The Selective Disclosure of Evidence
An Experiment

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Motivation

In many settings, agents communicate by disclosing **selected evidence**:

- A *job candidate* selects which experiences to list in her vitae
- A *journalist* selects which facts to include in an article
- A *scientist* selects which results to present in a paper
- A *lawyer* selects which evidence to subpoena for a trial
- A *company* selects which product features to highlight in an ad

Motivation

These examples have three distinguishing features:

- Evidence is **verifiable**: Sender does not fabricate it
- Evidence is **noisy**: A piece of evidence may not fully reveal the state
- Disclosure is **constrained** relative to abundance of evidence: Sender selects which pieces of evidence to disclose

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Yet, **selective disclosure** seems pervasive force in communication

This Paper

We build on a small theory literature in communication that studies disclosure of noisy evidence

We develop new comparative statics to inform parsimonious experimental design

We experimentally investigate how subjects deal with **selective disclosure**:

- Which evidence do senders select to disclose?
- How do receivers respond to evidence that may be selected?
- How does their behavior impact communication overall?

Outline of the Setting

Builds on Milgrom (1981)

- Sender has private information about a state of the world
- Sender receives N private signals that are informative about the state
- Sender can disclose up to K of these signals to the Receiver
- Receiver observes disclosed signals and guesses the state

Treatment variations consist of changing K and N: a rich set of predictions

Preview of Results

Data corroborates main qualitative predictions of the theory

1. Senders overwhelmingly engage in **selective disclosure**

   Main deviation: A minority of senders is "deception averse"

2. Receivers account for **selection bias**, i.e., for the fact that evidence they see is selected

   Main deviation: Often not as much as they should

3. Aggregate effects on communication are in line with prediction

   Main deviation: Some quantitative departures still to explore

Related Literature: Theory

The Basic Setting:

- Milgrom (1981, Bell), information unraveling
- Fishman and Hagerty (1990, QJE), optimal amount of discretion
- Di Tillio, Ottaviani and Sorensen (2021, Ecma), effect of selection on information transmission

Mechanism-Design Approach:

- Glazer and Rubinstein (2004, Ecma) – receiver's verification
- Glazer and Rubinstein (2006, TE) – sender's verification

Richer Settings

- Shin (2003, Ecma): uncertainty over available evidence
- Dziuda (2011, JET): unknown sender's preferences

Related Literature: Experiments

Disclosure:

- Jin, Luca and Martin (2022, AEJ: Micro) – failure of unravelling and why
- Hagenbach and Perez-Richet (2018, GEB) – preference alignment
- Li and Schipper (2020, GEB) – vague disclosure
- Frechette, Lizzeri and Perego (2022, Ecma) – partial commitment

Cheap Talk:

- Cai and Wang (2006, GEB) – overcommunication wrt the theory
- Blume, Lai and Lim (2020, Handbook of Experimental GT) - review

Partially Verifiable Disclosure

- Burdea, Montero, Sefton (2023, GEB) – Glazer and Rubinstein ('04, '06)
- Li and Schipper (2018) – asymmetric info on the amount of evidence
- Penczynski, Koch and Zhang (2023) – selection and competition

model

The Game

Milgrom (1981, §7)

Sender privately observes the state $\theta \in \Theta$:

- Θ finite and ordered, $p \in \Delta(\Theta)$ common prior

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Given θ, Sender draws N i.i.d. signals

- Exogenous info structure $f : \Theta \to \Delta(S)$, S finite and ordered, MLRP
- Notation: $\bar{s} = (s_1, ..., s_N) \in S^N$

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Receiver observes the message m and takes an action $a \in A$

Payoffs

Given state θ and action a,

- Receiver's payoff is $u(\theta, a) = -(a - \theta)^2$ wants to guess the state
- Sender's payoff is $v(\theta, a) = a$ higher actions preferred

Message Space

More formally, message space is

$$\mathcal{M} = \{\varnothing\} \cup \{\bar{s} \in S^k \mid 1 \leq k \leq K \text{ and } \bar{s}_i \geq \bar{s}_j \text{ for } i \leq j\}$$

Verifiability requires that Sender can only disclose signals that belong to $\bar{s}$:

$$m \in M(\bar{s}) = \{m' \in \mathcal{M} \mid \text{if } m' \neq \{\varnothing\}, \exists\ 1 \leq k \leq K \text{ and an injective } \\ \rho : \{1, ..., k\} \to \{1, ..., N\} \text{ s.t. } m' = (\bar{s}_{\rho(1)}, ..., \bar{s}_{\rho(k)})\}$$

Example

To fix ideas, suppose signal space is $S = \{A, B, C, D\}$ and $N = 4$

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If $K = 1$

- $M(\bar{s}) = \{\varnothing, A, B, D\}$

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If $K = 2$

- $M(\bar{s}) = \{\varnothing, A, B, D, AB, AD, BD, DD\}$

Discussion

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- Signals have both an *intrinsic* and a *contextual* meaning

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Changes in (K, N) span models from disclosure to cheap talk equilibrium

Equilibrium

Analysis focuses on pure-strategy **PBEs** in which sender's strategy does not depend on θ

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When $K < N$, game admits multiple equilibrium outcomes

We refine PBEs using a notion of **neologism proofness** (Farrel '93) that we adapted to our setting with verifiable information

Under this refinement, we show that our theory predicts a **unique** equilibrium outcome

Equilibrium

Definition

A sender's strategy is **maximally selective** if, given each $\bar{s}$, she discloses the K highest signals

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Theorem

There exists a pure-strategy PBE in which the sender plays a maximally selective strategy.

