure 1: Counter to expectations, the Strategy Method caused a decline in the percentage of equilibrium messages sent. Equilibrium messages are defined as those from the most informative partition, which has a cutpoint at $c = -60$.

Table 1: Model of Equilibrium Messages in *Low Shift* Condition

| | Message = Eq$^{\text{m}}$ Message |
|---|---|
| | Shift = 30 |
| Strategy Method | $-0.35$ |
| | (0.20) |
| Constant | $1.31^{*}$ |
| | (0.15) |
| $n$ Observations | 1375 |
| $n$ Subjects | 46 |
| *Error terms* | Group SD |
| Subject | 0.5 |
| Residual | 1.0 |

The table presents the mixed effects models of senders' messages with random intercepts for sessions and subjects. $^{*}p < 0.05$.

only the high message, or randomize between them. In SM, the only babbling equilibrium is to choose the cutpoint $c = -100$ and only send the high message. In both conditions, the key property of uninformativeness is that $m$ must be independent of $t$.[4] Testing **H1** for *High Shift* therefore requires a different model specification than the test for *Low Shift*. Thus, we estimate a logistic regression, with an indicator for the high message as the dependent variable, and the target $t$, an indicator for SM, and their interaction as the independent variables. If play conforms to equilibrium, the coefficient on $t$ should be 0. However, in keeping with the overcommunication phenomenon (Cai and Wang 2006), we anticipate a positive coefficient on $t$. Therefore, behavior closer to equilibrium implies that a negative coefficient on the interaction between $t$ and strategy method is consistent with **H1**.

The results in Table 2 are precisely the opposite of what we expect for the *High Shift* condition. While the coefficient for $t$ is indeed positive and statistically significant, consistent with overcommunication, the interaction coefficient is also positive and statistically significant. This result flatly contradicts **H1** in that messages are more, rather than less, informative in SM than they are in DR.

[4] Even though there are multiple babbling equilibria, this test is robust to subjects potentially mixing between many strategy profiles, because all must be uninformative.

Table 2: Model of High Messages in *High Shift* Condition

| | Message = High |
|---|---|
| | Shift = 60 |
| Strategy Method | $-1.10^{*}$ |
| | (0.51) |
| Target | $0.03^{*}$ |
| | $(< 0.01)$ |
| Strategy Method × Target | $0.03^{*}$ |
| | (0.01) |
| Constant | $2.16^{*}$ |
| | (0.35) |
| $n$ Observations | 1290 |
| $n$ Subjects | 46 |
| *Error terms* | Group SD |
| Subject | 1.5 |
| Residual | 1.0 |

The table presents the mixed effects models of senders' messages, separately by Shift, with random intercepts for subject. $^{*}p < 0.05$.

## 4.2 Informativeness

Turning to **H2**, regarding the degree of information transmission, we estimate the effect of the strategy method on informativeness, where informativeness is measured as the negative distance between the action and target, $-|a - t|$. Table 3 presents estimates of this effect, separately for each shift condition, from a model that also includes session- and subject-level random effects. Greater equilibrium play implies less informativeness, and so, for the results to be consistent with **H2**, the coefficient for SM should be negative for both shift regimes. But this is not what we find. In both the *High Shift* and *Low Shift* conditions, the strategy method has a positive and statistically significant effect on informativeness. Thus, contrary to expectations, more information is transmitted via SM than DR. Like H1, H2 is also refuted.

## 4.3 Theoretical and Empirical Best Responses

Why does the strategy method contribute to greater information transmission and, thus, more overcommunication than in direct response? To answer this question, we assess the degree to which senders' and receivers' choices are best responses to either equilibrium strategies or to

Table 3: Models of Informativeness

| | *Low Shift* | *High Shift* |
|---|---|---|
| Strategy Method | 6.30* | 12.02* |
| | (1.68) | (2.51) |
| Constant | −39.90* | −48.82* |
| | (1.16) | (1.67) |
| $n$ Observations | 1380 | 1290 |
| $n$ Subjects | 46 | 46 |
| *Error terms* | Group SD | |
| Subject | 2.5 | 5.9 |
| Residual | 27.9 | 32.4 |

The table presents the mixed effects models of the negative distance between Action and Target, separately by Shift, with random intercepts for subject. $^*p < 0.05$.

observed play of the game.

For Receivers, the best response is to match the action to the expected value of $t$ conditional on the message. In the *Low Shift* partition equilibrium, the cutpoint $c = -60$ would imply that $E[t|m =$ "Low"$] = -80$ and $E[t|m =$ "High"$] = 20$. The best responses would similarly be $a_L = -80$ and $a_H = 20$. The top panel of Figure 2 plots these equilibrium predictions for reference, with conditional average targets shown above and the receiver's responses shown below.

The middle panel presents observed behavior in DR. Here, the conditional averages (as determined by $S$'s behavior) of about $-47$ for the "Low" message and $31$ for the "High" message. Unsurprisingly, these conditional averages do not correspond to the equilibrium predictions. The vertical dotted lines show where the empirical best response should be. In DR, the average action after the "Low" message is about $-49$, surprisingly close to the empirical best response. However, the average action after the "High" message is $44$, which overshoots the best response.

As shown in the bottom panel, we see that the receivers' actions are spot-on empirical best responses in SM. Interestingly, this occurs despite the fact that the receivers' actions are nearly identical in DR and SM. Thus, receivers' actions appear to be empirical best responses in SM because senders' behavior is more naïve, as the conditional average targets are c loser to $-50$


Figure 2: Comparison of Receiver actions to best responses in *Low Shift*. In all panels, the circles indicate the conditional average target values associated with messages sent, and the triangles display the actions chosen given those messages. The top panel displays expectations under equilibrium play, in which circles and triangles must align. The other panels show play under the two empirical treatment conditions. Message strategies stray widely from equilibrium, but actions are surprisingly consistent with empirical best responses, moreso with the strategy method than direct response.

and $50$ (which would be the conditional averages if $S$ used the naïve cutpoint $c = 0$).

Figure 3 shows the predictions and observed averages for the *High Shift* case. Here, any equilibrium must involve babbling, so the conditional expected target must be the same as the unconditional expectation, $E[t] = 0$. The equilibrium best response is for the receiver to choose $a = 0$ regardless of the message. Because senders overcommunicate, this is not what we observe. As shown in the middle and lower panels, the conditional average targets are quite distinct and distant from the unconditional average. In the DR condition, receivers overestimated the target given the "High" message and underestimated the target given the "Low" message. Similar to the *Low Shift* condition, receivers' actions are closer to best responses in SM, though they also overshoot the target given the "High" message.

Turning next to senders, given the receiver's strategy of choosing the low action $a_L$ and high action $a_H$, we can characterize the best response in terms of the cutpoint $c$. The optimal cutpoint is chosen so that the sender is indifferent between the high and low actions,

$$c^* = \frac{a_L + a_H}{2} - s \ .$$

For reference, Figure 4 shows the equilibrium prediction for *Low Shift* in the top panel, where the red dots above indicate $a_L$ and $a_H$, the vertical dotted line indicates the best response, and the blue dot below indicates the predicted action. Although we do not observe cutpoints directly in DR (because subjects choose messages instead of cutpoints), we estimate a cutpoint for each subject based on their message choices in relation to the underlying targets.[5] Given that receivers' actions are close to the naïve choices ($a_L = -50$ and $a_H = 50$) in both DR and SM, the empirical best responses (vertical lines) are to the right of the equilibrium best response, and they are similar in both conditions. As shown in the middle panel, the average estimated cutpoint in DR is close to the empirical best response, with the confidence interval overlapping the best response. In contrast, the bottom panel shows that the average cutpoint is significantly higher than the

[5] Specifically, we attribute to each sender the cutpoint that maximizes the match rate between the hypothetical messages based on a proposed cutpoint (i.e., always play "High" for targets above the proposed cutpoint, and always play "Low" for targets below) and the actual messages the sender selected.

