

Supplement to “Meaning and credibility in experimental cheap-talk games”

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APPENDIX A: ADDITIONAL DATA ANALYSIS

A.1 *Alternative measure of fully revealing outcomes in games with literal messages*

Figure A.1 presents the round-by-round frequencies of fully revealing outcomes measured using an alternative definition. While the frequencies reported in the main text measure how often the receivers best respond to senders’ truthful messages on the realized paths, here we simply count how often the receivers take their ex post ideal actions on the realized paths, ignoring the messages sent under those realized contingencies.

The fully revealing outcomes so defined, with the less restrictive definition, are naturally observed more frequently. The all-round frequencies in Games 1M2, 1M3, 2M2, and 2M3 are, respectively, 67%, 32%, 55%, and 51%, compared to the corresponding 66%, 21%, 55%, and 39% when messages are included. Note that using the alternative frequencies to evaluate Hypotheses 1–3 results in the same conclusion.

A.2 *Receivers’ behavior in games with a priori meaningless messages*

For each matching group (observation) in Games 1E, 2E, and 1E^d, Table A.1 reports the first-20-round frequencies of actions conditional on messages. The shaded observations are those in which distinct meanings are established for the two messages as determined by the first 20-round frequencies of messages conditional types. Our analysis of receivers’ behavior focuses on these observations singled out based on senders’ uses of messages. We first evaluate receivers’ responses in the first 20 rounds in reference to the established meanings. We then examine how the receivers respond to the third messages in the last 20 rounds.

Among the 6 singled-out observations in Game 1E, there are 5 observations (bolded in the top panel of Table A.1) in which the best responses to the two messages—given

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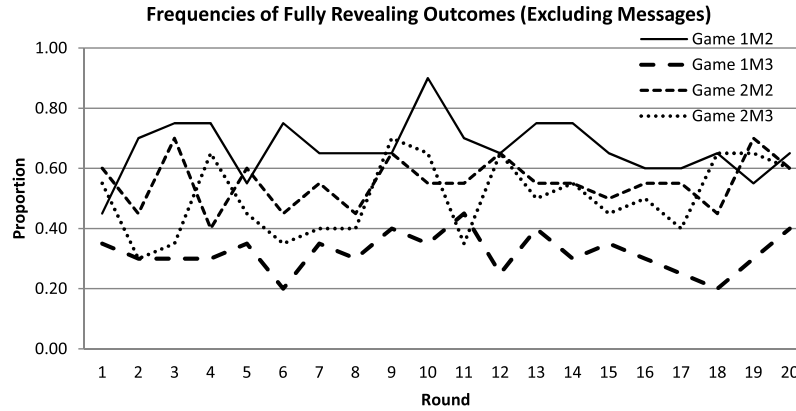


FIGURE A.1. Frequencies of fully revealing outcomes (excluding messages), Games 1M2, 1M3, 2M2, and 2M3.

their empirically determined meanings—are taken more than 50% of the time. Consider one of the strongest cases, Observation 2-2. The meaning of “\$” is established to be t and that of “%” established to be s ; action R , the receiver’s ideal action under t , is taken 88% of the time when “\$” is received, and C , the ideal action under s , is taken 65% of the time when “%” is received. Among the 9 singled-out observations in Game 2E, 6 observations (bolded in the middle panel of Table A.1) satisfy our criterion requiring best responses to be taken more than 50% of the time. In one of the strongest cases, Observation 1-5, the two best responses are taken 100% and 85% of the time. Finally, among the 7 singled-out observations in Game 1E^d, 5 observations (bolded in the bottom panel of Table A.1) satisfy our criterion. In the strongest case, Observation 2-4, the two best responses are taken 95% and 100% of the time.

Table A.2 further reports the last-20-round frequencies of actions conditional on messages. In 60% (3 out of 5) of the bolded observations in Game 1E, which are highlighted with a darker shade in the top panel of Table A.2, the ex ante ideal action, L , is taken more than 50% of the time in response to the third message “&.” Excluding the observation in which “&” is rarely received, the same happens only in $\frac{1}{3}$ (2 out of 6) of the bolded observations in Game 2E (highlighted with a darker shade in the middle panel of Table A.2). Finally, in none of the observations in the control Game 1E^d is L taken more than 50% of the time after “my type is s ” is received. As in the case of senders, these findings on receivers’ behavior reflect the different self-signaling properties of the neologisms in the games.