Moreover, the induced outcome is the unique one in the class of neologism-proof equilibrium outcomes.

comparative statics

Equilibrium Informativeness

We study the effects of changing N and K on **equilibrium informativeness**

- How effectively sender and receiver are able to communicate the state θ

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$$\mathcal{I}(K, N) = \mathbb{V}(\theta) - \mathbb{E}(\mathbb{V}(\theta|m))$$

$\mathcal{I}(K, N)$ is a monotone transformation of **correlation** btw θ and a

Increasing K

Proposition 1

Equilibrium informativeness increases in K

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Intuition

- Easier to send messages that other types cannot imitate

$\Rightarrow$ Less pooling

$\Rightarrow$ More information transmitted

Increasing N and K Together

Proposition 2

Assume $K = N$. Equilibrium informativeness increases in N.

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Assume $K = N$. Equilibrium informativeness increases in N.

Increasing N

Proposition 3

Suppose $f(\cdot|\theta)$ has full support for every θ.

Equilibrium informativeness decreases to zero as $N \to \infty$.

Moreover, equilibrium informativeness needs not be monotonic in N.

Increasing N

Intuition: Increasing N generates two contrasting effects:

Imitation Effect

- Sender can cherry pick more effectively, making higher signals less informative

Separation Effect

- Sender has more evidence to prove her type
- Selection contains information about undisclosed signals: "lower" signals are more informative

Example: Conclusive Good News

Suppose $\Theta = \{\theta_L, \theta_H\}$, $\quad p(\theta_H) = \frac{1}{2}$, $\quad S = \{A, B\}$, $\quad K = 1$

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$f(s\|\theta)$	Signal	
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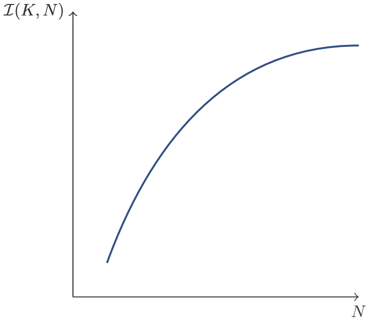

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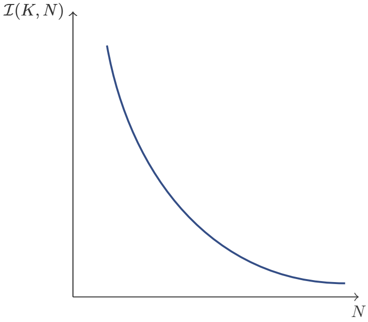

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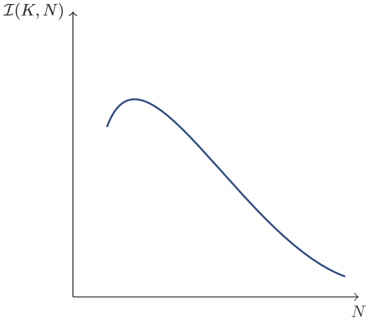

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experiment

Experimental Design

Binary state: Yellow Urn (θ_L, "low" state) and Red Urn (θ_H, "high" state)

Signal space: $S = \{A, B, C, D\}$

Information structure f:

State	Signal A	B	C	D
θ_L	10%	20%	25%	45%
θ_H	45%	25%	20%	10%

Receiver's action $a \in [0, 1]$

Belief Elicitation

Since Θ is binary and $u_R(a, \theta) = -(a - \theta)^2$, the receiver's task is equivalent elicit her beliefs via a quadratic scoring rule (QSR)

A large literature on belief elicitation has shown that QSR can be biased when subjects are not risk-neutral

To avoid this issue, we implement a binarized scoring rule *a la* Hossain and Okui ('13), which is robust to various risk preferences

Treatments

	$N = 1$	$N = 3$	$N = 10$	$N = 50$
$K = 1$	i	$\cdot$	ii	iii
$K = 3$	$\cdot$	iv	v	vi

Experimental Details

- Fixed roles
- 6 treatments, between subjects
- 4 sessions per treatment
- 30 rounds per session, random rematching
- 17.5 subjects per sessions on average
- Undergrad population Columbia and NYU: Spring, Summer, Fall 2023
- Average payout \$30 per subject

Round 7 of 30: Communication Stage | **You are the Sender**

Reminder:

If the secret Urn is **Yellow**, this is the probability of each ball being drawn:

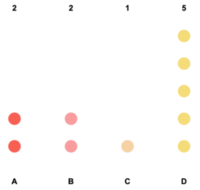
A	B	C	D
10 %	20 %	25 %	45 %

If the secret Urn is **Red**, this is the probability of each ball being drawn:

A	B	C	D
45 %	25 %	20 %	10 %

The secret Urn is Yellow

Available Balls



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Your message to the Receiver is:

Send

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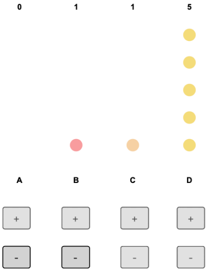
Available Balls



Your message to the Receiver is:

Send

Software

Round 7 of 30: Guessing Stage | **You are the Receiver**

Reminder:

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A	B	C	D
10 %	20 %	25 %	45 %

If the secret Urn is **Red**, this is the probability of each ball being drawn:

A	B	C	D
45 %	25 %	20 %	10 %

The Sender had 10 available balls and they could disclose 3 or less. This is the Sender's message:

A A B

Use the slider below to indicate your Guess of how likely it is that the secret Urn is Red.

Your Guess: 10

Submit

Round 7 of 30: Payoff	You are the Receiver

The secret Urn was **Yellow**

In this Round you earned 100 points.

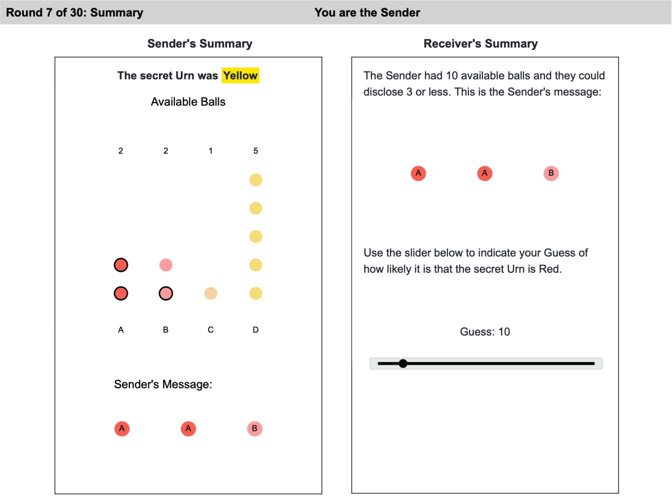
Continue

How were your points determined?

