The Informational Theory of Legislative Committees: An Experimental Analysis

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Online Appendices

Appendix A – Proof of Result 2

Since the receiver's expected payoff in Krishna and Morgan's (2001) equilibrium is higher than that in Gilligan and Krehbiel's (1989) under a given legislative rule, it suffices to show that the receiver's payoffs in Gilligan and Krehbiel's (1989) open-rule (O) and close-rule (C) equilibria are higher than that under the open rule with one sender (CS):

Open Rule. We have that $EU_O^R(b) = -\frac{16b^3}{3} > -\frac{4b^2}{3}$ for $b \in (0, \frac{1}{4})$. There are three cases to consider: i) if $N(b) > 2$, then $EU_{CS}^R(b) = -\frac{1}{12N(b)^2} - \frac{b^2[N(b)^2-1]}{3} < -\frac{b^2[N(b)^2-1]}{3} < -\frac{8b^2}{3} < -\frac{4b^2}{3}$ for $b \in (0, \frac{1}{4})$; ii) if $N(b) = 2$, then $EU_{CS}^R(b) = -\frac{1}{48} - b^2 < -\frac{4b^2}{3}$ for $b \in (0, \frac{1}{4})$; and iii) if $N(b) = 1$, then $EU_{CS}^R(b) = -\frac{1}{12} < -\frac{4b^2}{3}$ for $b \in (0, \frac{1}{4})$.

Closed Rule. We have that $EU_C^R(b) = -\frac{16b^3}{3} - b^2(1-8b) > -\frac{1}{48}$, where the inequality follows from the fact that $\frac{dEU_C^R(b)}{db} < 0$ for $b \in (0, \frac{1}{4})$. There are two cases to consider: i) if $N(b) \leqslant 2$, then $EU_{CS}^R(b) < -\frac{1}{48}$ for $b \in (0, \frac{1}{4})$; and ii) if $N(b) > 2$, then $EU_{CS}^R(b) < -\frac{8b^2}{3} < -\frac{1}{48}$ for $b \in (0, \frac{1}{4})$.

Appendix B – Additional Data Analysis

B.1 Additional Regression Results for Treatments *C-2*

Table B.1: Random-Effects GLS Regression: Treatments *C-2*

	(1) $b = 10$	(2) $b = 20$
Constant	11.20***	20.53***
	(0.826)	(3.250)
θ	0.967***	1.179
	(0.0194)	(0.633)
interval_low	−4.579	1.778
	(11.49)	(5.383)
$\theta \times$ *interval_low*	0.121	−0.249
	(0.331)	(0.668)
interval_middle	19.65**	18.96***
	(6.847)	(5.227)
$\theta \times$ *interval_middle*	−0.500***	−0.874
	(0.135)	(0.638)
interval_high_1	2.869	−36.87*
	(23.83)	(17.73)
$\theta \times$ *interval_high_1*	−0.151	0.0204
	(0.367)	(0.669)
interval_high_2	−66.58	242.5
	(36.80)	(130.8)
$\theta \times$ *interval_high_2*	0.943	−2.751
	(0.523)	(1.423)
interval_top	87.34*	209.4
	(35.03)	(161.9)
$\theta \times$ *interval_top*	−0.980**	−2.653
	(0.371)	(1.778)
No. of Observations	600	600

Note: The dependent variable is action a. *interval_low* is a dummy variable for $\theta \in (50 - 2b, 50 - b]$. *interval_middle* is a dummy variable for $\theta \in (50 - b, 50 + b]$. *interval_high_1* is a dummy variable for $\theta \in (50 + b, 50 + 2b]$. *interval_high_2* is a dummy variable for $\theta \in (50 + 2b, \min\{50 + 3b, 95\}]$. *interval_top* is a dummy variable for $\theta \in (\min\{50 + 4b, 95\}, 100]$. Standard errors are in parentheses. *** indicates significance at 0.1% level, ** significance at 1% level, and * significance at 5% level.

Table B.1 reports the estimation results mentioned in footnote 22 in the main text, in which we include additional segment dummies (*interval_low* and *interval_high_2*) and their interactions with the state to capture Krishna and Morgan's (2001) prediction. The estimated coefficients of the four variables are all insignificant.

B.2 Additional Analysis of Receivers' Responses to Messages in Treatments *O-2*

As mentioned in footnote 25 in the main text, we further evaluate whether receivers' observed responses to messages are consistent with Krishna and Morgan's (2001) fully revealing equilibrium. Specifically, we explore the extent to which the relevant incentive conditions that guarantee full revelation are satisfied by our data.

In equilibrium, action $a(m_1(\theta), m_2(\theta)) = \theta$ is induced by message pair $(m_1(\theta), m_2(\theta))$ for all $\theta \in \Theta$. Denote the actions induced pursuant to Sender 1's and Sender 2's deviations in an arbitrary state θ by, respectively, $a(\tilde{m}_1, m_2(\theta))$ and $a(m_1(\theta), \tilde{m}_2)$, where $\tilde{m}_1 \neq m_1(\theta)$ and $\tilde{m}_2 \neq m_2(\theta)$. Note that $\tilde{m}_i$, $i = 1, 2$, can itself be a message used in equilibrium in $\tilde{\theta} \neq \theta$, but $(\tilde{m}_1, m_2(\theta))$ and $(m_1(\theta), \tilde{m}_2)$ are out-of-equilibrium message pairs unexpected in equilibrium.

There is no incentive to deviate from the fully revealing equilibrium if the following two inequalities are satisfied:

$$\text{Sender 1: } -b^2 \geqslant -[a(\tilde{m}_1, m_2(\theta)) - (\theta + b)]^2, \text{ and} \tag{B.1}$$

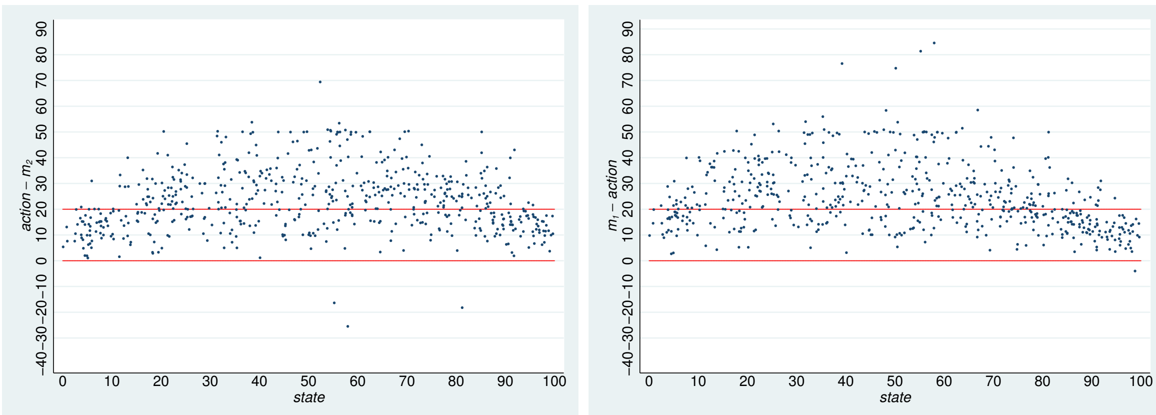
$$\text{Sender 2: } -b^2 \geqslant -[a(m_1(\theta), \tilde{m}_2) - (\theta - b)]^2. \tag{B.2}$$

for all $\theta \in \Theta$ and all $\tilde{m}_1, \tilde{m}_2 \in M$. Condition (B.1) guarantees that Sender 1 has no incentive to deviate when Sender 2 reveals θ. Condition (B.2) guarantees the same for Sender 2. Rearranging (B.1) and (B.2) gives the following that can be readily applied:

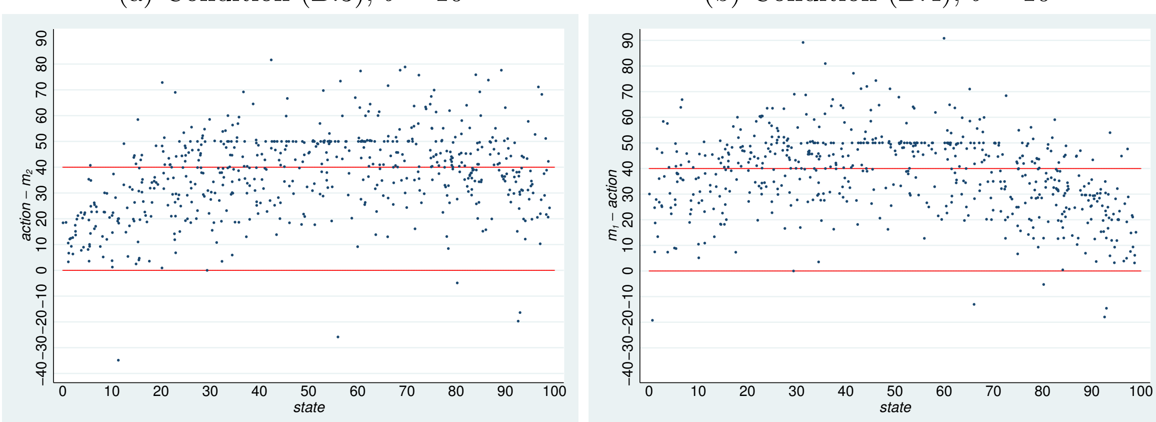
$$\text{Sender 1: } a(\tilde{m}_1, m_2(\theta)) - m_2(\theta) \notin (0, 2b), \text{ and} \tag{B.3}$$

$$\text{Sender 2: } m_1(\theta) - a(m_1(\theta), \tilde{m}_2) \notin (0, 2b). \tag{B.4}$$

Applying Conditions (B.3) and (B.4) to our data says that, if in a state the observed distances $a - m_2$ and $m_1 - a$ are in $(0, 2b)$, then receivers' responses are inviting deviations in that state. Krishna and Morgan's (2001) equilibrium construction requires (B.3) and (B.4) to be satisfied in all states in order to achieve a message-contingent optimal punishment of deviations. Figure B.1 shows that the conditions are respected for about half of the states only and for states that are closer to 50. Receivers' observed responses to messages fall short of punishing deviations as stipulated by Krishna and Morgan's (2001) construction.



