Coordination under Uncertainty and Restricted Communication: a Generalized Email Game

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The determinants of efficient behavior in coordination games

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ABSTRACT

We study the determinants of efficient behavior in stag hunt games (2×2 symmetric coordination games with Pareto ranked equilibria) using data from eight previous experiments on stag hunt games and a new experiment that allows for a more systematic variation of parameters. We find that subjects do not necessarily play the efficient action (stag), stressing the importance of strategic uncertainty in coordination games. While the frequency of playing stag is greater when stag is risk dominant, there is still large variation in behavior that cannot be explained by risk dominance. Part of this variation is explained by the risk arising from strategic uncertainty that we measure with the size of the basin of attraction of stag. We also explore the importance of other determinants of efficient behavior and we show that the results are robust to paying subjects using the lottery method in an attempt to induce risk neutral preferences.

Background

- Coordination games with **Pareto-ranked** multiple equilibria: bank run, minimum effort, stag-hunt...
- Experimental evidence: **communication improves efficiency**. Especially under incomplete information, e.g. Avoyan (2023)
- Rubinstein's Email Game (1989): Small **noise** in communication destroys Pareto-enhancing coordination.

This Paper

- communication protocol $\rightarrow$ info transmission $\rightarrow$ coordination
- How players **interpret** messages in an coordinative environment but with **noise + asymmetric info**?
- Deviation from Rubinstein: From rich to **succinct** info flow.
- Exogenous variation on protocol features to **restore** full coordination:
  - Automatic vs. Voluntary communication?
  - (sunk) communication cost?

Preview

- Restriction to minimal communication raises equilibrium selection: *Tacit* eq vs. *Vocal* eq.
- *Vocal* implies **efficient** use of message but is risky for players.
- Preliminary experimental findings
  - (1) Strategic uncertainty $\uparrow \Rightarrow$ Vocality $\downarrow$
  - (2) Voluntary messaging improves vocality.
  - (3) Improvement driven by voluntariness rather than cost.

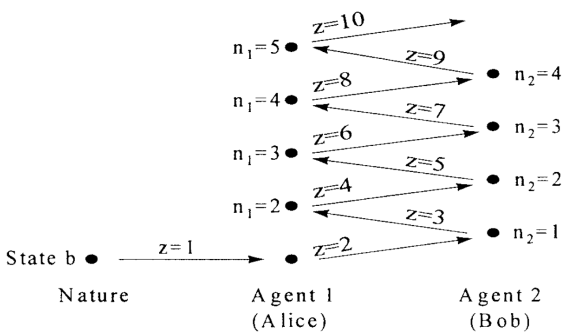
Roadmap

- 1. Rubinstein's Email Game
- 2. Email Game under Restricted Communication
- 3. Experimental Design
- 4. Preliminary Results
- 5. Interpretation

Rubinstein's Email Game: Rich Information Flow

state=a (1-p)		Uninformed P2	
		A	B
Informed P1	A	3, 3	2, 0
	B	0, 2	2, 2

state=b (p<0.5)		Uninformed P2	
		A	B
Informed P1	A	2, 2	2, 0
	B	0, 2	3, 3



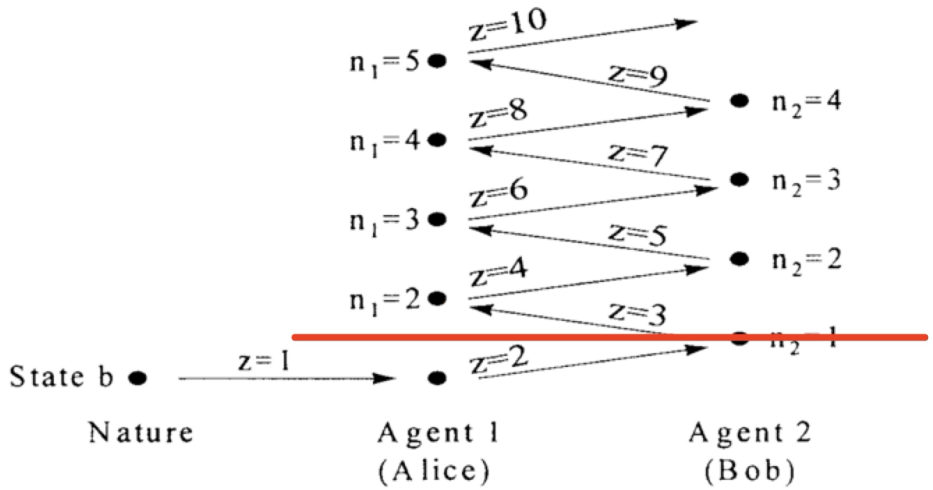
Each confirming message gets **lost** wp $\epsilon > 0$

#Messages received is **private info**
$f_i : \{0, 1, 2, ...\} \to \{A, B\}$

Option A is **safe** while B **risky**.