The secret Urn was Yellow. Your Guess was 10.

The two Computer's Random Numbers were 59 and 44.

Your Guess was smaller than or equal to the largest of the two Computer's Random Numbers, so you earned 100 points.



Round 7 of 30: Summary
You are the Sender
Sender's Summary
The secret Urn was Yellow
Available Balls
2
2
1
5
A
B
C
D
Sender's Message:
A
A
B
Receiver's Summary
The Sender had 10 available balls and they could disclose 3 or less. This is the Sender's message:
A
A
B
Use the slider below to indicate your Guess of how likely it is that the secret Urn is Red.
Guess: 10

Round 7 of 30: History **You are the Sender**

Round	Secret Urn	Message	Guess
7	Yellow	A A B	10
6	Red	A A	77
5	Red	A B B	77
4	Red	A A A	97
3	Red	A A	87
2	Yellow	C C	52
1	Red		0

Next

Testable Predictions

Senders: Do senders engage in selective disclosure as predicted by equilibrium?

- E.g., do they play the maximally selective strategy?

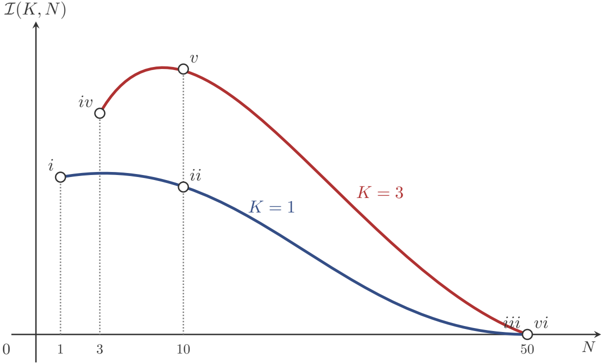
Receivers: Do receivers account for selection when responding to messages?

- E.g., do they become more skeptical of favorable messages as N increases?

Informativeness: Are comparative statics corroborated by the data?

- Four statistical tests

Testable Predictions: Informativeness



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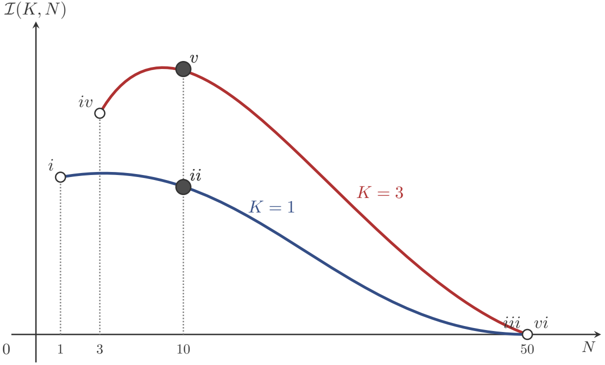
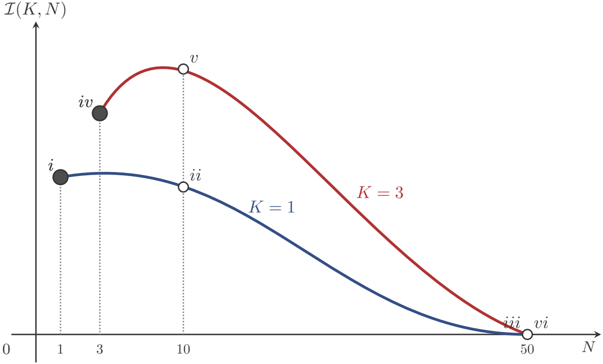


Test 1. Informativeness increases in K

$$v > ii$$

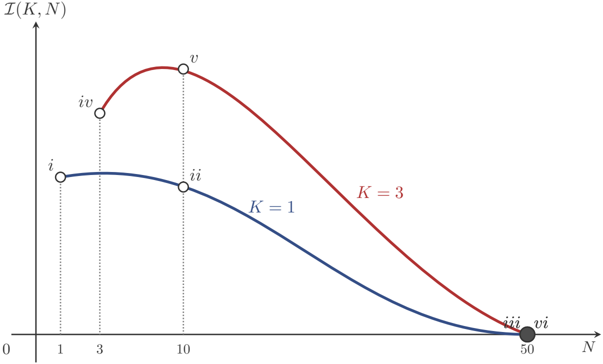
Testable Predictions: Informativeness



Test 2. Fixing $K = N$, informativeness increases in N

$$iv > i$$

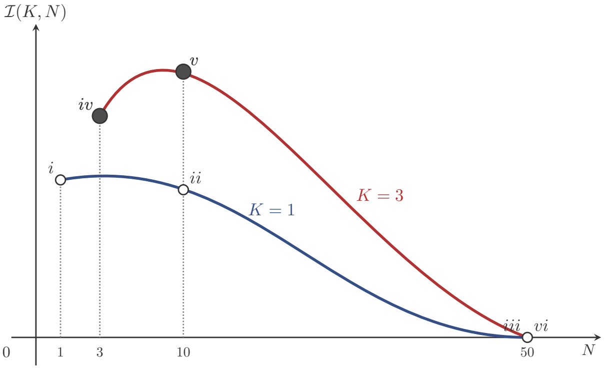
Testable Predictions: Informativeness



Test 3. Informativeness eventually decreases to 0 in N (imitation effect)

$$iii = vi = 0$$

Testable Predictions: Informativeness



Test 4. If $K = 3$, informativeness initially increases in N (separation effect)

$$v > iv$$

results

senders

Senders' Behavior

We begin by looking at Senders' behavior

Goal.