(a) Condition (B.3), $b = 10$ (b) Condition (B.4), $b = 10$



Condition (B.3), $b = 20$ Condition (B.4), $b = 20$

Figure B.1: Distance between Action and Message: Treatments *O-2*

B.3 Robustness Treatments

Table B.2: Robustness Treatments

	Two Senders (Heterogeneous Committees)	Single Sender (Homogeneous Committee)
Open Rule	*O-2-F* Fixed Matching Point Message 2 Treatments: $b = 10, 20$ Each Treatment: 1 Session Each Session: 6 Fixed Groups of 3 No. of Subjects: $2 \times 1 \times 6 \times 3 = 36$	*O-1-F* Fixed Matching Point Message 2 Treatments: $b = 10, 20$ Each Treatment: 1 Session Each Session: 9/10 Fixed Groups of 2 No. of Subjects: $(9 + 10) \times 2 = 38$
Closed Rule	*C-2-F* Fixed Matching Point Message 2 Treatments: $b = 10, 20$ Each Treatment: 1 Session Each Session: 6/7 Fixed Groups of 3 No. of Subjects: $(6 + 7) \times 3 = 39$ *C-2-I* Random Matching Interval Message 2 Treatments: $b = 10, 20$ Each Treatment: 4 Sessions Each Session: 5 Random Groups of 3 No. of Subjects: $2 \times 4 \times 5 \times 3 = 120$	

Table B.2 provides details about the eight robustness treatments. In the following, we provide data analysis to support the conclusion from the comparisons of the findings between the main and the robustness treatments summarized in Table 9 in the main text.

Finding 1. Columns (1), (2), (4), and (5) in Table B.3 show that the correlation between state and action in treatments *O-2-F* decreases in the bias as is observed in main treatments *O-2*. However, the estimated coefficients of the dummy variable *pooling_interval* and its interaction with the state are not statistically significant. Although Figure 10(b) in the main text shows that, similar to *O-2* with $b = 20$, there is a cluster of actions around 50 that is more concentrated than the clusters at the other actions, the regression does not pick up the effect quantitatively, perhaps because of the comparably few number of observations. These account for the “partial quantitative change” of Finding 1.

Table B.3: Random-Effects GLS Regression: Treatments *O-2-F* and *O-1-F*

	O-2-F						*O-1-F*	
	$b=10$			$b=20$			$b=10$	$b=20$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	6.471***	6.853***	5.460***	16.52***	17.40***	18.62***	6.389**	9.204**
	(0.882)	(0.975)	(1.289)	(2.008)	(3.543)	(3.182)	(2.08)	(3.202)
θ	0.886***	0.881***	0.948***	0.653***	0.643***	0.532***	1.064***	1.437***
	(0.015)	(0.0155)	(0.06)	(0.0358)	(0.0358)	(0.147)	(0.0716)	(0.141)
θ^2	–	–	−0.0063	–	–	0.00119	−0.00220**	−0.00821***
	–	–	(0.000586)	–	–	(0.0014)	(0.000687)	(0.00134)
pooling_interval	–	−4.616	–	–	−1.389	–	–	–
	–	(3.388)	–	–	(4.439)	–	–	–
$\theta \times$ *pooling_interval*	–	0.0861	–	–	0.0192	–	–	–
	–	(0.0656)	–	–	(0.0723)	–	–	–
No. of Observations	180	180	180	180	180	180	270	300

Note: The dependent variable is action a. *pooling_interval* is a dummy variable for $\theta \in [50-2b, 50+2b]$. Standard errors are in parentheses. *** indicates significance at 0.1% level, ** significance at 1% level, and * significance at 5% level.

Finding 2. Table B.6 reports the observed efficiencies and receivers' payoffs in the robustness treatments. In treatments *O-2-F*, an increase in the bias from $b = 10$ to $b = 20$ leads to: i) a significant increase in the average $\mathrm{Var}(X(\theta))$ from 44.49 to 283.48 ($p = 0.0076$, Mann-Whitney test), ii) an insignificant increase in the average $(EX(\theta))^2$ from 1.17 to 1.47 ($p = 0.197$, Mann-Whitney test), and iii) an significant decrease in the average receivers' payoff from −45.66 to −284.94 ($p = 0.0076$, Mann-Whitney test). These account for the "no change" of Finding 2.

Finding 3. The data patterns in Figures 10(c)–(f) in the main text for treatments *C-2-F* and *C-2-I* are highly similar to those in Figures 4(a)–(b) for main treatments *C-2*. Table B.6 show that, for *C-2-F*, the average $(EX(\theta))^2 = 50.77$ for $b = 10$ and $(EX(\theta))^2 = 60.60$ for $b = 20$ and, for *C-2-I*, $(EX(\theta))^2 = 27.80$ for $b = 10$ and $(EX(\theta))^2 = 55.11$, which are all significantly greater than 0 ($p \leqslant 0.0625$ in all four cases, Wilcoxon signed-rank tests).[1] Table B.4 reports estimation results from piecewise random-effects GLS models, which corresponds to Table 6 in the main text for *C-2*. For *C-2-F*, there are a few changes in the significance of the estimates. There is also one change for *C-2-I*. These account for the "partial quantitative change" of Finding 3 for the two robustness treatments.

Finding 4. Table B.6 shows that an increase in the bias from $b = 10$ to $b = 20$ leads to: i) significant increases in the average $\mathrm{Var}(X(\theta))$ from 50.29 to 235.03 in *C-2-F* and from 47.20 to 296.11 in *C-2-I* ($p \leqslant 0.0143$ in both cases, Mann-Whitney tests), ii) no significant

[1] The p-value of 0.0625 is the lowest possible value for four observations (treatments *C-2-I*) from the Wilcoxon signed-rank test.

Table B.4: Random-Effects GLS Regression: Treatments *C-2-F* and *C-2-I*

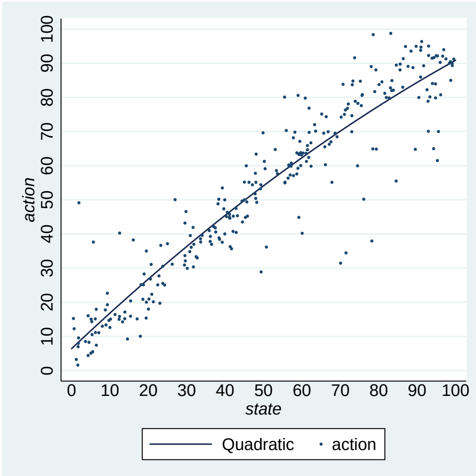
	C-2-F		*C-2-I*	
	$b = 10$	$b = 20$	$b = 10$	$b = 20$
	(1)	(2)	(3)	(4)
Constant	9.778***	15.77***	8.925***	22.23***
	(1.091)	(3.094)	(0.558)	(2.268)
θ	0.991***	1.097***	0.973***	0.913***
	(0.0236)	(0.193)	(0.0122)	(0.117)
interval_middle	24.15**	9.494	26.56***	10.68***
	(8.867)	(7.434)	(4.624)	(4.088)
$\theta \times$ *interval_middle*	−0.636***	−0.490*	−0.656***	−0.456***
	(0.135)	(0.147)	(0.0933)	0.135
interval_high	−42.76**	18.60	−47.84***	−35.45**
	(13.27)	(22.07)	(5.918)	(13.05)
$\theta \times$ *interval_high*	0.592*	−0.525	0.622***	0.181
	(0.191)	(0.327)	(0.0847)	(0.195)
interval_top	52.19	−201.8	80.03**	−101.3
	(43.89)	(294.4)	(25.55)	(161.8)
$\theta \times$ *interval_top*	−0.629	1.703	−0.867**	0.82
	(0.464)	(3.03)	(0.27)	(1.661)
No. of Observations	180	210	600	600

Note: The dependent variable is action a. *interval_middle* is a dummy variable for $\theta \in (50 - b, 50 + b]$. *interval_high* is a dummy variable for $\theta \in (50 + b, \min\{50 + 3b, 95\}]$. *interval_top* is a dummy variable for $\theta \in (\min\{50 + 4b, 95\}, 100]$. Standard errors are in parentheses. *** indicates significance at 0.1% level, ** significance at 1% level, and * significance at 5% level.