APPENDIX B: LEVEL- k ANALYSIS

Motivated by the over-communication phenomenon well documented in the literature of experimental cheap-talk games and following the convention in the literature (Crawford (2003), Cai and Wang (2006)), we specify the following level- k model. The model starts with a credulous L_0 receiver and a truthful L_0 sender. The sender of the lowest level of sophistication, L_0 , sends truthful message all the time. In response to the

TABLE A.1. Frequencies of Actions Conditional on Messages, Games 1E, 2E, and 1E^d, First 20 Rounds.

Game/Observation (Session-Group)	Frequency(Action Message)							
	“\$”				“%”			
Game 1E	Received	<i>L</i>	<i>C</i>	<i>R</i>	Received	<i>L</i>	<i>C</i>	<i>R</i>
1-1	0.65	0.58	0.23	0.19	0.35	0.07	0.29	0.64
1-2	0.62	0.44	0.28	0.28	0.38	0.20	0.33	0.47
1-3	0.50	0.15	0.50	0.35	0.50	0.30	0.20	0.50
1-4	0.48	0.26	0.00	0.74	0.52	0.38	0.57	0.05
1-5	0.40	0.19	0.25	0.56	0.60	0.17	0.58	0.25
1-6	0.48	0.16	0.11	0.73	0.52	0.29	0.57	0.14
2-1	0.30	0.17	0.33	0.50	0.70	0.29	0.29	0.42
2-2	0.43	0.12	0.00	0.88	0.57	0.26	0.65	0.09
2-3	0.70	0.46	0.00	0.54	0.30	0.17	0.33	0.50
2-4	0.43	0.41	0.06	0.53	0.57	0.13	0.74	0.13
2-5	0.50	0.35	0.10	0.55	0.50	0.45	0.15	0.40
2-6	0.25	0.10	0.00	0.90	0.75	0.10	0.83	0.07
Mean	0.48	–	–	–	0.52	–	–	–
Game/Observation (Session-Group)	Frequency(Action Message)							
	“\$”				“%”			
Game 2E	Received	<i>L</i>	<i>C</i>	<i>R</i>	Received	<i>L</i>	<i>C</i>	<i>R</i>
1-1	0.55	0.09	0.23	0.68	0.45	0.22	0.56	0.22
1-2	0.38	0.47	0.20	0.33	0.62	0.64	0.20	0.16
1-3	0.35	0.00	0.00	1.00	0.65	0.38	0.58	0.04
1-4	0.45	0.06	0.00	0.94	0.55	0.00	0.91	0.09
1-5	0.50	0.00	0.00	1.00	0.50	0.15	0.85	0.00
1-6	0.45	0.00	0.06	0.94	0.55	0.64	0.27	0.09
2-1	0.48	0.26	0.21	0.53	0.52	0.38	0.43	0.19
2-2	0.50	0.35	0.05	0.60	0.50	0.30	0.50	0.20
2-3	0.48	0.05	0.16	0.79	0.52	0.43	0.47	0.10
2-4	0.48	0.47	0.21	0.32	0.52	0.52	0.19	0.29
2-5	0.50	0.00	0.05	0.95	0.50	0.40	0.55	0.05
2-6	0.62	0.40	0.04	0.56	0.38	0.33	0.60	0.07
Mean	0.48	–	–	–	0.52	–	–	–
Game/Observation (Session-Group)	Frequency(Action Message)							
	“\$”				“%”			
Game 1E^d	Received	<i>L</i>	<i>C</i>	<i>R</i>	Received	<i>L</i>	<i>C</i>	<i>R</i>
1-1	0.57	0.57	0.43	0.00	0.43	0.53	0.00	0.47
1-2	0.57	0.04	0.17	0.79	0.43	0.18	0.82	0.00
1-3	0.43	0.47	0.24	0.29	0.57	0.35	0.39	0.26
1-4	0.52	0.38	0.62	0.00	0.48	0.26	0.00	0.74
2-1	0.30	1.00	0.00	0.00	0.70	0.78	0.11	0.11
2-2	0.52	0.14	0.00	0.86	0.48	0.00	1.00	0.00
2-3	0.75	0.27	0.07	0.66	0.25	0.20	0.70	0.10
2-4	0.52	0.05	0.00	0.95	0.48	0.00	1.00	0.00
2-5	0.50	0.55	0.00	0.45	0.50	0.55	0.30	0.15
Mean	0.52	–	–	–	0.48	–	–	–

Note: “Frequency(Action|Message)” is used to evaluate how receivers respond to senders’ messages. The additional columns “Received” provide the total frequency at which the particular message is received (sent by the senders). Means are reported only for these “Received” frequencies, because the different responses to the meaningless messages in different matching groups render the means of other frequencies not informative about average behavior. The shaded observations represent those in which distinct meanings are established for the two messages based on how they are used by the senders; the bolded observations are the nested observations in which the best responses to the established meanings of the messages are taken more than 50% of the time.