– Investigate the extent to which senders engage in **selective disclosure**?

We present three facts about sender's behavior, from aggregate to disaggregate

Senders' Behavior (1/3)

How often do senders play the **maximally selective** strategy, i.e., disclose the K highest available signals?

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$K = 1$	**83%**	80%	·	90%	79%
$K = 3$	**64%**	·	57%	74%	61%

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Equilibrium behavior is predominant. Yet, many senders don't play equilibrium

What do they do? Need a more disaggregated approach

Senders' Behavior (2/3)

What messages are sent? Highly-dimensional problem.

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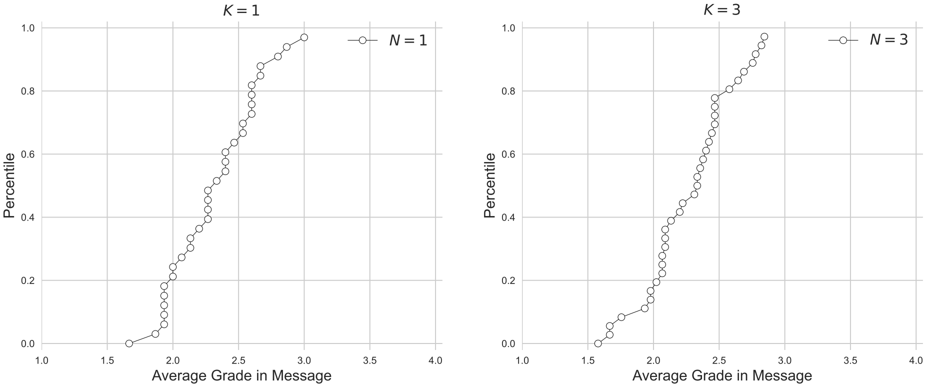

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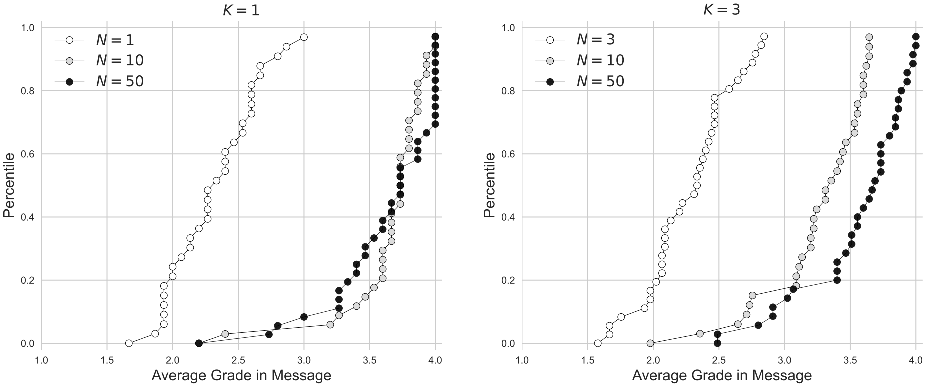
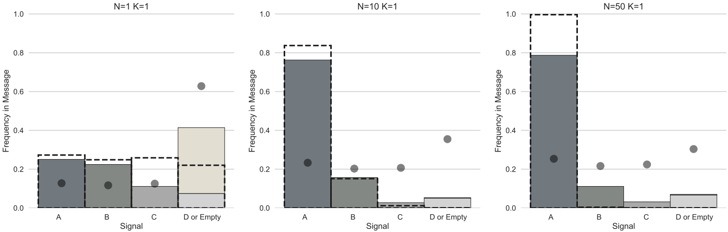


Senders' Behavior (3/3)

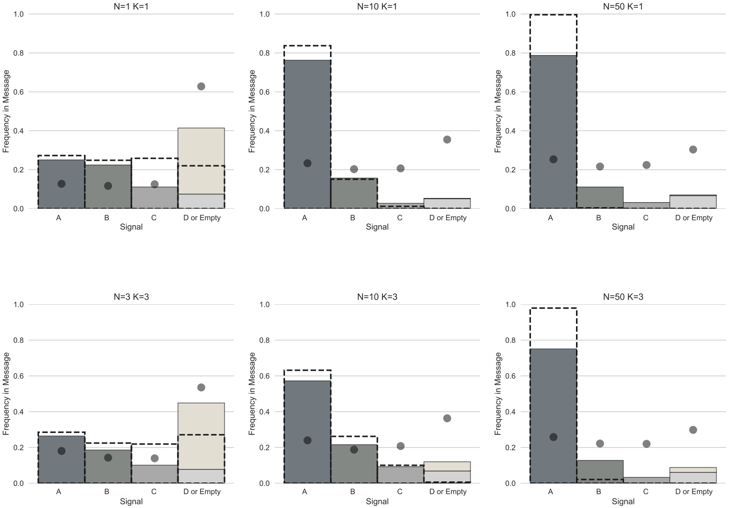
Finally, we can look at the *distribution* of signals that are disclosed

The frequency of A-signals should increase in N

Senders's Behavior (3/3)



Senders's Behavior (3/3)



Summary

Summary for Senders.