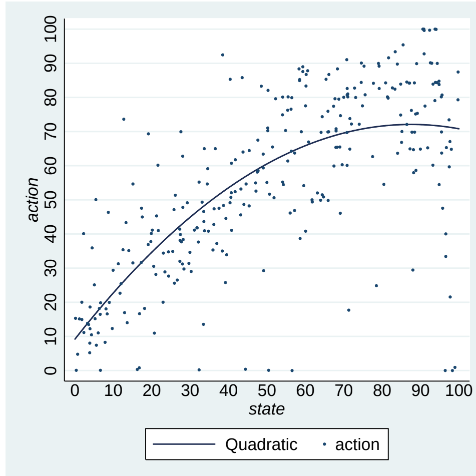
changes in the average $E(X(\theta))^2$ from 50.77 to 60.6 in *C-2-F* and from 27.8 to 55.11 in *C-2-I* (two-sided $p \geqslant 0.3429$ in both cases, Mann-Whitney tests), and iii) significant decreases in the average receivers' payoff from −101.06 to −295.63 in *C-2-F* and from −75 to −351.22 in *C-2-I* ($p \leqslant 0.0143$ in both cases, Mann-Whitney tests). These account for the "no change" of Finding 4 for the two robustness treatments.

Finding 5. Table B.6 shows that, for $b = 10$, the average receivers' payoff is −45.66 in *O-2-F*, which is significantly higher than the −111.33 in *O-1-F* ($p = 0.044$, Mann-Whitney test), and, for $b = 20$, the payoff is −284.94 in *O-2-F*, which is higher than the −500.76 in *O-1-F* but without statistical significance ($p = 0.1838$, Mann-Whitney test). The statistically significant comparison for $b = 10$ accounts for the "partial quantitative change" of Finding 5.

Finding 6. Figure B.2 presents the relationships between realized states and chosen actions in treatments *O-1-F*. The estimation results reported in columns (7) and (8) in Table B.3 confirm that the similar quadratic relationships seen in treatments *O-1* are also



(a) $b = 10$



(b) $b = 20$

Figure B.2: Relationship between State and Action: Treatments *O-1-F*

Table B.5: Random-Effects Probit Regression:
Open-Rule Robustness Treatments

	$b = 10$	$b = 20$
	(1)	(2)
Constant	−1.728***	−1.192***
	(0.283)	(0.284)
θ	−0.00391	−0.0033
	(0.00456)	(0.00412)
one_sender	−0.0276	−1.014**
	(0.251)	(0.332)
No. of Observations	450	480

Note: The dependent variable is a dummy variable for $a \in [49.5, 50.5]$. *one_sender* is dummy variable for treatments *O-1-F*. Standard errors are in parentheses. *** indicates significance at 0.1% level, ** significance at 1% level, and * significance at 5% level.

observed in *O-1-F*. Table B.5 shows that the same kind of results as those reported in Table 8 in the main text are also obtained from the probit regressions: actions in a close neighborhood of 50 are less frequently obtained with one sender, but only the case with $b = 20$ is statistically significant. This accounts for the "no change" of Finding 6.

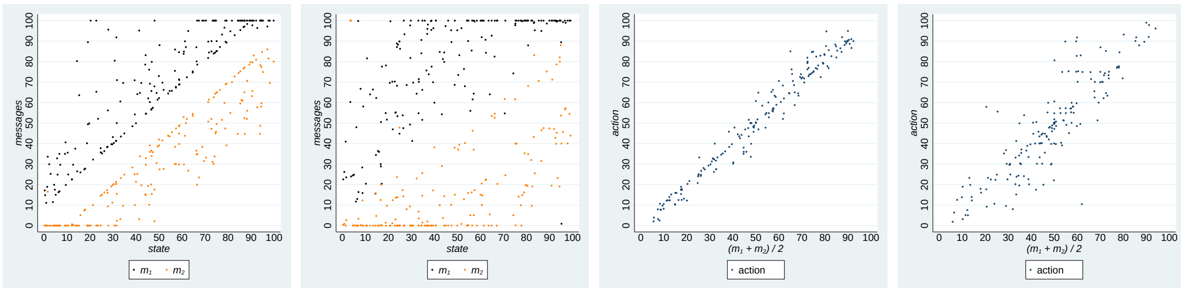
Finding 7. Table B.6 shows that, for $b = 10$, the average receivers' payoff is −101.06 in *C-2-F*, which is higher than the −111.33 in *O-1-F* but without statistical significance, and, for $b = 20$, the payoff is −295.63 in *C-2-F*, which is again higher than the −500.76 in *O-1-F* but without statistical significance ($p \geqslant 0.2681$ in both cases, Mann-Whitney tests). These account for the "no change" of Finding 7 for *C-2-F* and *O-1-F*. The "partial quantitative change" for *C-2-I* is reported in the main text as an example.

Finding 8. For distributional inefficiencies, Table B.6 shows that, for $b = 10$, the average $(EX(\theta))^2$ is 1.17 in *O-2-F*, which is significantly lower than the 50.77 in *C-2-F*, and, for $b = 20$, the average $(EX(\theta))^2$ is 1.47 in *O-2-F*, which is again significantly lower than the 60.6 in *C-2-F* ($p \leqslant 0.0023$ in both cases, Mann-Whitney tests). For informational inefficiencies, for $b = 10$, the average $\mathrm{Var}(X(\theta))$ is 44.49 in *O-2-F*, which is lower than the 50.29 in *C-2-F* but without statistical significance, and, for $b = 20$, the average $\mathrm{Var}(X(\theta))$ is 283.48 in *O-2-F*, which is higher than the 235.03 in *C-2-F* but without statistical significance ($p \geqslant 0.2226$ in both cases, Mann-Whitney tests). For receivers' payoffs, for $b = 10$, the average payoff is -45.66 in *O-2-F*, which is significantly higher than the -101.06 in *C-2-F* ($p = 0.0325$, Mann-Whitney test), and, for $b = 20$, the payoff is -284.94 in *O-2-F*, which is higher than the -295.63 in *C-2-F* but without statistical significance ($p = 0.5822$, Mann-Whitney test).

For treatments *C-2-I*, since random matchings are used, the comparison should be made to main treatments *O-2*. For distributional inefficiencies, Table 5 in the main text and Table B.6 show that, for $b = 10$, the average $(EX(\theta))^2$ is 1.05 in *O-2*, which is significantly lower than the 27.8 in *C-2-I*, and, for $b = 20$, the average $(EX(\theta))^2$ is 6.63 in *O-2*, which is again significantly lower than the 55.11 in *C-2-I* ($p = 0.0143$ in both cases, Mann-Whitney tests). For informational inefficiencies, for $b = 10$, the average $\mathrm{Var}(X(\theta))$ is 93.37 in *O-2*, which is significantly higher than the 47.2 in *C-2-I* ($p = 0.0143$, Mann-Whitney test), and, for $b = 20$, the average $\mathrm{Var}(X(\theta))$ is 300.77 in *O-2*, which is higher than the 296.11 in *C-2-I* but without statistical significance ($p = 0.5571$, Mann-Whitney test). For receivers' payoffs, for $b = 10$, the average payoff is -94.42 in *O-2*, which is lower than the -75 in *C-2-I* but without statistical significance, and, for $b = 20$, the payoff is -307.4 in *O-2*, which is higher than the -351.22 in *C-2-I* but again without statistical significance ($p = 0.1$ in both cases, Mann-Whitney tests).

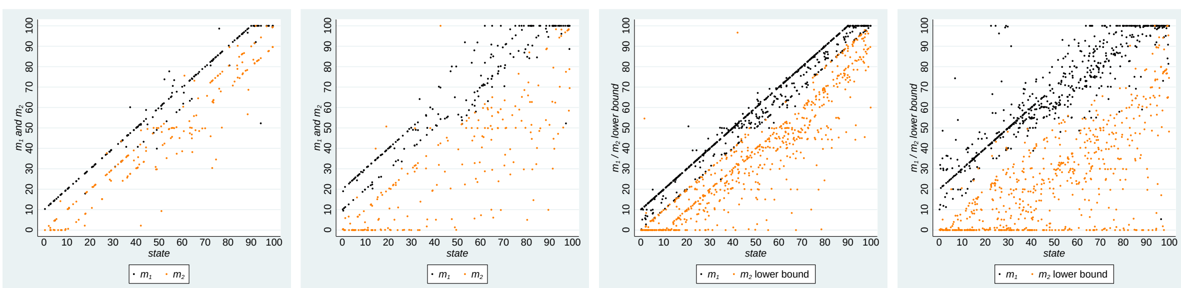
The two sets of comparisons with changes in statistical significance in the latter account for the "no change" of Finding 8 for *O-2-F* and *C-2-F* and the "partial quantitative change" for *C-2-I*.