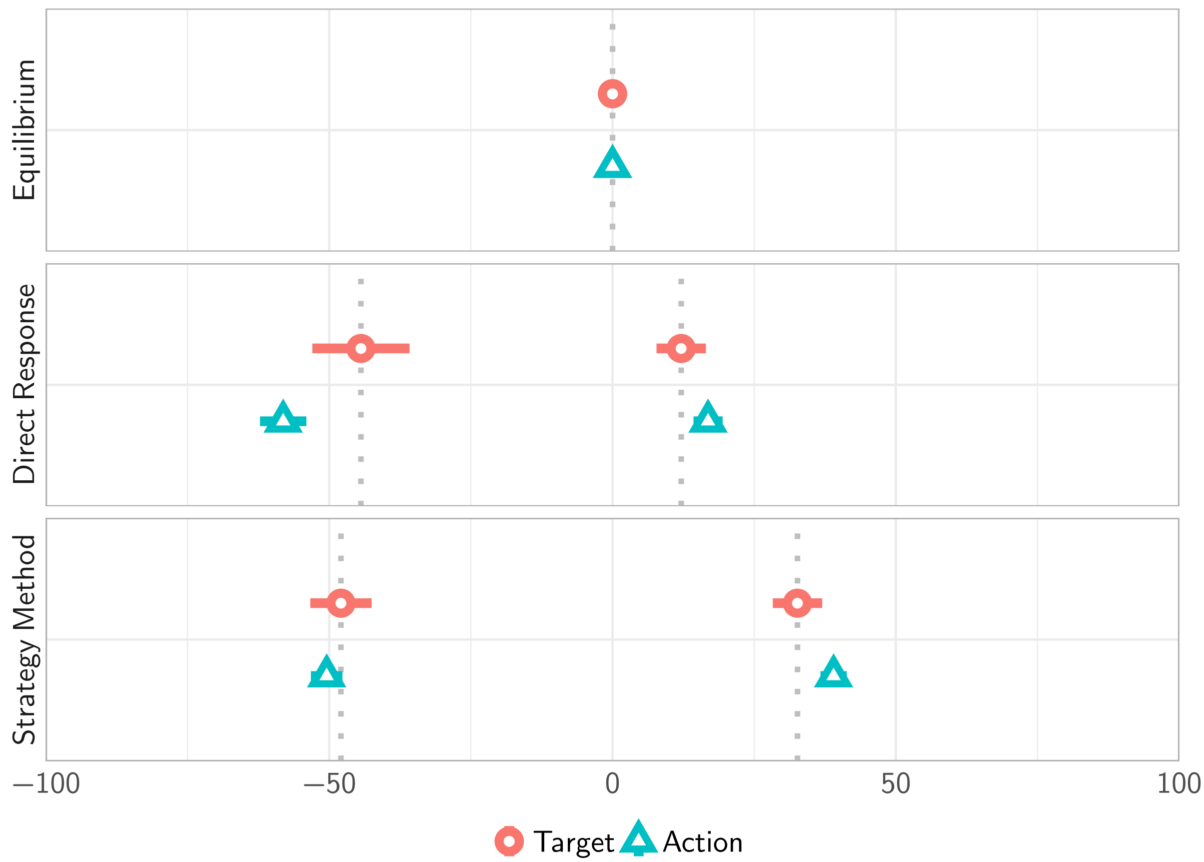


Figure 3: Comparison of Receiver actions to best responses in *High Shift*. See the note from Figure 2 for details.

empirical best response in SM. Furthermore, we can characterize sender behavior in SM as a naïve strategy, as the average the cutpoint is not far from 0 (i.e., sending "High" for positively-valued targets and "Low" for negative-valued targets).

Figure 5 shows the corresponding predictions, empirical best responses, and cutpoints for the *High Shift* condition. While the empirical best responses implied by the receivers' actions are to the right of the equilibrium prediction, in both DR and SM, the observed cutpoints are significantly to the right of even these empirical best responses, consistent with overcommunication. Moreover, although there is overcommunication in DR, the implied cutpoints are closer to the empirical best response than the naïve cutpoint at 0. In contrast, cutpoints in SM are closer to naïve behavior than the empirical best response.

To better understand how the strategy method increased overcommunication, we examined whether the behaviors of senders and receivers could be characterized as best responses. Receivers' actions were generally close to the conditional average targets and, surprisingly, they were closer in SM than in DR. In contrast, senders selected cutpoints that were distant from the empirical best responses (with the exception of *Low Shift* in DR) and closer to naïve behavior. We therefore attribute overcommunication to the increasingly naïve behavior of senders in the *Strategy Method*.[6] Receivers seem to do as well as they can given senders' behavior in this case.

## 4.4 Welfare

How does the increase in overcommunication induced by the strategy method affect payoffs? We suspected that because overcommunication is generally more truthful than equilibrium behavior, increased overcommunication would benefit receivers. However, because senders would do better if they overcommunicated less, they may fare more poorly in the strategy method.

To assess the welfare consequences of the strategy method, we examine treatment effects on

[6] The effect of the strategy method on senders is potentially confounded because our design does not cleanly distinguish between the effect of the strategy method on senders from the potential effect on the *interaction* between senders and receivers. A better design would hold constant the elicitation of receivers' actions (e.g., direct response) while varying the elicitation method only for senders. While it would be straightforward to run sessions with this additional treatment, the analysis of each type of player's best response in this section suggests that the strategy method primarily influences sender, rather than receiver, behavior.

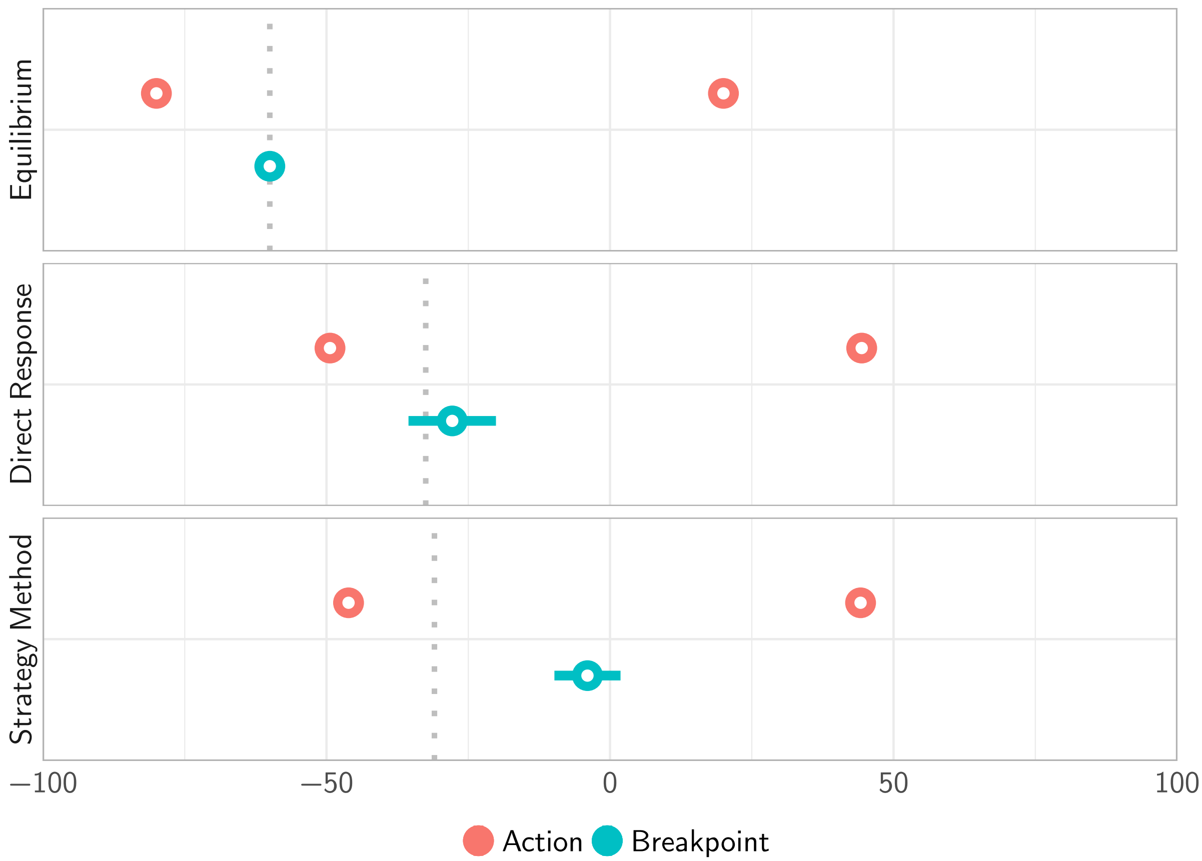


Figure 4: Comparison of Sender cutpoints to best responses in *Low Shift*. See the note from Figure 2 for interpretive details.