- We find that senders' behavior is consistent with the equilibrium force of **selective disclosure**
- Predominantly, Senders attempt to deceive receivers by selecting the most favorable evidence available to them

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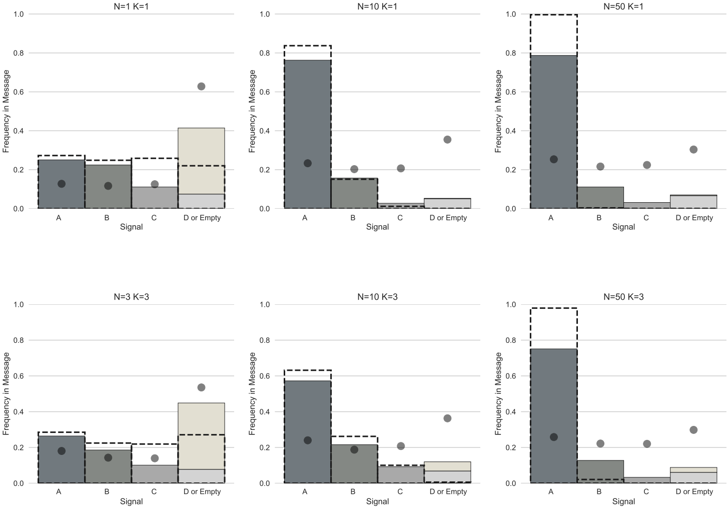
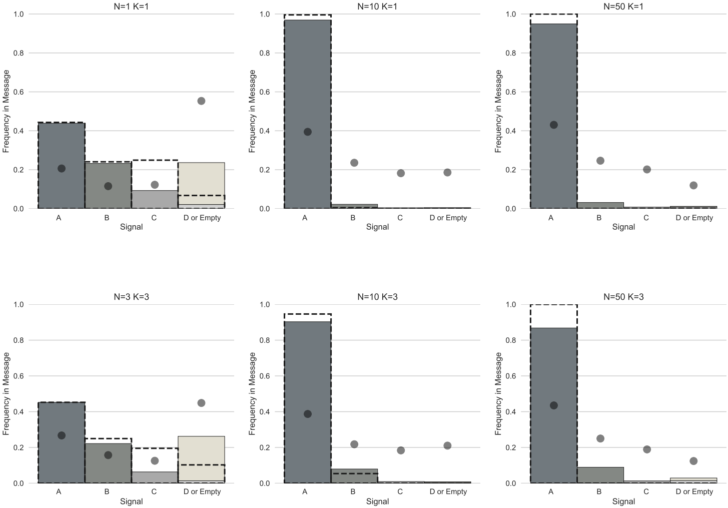
- We find that senders' behavior is consistent with the equilibrium force of **selective disclosure**
- Predominantly, Senders attempt to deceive receivers by selecting the most favorable evidence available to them

Yet, this behavior is not universal and we also see some **deception aversion**

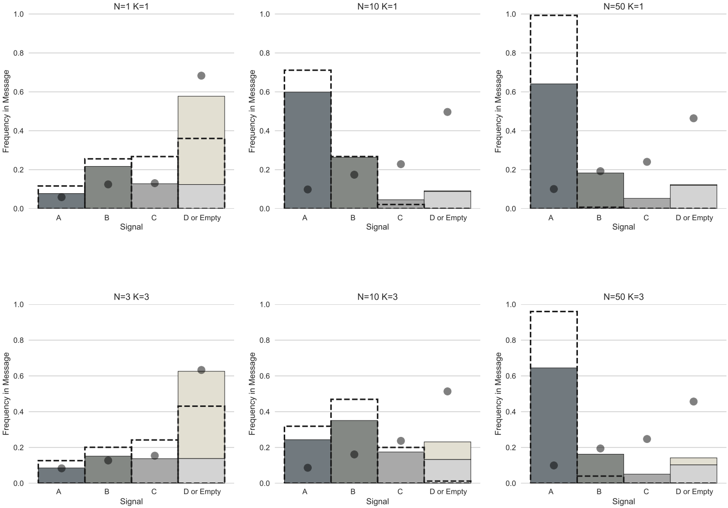
Senders's Behavior: Missing As



Senders's Behavior: Missing As, θ_H



Senders's Behavior: Missing As, θ_L



Unpacking Senders' Heterogeneity

Equilibrium type (56%)

- Most common
- $N > K$: Mostly report best balls independently of the state
- $N = K$: Disclose fewer than K balls

Deception Averse Type (17%)

- A's reported more often when the state is high
- D's reported more often when the state is low
- $N = K$: Disclose fewer than K balls

Others (27%)

- Similar to equilibrium types when the state is high
- Report A's less but do not report D's when the state is low
- Some low rates of A's when the state is high [confusion]

receivers

Receivers' Behavior

We now turn to receivers' behavior

Goal.

- Investigate the extent to which receivers account for the fact that the evidence they see is selected?

We present two facts about receivers' behavior, from aggregate to disaggregate

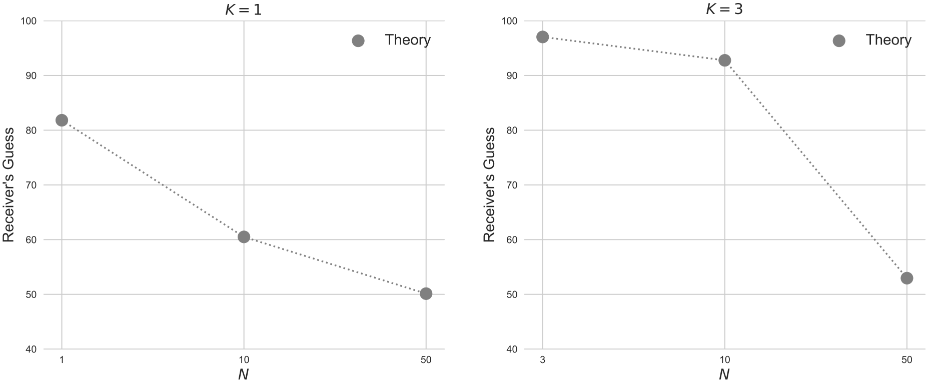
Receivers' Behavior (1/2)

We consider the "most favorable" messages that are sent by senders

"Most favorable" messages are those with the highest GPA (top quintile)

As N increases, due to selective disclosure on the part of senders, receivers should become **increasingly skeptical** of these messages

Receivers' Behavior (1/2)