Finally, Figures B.3–B.5 present senders' and receivers' behavior in the robustness treatments analogous to Figures 6–9 in the main text.



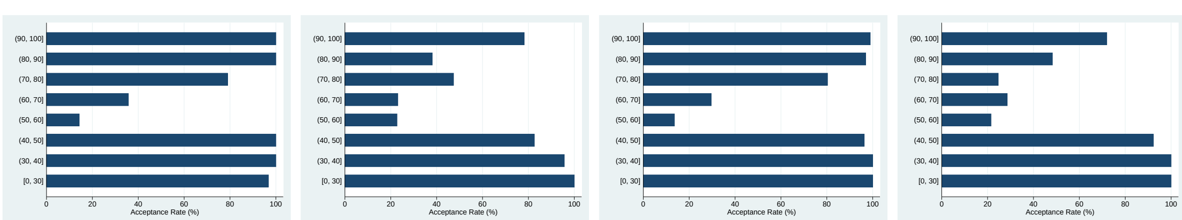
(a) State-Message, $b = 10$ (b) State-Message, $b = 20$ (c) Average Message-Action, $b = 10$ (d) Average Message-Action, $b = 20$

Figure B.3: Relationship between State and Message and Action as a Function of Average Message: Treatments *O-2-F*



(a) *C-2-F*, $b = 10$ (b) *C-2-F*, $b = 20$ (c) *C-2-I*, $b = 10$ (d) *C-2-I*, $b = 20$

Figure B.4: Relationship between State and Message: Treatments *C-2-F* and *C-2-I*



(a) *C-2-F*, $b = 10$ (b) *C-2-F*, $b = 20$ (c) *C-2-I*, $b = 10$ (d) *C-2-I*, $b = 20$

Figure B.5: Receivers' Adoption Rate of Proposals from Senders 1: Treatments *C-2-F* and *C-2-I*

Table B.6: Observed Efficiencies and Receivers' Payoffs: Robustness Treatments

Session / Fixed Group	Informa. Efficiency $-\text{Var}(X(\theta))$	Distrib. Efficiency $-(EX(\theta))^2$	Receiver Payoffs	Informa. Efficiency $-\text{Var}(X(\theta))$	Distrib. Efficiency $-(EX(\theta))^2$	Receiver Payoffs	Informa. Efficiency $-\text{Var}(X(\theta))$	Distrib. Efficiency $-(EX(\theta))^2$	Receiver Payoffs	Informa. Efficiency $-\text{Var}(X(\theta))$	Distrib. Efficiency $-(EX(\theta))^2$	Receiver Payoffs
	$b = 10$											
	O-2-F			*C-2-F*			*C-2-I*			*O-1-F*		
1	−16.51	0.00	−16.51	−24.19	−63.23	−87.42	−42.20	−27.29	−69.49	−13.15	−29.58	−42.73
2	−6.27	−0.12	−6.39	−129.21	−4.57	−133.78	−49.48	−30.16	−79.64	−11.65	−8.02	−19.66
3	−50.81	−0.18	−51.00	−76.49	−66.77	−143.26	−52.76	−22.91	−75.67	−112.76	−20.05	−132.80
4	−5.55	−0.17	−5.71	−35.76	−42.45	−78.21	−44.38	−30.83	−75.21	−40.59	−2.77	−43.36
5	−151.07	−6.53	−157.60	−18.52	−71.77	−90.28	–	–	–	−131.49	−31.35	−162.84
6	−36.72	−0.02	−36.74	−17.60	−55.82	−73.42	–	–	–	−21.94	−0.04	−21.98
7	–	–	–	–	–	–	–	–	–	−171.29	−1.20	−172.49
8	–	–	–	–	–	–	–	–	–	−119.05	−31.95	−151.00
9	–	–	–	–	–	–	–	–	–	−227.66	−27.47	−255.13
Mean	−44.49	−1.17	−45.66	−50.29	−50.77	−101.06	−47.20	−27.80	−75.00	−94.40	−16.94	−111.33
	$b = 20$											
	O-2-F			*C-2-F*			*C-2-I*			*O-1-F*		
1	−322.62	−0.26	−322.88	−178.32	−46.00	−224.31	−449.08	−31.08	−480.13	−85.97	−7.24	−93.21
2	−313.39	−6.07	−319.46	−217.13	−137.10	−354.24	−287.98	−13.68	−301.66	−341.35	−10.82	−352.17
3	−406.42	−2.10	−408.53	−514.78	−1.91	−516.69	−190.54	−118.33	−308.87	−527.44	−0.01	−527.45
4	−207.05	−0.14	−207.19	−222.24	−109.98	−332.22	−256.85	−57.36	−314.21	−4.95	−99.81	−104.77
5	−425.66	−0.21	−425.87	−135.03	−43.87	−178.90	–	–	–	−574.22	−40.10	−614.33
6	−25.73	−0.02	−25.75	−138.75	−31.53	−170.28	–	–	–	−149.33	−0.13	−149.45
7	–	–	–	−238.93	−53.84	−292.77	–	–	–	−1044.45	−15.93	−1060.38
8	–	–	–	–	–	–	–	–	–	−891.23	−4.46	−895.69
9	–	–	–	–	–	–	–	–	–	−210.98	−6.80	−217.78
10	–	–	–	–	–	–	–	–	–	−985.04	−7.38	−992.42
Mean	−283.48	−1.47	−284.94	−235.03	−60.60	−295.63	−296.11	−55.11	−351.22	−481.49	−19.27	−500.76

Note: Informational and distributional *efficiencies* are measured by, respectively, the negative numbers $-\text{Var}(X(\theta))$ and $-(EX(\theta))^2$. The corresponding *inefficiencies* are thus measured by the absolute magnitudes of the variances and the squared expectations. Receiver payoffs are calculated as $[-\text{Var}(X(\theta)) - (EX(\theta))^2]$.

Appendix C – Experimental Instructions

Instructions for Treatment *O-2* with $b = 20$

Welcome to the experiment. This experiment studies decision making between three individuals. In the following two hours or less, you will participate in 30 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 well you make your decisions according to these instructions.

Your Role and Decision Group

There are 15 participants in today's session. One third of the participants will be randomly assigned the role of Member A, another one third the role of Member B, and the remaining the role of Member C. Your role will remain fixed throughout the experiment. In each round, three participants, one Member A, one Member B and one Member C, will be matched to form a group of three. The three members in a group make decisions that will affect their rewards in the round. Participants will be randomly rematched after each round to form new groups.

Your Decision in Each Round

In each round and for each group, the computer will randomly select a number with two decimal places from the range $[0.00, 100.00]$. Each possible number has equal chance to be selected. The selected number will be revealed to Member A and Member B. Member C, without seeing the number, will have to choose an action. In the rest of the instruction, we will call the randomly selected number X and Member C's chosen action Y.

Member A's and B's Decisions

You will be presented with a line on your screen. The left end of the line represents -20.00 and the right end 120.00. You will see a green ball on the line, which represents the randomly selected number X. There is another ball, a blue one, that represents your "ideal action," which is equal to $X + 20$ (Member A) or $X - 20$ (Member B). This ideal action is related to your reward in the round, which will be explained below.

With all this information on your screen, you will be asked to report to Member C what X is. You do so by clicking on the line. A red ball, which represents your reported X, will move to the point you click on. You can adjust your click until you arrive at the point/number you wish to report, after which you click the submit button. You are free to choose any point in the range $[0.00, 100.00]$ for your report; it is not part of the instructions that you have to tell the truth.

Once you click the submit button, your decision in the round is completed and your report will be transmitted to your paired Member C, who will then be asked to choose an action.

(a) Member A's Screen

(b) Member B's Screen

Figure C.1: Screen Shots

Member C's Decision

You will be presented with a similar line on your screen. After seeing Member A's report represented by a green ball and Member B's report represented by a white ball on the line, you will be asked to make your action choice by clicking on the line. A red ball, which represents your action, will move to the point you click on. You can adjust your click until you arrive at the point/number you wish to choose, after which you click the submit button. The final position of the red ball will represent your action choice Y. You are free to choose any point in the range $[0.00, 100.00]$ for your action. Once you click the submit button, your decision in the round is completed.

Similar to Member A or Member B, you will have your "ideal action," which is equal to the X unknown to you. More details will be explained below.

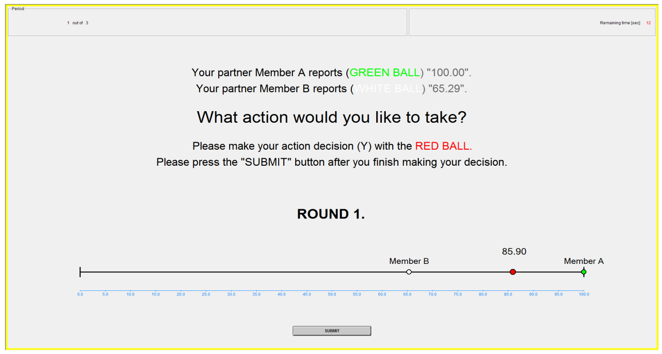


Figure C.2: Member C's Screen

Your Reward in Each Round

Your reward in the experiment will be expressed in terms of experimental currency unit (ECU). The following describes how your reward in each round is determined.