Inefficient Tacitness in Rubinstein

- An (ex-ante) inefficient EQ: Players **ignore** all messages and always choose safe option A. (Proof by Induction)
- Mismatch between players' info sets causes unending escalation of message threshold.
- Experimental evidence from Camerer et al (2003) **favoring tacitness**, driven by learning (losses from choosing B).
- What if P2 is *unable* to reply to P1's first message?



Single-Cap Email Game: Variations

- Voluntary communication (Binmore&Samuelson, 2001).
  Endogenized messaging decision for P1 (sender) in state b.

- Varying temptation of B and hence vocal's basin of attraction.
  X = 3(L), 4(M), 6(H)

state=a (1-p)	Uninformed P2		
		A	B
Informed P1	A	3, 3	2, 0
	B	0, 2	2, 2

state=b (p<0.5)	Uninformed P2		
		A	B
Informed P1	A	2, 2	2, 0
	B	0, 2	X, X

Structure of the Game: Voluntary Communication

- Nature draws state $s \in \{a, b\}$ according to prior $(1-p, p)$
- P1 observes selected state s but P2 does not.
- In state b only, P1 chooses *Send* or *Not Send*, **a choice that P2 cannot observe**.
- If P2 has chosen *Send*, Nature decides if message arrives or drops, with chance $(1-\epsilon, \epsilon)$.
- P2 observes if she has received a message or not, $m \in \{0, 1\}$, where $m = 1$ iff Nature has dictated that message arrive.
- After the communication stage, P1 and P2 simultaneously and independently choose A or B.

Equilibrium Indeterminacy

- *Tacit* EQ:
  Players always play A.
  Inefficient info transmission.

- *Vocal* EQ (under tighter parameter constraints):
  P1 (sends message and) plays B iff **observing state b**.
  P2 plays B iff **receiving the message**.
  Efficient use of message.

Experimental Design

Table 1: Number of Participants by Configuration

protocol/temptation	*Low*	*Medium*	*High*
Automatic	20	24	22
Voluntary-Costly	(♯ vocal)	20	10
Voluntary-Free	10	10	

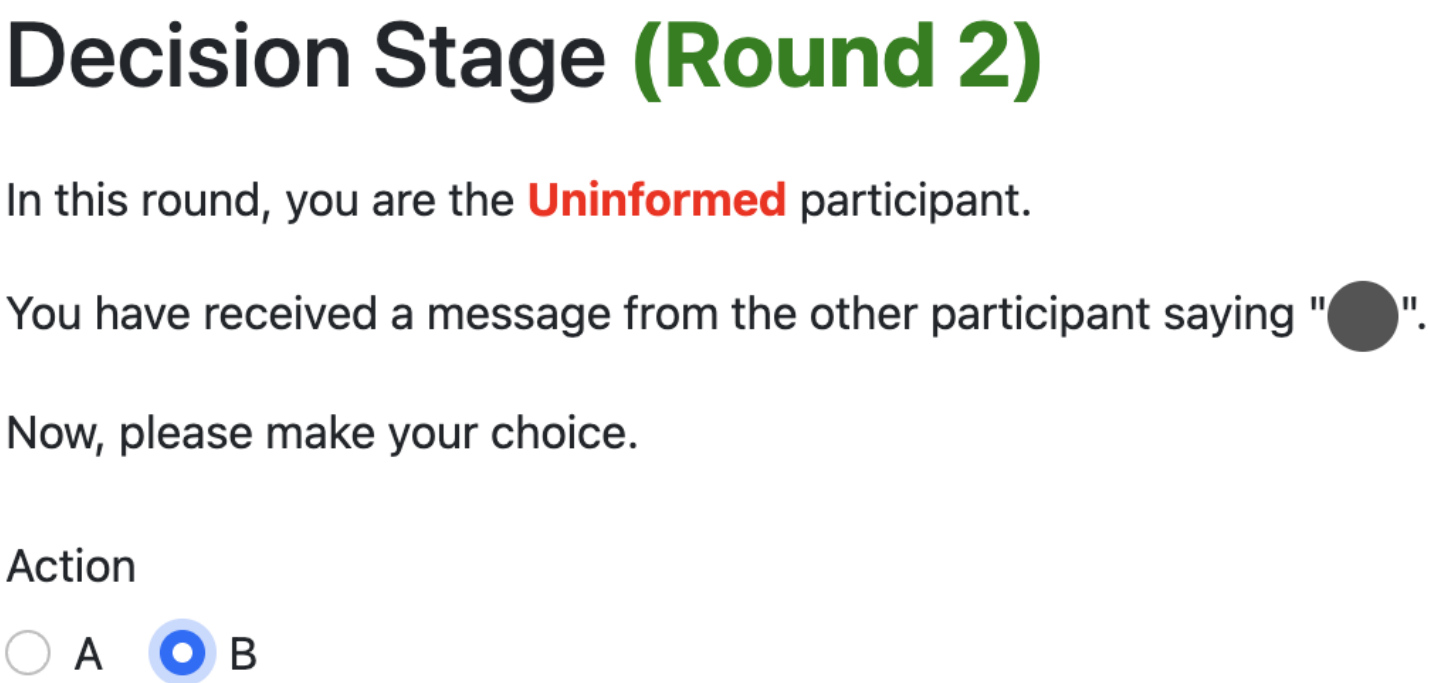
- *Voluntary-Costly*: P1 bears $c = 0.5$ for sending the message
- Measure of vocality:
  - For P1: fraction of B $\mid$ $s = b$
  - For P2: fraction of B $\mid$ $m = 1$
- Dual effects of message cost on vocality
  - (+) intensive: sunk cost as signaling coordinative intent
  - (-) extensive: less message adoption