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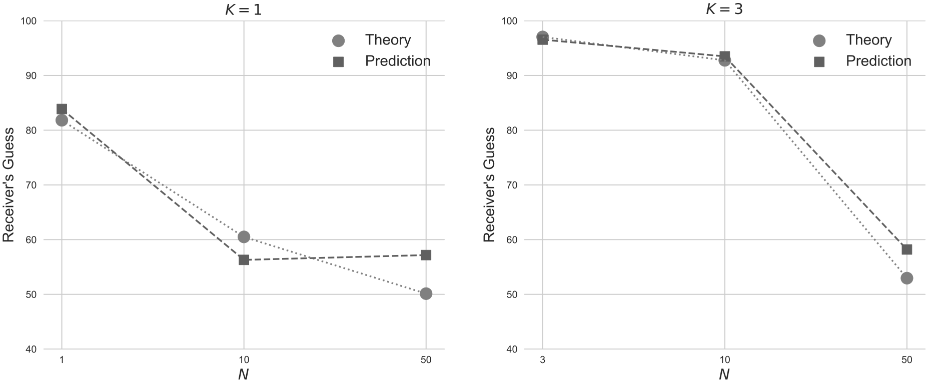
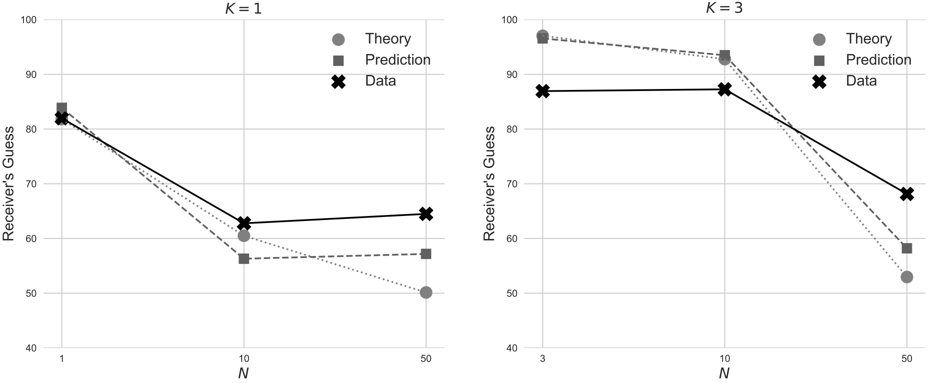


Receivers' Behavior (1/2)



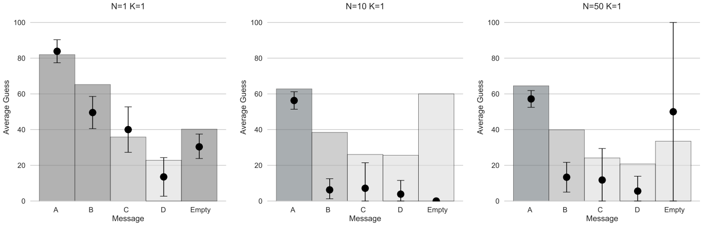
Receivers' Behavior (2/2)

What about receivers' response to messages that are not the "most favorable"

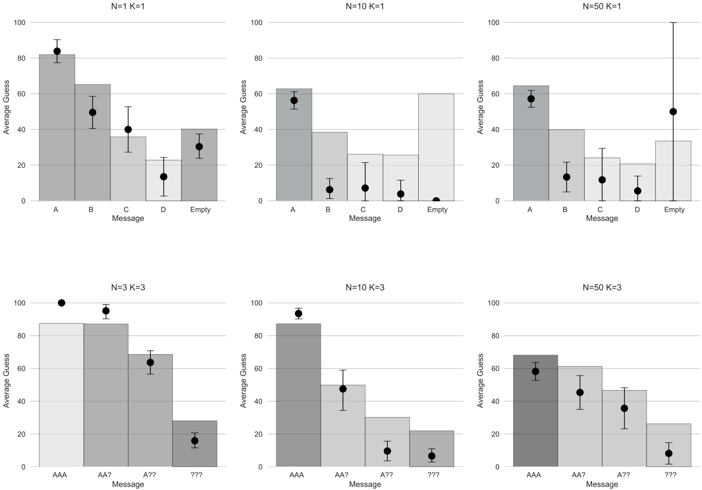
For this, we need a more disaggregated look

As N increases, due to selective disclosure on the part of senders, receivers should become **extremely skeptical** to the least-favorable messages

Receivers' Behavior (2/2)



Receivers' Behavior (2/2)



Summary

Summary for Receivers.

- We find that receivers' behavior correctly accounts for the fact that the evidence they see is selected
- For the most favorable evidence, behavior is *quantitatively* close to equilibrium
- For less favorable evidence, while *qualitatively* consistent with equilibrium, receivers' are insufficiently skeptical

Summary

Summary for Receivers.

- We find that receivers' behavior correctly accounts for the fact that the evidence they see is selected
- For the most favorable evidence, behavior is *quantitatively* close to equilibrium
- For less favorable evidence, while *qualitatively* consistent with equilibrium, receivers' are insufficiently skeptical

Connection to experimental literature on disclosure: "no news is bad news"

Unpacking Receivers' Heterogeneity

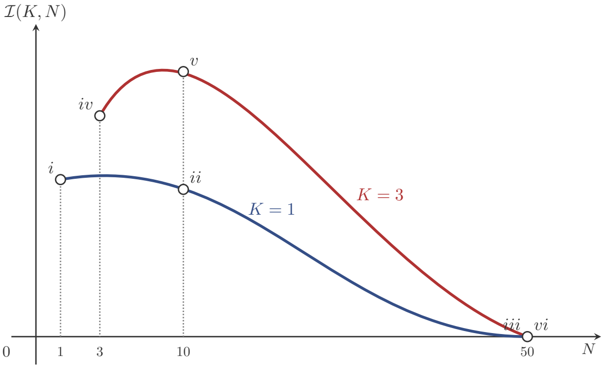
- Variation in updating strategies
  - Extent they **account for selection**
- Being closer to equilibrium $\not\to$ higher payoffs
- However, in many treatments, subjects better at accounting for selection get the highest payoff

informativeness

Informativeness: Test 1

Test 1. Informativeness increases in K

$$\boxed{v > ii}$$



Informativeness: Test 1

	theory	senders' data	all data
$v.\ (N10, K3)$	.93	.93	.84
$ii.\ (N10, K1)$	.79	.80	.74