TABLE B.1. Level- k Predictions for Game 1M3.

	Sender's Strategy		Receiver's Strategy		
	s	t	"My type is s "	"My type is t "	"I won't tell you my type"
L_0	"My type is s "	"My type is t "	C	R	L
L_1	"I won't tell you my type"	"I won't tell you my type"	C	R	L
$L_{k \geq 2}$	"I won't tell you my type"	"I won't tell you my type"	C	R	L

TABLE B.2. Level- k Predictions for Game 2M3.

	Sender's Strategy		Receiver's Strategy		
	s	t	"My type is s "	"My type is t "	"I won't tell you my type"
L_0	"My type is s "	"My type is t "	C	R	L
L_1	"I won't tell you"	"My type is t "	C	R	C
$L_{k \geq 2}$	"My type is s " / "I won't tell you my type"	"My type is t "	C	R	C

TABLE B.3. Level- k Predictions for Game 1M2 and Game 2M2.

	Sender's Strategy		Receiver's Strategy	
	s	t	"My type is s "	"My type is t "
L_0	"My type is s "	"My type is t "	C	R
L_1	"My type is s "	"My type is t "	C	R
$L_{k \geq 2}$	"My type is s "	"My type is t "	C	R

vealing outcome for Game 2M3. Similarly, the model predicts a fully revealing outcome for Games 1M2 and 2M2. However, unlike neologism-proofness, the model fails to predict the systematic difference between receivers' strategies in Games 1M3 and 2M3. Recall that neologism-proofness predicts that when the neologism becomes credible in Game 1M3, the receiver would use the pooling strategy in which action L is taken regardless of the message received. Our data indicate that the frequency of the pooling strategy being used by receivers is indeed significantly higher in Game 1M3 than in Game 2M3. On the other hand, the specified level- k model organizes the data from Game 2M3 quite well. In particular, the model predicts that the message "I won't tell you my type" would be paired with another message "My type is t " to effectively reveal senders' types, which is indeed observed in our strategy-level data.

A few remarks regarding alternative specifications of L_0 players are in order. One plausible alternative is to specify that the L_0 receiver uniformly randomizes over the three actions regardless of the message. But this alternative specification is somewhat unnatural given our adopted message space in which each message has a clear literal

meaning, and secondly the specification essentially generates the same fully revealing outcomes from Game 1M3 and Game 2M3, which do not match our data.

We believe that the level- k model and the equilibrium notion of neologism proofness should be complements rather than substitutes in explaining our data. Our result indicates that neologism-proofness is crucial to explain the observed treatment effects or the difference among the four treatments. However, the finding does not imply that the level- k model has no power to explain the data. Our simple analysis in this section demonstrates that the level- k model can explain some feature of our data.

APPENDIX C: SAMPLE EXPERIMENTAL INSTRUCTIONS

Instructions for game 1M3

Welcome to the experiment. This experiment studies decision making between two individuals. In the following hour or so, you will participate in 20 rounds of decision making. Please read the instructions below carefully; the cash payment you will receive at the end of the experiment depends on how you make your decisions according to these instructions.

Your role and decision group There are 20 participants in today's session. Prior to the first round, one half of the participants will be randomly assigned the role of Member A and the other half the role of Member B. Your role will remain fixed throughout the experiment. In each round, one Member A and one Member B will be randomly and anonymously paired to form a group, with a total of 10 groups.

Regarding how players are matched, the 10 groups are equally divided into two classes so that there are five groups in each class with 10 participants, 5 Members A and 5 Members B; in each and every round, you will be randomly matched with a participant in the other role in your class. Thus, in a round you will have an equal, 1 in 5 chance of being paired with a participant in the other role in your class. You will not be told the identity of the participant you are matched with, nor will that participant be told your identity—even after the end of the experiment.