Experimental Implementation

- Lab experiment to test for equilibrium selection.
- 11 sessions, 116 participants at UVA Veconlab, June-Sep 2025
- Random group re-matching; between-subject.
- 15 rounds of game with feedback + Holt and Laury (2002).
- One random round for payment; average earnings \$25.
- Parameters in experimental games:
  Prior(b)=0.4, noise $\epsilon = 0.3$, $X \in \{3, 4, 6\}$, $c \in \{0, 0.5\}$

Decision Screen

- △ ≡ state a; ◯ ≡ state b



Decision Aid Summary

Instructions Summary (Page 5 of 6)

Matching and Earnings: Random group pairing for each round. Your performance in one random round determines your earnings.

Chance of Situation: ▲--**60%**; ●--**40%**. Generated randomly and independently for each round.

Role: Only **Informed** knows the generated situation, while **Uninformed** does not know.

Situation-Dependent Payoffs:

Payoff Matrix under ▲
(**Informed**,**Uninformed**)

▲		Uninformed	
		A	B
Informed	A	**3**, **3**	**2**, **0**
	B	**0**, **2**	**2**, **2**

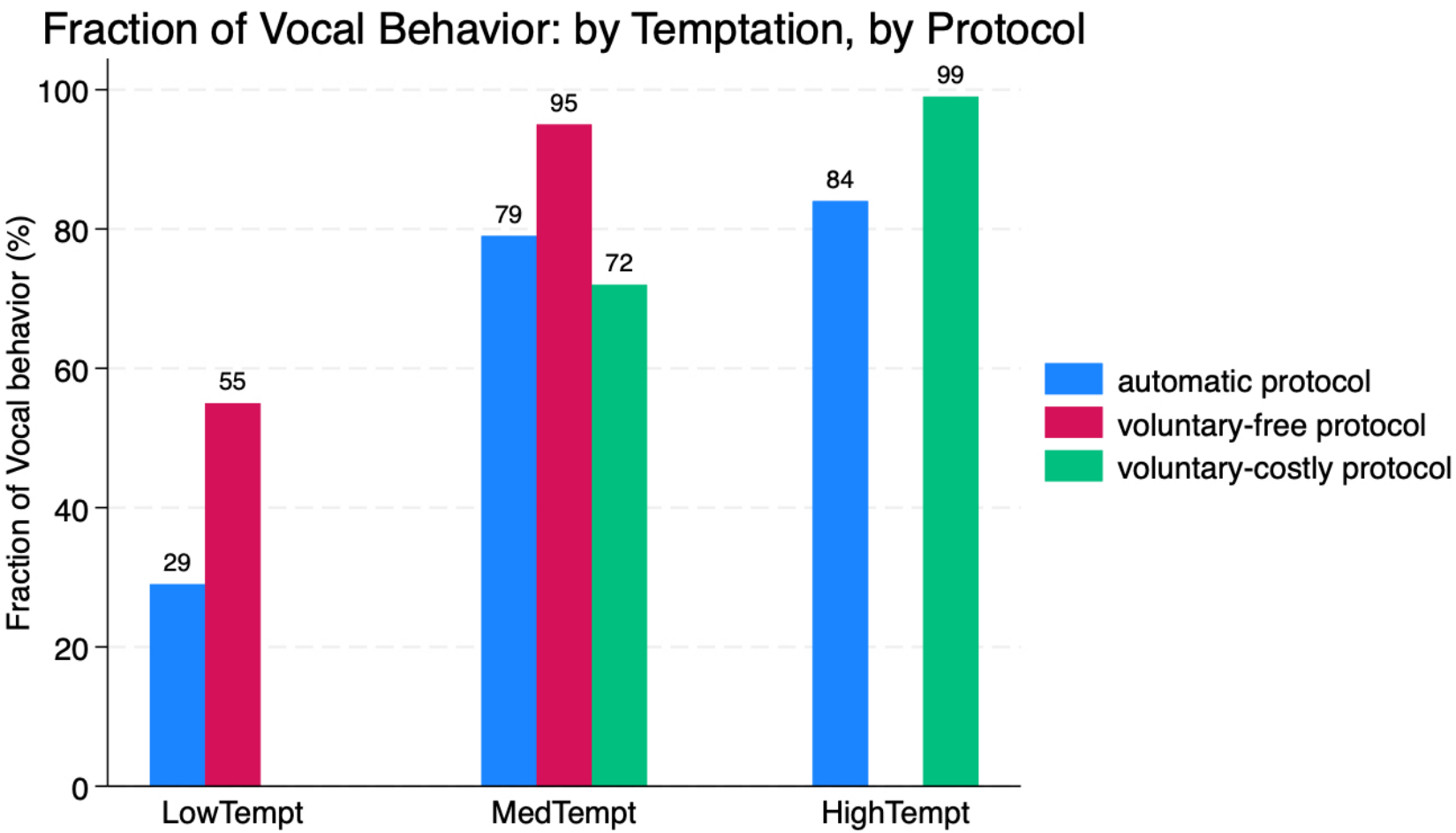
Payoff Matrix under ●
(**Informed**,**Uninformed**)

●		Uninformed	
		A	B
Informed	A	**2**, **2**	**2**, **0**
	B	**0**, **2**	**3**, **3**

Automatic Messaging System:

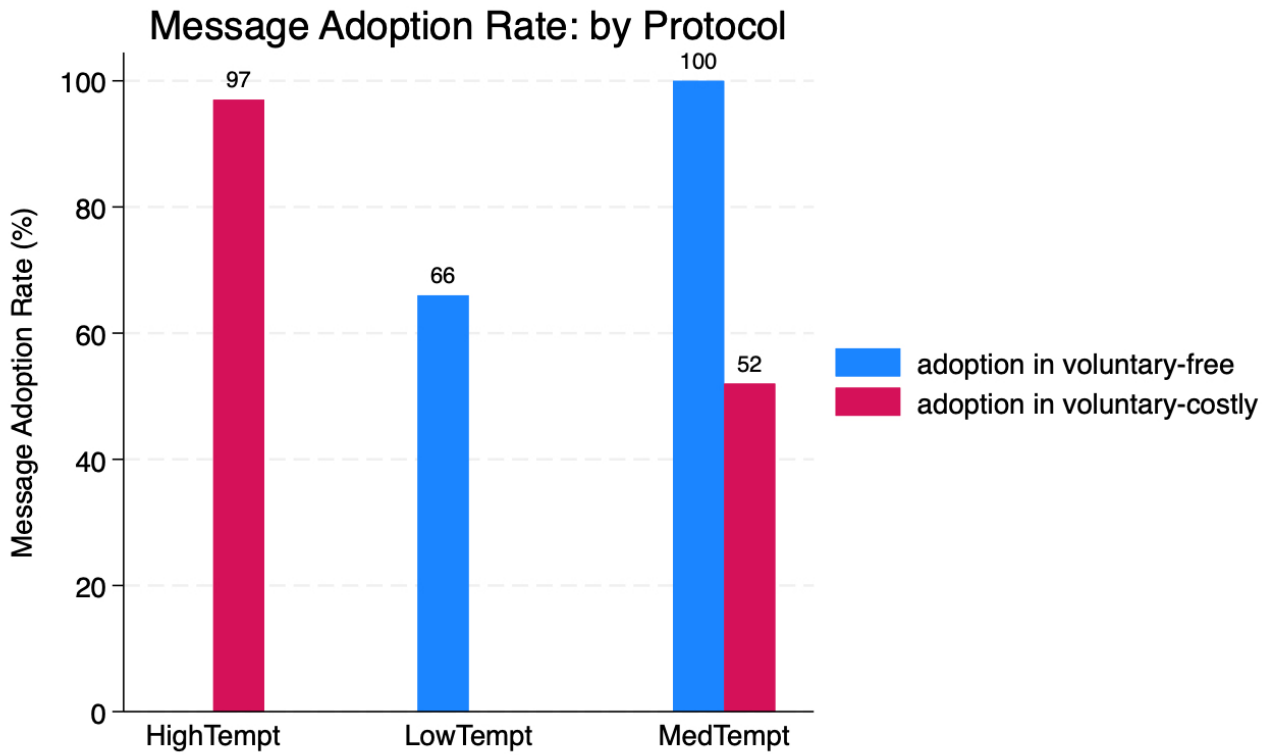
- In situation ●, sends message "●" to **Uninformed**. But message gets **lost** with a chance of **30%**, in which case **Uninformed** won't receive anything.
- Does nothing in situation ▲

