Overcommunication in strategic information transmission games

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Timeline

-Basic insight of the theory and Introduction
-Experiments
-Theoretical model and predictions
-Hypothesis
-Experiment design
-Results
-Conclusion

Basic insight of the theory

- The less information is transmitted when preferences of the sender and the reciever diverge. Moreover, the average payoffs for the senders, the recievers, and overall subject population are very close to those predicted by the most informative equilibrium.

Introduction to different experiments

- -Decision makers have to rely on others for information needed to make good decisions.

  - **Laboratory Experiments:**

Crawford and sobel
Costa-Gomes and Costa-Gomes and Crawford
McKelvey and Palfrey
Dickhaut

Theoretical model and predictions

- The sender is informed about the state of the world: S = {1, 3, 5, 7, 9}
  The sender then chooses to send a message to the receiver: M = {1, 3, 5, 7, 9}
  After receiving a message from the sender, the receiver chooses an action:
  A = {1, 2, 3, 4, 5, 6, 7, 8, 9}

Formula: $$uR = 110 - 10 \cdot |s - a|^k$$
$$uS = 110 - 10 \cdot |s + d - a|^k$$

Where uR and uS are the payoffs for the receiver and the sender, respectively, s is the true state of the world,a is the receiver's action, d is the preference difference between the sender and the receiver, and k is a positive parameter.

Babbling equilibrium

- The correlation is zero in the babbling equilibrium, and takes the maximum value of one if actions perfectly match the states of the world.

Equilibria when preference difference varies

Proposition 1. *For* k 1, *the most informative equilibria of the game* (*for different* d*'s*) *are:*

- (1) *the* separating (completely informative) equilibrium *if* d 1, *in which for every state of the world, the sender always tells the truth, and the receiver always chooses the action according to the*(*truthful*) *message*;
- (2) *the* partial pooling equilibrium *if* 1 < d 1.5, *in which the sender sends a same message for states* 1 *and* 3, *and another message for states* 5, 7, *and* 9, *and the receiver chooses* 2 *or* 7;
- (3) *the* partial pooling equilibrium *if* 1.5 < d 2.5, *in which the sender chooses* m(s = 1) = 1 *and pools for states* 3, 5, 7, *and* 9, *while the receiver chooses* 1 *if* m = 1 *and* 6 *otherwise*;
- (4) *the* babbling equilibrium *if* d > 2.5, *in which the sender pools for states* 1, 3, 5, 7, *and* 9, *and the receiver always chooses* 5 *no matter what message it receives.*

Hypothesis

- **Hypothesis 1.** *As the preferences of the sender and the receiver diverge, less information is transmitted by the sender and utilized by the receiver: the correlations between states and messages, between messages and actions, and between states and actions all decrease.*
- **Hypothesis 2.** *As the preferences of the sender and the receiver diverge, both the sender's and the receiver's payoffs decrease*

Experiment design

In each round, within each pair one player was randomly chosen to be the sender and the other to be the receiver. For each pair, the computer program generated a number uniformly from {1, 3, 5, 7, 9}, and revealed the number to the sender. After knowing this number, the sender chose a message to send to the receiver.

Experimental results

- Result 1 : Hypothesis 1
- Result 2 : Hypothesis 2
- Result 3 : Overcommunication

Result 1

- Less information is transmitted by the sender and utilized by the receiver as preferences between the sender and receiver diverge.

- Corr(S,M) , Corr(M,A) , Corr(S,A)

Result 1

Table 3
Actual information transmission

# of obs.	k	d	Correlation		
			(S, M)	(M, A)	(S, A)
70	1.4	0.5	0.916	0.965	0.876
70	1.4	1.2	0.896	0.924	0.830
390	1.4	2	0.734	0.794	0.618
580	1.4	4	0.391	0.542	0.207

Result 2

- Both the senders' and receivers' average payoffs decrease as the preference different increases.

- The average payoffs for the senders, the receivers, and the subject population are very close to those predicted by the most informative equilibrium.

Result 2

Table 4
Theoretical vs. actual payoffs

# of obs.	*d*	Senders' payoffs		Receivers' payoffs		Average	
		Predicted (s.d.)	Actual (s.d.)	Predicted (s.d.)	Actual (s.d.)	Predicted (s.d.)	Actual (s.d.)
70	0.5	106.21 (0.00)	99.08* (24.16)	110.00 (0.00)	101.79** (25.82)	108.11 (1.89)	100.44* (24.95)
70	1.2	89.52 (18.06)	88.76 (18.10)	95.44 (10.33)	93.54 (19.97)	92.48 (15.01)	91.15 (19.14)
390	2	72.37 (31.77)	75.03 (37.28)	87.38 (19.88)	83.69* (32.69)	79.88 (27.54)	79.36 (35.30)
580	4	29.46 (66.32)	36.89** (68.38)	71.59 (27.26)	65.84** (42.72)	50.52 (54.90)	51.37 (58.80)

* *t*-test shows actual payoffs differ from equilibrium payoffs significantly at the 5% level of confidence.
** Idem., 1%.

Result 3

- Senders tend to communicate more information
- Receivers tend to trust the senders more

Result 3

Table 5
Theoretical vs. actual information transmission

# of obs.	d	Correlation (S, M)		Correlation (M, A)		Correlation (S, A)	
		Predicted	Actual	Predicted	Actual	Predicted	Actual
70	0.5	1.000	0.916	1.000	0.965	1.000	0.876*
70	1.2	0.750	0.896**	0.866	0.924	0.866	0.830
390	2	0.500	0.734**	0.707	0.794**	0.707	0.618*
580	4	0.000	0.391**	0.000	0.542**	0.000	0.207**

* t-test shows actual correlations differ from equilibrium correlations significantly at the 5% level of confidence.
** Idem., 1%.