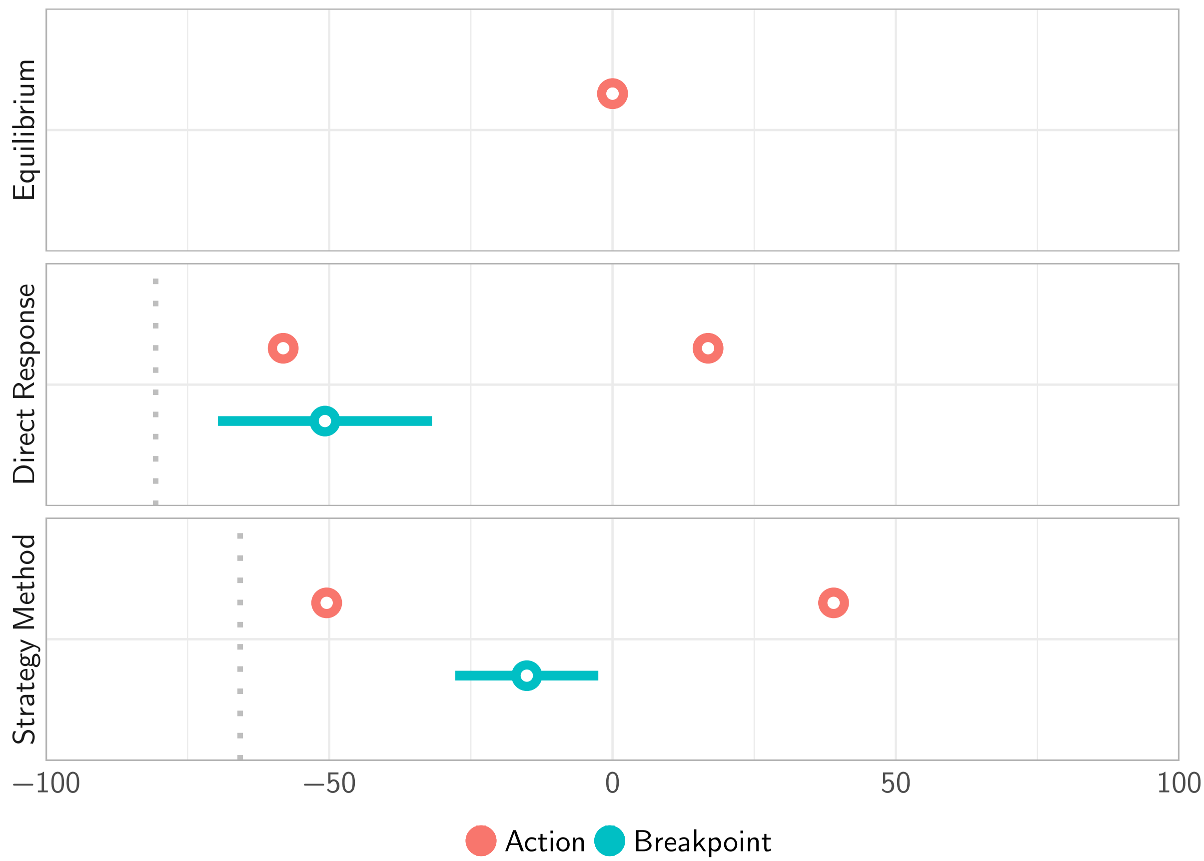


Figure 5: Comparison of Sender cutpoints to best responses in *High Shift*. See the note from Figure 2 for details.

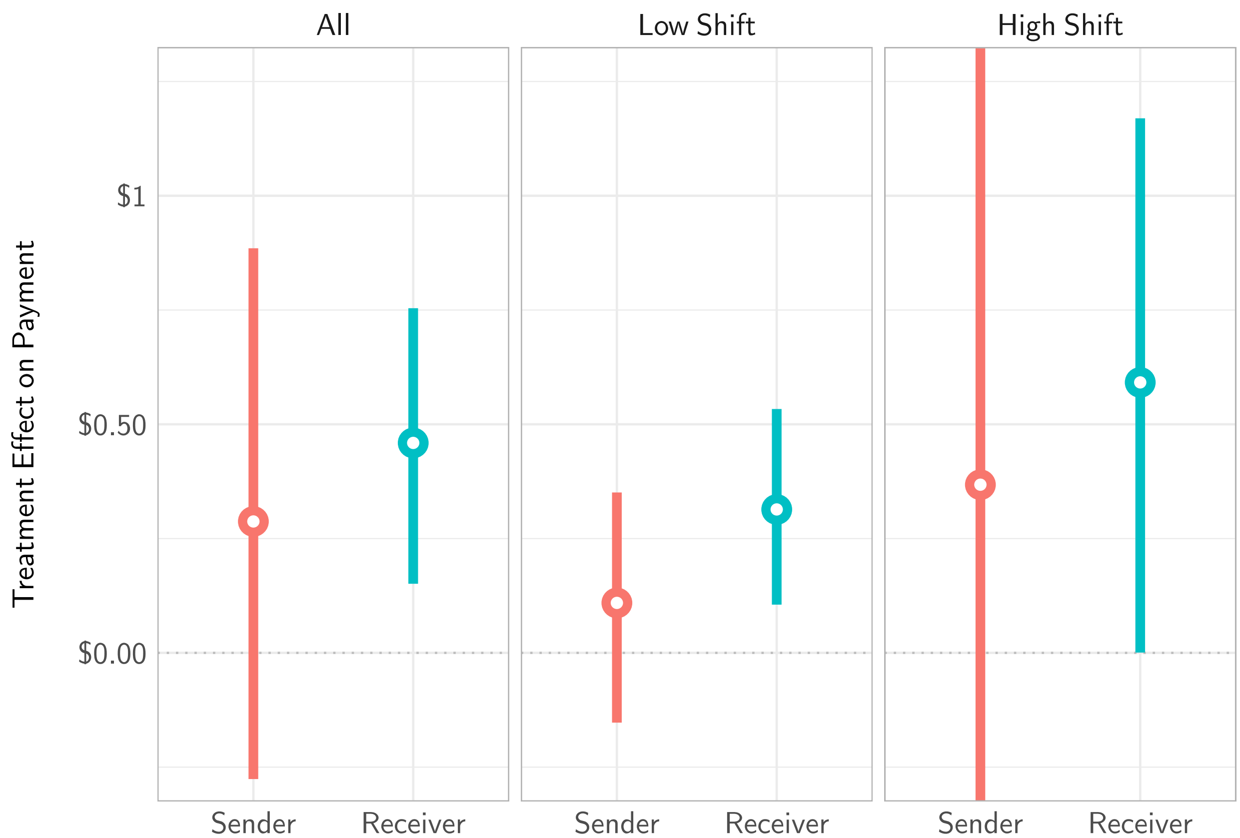


Figure 6: Strategy Method increased welfare. Estimates and confidence intervals are based on a linear regression model of hypothetical payoffs associated with all rounds of play, with random intercepts for sessions.

subjects' monetary payoffs. Here, we use data from all rounds, reporting on the hypothetical payoffs that would have occurred had any round been selected for actual payment. Figure 6 summarizes the results, pooling the *Low Shift* and *High Shift* rounds together shown on the left, from *Low Shift* alone in the middle, and *High Shift* alone on the right. Bars illustrate 95% confidence intervals from linear regressions with random intercepts for sessions. We find that *both* senders and receivers earn more in SM than in DR. Overcommunication clearly benefits receivers, who are able to better match their actions to the unobserved target. But it also benefits senders, as the effect is positive (although insignificant) in both the *High Shift* and *Low Shift* conditions. Taken together, these results show that increasing information transmission via the strategy method benefits receivers, and might even be potentially Pareto-improving.