Informativeness: Test 1

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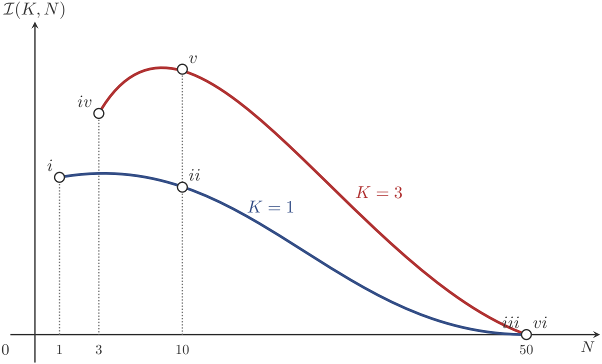
$v.\ (N10, K3)$	$.93$	$.93$	$.84$
$ii.\ (N10, K1)$	$.79$	$.80$	$.74$

Test 1, $\checkmark$ Informativeness significantly increases from ii to v (p-value 0.00)

Informativeness: Test 2

Test 2. Fixing $K = N$, informativeness increases in N

$$\boxed{iv > i}$$



Informativeness: Test 2

	theory	senders' data	all data
$iv.\ (N3, K3)$	.88	.90	.84
$i.\ (N1, K1)$	.81	.81	.75

Informativeness: Test 2

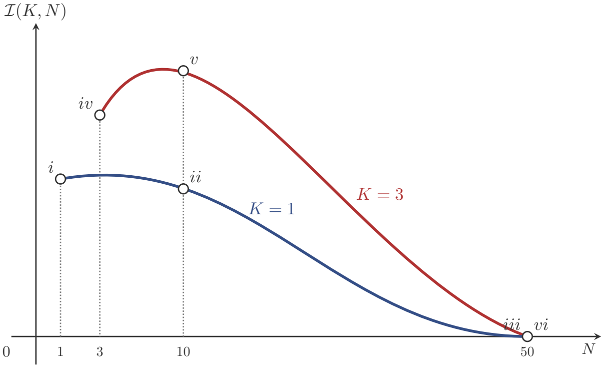
	theory	senders' data	all data
$iv.\ (N3, K3)$	.88	.90	.84
$i.\ (N1, K1)$	.81	.81	.75

Test 2, ✓ Informativeness significantly increases from i vs iv (p-value 0.00)

Informativeness: Test 3

Test 3. Informativeness eventually decreases to 0 in N (imitation effect)

$$\boxed{iii = vi = 0}$$



Informativeness: Test 3

	theory	senders' data	all data
$vi.\ (N50, K3)$	.76	.80	.71
$iii.\ (N50, K1)$	.75	.79	.72

Informativeness: Test 3

	theory	senders' data	all data
$vi.\ (N50, K3)$	$.76$	$.80$	$.71$
$iii.\ (N50, K1)$	$.75$	$.79$	$.72$

Test 3

✓ Informativeness in iii and vi are not significantly different from each other

Informativeness: Test 3

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$vi.\ (N50, K3)$	$.76$	$.80$	$.71$
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Test 3

- ✓ Informativeness in iii and vi are not significantly different from each other
- ✓ They are significantly lower than in ii and v qualitatively OK

Informativeness: Test 3

	theory	senders' data	all data
$vi.\ (N50, K3)$	.76	.80	.71
$iii.\ (N50, K1)$	.75	.79	.72

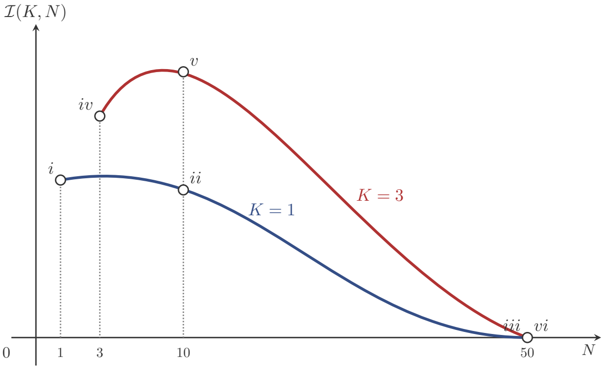
Test 3

- ✓ Informativeness in iii and vi are not significantly different from each other
- ✓ They are significantly lower than in ii and v — qualitatively OK
- ✗ But are significantly different than zero — quantitatively off

Informativeness: Test 4

Test 4. If $K = 4$, informativeness initially increases in N (separation effect)

$$\boxed{v > vi}$$



Informativeness: Test 4

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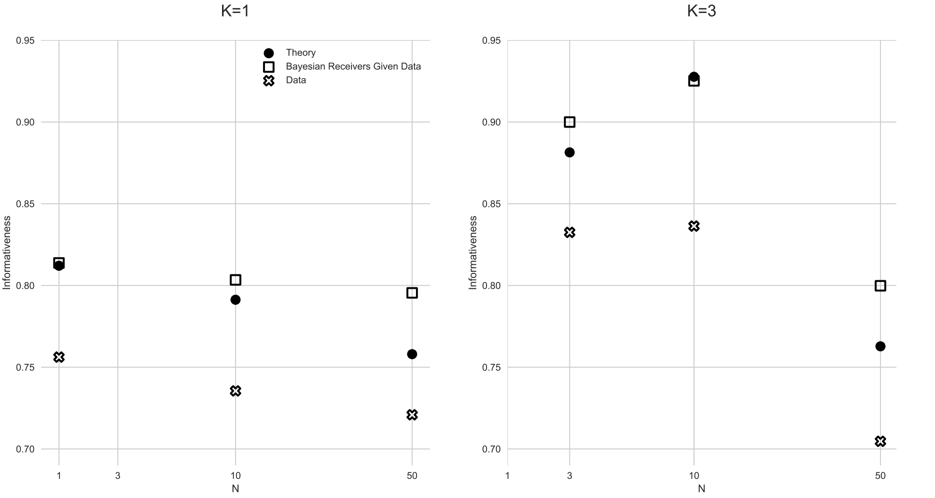
Test 4