Bounded rationality

- Explanation of result 3

- Behavior type analysis

Behavior type analysis

- Sender : L0 , L1 , L2
- Receiver : L0 , L1 , L2

Table 7
Type classification definition ($d = 4$)

Type name	Sender's message (given S)					Receiver's action (given M)				
	$S=1$	$S=3$	$S=5$	$S=7$	$S=9$	$M=1$	$M=3$	$M=5$	$M=7$	$M=9$
$L0$	1	3	5	7	9	1	3	5	7	9
$L1$	5	7	9	9	9	1	1	1	3	7
$L2$	9	9	9	9	9	5	5	5	5	5
Eq.	any	any	any	any	any	5	5	5	5	5
Soph.	7	9	9	9	9	2	3	3	4	6

Table 8
Type classifications results: senders

Type	Count	Subject number (% of consistency)
*L*0	2	18 (80%), 22 (90.9%)
*L*1	8	1 (83.3%), 2 (66.7%), 12 (71.4%), 14 (69.2%), 16 (60%), 23 (76.9%), 29 (63.2%), 32 (64.7%)
*L*2	10	3 (78.9%), 4 (100%), 6 (100%), 9 (62.5%), 11 (85.7%), 17 (86.7%), 20 (82.4%), 25 (81.3%), 27 (72.2%), 31 (64.7%)
Soph.	4	5 (94.4%), 8 (88.2%), 19 (100%), 30 (100%)
N/A	8	7, 10, 13, 15, 21, 24, 26, 28

Table 9
Type classifications results: receivers

Type	Count	Subject number (% of consistency)
*L*0	3	18 (62.5%), 22 (95%), 25 (66.7%)
*L*1	3	5 (69.2%), 8 (92.9%), 19 (86.7%)
*L*2/Eq.	11	1 (68.4%), 4 (100%), 6 (77.8%), 9 (80%), 12 (82.4%), 15 (70.6%), 21 (66.7%), 24 (88.2%), 27 (61.5%), 30 (80%), 32 (100%)
Soph.	9	2 (78.9%), 7 (62.5%), 10 (60%), 11 (70.6%), 14 (77.8%), 17 (81.3%), 23 (72.2%), 26 (73.3%), 28 (71.4%)
N/A	6	3, 13, 16, 20, 29, 31

Behavior type analysis

Table 10
Estimation results of Nash equilibrium, type analysis and AQRE ($d = 4$)

	Actual	Nash	Type scenario		Crawford equilibrium	AQRE ($\lambda = 2.00$)
			1	2		
Senders' u_S	37.37	29.46	40.54	35.82	50.24	23.49
Receivers' u_R	65.67	71.59	72.86	67.85	79.75	66.20
$Corr(S, M)$	0.376	0.000	0.531	0.388	0.630	0.326
$Corr(M, A)$	0.534	0.000	0.631	0.517	0.829	0.400
$Corr(S, A)$	0.183	0.000	0.361	0.222	0.608	0.178

Robustness analysis

Table 11
Theoretical vs. actual information transmission for robustness tests

# of obs.	Prob. correct signal	k	d	Correlation (S, M)		Correlation (M, A)		Correlation (S, A)	
				Predicted	Actual	Predicted	Actual	Predicted	Actual
80	1	1.2	0.5	1.000	0.916	1.000	0.955	1.000	0.923
208	1	1.2	1.2	0.750	0.897	0.866	0.912	0.866	0.895
80	1	1.2	2	0.500	0.837	0.707	0.850	0.707	0.755
128	1	1.2	4	0.000	0.391	0.000	0.642	0.000	0.312
120	0.9	1.0	0.5	1.000	0.868	1.000	0.924	1.000	0.870
120	0.9	1.0	1.2	0.750	0.887	0.866	0.904	0.866	0.832
120	0.9	1.0	2	0.500	0.858	0.707	0.862	0.707	0.769
120	0.9	1.0	4	0.000	0.354	0.000	0.457	0.000	0.259

Learning effect

Table 12
Actual information transmission and average state for each message: learning effect

Rounds	k	d	Correlation			Average state for each message				
			(S, M)	(M, A)	(S, A)	$M = 1$	$M = 3$	$M = 5$	$M = 7$	$M = 9$
1–5	1.4	4	0.244**	0.500	0.139	5.000	3.857	3.714	5.667	5.533
6–10	1.4	4	0.351	0.530	0.091	5.000	3.444	2.600	3.462	5.978
11–15	1.4	4	0.434	0.449	0.329	2.200	4.333	3.250	4.000	6.111
16–20	1.4	4	0.470	0.566	0.175	1.000	3.500	3.600	4.778	6.171
21–25	1.4	4	0.439	0.627	0.245	2.000	4.500	2.200	4.778	6.107
26–31	1.4	4	0.344	0.557	0.133	1.000	3.889	3.000	3.615	5.567

** Significantly different from the last 6 rounds (rounds 26–31) at the 1% level of confidence.

Conclusion

- Experimental results strongly support the basic insight of the theory.
- Subjects consistently overcommunicate
- Results are robust to certain variations of payoff parameters and noisy signals, and robust to subject's learning.
- behavior type analysis