# 5 Conclusion

Analytic game theory makes the unambiguous prediction that senders will refrain from revealing too much to receivers in cheap talk games. Yet despite the clear predictions of equilibrium theory, overcommunication is pervasive when people play such games in experimental settings. In this paper, we looked into one possible explanation: that overcommunication may be caused by incomplete counterfactual thinking, which would also serve as a plausible mechanism for level-$k$ models.

However, we found that eliciting complete strategies from subjects did not cause behavior to move toward the equilibrium predictions. Thus, our results do not support the incomplete counterfactual thinking explanation. To the extent that level-$k$ thinking might operate on the basis of such counterfactual thinking, this experiment also indirectly calls that framework into question. Regardless, we did find an unmistakable treatment effect, despite the strategic invariance of the direct response and strategy method modes of elicitation. Rather than decreasing overcommunication, the strategy method increased it.[7]

Moreover, we observed overcommunication in these sessions even though we simplified the game to encourage partition equilibria. The persistence of overcommunication may be explicated in terms of heuristic behavior in which subjects naïvely exaggerate without employing much cognitive effort. First, both treatment conditions used a highly restricted message space, constituting a major simplification over previous sender-receiver experiments. This modification of the game encouraged the use of partition strategies, yet still failed to yield such equilibria. The persistence of overcommunication suggests that subjects are using simple rules like naïve exaggeration regardless of the choice architecture, perhaps because of the difficulty of coordinating on a partition equilibrium or the complexity of the strategic situation itself. Second, the strategy method may have had an effect by making the game more cognitively taxing. By framing the problem in a way that encouraged subjects to think about different paths of play—that is, by encouraging counterfactual thinking—we also may have increased the cognitive complexity of the task, especially for

[7] While altruism could explain over-communication in general, it could not explain this treatment effect.

senders. It is far easier to select a message on one particular path of play than to think of which messages should be sent for any of multiple potential paths of play. This line of thought also suggests that overcommunication may result from people falling back on simple heuristics when faced with challenging problems. By increasing the cognitive difficulty of the sender's task, the strategy method may have increased the propensity to rely on such heuristics.

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# Instructions

## General Information

This is an experiment on the economics of communication. You will be paid in cash for your participation, and the exact amount you receive will be determined during the experiment and will depend on your decisions and the decisions of others. You will be paid your earnings privately so that no other participant will find out how much you earn. These earnings will be paid to you at the end of the experiment along with the $7 participation payment.

Each participant has a printed copy of these instructions, and you may refer to them at any time.

If you have any questions during the experiment, please raise your hand and wait for an experimenter to come to you. Please do not talk, exclaim, or try to communicate with other participants in any way except through the computer interface. Phones must be silenced and your personal belongings must be put away for the duration of the experiment.

## Parts and Rounds

This experiment consists of two parts, and we will explain the instructions for each part before beginning that part. Each part consists of 30 rounds, and each round is a separate decision task.

We will **randomly select one round to count** for payment from the entire session. Each round is equally likely to be selected. The points you receive from that round will be used to calculate your payment for the experiment, and points will be converted to cash at the rate of $1 for every 20 points. More specifically, we will take the total number of points you earned in the round that counts, divide by 20, and then round this amount to the nearest quarter. We will pay you this amount in addition to the $7 participation payment.

## Roles and Matching

Each participant will be assigned to one of two roles: S or R. Your role will be assigned before the first round and will remain fixed throughout the experiment; it will be the same in both parts.

Before every round, you will be randomly matched with one other participant. In every pair of participants there will be one player in each role (one S player and one R player).

Note that you will not know the identity of the other participant you are matched with in any round, and your earnings for each round depend only on your decision in that round and the decision of the participant you are matched with in that round.

# Part 1

## Targets

In every round there will be a set of targets:

**Player R's Target** will be a randomly selected number between -100 and 100. Each number is equally likely to be R's target. R's Target for one round does not affect the value that is randomly selected for any other round.

**Player S's Target** will always be 30 more than Player R's Target. For example, if R's Target is 50, then S's Target is 80; if R's Target is -50, then S's Target is -20, etc.

## Messages and Actions

The players' decisions in every round are as follows:

1. **Player S** first observes the set of targets and chooses a **Message**. There are two possible messages that S can send: High or Low.

2. **Player R** then observes the Message, but not the targets, and chooses an **Action**, which can also be any whole number from -100 to 100.

## Payoffs

In each round, each player's payoff depends on how close R's Action is to his or her own Target. Specifically, each player earns 320 points if R's Action equals his or her own Target and 1 point less for each unit of difference between R's Action and his or her Target. Mathematically, this is described by the following formula, where the straight lines indicate absolute value:

$$\text{Player's Payoff} = 320 - |\text{Player's Target} - \text{R's Action}|$$

Note that the Message is not part of the payoff formula. To illustrate, consider a few examples.

Example 1: R's Target is 50, so S's Target is 80. If R chooses the Action 50, R's payoff is 320 since the Action equals R's Target. The difference between R's Action and S's Target is 30, so S's payoff is 290. If R instead chooses the Action 0, then R's payoff would be 270 and S's payoff would be 240.

Example 2: R's Target is -60, so S's Target is -30. If R chooses the Action -90, then R's payoff is 290 and S's payoff is 260. If R instead chooses the Action 40, then R's payoff would be 220 and S's payoff would be 250.

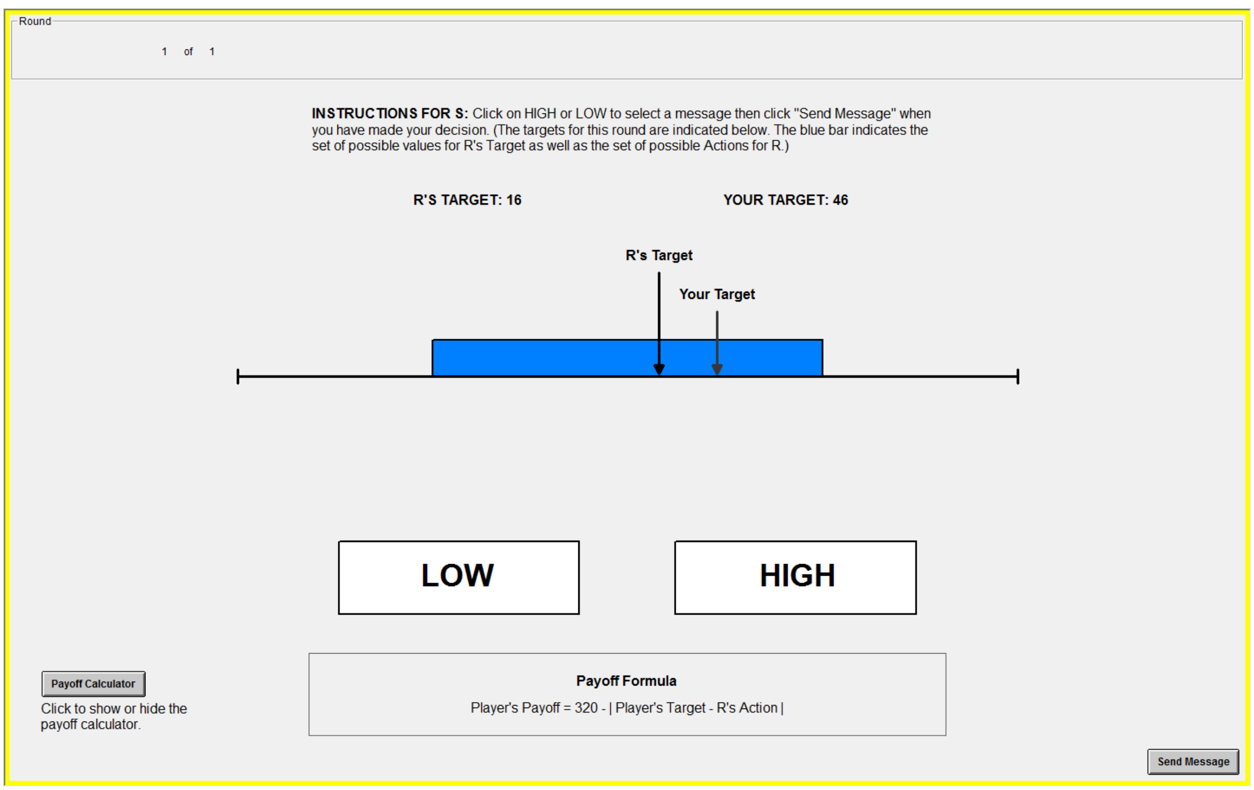
Of course these are only a few examples. During the experiment, the software will provide you with a "Payoff Calculator" that will compute each player's payoff for any combination of R's Target and Action.