Vocality Responds to Changes in Incentives



- L << M < H

Source of Credibility: Voluntariness or Cost?



- The (-) adoption effect of message cost dominates, driving down vocality (though increasing credibility slightly).
- Sender is leading EQ selection through the voluntary signal.
- Policy: **small cost is enough, voluntariness is the key.**

Who is Facing a Harder Problem?

- vocality of P2 $>$ vocality of P1, esp. in *Voluntary* protocols.
- Evidence of sender's inconsistency in *Voluntary-Costly*.
- P1 has to lead EQ selection, higher cognitive burden.

EQ Selection under Misaligned Interests

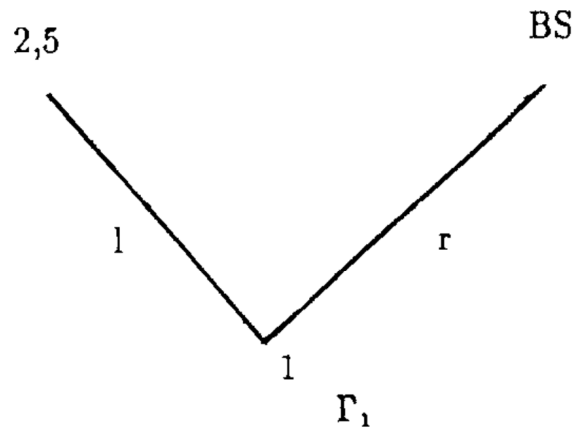
- Forward Induction in BoS: A player's **earlier choice** shapes beliefs in the **later subgame** (Van Damme, 1989).

a

	s	w
s	0,0	3,1
w	1,3	0,0

BS

b



- Pre-move money-burning creates (pseudo) first-mover adv.
- BoS with cheap talk: 1-way vs. 2-way (Cooper et al, 1990).
- It's what you SAY, not what you PAY (Brandts&Cooper, 07).
- **Belief selection vs. Sunk-cost signaling**

Conclusion

- Coordination game with aligned interests, asymmetric information, and communication noise.
- Equilibrium selection under a restricted communication protocol: *tacit* vs. *vocal*.
- Lab experiment varying comm. rules and basins of *vocal*.
  - Vocal behavior is rare when strategic uncertainty is high.
  - A protocol that allows **voluntary and free messaging** performs best, fixing temptation.
  - **Voluntariness** on its own, rather than sunk message cost, carries the information content by **signaling sender's coordinative intent**.

Extensions

- Optimal communication protocol design in **multi-party** coordination under various info structures.
- Varying the **message cap** = 2,5,10...to see if vocality disappears in the limit to Rubinstein's tacit prediction.
- Behavioral models to explain vocality (or lack thereof): e.g. failure of Bayesian reasoning, cursedness; QRE

Thanks!

Thank you!

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