Member A's Reward

The amount of ECU you earn in a round depends on the distance between **your ideal action** $(X+20)$ **and Member C's action choice** Y. In particular,

$$\text{Your reward in each round} = 100 - \frac{[(X+20)-Y]^2}{50}.$$

In case that this value is negative, you will get 0.

Here are some examples:

1. The computer selected the random number $X = 25$. (Thus, your idea action is $X+20 = 45$.) Your reported X is 70. Member B reported X is 40. After the reports, Member C chooses action $Y = 55$. The distance between your ideal action X+20 and Y is **10**. Your earning in the round will be $100 - \frac{[\mathbf{10}]^2}{50} = 98$ ECU.
2. The computer selected the random number $X = 25$. (Thus, your idea action is $X+20 = 45$.) Your reported X is 70. Member B reported X is 40. After the reports, Member C chooses action $Y = 65$. The distance between your ideal action X+20 and Y is **20**. Your earning in the round will be $100 - \frac{[\mathbf{20}]^2}{50} = 92$ ECU.
3. The computer selected the random number $X = 25$. (Thus, your idea action is $X+20 = 45$.) Your reported X is 70. Member B reported X is 40. After the reports, Member C chooses

action $Y = 75$. The distance between your ideal action X+20 and Y is **30**. Your earning in the round will be $100 - \frac{[\mathbf{30}]^2}{50} = 82$ ECU.

These examples demonstrate that the loss of earning from the first 10 distance is only 2 ECU whereas the loss of earning from the second and the third 10 distances are 6 ECU and 10 ECU respectively. In other words, the father away the action is from your ideal action, the higher the rate of loss. Table C.1 provides an elaborate example regarding your earning and the distance between your ideal action and the action taken by Member C.

Member B's Reward

The amount of ECU you earn in a round depends on the distance between **your ideal action** $(X - 20)$ **and Member C's action choice** Y. In particular,

$$\text{Your reward in each round} = 100 - \frac{[(X-20)-Y]^2}{50}.$$

In case that this value is negative, you will get 0.

Member C's Reward

The amount of ECU you earn in a round depends on the distance between **your ideal action** X **and the action choice** Y. More precisely,

$$\text{Your reward in each round} = 100 - \frac{[X-Y]^2}{50}.$$

In case that this value is negative, you will get 0.

Here are some examples:

1. You choose action $Y = 30$. It turns out that the computer selected the random number $X = 20$. The distance between your ideal action X and your action choice Y is **10**. Then your earning in the round will be $100 - \frac{[\mathbf{10}]^2}{50} = 98$ ECU.
2. You choose action $Y = 40$. It turns out that the computer selected the random number $X = 20$. The distance between your ideal action X and your action choice Y is **20**. Then your earning in the round will be $100 - \frac{[\mathbf{20}]^2}{50} = 92$ ECU.

Distance between (Your Ideal Action) and Y	0	10	20	30	40	50	60	70	>70
Your earning	100	98	92	82	68	50	28	2	0

Table C.1: Your earnings

3. You choose action $Y = 50$. It turns out that the computer selected the random number $X = 20$. The distance between your ideal action X and your action choice Y is **30**. Then your earning in the round will be $100 - \frac{[\mathbf{30}]^2}{50} = 82$ ECU.

These examples demonstrate that the loss of earning from the first 10 distance is only 2 ECU whereas the loss of earning from the second and the third 10 distances are 6 ECU and 10 ECU respectively. In other words, the father away the action is from your ideal action, the higher the rate of loss. Table C.1 provides an elaborate example regarding your earning and the distance between your ideal action and the action taken by Member C.

Information Feedback

At the end of each round, the computer will provide a summary for the round: which number was selected and revealed to Member A and Member B, Member A's report, Member B's report, Member C's action choice, distance between your ideal action and Member C's action choice and your earning in ECU.

Your Cash Payment

The experimenter randomly selects 3 rounds out of 30 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 average amount of ECU you earned in the 3 selected rounds plus a HK$40 show-up fee.

Quiz and Practice

To ensure your understanding of the instructions, we will provide you with a quiz and practice round. We will go through the quiz after you answer it on your own.

You will then participate in 1 practice round. The practice round is part of the instructions which is not relevant to your cash payment; its objective is to get you familiar with the computer interface and the flow of the decisions in each round. Once the practice round is over, the computer will tell you "The official rounds begin now!"

Adminstration

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. 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.

1. Which of the following is true?
   (a) *Member A* and *Member B* must pay more to report to *Member C* a higher value of X.
   (b) *Member A* and *Member B* must pay less to report to *Member C* a lower value of X.
   (c) *Member A* and *Member B* are free to report to *Member C* any value of X in the range of $[0.00, 100.00]$. There is no direct cost of report.
2. Suppose you are assigned to be a *Member A*. Which of the following is true? What is your answer if you are assigned to be a *Member B* or *Member C*?
   (a) Your reward is higher if the distance between $X + 20$ and Y is bigger.
   (b) Your reward is higher if the distance between X and Y is bigger.
   (c) Your reward is higher if the distance between $X + 20$ and Y is smaller.
   (d) Your reward is higher if the distance between X and Y is smaller.
   (e) Your reward is higher if the distance between $X - 20$ and Y is bigger.
   (f) Your reward is higher if the distance between $X - 20$ and Y is smaller.
3. Suppose you are assigned to be a *Member A*. The computer chooses the random number $X = 25$. Which of the following is true?
   (a) Both you and *Member B* know the chosen number X but *Member C* does not know the chosen number X.
   (b) Neither you nor *Member B* knows the chosen number X.
   (c) You are the only person in your group who knows the chosen number X.

Instructions for Treatment *C-2* with $b = 20$

INSTRUCTION

Welcome to the experiment. This experiment studies decision making among three individuals. In the following two hours or less, you will participate in 30 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 well you make your decisions according to these instructions.

Your Role and Decision Group

There are 15 participants in today's session. One third of the participants will be randomly assigned the role of Member A, another one third the role of Member B, and the remaining the role of Member C. Your role will remain fixed throughout the experiment. In each round, three participants, one Member A, one Member B and one Member C, will be matched to form a group of three. The three members in a group make decisions that will affect their rewards in the round. Participants will be randomly rematched after each round to form new groups.

Your Decision in Each Round

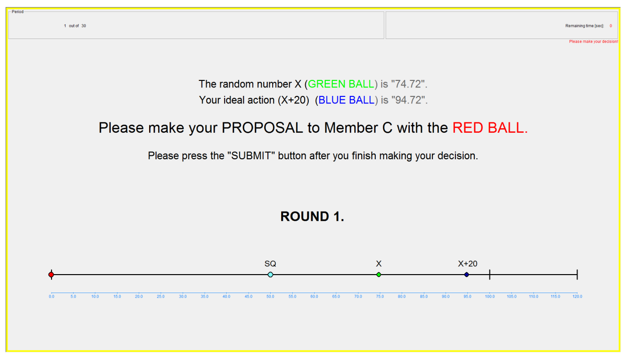
In each round and for each group, the computer will randomly select a number with two decimal places from the range $[0.00, 100.00]$. Each possible number has equal chance to be selected. The selected number will be revealed to Member A and Member B. Member C, without seeing the number, will have to choose an action. In the rest of the instruction, we will call the randomly selected number X and Member C's chosen action Y.

Member A's Decisions

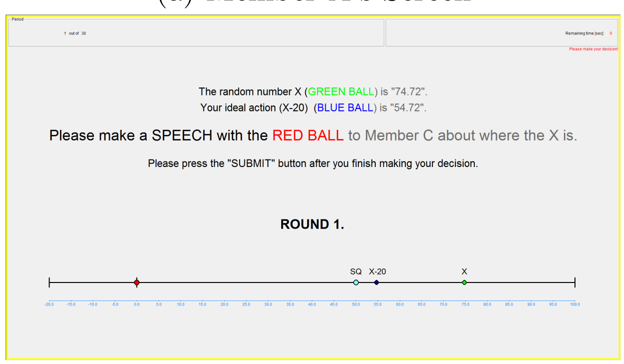
You will be presented with a horizontal line on your screen. The left end of the line represents 0.00 and the right end 120.00. You will see a green ball on the line, which represents the randomly selected number X. There is another blue ball that represents your "ideal action," which is equal to $X + 20$. This ideal action is related to your reward in the round, which will be explained below.

With all this information on your screen, you will be asked to make a **proposal** to Member C on what action to take. You do so by clicking on the line. A red ball, which represents your proposal, will move to the point you click on. You can adjust your click until you arrive at the point/number you desire, after which you click the submit button. You are free to choose any point in the range $[0.00, 100.00]$ for your proposal.