## Sample Screens

Below is a screenshot of the interface for Player S. There is a brief set of instructions at the top, and below the instructions the set of targets are shown textually and graphically. To select a message, Player S clicks on the white box corresponding to the message they want to send. When a box is clicked, the selected message will be highlighted.

Note that there is a button in the lower left-hand corner of the screen marked "Payoff Calculator." You can click on this button to reveal two white tabs, and then you can use these tabs to calculate hypothetical payoffs for any possible values of R's Target and Action.

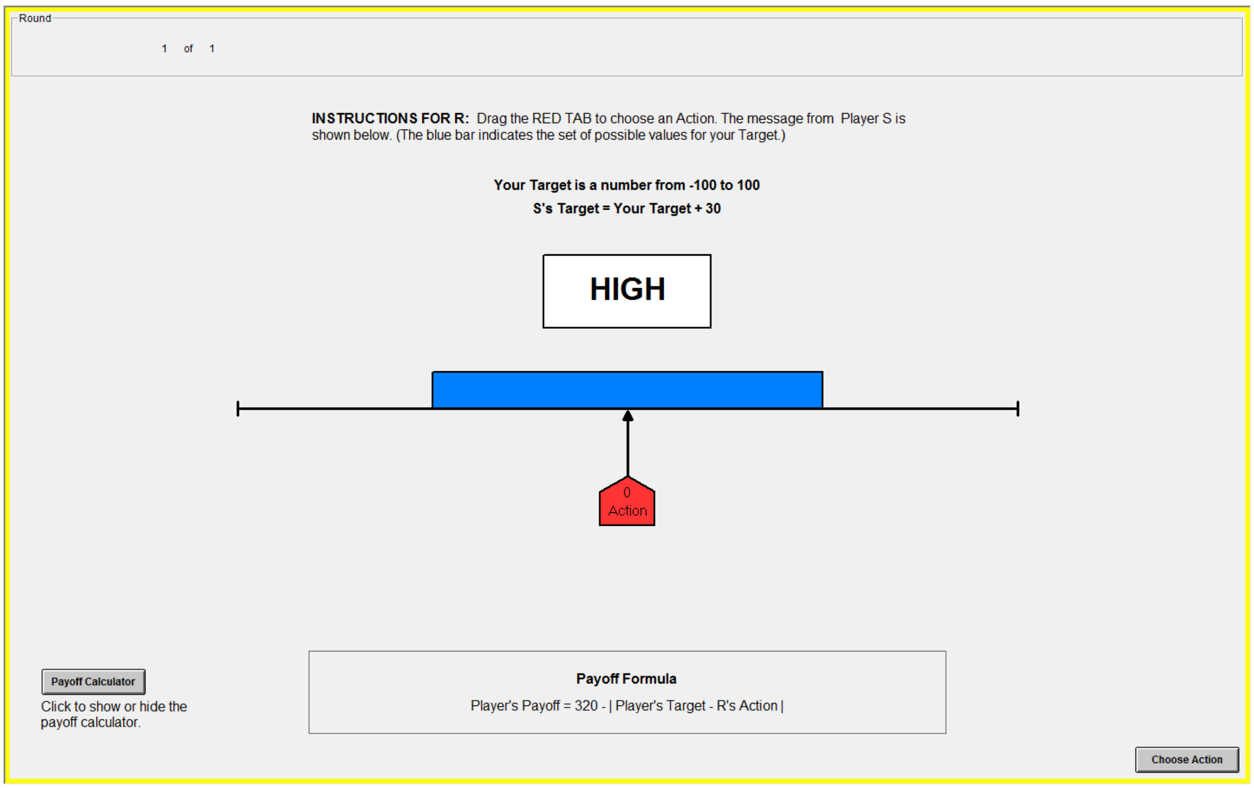
When Player S is finished making a decision, he or she will click on the "Send Message" button in the lower right-hand corner of the screen.



The next figure shows the interface that Player R will use. Below the instructions, Player R will see the message sent by Player S. Below this, there is a red tab that Player R uses to select an action by clicking and dragging the tab to the desired location.

Note that Player R also has a payoff calculator.

When Player R is finished making a decision, he or she will need to click on the “Choose Action” button in the lower-right hand part of the screen.



**SUMMARY**

**Targets**

R’s Target = Number between -100 and 100

S’s Target = R’s Target + 30

Note that it is possible for S’s Target to be outside the set of possible Actions.

**Sequence**

1. S sees both players’ targets, then chooses one of two Messages: High or Low
2. R sees only the Message and chooses an Action from -100 to 100

**Payoffs**

Player’s Payoff = 320 – |Player’s Target – R’s Action|

**Payment**

One round randomly selected for payment.

**INSTRUCTION QUIZ.** To check your understanding of the decision tasks, there will be a set of questions on your computer. When you are finished, the computer will check your answers and feedback will be shown on the screen. Note that your quiz answers do not affect your earnings, but you must attempt to answer all of the questions before the computer will check them. During the quiz, you are free to refer to your printed instructions.

Once everyone has completed the instruction quiz, we will begin the experiment. If you have any further questions at this time, please raise your hand and the experimenter will come to you.

1. Will you always be matched with same participant in every round? [Yes, No]

2. Player R's target can be any number from: [0 to 10, 0 to 100, -100 to 100, -150 to 150]

3. If Player R's target is 55, then what is **Player S's** target? [-55, 25, 85, 135]

4. If Player R's target is -40, then what is **Player S's** target? [-70, -10, 40, 60]

5. Suppose the Message is Low and Player R chooses the Action 30. If the Target turns out to be 20, how many points will **Player R** receive? [10, 20, 270, 310]

6. Suppose the Message is High and Player R chooses Action 80. If the Target turns out to be -60, how many points will **Player R** receive? [80, 140, 180, 260]

7. If Player S's Target is 70, Player R's Target is 40, and Player R chooses the Action 100, how many points will **Player S** receive? [50, 250, 290, 320]

8. If Player S's Target is -50, R's Target is -80, and Player R chooses the Action 0, how many points will **Player S** receive? [80, 240, 270, 320]

# Part 2

The game in Part 2 is almost exactly the same as in Part 1, except for one difference: In Part 2, Player S's Target will always be 60 more than Player R's Target. For example, if R's Target is -50, then S's Target is 10; if R's Target is 25, then S's Target is 85, etc.