Your decision in each round

Member A's decision In each round and for each group, the computer randomly selects, with equal chance, an integer X from 1 to 100. (Each number therefore has probability $\frac{1}{100}$ to be selected.)

Figure C.1 shows Member A's decision screen. You as Member A have two kinds of decisions to make:

1. what to tell Member B if it turns out that $X > 50$; and
2. what to tell Member B if it turns out that $X \leq 50$.

Note that you are making a decision plan (what to do if this happens and what to do if that happens), where you will make these decisions without knowing the actually selected X.

You are a Member A.

	L	C	R						
X > 50	<table border="1" style="display: inline-table; text-align: left;"><tr><td>30</td><td>20</td></tr></table>	30	20	<table border="1" style="display: inline-table; text-align: left;"><tr><td>20</td><td>30</td></tr></table>	20	30	<table border="1" style="display: inline-table; text-align: left;"><tr><td>0</td><td>8</td></tr></table>	0	8
30	20								
20	30								
0	8								
X ≤ 50	<table border="1" style="display: inline-table; text-align: left;"><tr><td>30</td><td>20</td></tr></table>	30	20	<table border="1" style="display: inline-table; text-align: left;"><tr><td>8</td><td>0</td></tr></table>	8	0	<table border="1" style="display: inline-table; text-align: left;"><tr><td>20</td><td>30</td></tr></table>	20	30
30	20								
8	0								
20	30								

ROUND 1.

What would you like to tell Member B when X > 50?

X is bigger than 50
 X is smaller than or equal to 50
 I won't tell you.

What would you like tell Member B when X ≤ 50?

X is bigger than 50
 X is smaller than or equal to 50
 I won't tell you.

Round 1 / 20
Number of seconds remaining: 35

FIGURE C.1. Member A's decision.

You are a Member B.

	L	C	R						
X > 50	<table border="1" style="display: inline-table; text-align: left;"><tr><td>30</td><td>20</td></tr></table>	30	20	<table border="1" style="display: inline-table; text-align: left;"><tr><td>20</td><td>30</td></tr></table>	20	30	<table border="1" style="display: inline-table; text-align: left;"><tr><td>0</td><td>8</td></tr></table>	0	8
30	20								
20	30								
0	8								
X ≤ 50	<table border="1" style="display: inline-table; text-align: left;"><tr><td>30</td><td>20</td></tr></table>	30	20	<table border="1" style="display: inline-table; text-align: left;"><tr><td>8</td><td>0</td></tr></table>	8	0	<table border="1" style="display: inline-table; text-align: left;"><tr><td>20</td><td>30</td></tr></table>	20	30
30	20								
8	0								
20	30								

ROUND 1.

What action would you like to take if Member A says "X is bigger than 50"?

L
 C
 R

What action would you like to take if Member A says "X is smaller than or equal to 50"?

L
 C
 R

What action would you like to take if Member A says "I won't tell you"?

L
 C
 R

Round 1 / 20
Number of seconds remaining: 42

FIGURE C.2. Member B's decision.

For each decision, you can choose from the following three options: (1) "X is bigger than 50"; (2) "X is smaller than or equal to 50"; and (3) "I won't tell you." Your choices for different decisions could be different or the same.

Your decision for the round is completed after the two choices, which will then enter into the determination of rewards at a later stage of the round.

Member B's decision Figure C.2 shows Member B's decision screen. You as Member B have three kinds of decisions to make:

1. what action to take if Member A says "X is bigger than 50";

2. what action to take if Member A says “X is smaller than or equal to 50”; and
3. what action to take if Member A says “I won’t tell you.”

Note that you are making a decision plan (what to do if this happens and what to do if that happens and etc.), where you will make these decisions without knowing what Member A actually says. For each decision, you can choose from the following three options: (1) action L; (2) action C; and (3) action R. Your choices for different decisions could be different or the same.

Your decision for the round is completed after the three choices, which will then enter into the determination of rewards at a later stage of the round.

Your reward in each round After Member A’s and Member B’s decisions, the computer will proceed to draw the integer X randomly from 1 to 100. Then the realization of X will be revealed to Member A and Member B. Member A’s and Member B’s rewards will be determined according to the reward table in Figures C.1 and C.2 and what choices they have made. In each cell of the reward table, the first number represents the reward in HKD to Member A and the second number the reward in HKD to Member B. (The relevant numbers for each role are highlighted in Blue.)

The reward procedure, in which the computer draw determines the relevant row of the reward table and Member B’s action the relevant column, may best be illustrated with an example.