Once you click the submit button, your decision in the round is completed and your proposal will be transmitted to your paired Member C. With the additional information provided by Member B, Member C will then decide whether to accept your proposal or take a status quo action SQ=50.00.



(a) Member A's Screen



(b) Member B's Screen

Figure C.3: Screen Shots

Member B's Decisions

You will be presented with a horizontal line on your screen. The left end of the line represents -20.00 and the right end 100.00. You will see a green ball on the line, which represents the randomly selected number X. There is another blue ball that represents your “ideal action,” which is equal to $X - 20$. This ideal action is related to your reward in the round, which will be explained below.

With all this information on your screen, you will be asked to make a **speech** to Member C regarding where X is. You do so by clicking on the line. A red ball, which represents your speech, will move to the point you click on. You can adjust your click until you arrive at the point/number you desire, after which you click the submit button. You are free to choose any point in the range $[0.00, 100.00]$ for your speech.

Once you click the submit button, your decision in the round is completed and your speech will be transmitted to your paired Member C, who will then decide whether to accept Member A’s proposal or take a status quo action SQ=50.00.

Member C’s Decision

You will be presented with a similar horizontal line on your screen. After seeing Member A’s proposal represented by a green ball and Member B’s speech represented by a red ball, you will be prompted to enter your choice of action. You must choose one of the two options: either to “TAKE the PROPOSAL” from Member A or to “TAKE the STATUS QUO” which is represented by a light blue ball (50.00) on the line. Once you click one of the buttons, your decision in the round is completed.

Similar to Member A or Member B, you will have your “ideal action,” which is equal to the X unknown to you. More details will be explained below.

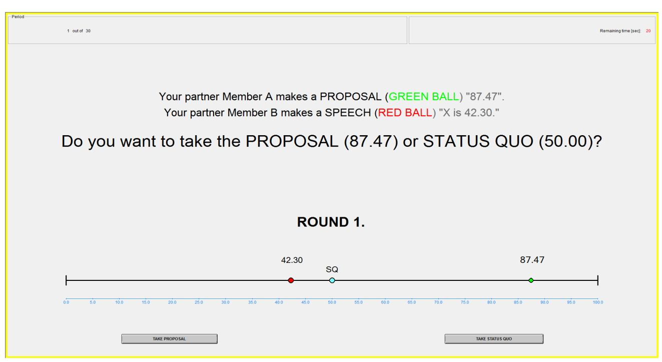


Figure C.4: Member C’s Screen

Your Reward in Each Round

Your reward in the experiment will be expressed in terms of experimental currency unit (ECU). The following describes how your reward in each round is determined.

Member A's Reward

The amount of ECU you earn in a round depends on the distance between **your ideal action** $(X + 20)$ **and Member C's action choice** Y. In particular,

$$\text{Your reward in each round} = 100 - \frac{[(X+20)-Y]^2}{50}.$$

In case that this value is negative, you will get 0.

Here are some examples:

1. The computer selected the random number $X = 25$. (Thus, your idea action is $X+20 = 45$.) You make a proposal "55". Member B made a speech "X is 10." After the proposal and the speech, Member C chooses to take the proposal $Y = 55$. The distance between your ideal action X+20 and Y is **10**. Your earning in the round will be $100 - \frac{[\mathbf{10}]^2}{50} = 98$ ECU.
2. The computer selected the random number $X = 25$. (Thus, your idea action is $X+20 = 45$.) You make a proposal "65". Member B made a speech "X is 10." After the proposal and the speech, Member C chooses to take the proposal $Y = 65$. The distance between your ideal action X+20 and Y is **20**. Your earning in the round will be $100 - \frac{[\mathbf{20}]^2}{50} = 92$ ECU.
3. The computer selected the random number $X = 25$. (Thus, your idea action is $X+20 = 45$.) You make a proposal "75". Member B made a speech "'X is 10." After the proposal and the speech, Member C chooses to take the proposal $Y = 75$. The distance between your ideal action X+20 and Y is **30**. Your earning in the round will be $100 - \frac{[\mathbf{30}]^2}{50} = 82$ ECU.

These examples demonstrate that the loss of earning from the first 10 distance is only 2 ECU whereas the loss of earning from the second and the third 10 distances are 6 ECU and 10 ECU respectively. In other words, the farther away the action is from your ideal action, the higher the rate of loss. Table C.2 provides an elaborate example regarding your earning and the distance between your ideal action and the action taken by Member C.

Member B's Reward

The amount of ECU you earn in a round depends on the distance between **your ideal action** $(X - 20)$ **and Member C's action choice** Y. In particular,

$$\text{Your reward in each round} = 100 - \frac{[(X-20)-Y]^2}{50}.$$

In case that this value is negative, you will get 0.

Member C's Reward

The amount of ECU you earn in a round depends on the distance between **your ideal action** X **and the action choice** Y. More precisely,

$$\text{Your reward in each round} = 100 - \frac{[X-Y]^2}{50}.$$

In case that this value is negative, you will get 0.

Here are some examples:

1. Member A makes a proposal "30" and Member B makes a speech "'X is 10." You choose to take the proposal $Y = 30$. It turns out that the computer selected the random number $X = 20$. The distance between your ideal action X and your action choice Y is **10**. Then your earning in the round will be $100 - \frac{[\mathbf{10}]^2}{50} = 98$ ECU.
2. Member A makes a proposal "40" and Member B makes a speech "'X is 10." You choose to take the proposal $Y = 40$. It turns out that the computer selected the random number $X = 20$. The distance between your ideal action X and your action choice Y is **20**. Then your earning in the round will be $100 - \frac{[\mathbf{20}]^2}{50} = 92$ ECU.
3. Member A makes a proposal "50" and Member B makes a speech "'X is 10." You choose to take the proposal $Y = 50$. It turns out that the computer selected the random number $X = 20$. The distance between your ideal action X and your action choice Y is **30**. Then your earning in the round will be $100 - \frac{[\mathbf{30}]^2}{50} = 82$ ECU.

These examples demonstrate that the loss of earning from the first 10 distance is only 2 ECU whereas the loss of earning from the second and the third 10 distances are 6 ECU and 10 ECU respectively. In other words, the father away the action is from your ideal action, the higher the rate of loss. Table C.2 provides an elaborate example regarding your earning and the distance between your ideal action and the action taken by Member C.

Distance between (Your Ideal Action) and Y	0	10	20	30	40	50	60	70	>70
Your earning	100	98	92	82	68	50	28	2	0

Table C.2: Your earnings

Information Feedback

At the end of each round, the computer will provide a summary for the round: which number was selected and revealed to Member A and Member B, Member A's proposal, Member B's speech, Member C's action choice, distance between your ideal action and Member C's action choice and your earning in ECU.

Your Cash Payment

The experimenter randomly selects 3 rounds out of 30 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 average amount of ECU you earned in the 3 selected rounds plus a HK$40 show-up fee.

Quiz and Practice

To ensure your understanding of the instructions, we will provide you with a quiz and practice round. We will go through the quiz after you answer it on your own.

You will then participate in 1 practice round. The practice round is part of the instructions which is not relevant to your cash payment; its objective is to get you familiar with the computer interface and the flow of the decisions in each 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. 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.

1. Which of the following is true?
   (a) *Member A* must pay more to propose to *Member C* a higher value of X.
   (b) *Member A* must pay less to propose to *Member C* a lower value of X.
   (c) *Member A* is free to propose to *Member C* any value of X in the range of $[0.00, 100.00]$. There is no direct cost of proposal.
2. Suppose you are assigned to be a *Member A*. Which of the following is true? What is your answer if you are assigned to be a *Member B* or a *Member C*?
   (a) Your reward is higher if the distance between $X + 20$ and Y is bigger.
   (b) Your reward is higher if the distance between X and Y is bigger.
   (c) Your reward is higher if the distance between $X + 20$ and Y is smaller.
   (d) Your reward is higher if the distance between X and Y is smaller.
   (e) Your reward is higher if the distance between $X - 20$ and Y is bigger.
   (f) Your reward is higher if the distance between $X - 20$ and Y is smaller.
3. Suppose you are assigned to be a *Member A*. The computer chooses the random number $X = 25$. Which of the following is true?
   (a) Both you and *Member B* know the chosen number X.
   (b) Neither you nor *Member B* knows the chosen number X.
   (c) You are the only person in your group who knows the chosen number X.

Appendix D – Level-k Models

As a supplementary, non-equilibrium analysis of our experimental environment, we construct two level-k models, one for the open rule with two senders and one for the closed rule with two senders. As the anchoring point of the model, we assume, following the convention in the level-k literature on communication games, that level-0 senders tell the truth so that $m_1(\theta) = m_2(\theta) = \theta$ and that level-0 receiver credulously adopts the senders' recommendations or proposals.[2] For the open rule, this means that level-0 receiver takes an action that is equal to the average of the two messages so that $a(m_1, m_2) = \overline{m} = \frac{m_1+m_2}{2}$.[3] For the closed rule, we assume that level-0 receiver adopts Sender 1's proposal so that $a(m_1, m_2) = m_1$, since the receiver can only choose between adopting Sender 1's proposal and taking the *status quo* action.