## PART 2 SUMMARY

**Targets**

R's Target = Number between -100 and 100

**S's Target = R's Target + 60**

Note that it is possible for S's Target to be outside the set of possible Actions.

**Sequence**

1. S sees both targets, then chooses a Message: High, Low, or Blank
2. R sees only the Message and chooses an Action from -100 to 100

**Payoffs**

Player's Payoff = 320 – |Player's Target – R's Action|

Instructions: Strategy Method

# Instructions

## General Information

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## Roles and Matching

Each participant will be assigned to one of two roles: S or R. Your role will be assigned before the first round and will remain fixed throughout the experiment; it will be the same in both parts.

Before every round, you will be randomly matched with one other participant. In every pair of participants there will be one player in each role (one S player and one R player).

Note that you will not know the identity of the other participant you are matched with in any round, and your earnings for each round depend only on your decision in that round and the decision of the participant you are matched with in that round.

# Part 1

## Targets

In every round there will be a set of targets:

**<u>Player R's Target</u>** will be a randomly selected number between -100 and 100. Each number is equally likely to be R's target. R's Target for one round does not affect the value that is randomly selected for any other round.

**<u>Player S's Target</u>** will always be 30 more than Player R's Target. For example, if R's Target is 50, then S's Target is 80; if R's Target is -50, then S's Target is -20, etc.

## Messages and Actions

The players' decisions in every round are as follows:

1. **<u>Player S</u>** chooses which **<u>Message</u>** to send for every possible target that might be selected. There are two possible messages that S can send: High or Low. Player S will choose a number that divides the set of R's targets into a high range and a low range such that the High message is sent if R's target is in the high range and the Low message is sent if R's target is in the low range.

2. **<u>Player R</u>** does not observe the targets, but chooses an **<u>Action</u>** for each possible message that Player S can send. Each Action can be any whole number from -100 to 100. That is, Player R chooses which Action to take if Player S sends the High message and which Action to take if Player S sends the Low message.

Both players will make their decisions simultaneously. Once the players make their decisions, the computer will then randomly select R's target. This value of R's target will then determine which message Player S sends (depending on if R's target is in the high or low range), and then the message Player R receives determines Player R's action (depending on whether the message is High or Low).

## Payoffs

In each round, each player's payoff depends on how close R's Action is to his or her own Target. Specifically, each player earns 320 points if R's Action equals his or her own Target and 1 point less for each unit of difference between R's Action and his or her Target. Mathematically, this is described by the following formula, where the straight lines indicate absolute value:

$$\text{Player's Payoff} = 320 - |\text{Player's Target} - \text{R's Action}|$$

Note that the Message is not part of the payoff formula. To illustrate how the payoff formula works, consider a few examples.

Example 1: R's Target turns out to be 50, so S's Target is 80. If R chooses the Action 50, R's payoff is 320 since the Action equals R's Target. The difference between R's Action and S's Target is 30, so S's payoff is 290. If R instead chooses the Action 0, then R's payoff would be 270 and S's payoff would be 240.

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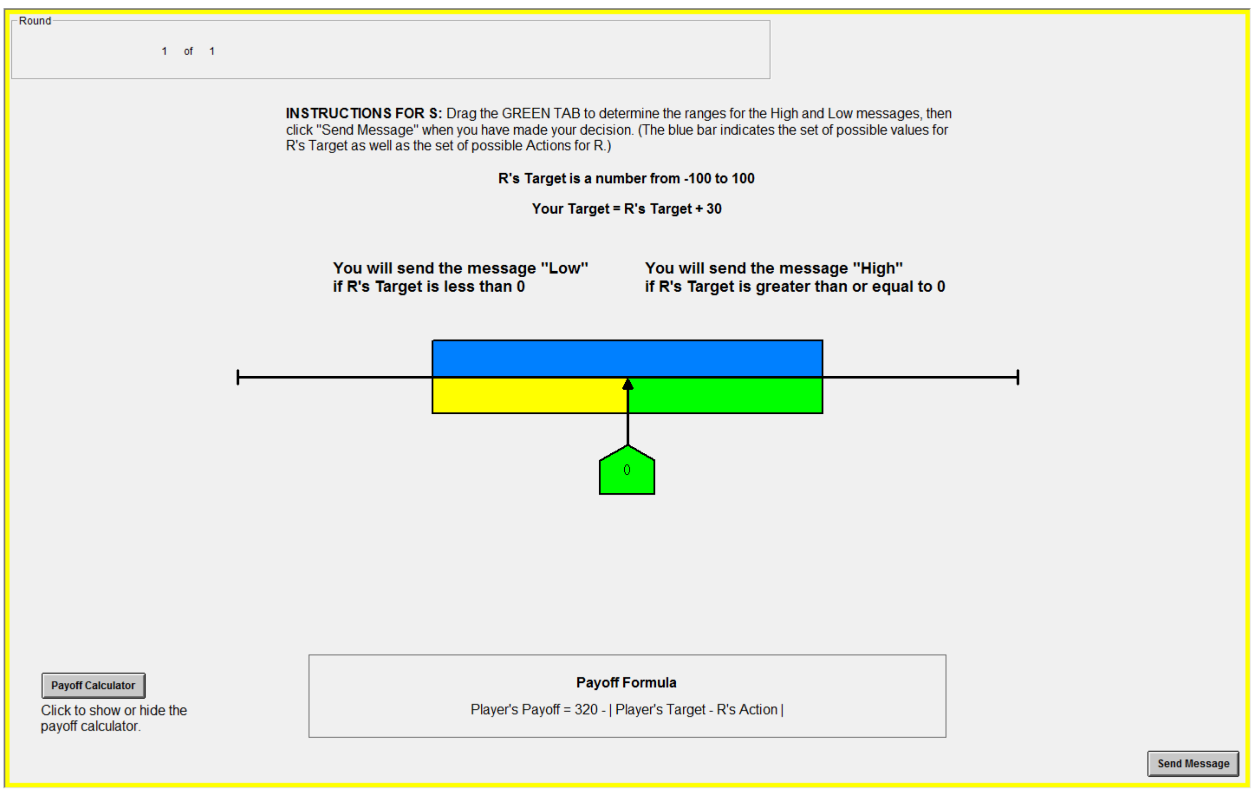
Of course these are only a few examples. During the experiment, the software will provide you with a "Payoff Calculator" that will compute each player's payoff for any combination of R's Target and Action.

## Sample Screens

Below is a screenshot of the interface for Player S. There is a brief set of instructions at the top, and below the instructions the possible set of R's targets is shown graphically (by the blue bar). To divide the set of R's targets into high and low ranges, Player S clicks and drags the green slider to the desired location. When the slider is moved, the text above the blue bar will change to reflect the rule used to determine which message to send.