Consider the following choices made by the two members. Member A chooses to say:

1. “X is bigger than 50” if $X > 50$;
2. “I won’t tell you” if $X \leq 50$.

Member B chooses to take:

1. action L if Member A says “X is bigger than 50”;
2. action C if Member A says “X is smaller than or equal to 50”;
3. action R if Member A says “I won’t tell you.”

Suppose the computer randomly draws $X = 27$. According to the choices, Member A says “I won’t tell you” and Member B takes action R. Given that $X \leq 50$, Member A will receive 20 HKD and Member B will receive 30 HKD. On the other hand, if the computer draws $X = 79$, according to the choices Member A says “X is bigger than 50” and Member B takes action L. Given that $X > 50$, Member A will receive 30 HKD and Member B will receive 20 HKD.

Prediction Reward by Member A. If you are Member A, you have an opportunity to earn an extra reward. After the computer draws X, you will be asked to predict what Member B will take after listening to what you choose to say to him/her for the relevant range of X. If your prediction is correct, you will receive an extra 2 HKD.

Information feedback During the course of a round, you will be informed about the drawn X, what Member A chooses to say for the relevant range of X, and what Member B

chooses to take for what Member A chooses to say. (The information provided does not include the whole decision plan of the members.)

Your cash payment The experimenter randomly selects 2 rounds out of 20 to calculate your cash payment. (So it is in your best interest to take each round seriously.) Your total cash payment at the end of the experiment will be the sum of HKD you earned in the 2 selected rounds plus a 30 HKD show-up fee.

Quiz and practice To ensure your comprehension of the instructions, we will provide you with a quiz and a practice round. We will go through the quiz after you answer it on your own. You will then participate in one practice round. At the beginning of the practice round, you will be randomly assigned the role of either Member A or Member B. Your role in the official rounds is the same as that in the practice round.

Once the practice round is over, the computer will tell you “The official rounds begin now!”

Administration Your decisions as well as your monetary payment will be kept confidential. Remember that you have to make your decisions entirely on your own; please do not discuss your decisions with any other participants.

Upon finishing the experiment, you will receive your cash payment. You will be asked to sign your name to acknowledge your receipt of the payment (which will not be used for tax purposes). You are then free to leave.

If you have any question, please raise your hand now. We will answer your question individually. If there is no question, we will proceed to the quiz.

Quiz

1. True or False: I will remain as a Member A or Member B in all 20 rounds of decision-making. Circle one: True/False
2. True or False: I will be matched with the same player in the other role in all 20 rounds. Circle one: True/False
3. True or False: My decisions involve making plans for different scenarios but not specific choice for single scenario. Circle one: True/False
4. True or False: At the end of the experiment, I will be paid my earnings in HKD from two randomly chosen rounds in addition to 30 HKD show-up fee. Circle one: True/False.

Instructions for Game 1E

Instruction Welcome to the experiment. This experiment studies decision making between two individuals. In the following hour or so, you will participate in 40 rounds of decision making. Please read the instructions below carefully; the cash payment you will receive at the end of the experiment depends on how you make your decisions according to these instructions.

Your role and decision group There are 20 participants in today's session. At the beginning of the experiment, one half of the participants will be randomly assigned the role of Member A and the other half the role of Member B. Your role will remain fixed throughout the experiment. In each round, one Member A and one Member B will be randomly and anonymously paired to form a group, with a total of 10 groups.

Regarding how participants are matched, the 10 groups are equally divided into five classes so that there are two groups in each class with four participants, 2 Member As and 2 Member Bs; in each and every round, you will be randomly matched with a participant in the other role in your class. Thus, in a round you will have an equal, 1 in 2 chance of being paired with a participant in the other role in your class. You will not be told the identity of the participant you are matched with, nor will that participant be told your identity—even after the end of the experiment.

Your decision in each of round 1–20 In each round and for each group, the computer randomly selects, with equal chance, an integer X from 1 to 100. (Each number therefore has probability $\frac{1}{100}$ to be selected.) The computer will reveal (only) to Member A whether the selected X is bigger than 50 ($X > 50$) or it is smaller than or equal to 50 ($X \leq 50$). Member B, without knowing the range of the selected X , needs to make an action choice.