We further assume that level-k Sender i, $i = 1, 2$ and $k = 1, \ldots, K$, best responds to level-k Sender $j \neq i$ and level-$(k-1)$ receiver, while level-k receiver best responds to level-k senders.[4] Since the games in question are communication games, in addition to the standard assumptions for level-k models such as the specification of level-0 behavior, we need to make further assumptions regarding how the receiver responds to unexpected (off-path) messages. For both level-k models, we assume that level-k receiver, $k = 1, \ldots, K$, takes $a = 50$, the optimal action under the prior, when messages not expected from level-k senders are received. For the close rule, this is to say that the receiver will take the *status quo* action under these scenarios. Note that this assumption parallels that in Gilligan and Krehbiel [1989] regarding how the receiver responds to out-of-equilibrium messages. We adopt the assumption out of simplicity concern, a guiding principle for our modeling choice.

Open Rule. Under our specification, level-1 senders' strategies are $m_1(\theta) = \min\{2(\theta + b), 100\}$ and $m_2(\theta) = \max\{2(\theta - b) - 100, 0\}$. To illustrate that these are best responses to level-0 receiver and level-1 other sender, suppose that the realized $\theta = 20$ and the bias is $b = 10$. Sender 1 sends $m_1 = 60$, and Sender 2 sends $m_2 = 0$. The level-0 receiver

[2]The use of truthful senders and credulous receivers as the anchoring level-0 types can be traced back to Crawford (2003). Such a specification is adopted by the experimental literature (e.g, Cai and Wang 2006; Wang, Spezio, and Camerer 2010; Crawford and Irreberri 2007a; 2007b) and the theoretical work on lying aversion (e.g., Kartik 2006; Kartik, Ottaviani, and Squintani 2007).

[3]For expositional convenience, we now use $m_1(\cdot)$, $m_2(\cdot)$ and $a(\cdot, \cdot)$ to denote pure strategies.

[4]Unlike most level-k models that have at most two different roles of players choose simultaneously and level-k players best respond to level-$(k-1)$ players, we have three player-roles with the receiver choosing after seeing the senders' messages. Accordingly, we follow Wang, Spezio and Camerer's (2010) asymmetric sender-receiver level-k model, in which level-k receiver best responds to level-k senders and level-k senders best respond to each other as well as to level-$(k-1)$ receiver.

takes action $a = \overline{m} = 30$. Since this is the ideal action of Sender 1, he has no incentive to deviate. Given that Sender 2's ideal action is 10, he would want to send a lower message. But since zero is the lowest possible message, $m_2 = 0$ is the best response.[5]

Best responding to the beliefs derived from the level-1 senders' strategies, level-1 receiver's on-path response rule is

$$a(m_1, m_2) = \begin{cases} \max\{\overline{m} - b, 0\}, & \overline{m} < 50, \\ \overline{m}, & \overline{m} = 50, \\ \min\{\overline{m} + b, 100\}, & \overline{m} > 50. \end{cases}$$

Suppose that the bias is $b = 10$ and the receiver receives on-path messages $m_1 = 60$ and $m_2 = 0$. This is the case where $\overline{m} = 30 < 50$, and the receiver takes $a = 30 - 10 = 20$. Level-1 Sender 2 sends $m_2 = 0$ only for $\theta \leqslant 60$. The message thus contains only coarse information. On the other hand, level-1 Sender 1 sends $m_1 = 60$ only when $\theta = 20$, and the precise information in m_1 makes Sender 2's message effectively useless. The receiver updates beliefs accordingly and takes $a = 20$, her ideal action for $\theta = 20$. Similarly, if the two on-path messages are such that $\overline{m} > 50$, the receiver follows Sender 2's message given that Sender 1 will then be providing coarse information. If $m_1 = 100$ and $m_2 = 0$ so that $\overline{m} = 50$, combining the two messages the receiver believes that $\theta \in [40, 60]$ (note that Sender 1 sends $m_1 = 100$ only for $\theta \geqslant 40$). Given the uniform prior, the receiver takes $a = 50$, which equals the conditional expected value of $\theta \in [40, 60]$.

Level-2 players' strategies follow a similar logic. Knowing that (in most cases) level-1 receiver discounts or adds on the average message by b, level-2 senders further bias their message and adopt strategies $m_1(\theta) = \min\{2(\theta + 2b), 100\}$ and $m_2(\theta) = \max\{2(\theta - 2b) - 100, 0\}$.[6] Given these level-2 senders' strategies, the best-responding level-2 receiver then

[5]For the bias parameters we adopt in the experiment, the detailed cases of level-1 senders' strategies are:

for $b = 10$, $m_1(\theta) = \begin{cases} 100, & \theta > 40, \\ 2(\theta + 10), & \theta \leqslant 40, \end{cases}$ and $m_2(\theta) = \begin{cases} 0, & \theta < 60, \\ 2(\theta - 10) - 100, & \theta \geqslant 60; \end{cases}$

for $b = 20$, $m_1(\theta) = \begin{cases} 100, & \theta > 30, \\ 2(\theta + 20), & \theta \leqslant 30, \end{cases}$ and $m_2(\theta) = \begin{cases} 0, & \theta < 70, \\ 2(\theta - 20) - 100, & \theta \geqslant 70. \end{cases}$

Under these strategies and the level-0 receiver's action rule, Sender 1 obtains his ideal action for $\theta \leqslant 50 - b$, and Sender 2 obtains his for $\theta \geqslant 50 + b$. For $\theta \in (50 - b, 50 + b)$, in which the level-0 receiver's action is $a = 50$, Sender 1 (Sender 2) obtains an action that is closer to his ideal action than it is to Sender 2's (Sender 1's) when $\theta < 50$ ($\theta > 50$); when $\theta = 50$, they obtain an action that is of equal distance to their respective ideal actions.

[6]For our adopted bias parameters, the detailed cases of the strategies are:

discounts or adds on the average messages by $2b$:

$$a(m_1, m_2) = \begin{cases} \max\{\overline{m} - 2b, 0\}, & \overline{m} < 50, \\ \overline{m}, & \overline{m} = 50, \\ \min\{\overline{m} + 2b, 100\}, & \overline{m} > 50. \end{cases}$$

Higher level players' strategies are similarly derived by iterating on these best-responding processes.[7]

Closed Rule. Best responding to level-0 receiver, level-1 senders' strategies are $m_1(\theta) = \min\{\theta + b, 100\}$ and $m_2(\theta) = \max\{\theta - b, 0\}$, i.e., they are recommending their ideal actions.[8]

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for $b = 10$, $m_1(\theta) = \begin{cases} 100, & \theta > 30, \\ 2(\theta + 20), & \theta \leqslant 30, \end{cases}$ and $m_2(\theta) = \begin{cases} 0, & \theta < 70, \\ 2(\theta - 20) - 100, & \theta \geqslant 70; \end{cases}$

for $b = 20$, $m_1(\theta) = \begin{cases} 100, & \theta > 10, \\ 2(\theta + 40), & \theta \leqslant 10, \end{cases}$ and $m_2(\theta) = \begin{cases} 0, & \theta < 90, \\ 2(\theta - 40) - 100, & \theta \geqslant 90. \end{cases}$

Under these strategies and the level-1 receiver's action rule, Sender 1 obtains his ideal action for $\theta \leqslant 50 - 2b$, and Sender 2 obtains his for $\theta \geqslant 50 + 2b$. Note that even though for $\theta \leqslant 50 - 2b$, Sender 2 does not obtain a very desirable action, the action taken (i.e., Sender 1's ideal action) is closer to Sender 2's ideal action than is 50, the assumed response for off-path messages. Thus, Sender 2 has no incentive to create off-path messages by deviating from $m_2(\theta) = \max\{2(\theta - 2b) - 100, 0\}$. A similar argument applies for the symmetric case of Sender 1's absence of incentive to deviate when $\theta \geqslant 50 + 2b$. For $\theta \in (50 - 2b, 50 + 2b)$, in which the level-1 receiver's action is $a = 50$, Sender 1 (Sender 2) obtains an action that is closer to his ideal action than it is to Sender 2's (Sender 1's) when $\theta < 50$ ($\theta > 50$); when $\theta = 50$, they obtain an action that is of equal distance to their respective ideal actions. Note that since the on-path action is the same as the assumed response for off-path messages, the senders also have no incentive to deviate in this case.