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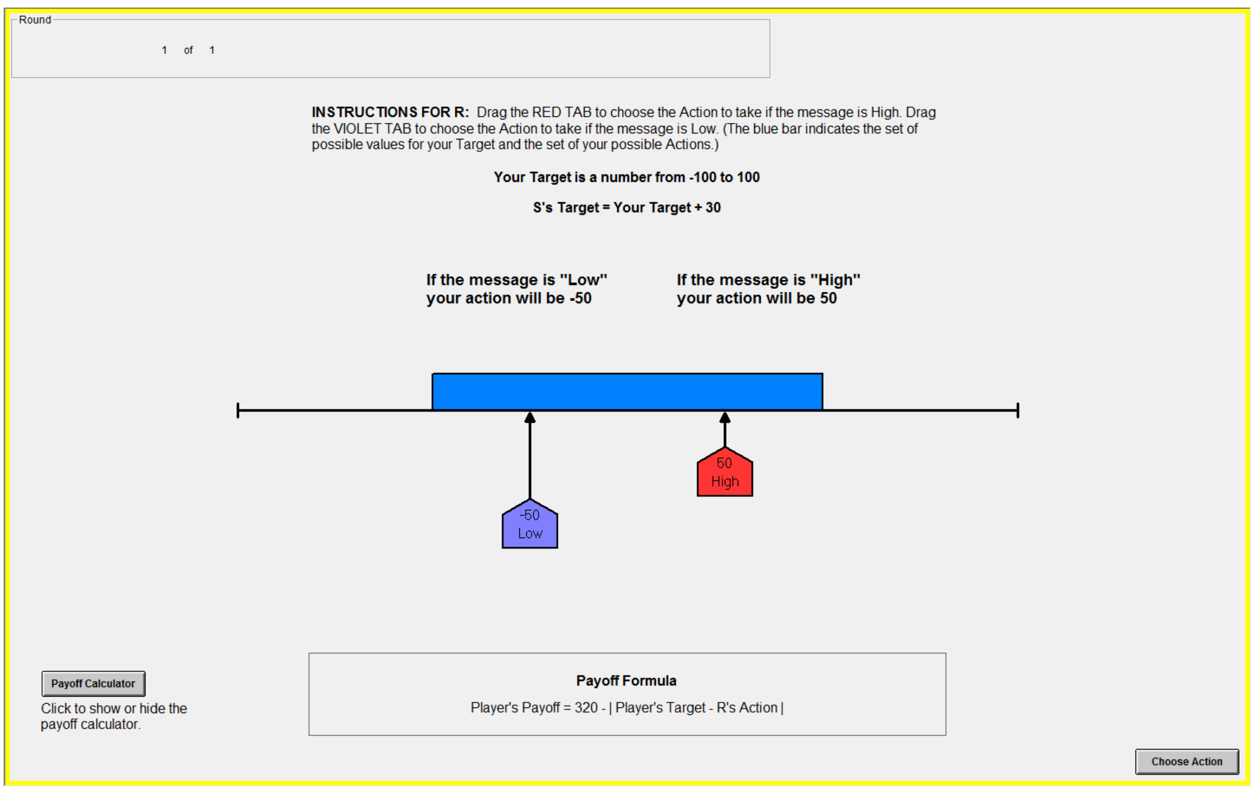
When Player S is finished making a decision, he or she will click on the "Send Message" button in the lower right-hand corner of the screen.

The next figure shows the interface that Player R will use. Below the instructions, Player R will also see a blue bar that represents the set of possible values for R's Target. Below this, there are two tabs that Player R uses to select the actions corresponding to each possible message that can be received: a red tab for the action if the message is High and violet tab for the action if the message is Low. Player R chooses each action by clicking and dragging the appropriate tab to the desired location.

Note that Player R also has a payoff calculator.

When Player R is finished making a decision, he or she will need to click on the "Choose Actions" button in the lower-right hand part of the screen.



## SUMMARY

### Targets

R’s Target = Number between -100 and 100

S’s Target = R’s Target + 30

Note that it is possible for S’s Target to be outside the set of possible Actions.

### Sequence

1. S divides the set of R’s targets into a high region and a low region. If R’s target is in the high region, the High message will be sent. If R’s target is in the low region, the Low message will be sent.

2. At the same time, R chooses an Action from -100 to 100 corresponding to when the Message is High and another Action from -100 to 100 corresponding to when the Message is Low.

3. The computer will randomly select R’s target, then the Message to send based on R’s target and Player S’s decision, then the Action to implement based on the Message and Player R’s decision.

### Payoffs

Player’s Payoff = 320 – |Player’s Target – R’s Action|

### Payment

One round randomly selected for payment.

**INSTRUCTION QUIZ.** To check your understanding of the decision tasks, there will be a set of questions on your computer. When you are finished, the computer will check your answers and feedback will be shown on the screen. Note that your quiz answers do not affect your earnings, but you must attempt to answer all of the questions before the computer will check them. During the quiz, you are free to refer to your printed instructions.

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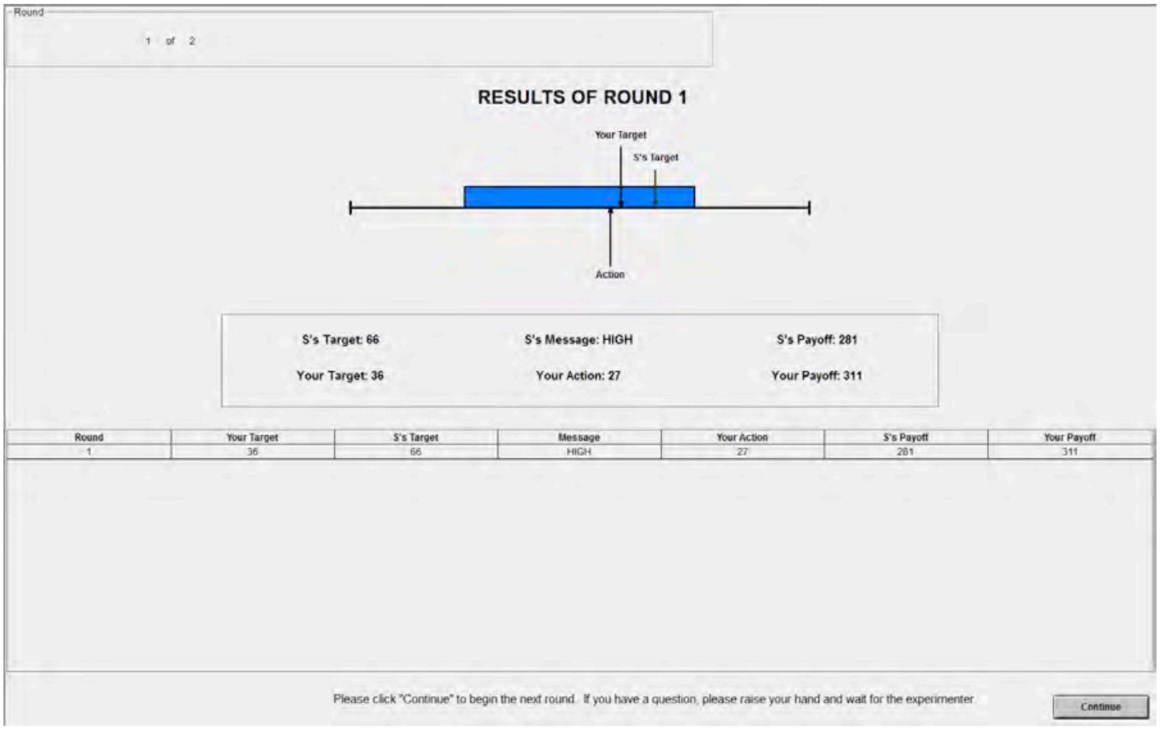
8. If Player S's Target is -50, R's Target is -80, and Player R chooses the Action 0, how many points will **Player S** receive? [80, 240, 270, 320]