Member A's decision Figure C.3 shows Member A's decision screen. After being informed of the range of the selected X (whether $X > 50$ or $X \leq 50$), you as Member A have to decide what message to send to your paired Member B. You will be prompted to enter your choice of message by clicking one of the two buttons “%” or “\$.” Note that the relative positions of the two message buttons are randomly determined in each round, so the positions of the buttons “%” and “\$” in a round may

You are a Member A.

	L	C	R
X > 50	30 20	20 30	0 8
X <= 50	30 20	8 0	20 30

ROUND 0.
X is bigger than 50.
What would you like to tell your paired Member B?

Buttons: % \$

Round: Trail / 1 Number of seconds remaining

FIGURE C.3. Member A's decision.

You are a Member B.

	L	C	R
X > 50	30 20	20 30	0 8
X ≤ 50	30 20	8 0	20 30

ROUND 0.

The message from your paired Member A: \$.

What action would you like take?

L C R

Round: 0 / 1

Number of seconds remaining: 30

FIGURE C.4. Member B's decision.

or may not be the same as those in the previous or later round.¹ Once you click one of the buttons, your decision in the round is completed and the chosen message will be transmitted to the paired Member B.

Member B's decision Figure C.4 shows Member B's decision screen. You as Member B will see the message sent by your paired Member A. After that, you will be prompted to enter your choice of action by clicking one of the three buttons "L," "C," or "R."

Your decision for the round is then completed.

Your reward in each round After Member A's and Member B's decisions, the realization of X and Member B's choice of action will be revealed to both Member A and Member B. Member A's and Member B's rewards will be determined according to the reward table in Figures C.1 and C.2 and the choices they have made. In each cell of the reward table, the first number represents the reward in HKD to Member A and the second number the reward in HKD to Member B. (The relevant numbers for each role are highlighted in Blue.)

Information feedback At the end of a round, you will be informed about the selected X, Member A's choice of message, Member B choice of action, and your reward for the round.

Your decision in each of round 21–40 After the 20th round, your screen will provide further instructions for your decisions in Round 21–40. Please read the instructions care-

¹We also have two sets of instructions for today's session, one in which the two symbols are stated in the order "%" followed by "\$" and the other in the order "\$" followed by "%." We randomly distribute the instructions so that half of the participants have their instructions adopting one order and the other half have their instructions adopting the other order. This means that another participant in your group may or may not have the same symbol order in his/her instructions.

fully before you start the 21st round. You will have an opportunity to ask questions if anything is unclear about the new instructions.

Your cash payment The experimenter will randomly select three rounds out of the 40 to calculate your cash payment. (So it is in your best interest to take each round seriously.) Your total cash payment at the end of the experiment will be the sum of HKD you earned in the three selected rounds plus a 40 HKD show-up fee.

Quiz and practice To ensure your comprehension of the instructions, we will provide you with a quiz and a practice round. We will go through the quiz after you answer it on your own. You will then participate in one practice round. At the beginning of the practice round, you will be randomly assigned the role of either Member A or Member B. Your role in the official rounds is the same as that in the practice round.

Once the practice round is over, the computer will tell you “The official rounds begin now!”

Administration Your decisions as well as your monetary payment will be kept confidential. Remember that you have to make your decisions entirely on your own; please do not discuss your decisions with any other participants.

Upon finishing the experiment, you will receive your cash payment. You will be asked to sign your name to acknowledge your receipt of the payment (which will not be used for tax purposes). You are then free to leave.

If you have any question, please raise your hand now. We will answer your question individually. If there is no question, we will proceed to the quiz now.

Quiz

1. True or False: I will remain as a Member A or Member B in all 40 rounds of decision-making. Circle one: True/False
2. True or False: I will be matched with the same player in the other role in all 40 rounds. Circle one: True/False
3. True or False: Member A, but not Member B, will be informed of the randomly selected X. Circle one: True/False.
4. True or False: Member A will be responsible for taking action, while Member B will be sending message. Circle one: True/False

You are a Member A.

	L	C	R
X > 50	30 20	20 30	0 8
X ≤ 50	30 20	8 0	20 30

So far, you have participated in 20 rounds of decision making, where two messages % and \$ are available for every Member A.

Now, you will participate in **another 20 rounds** of decision making, where **one additional message, &**, will be made available to every Member A.

Thus, Member A now has **three available messages** to choose from. All other things will remain the same as before.

If you have any questions, please raise your hand. Otherwise, please click the OK button.

Round Number of seconds remaining 30

FIGURE C.5. Instruction regarding the introduction of the third message “&.”

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