[7]In particular, level-k senders' strategies, $k = 3, \ldots, K$, are $m_1(\theta) = \min\{2(\theta + kb), 100\}$ and $m_2(\theta) = \max\{2(\theta - kb) - 100, 0\}$. Note that for $k \geqslant \frac{50}{b}$, the strategies coincide with the strategies in a babbling equilibrium in which $m_1(\theta) = 100$ and $m_2(\theta) = 0$. For level-k receiver, $k = 3, \ldots, K$, the on-path response rule is

$$a(m_1, m_2) = \begin{cases} \max\{\overline{m} - kb, 0\}, & \overline{m} < 50, \\ \overline{m}, & \overline{m} = 50, \\ \min\{\overline{m} + kb, 100\}, & \overline{m} > 50. \end{cases}$$

Similarly, for $k \geqslant \frac{50}{b}$, the receiver's best response coincides with the babbling action $a(m_1, m_2) = 50$.

[8]Given that level-0 receiver follows Sender 1's proposal, any message by Sender 2 is a best response. We adopt a natural choice so that Sender 1's and Sender 2's strategies are symmetric in the sense that they both recommend their ideal actions. For the bias parameters we adopt in the experiment, the detailed cases of the strategies are:

for $b = 10$, $m_1(\theta) = \begin{cases} 100, & \theta > 90, \\ \theta + 10, & \theta \leqslant 90, \end{cases}$ and $m_2(\theta) = \begin{cases} 0, & \theta < 10, \\ \theta - 10, & \theta \geqslant 10; \end{cases}$

for $b = 20$, $m_1(\theta) = \begin{cases} 100, & \theta > 80, \\ \theta + 20, & \theta \leqslant 80, \end{cases}$ and $m_2(\theta) = \begin{cases} 0, & \theta < 20, \\ \theta - 20, & \theta \geqslant 20. \end{cases}$

Given these strategies, the on-path response rule of level-1 receiver is

$$a(m_1, m_2) = \begin{cases} m_1, & m_1 \in [b, 50] \cup [50 + 2b, 100), m_2 = \max\{m_1 - 2b, 0\}, \\ m_1, & m_1 = 100, m_2 \in [100 - 2b, 100 - b], \\ 50, & m_1 \in (50, 50 + 2b), m_2 = m_1 - 2b. \end{cases}$$

Best responding to level-1 receiver, level-2 Sender 1's strategy coincides with that of level-1, i.e., $m_1(\theta) = \min\{\theta + b, 100\}$. For level-2 Sender 2, note that he strictly prefers the *status quo* $a = 50$ over $a = \min\{\theta + b, 100\}$ if $(\theta - b) \in [50, \min\{50 + 2b, 75\})$. Accordingly, level-2 Sender 2 will have an incentive to induce the off-path response if $\theta \in [50+b, \min\{50+3b, 75 + b\})$. In this, Sender 2 will be indifferent between any messages that result in an unexpected message pair. We prescribe a message rule so that the resulting specification is as parsimonious as possible. We assume that level-2 Sender 2 sends the same message for all $\theta \in [50+b, \min\{50+3b, 75+b\})$ to induce unexpected message pairs, where such message will not create incentive for level-2 Sender 1 to deviate from $m_1(\theta) = \min\{\theta + b, 100\}$. Any $m_2 \in [0, 50) \cup (100 - b, 100]$ will satisfy these requirements.[9] To pin down a message that will be used, we assume that level-2 Sender 2 will choose a message in $[0, 50)$. In particular, the strategy of level-2 Sender 2 is specified to be:

$$m_2(\theta) = \begin{cases} \max\{\theta - b, 0\}, & \theta \in [0, 50 + b) \cup [\min\{50 + 3b, 75 + b\}, 100], \\ 50 - b, & \theta \in [50 + b, \min\{50 + 3b, 75 + b\}). \end{cases}$$

Best responding to the beliefs derived from level-2 senders' strategies, the on-path response rule of level-2 receiver (stated as a function of m_1 only) coincides with that of level-1.[10] The difference lies in their off-path responses. Note first that when level-2 receiver receives $m_1 \in [50 + 2b, \min\{50 + 4b, 75 + 2b, 100\})$, she expects to receive $m_2 = 50 - b$ from Sender 2. When $b > 12.5$, she also expects to see $m_2 = 50 - b$ when $m_1 = 100$. Any other m_2 will induce an off-path response in these cases. Furthermore, level-2 receiver does not

[9]Note first that the message cannot be in $[50, \min\{50 + 2b, 75\})$, otherwise there will exist a $\theta \in [50 + b, \min\{50 + 3b, 75 + b\})$ at which Sender 2 cannot induce the off-path response. For $m_2 \in [100 - 2b, 100 - b]$, there exist some $\theta \in [50+b, \min\{50+3b, 75+b\})$ (e.g., $\theta = 75+\varepsilon-b$) for which level-2 Sender 1 strictly prefers to send $m_1 = 100$ instead of $m_1 = \theta + b$ in order to induce $a = 100$. For $b \geqslant 12.5$, $50 + 2b \geqslant 75 \geqslant 100 - 2b$, and thus all $m_2 \in [50, 100 - b]$ are ruled out as candidates for Sender 2's off-path message. For $b < 12.5$, $50 + 2b < 75 < 100 - 2b$; when b is sufficiently small, there are messages close to $100 - 2b$ that will not create incentive for Sender 1 to deviate from $m_1(\theta) = \min\{\theta + b, 100\}$. The range $[0, 50) \cup (100 - b, 100]$ stated above, however, guarantees that there is no incentive for Sender 1 to deviate for any b.

[10]Specifically, for $b \geqslant 12.5$, level-2 receivers choose (for $\theta \in [0, 50 - b]$, $(50 - b, 50 + b)$, $[50 + b, \min\{50 +$

expect to receive $m_2 \in [50, \min\{50+2b, 75\})$; if she does, she will take the *status quo* action as off-path response regardless of what m_1 is.

The above implies that the strategies of higher-level Sender 1s remain the same as that of level-1.[11] For higher-level Sender 2s, the strategies are essentially the same as that of level-2, except that they need to use a different message to induce the off-path response. We specify, e.g., that level-3 Sender 2 adopts

$$m_2(\theta) = \begin{cases} \max\{\theta - b, 0\}, & \theta \in [0, 50+b) \cup [\min\{50+3b, 75+b\}, 100], \\ 50 - b - \varepsilon, & \theta \in [50+b, \min\{50+3b, 75+b\}). \end{cases}$$

for some $\varepsilon > 0$. The strategies of higher-level receivers will also coincide with that of level-1, except for what message combinations they consider to be off path.

$3b, 75+b\})$, and $[\min\{50+3b, 75+b\}, 100]$, respectively)

$$a(m_1, m_2) = \begin{cases} m_1, & m_1 \in [b, 50], m_2 = \max\{m_1 - 2b, 0\}, \\ 50, & m_1 \in (50, 50+2b), m_2 = m_1 - 2b, \\ m_1, & m_1 \in [50+2b, \min\{50+4b, 75+2b, 100\}), m_2 = 50 - b, \\ m_1, & m_1 = 100, m_2 = 50 - b \text{ or } m_2 \in [\max\big\{\min\{50+2b, 75\}, 100-2b\big\}, 100-b]. \end{cases}$$

For $b < 12.5$, level-2 receivers choose (for $\theta \in [0, 50-b]$, $(50-b, 50+b)$, $[50+b, \min\{50+3b, 75+b\})$, $[\min\{50+3b, 75+b\}, 100-b)$, and $[100-b, 100]$, respectively)

$$a(m_1, m_2) = \begin{cases} m_1, & m_1 \in [b, 50], m_2 = \max\{m_1 - 2b, 0\}, \\ 50, & m_1 \in (50, 50+2b), m_2 = m_1 - 2b, \\ m_1, & m_1 \in [50+2b, \min\{50+4b, 75+2b, 100\}), m_2 = 50 - b, \\ m_1, & m_1 \in [\min\{50+4b, 75+2b, 100\}, 100), m_2 = \max\{m_1 - 2b, 0\}, \\ m_1, & m_1 = 100, m_2 \in [100-2b, 100-b]. \end{cases}$$

[11] Note that $m_2 = 50 - b$ is sent by level-2 Sender 2 for both $\theta = 50$ and $\theta = 50 + b$. Thus, $m_2 = 50 - b$ paired with $m_1 = 50+b$ and $m_2 = 50-b$ paired with $m_1 = 50+2b$ are both expected by level-2 receiver. The former message pair induces $a = 50$ while the latter induces $a = 50 + 2b$. Accordingly, level-3 Sender 1 has no strict incentive to deviate from $m_1(\theta) = \min\{\theta+b, 100\}$ when his ideal action is $50+b$, i.e., when $\theta = 50$. Had for $\theta \in [50+b, \min\{50+3b, 75+b\})$ level-2 receiver expected level-2 Sender 2 to send $m_2 \in (50-b, 50)$, say, $m_2 = 50 - b + \delta$, level-3 Sender 1 would have preferred to send $m_1 \in [50+2b, \min\{50+3b, 75+b, 100\})$ instead of $50 + b + \delta$ when $\theta = 50 + \delta$. Our choice of $m_2 = 50 - b$ for level-2 Sender 2's strategy when $\theta \in [50+b, \min\{50+3b, 75+b\})$ is to maintain a simple specification where the strategies of higher-level Sender 1s remain the same as that of level-1.

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