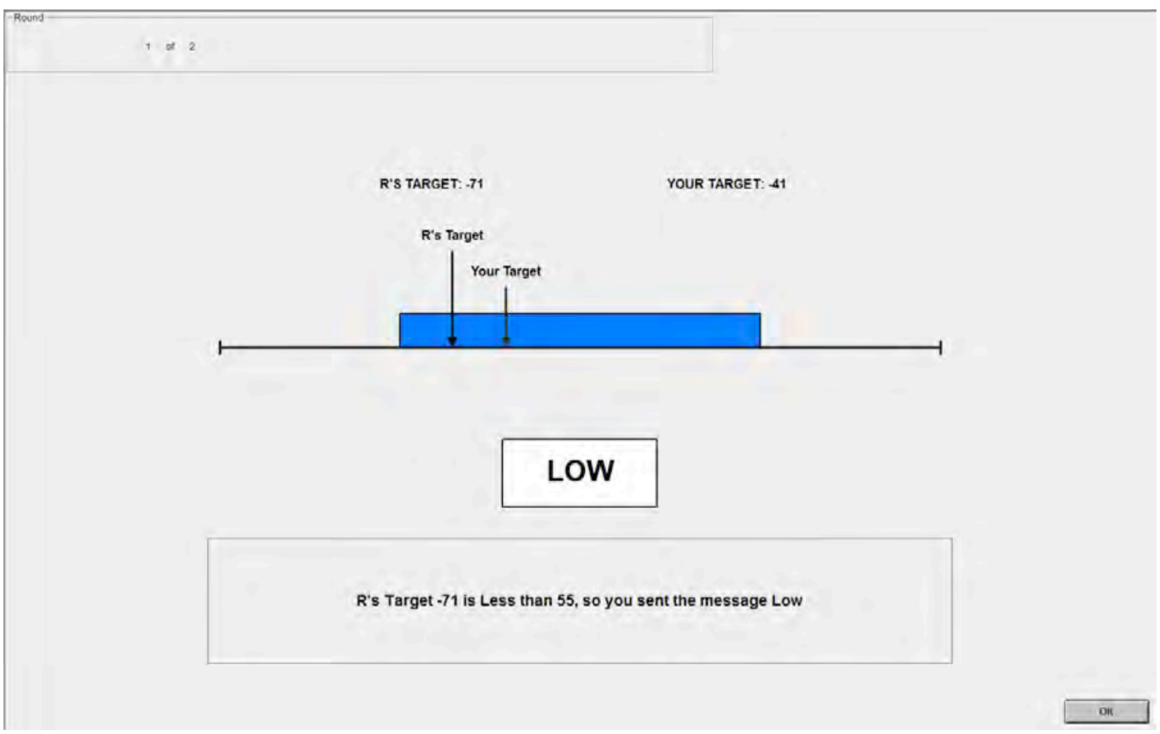
## Part 2

The game in Part 2 is almost exactly the same as in Part 1, except for one difference: In Part 2, Player S's Target will always be 60 more than Player R's Target. For example, if R's Target is -50, then S's Target is 10; if R's Target is 25, then S's Target is 85, etc.

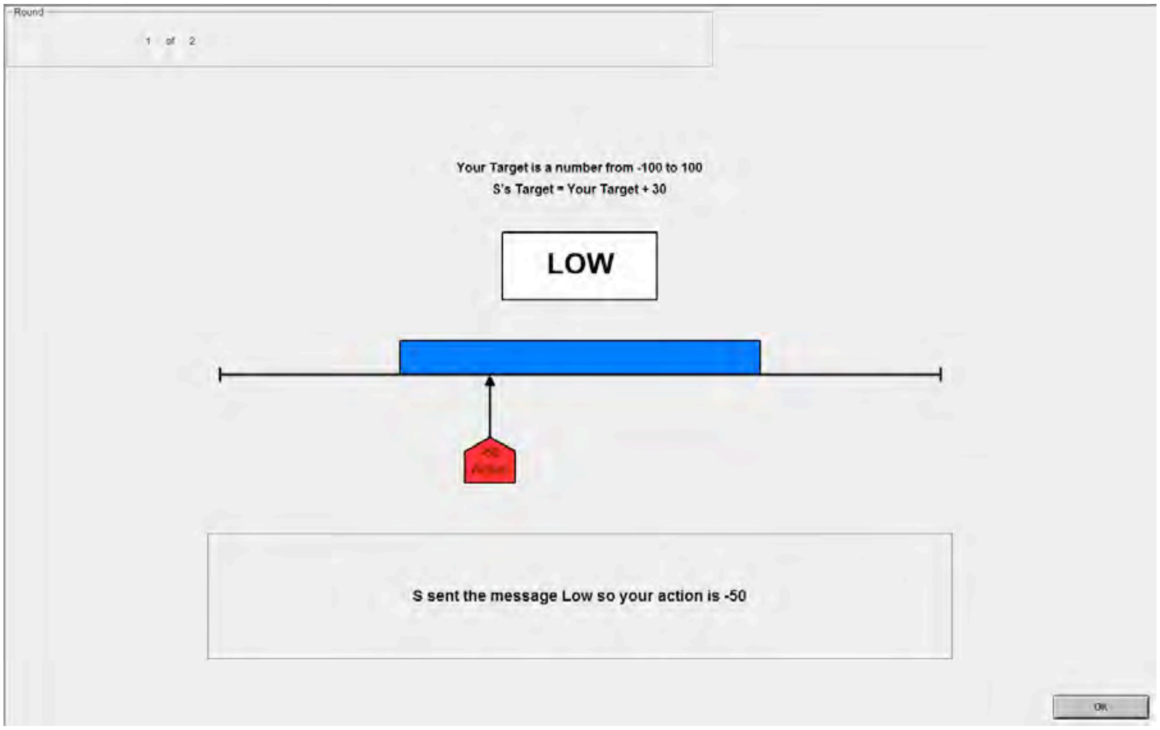
### Additional screen shots



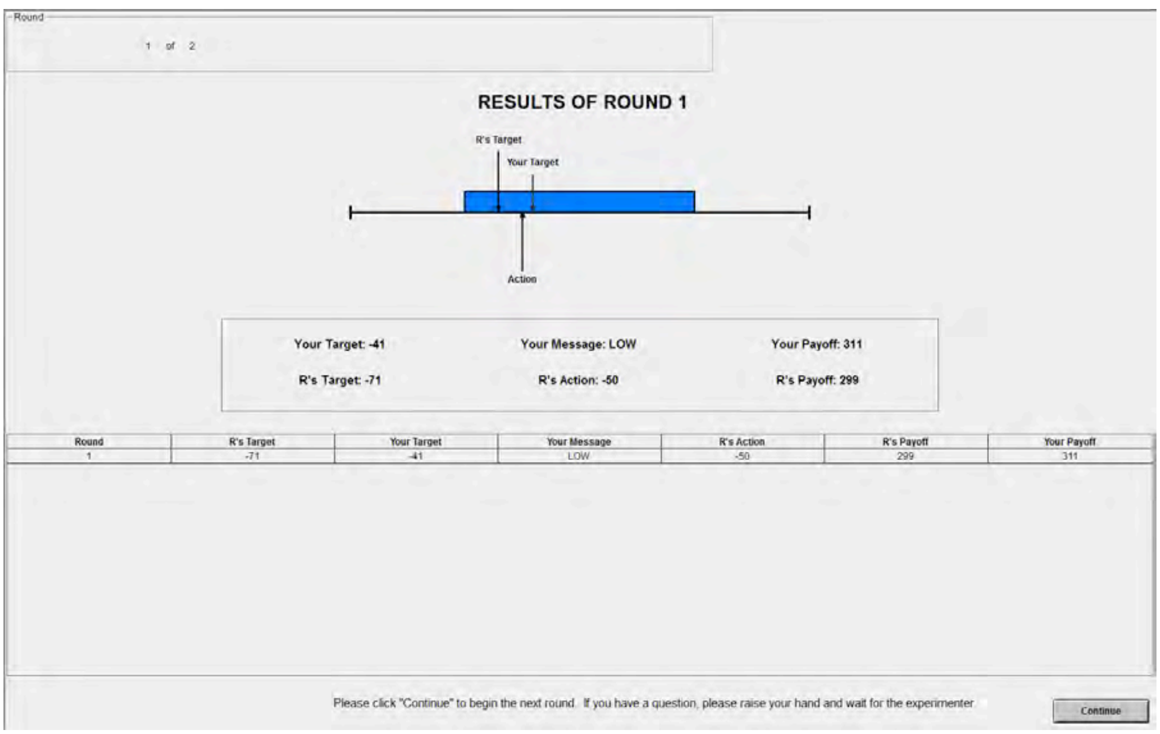

Direct Response: Feedback Screen




Strategy Method: Realized Message Screen




Strategy Method: Realized Action Screen




Strategy Method: Feedback Screen