✓ Informativeness significantly increases from iv and v in senders' data

✗ It doesn't in receivers' data

Informativeness: All Results



Summary

The model offers a rich set of comparative statics

We find some quantitative deviations from theoretical point predictions

Yet, for the most part, data support qualitative predictions of the theory

conclusion

Conclusion

An experimental study of selective disclosure, a pervasive force in communication

We develop new comparative statics in a model of constrained disclosure of noisy evidence: Theory to inform a parsimonious experimental design

Data corroborates main qualitative predictions of the theory

1. Senders overwhelmingly engage in **selective disclosure**

   Main deviation: A minority of senders is "deception averse"

2. Receivers account for **selection bias**, i.e., for the fact that evidence they see is selected

   Main deviation: Often not as much as they should

3. Aggregate effects on communication are in line with prediction

   Main deviation: Some quantitative departures still to explore thank you

Appendix

Some Literature

Disclosure: Jin, Luca and Martin (2022, AEJ: Micro)

Cheap talk: Blume, Lai and Lim (2020, Handbook of Experimental GT)

Partially verifiable disclosure: Penczynski, Koch and Zhang (2021)

Theory: Milgrom (1981, Bell), Fishman and Hagerty (1990, QJE), Di Tillio, Ottaviani and Sorensen (2021, Ecma)

Some Notation: Strategies and Beliefs

Denote $\mathcal{M}$ the space of all messages

Sender's Strategy

pure and θ-independent

- $\sigma : \Omega^N \to \mathcal{M}$ s.t. $\sigma(\bar{\omega}) \in M(\bar{\omega})$, for all $\bar{\omega}$

where $M(\bar{\omega})$ is the space of available messages given $\bar{\omega}$

Receiver's Beliefs and Strategy

- $\mu : \mathcal{M} \to \Delta(\Omega^N)$
- $a : \mathcal{M} \to \Delta(A)$

Given μ, receiver's optimal strategy given by

$$a(m) = \mathbb{E}(\theta|m) = \sum_{\bar{\omega}} \mu(\bar{\omega}|m)\mathbb{E}(\theta|\bar{\omega}) \qquad \forall\, m$$

Sequential Equilibrium

A **Sequential Equilibrium** is a pair (σ^*, μ^*) s.t.

1. For all $\bar{\omega} \in \Omega^N$, $\sigma^*(\bar{\omega}) \in M(\bar{\omega})$ and

$$\sum_{\bar{\omega}'} \mu^*(\bar{\omega}'|\sigma^*(\bar{\omega}))\mathbb{E}(\theta|\bar{\omega}') \geq \sum_{\bar{\omega}'} \mu^*(\bar{\omega}'|m')\mathbb{E}(\theta|\bar{\omega}') \qquad m' \in M(\bar{\omega})$$

2. For all m, supp $\mu^*(\cdot|m) \subseteq C(m) = \{\bar{\omega} \in \Omega^N : m \in M(\bar{\omega})\}$. In particular, if $m \in \sigma^*(\Omega^N)$,

$$\mu^*(\bar{\omega}|m) = q(\bar{\omega}|{\sigma^\star}^{-1}(m)) \quad \forall\, \bar{\omega}$$

where $q(\bar{\omega}) = \sum_\theta p(\theta) f(\bar{\omega}|\theta)$

Back

Equilibrium: Refinements

Unlike classic disclosure games, the sequential equilibrium outcome is **not unique** when $K < N$.

- Off-path beliefs can support other equilibrium outcome.
- Refinements for signalling games (e.g., Cho-Kreps '87, Banks-Sobel '87) have no force here.
- Refinements for cheap talk games: Farrel (1993)'s **Neologism Proofness**.

Equilibrium Multiplicity

$\Theta = \{0, 1\}$ and $p(1) = \frac{1}{2}$. $N = 2$ and $K = 1$.

$\Omega = \{A, B\}$, $f(A|\theta_H) = 1$ and $f(A|\theta_L) = \frac{1}{2}$.

θ	$\bar{\omega}$	$M(\bar{\omega})$	$\sigma^*(\bar{\omega})$
1	(A, A)	$\{\varnothing, A\}$	A
0	(A, B)	$\{\varnothing, A, B\}$	A
	(B, B)	$\{\varnothing, B\}$	B

$$\mathbb{E}[\theta|m = A] = \frac{4}{7} \text{ and } \mathbb{E}[\theta|m = B] = \mathbb{E}[\theta|m = \varnothing] = 0 \implies$$

No incentive to deviate

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No incentive to deviate

Equilibrium: Uniqueness

Proposition

The equilibrium with maximal selective disclosure is Neologism Proof.

Neologism Proof Equilibrium

A **neologism** is a a pair (m, C), $C \subseteq \{\bar{\omega} \in \Omega^N : m \in M(\bar{\omega})\}$

Literal meaning of (m, C) $\rightsquigarrow$ "*My type* $\bar{\omega}$ *belongs to* C"

A neologism (m, C) is **credible** relative to equilibrium (σ^*, μ^*) if

1. $\sum_{\bar{\omega}'} q(\bar{\omega}'|C)\mathbb{E}(\theta|\bar{\omega}') > \sum_{\bar{\omega}'} \mu^*(\bar{\omega}'|\sigma^*(\bar{\omega}))\mathbb{E}(\theta|\bar{\omega}')$ for all $\bar{\omega} \in C$
2. $\sum_{\bar{\omega}'} q(\bar{\omega}'|C)\mathbb{E}(\theta|\bar{\omega}') \leq \sum_{\bar{\omega}'} \mu^*(\bar{\omega}'|\sigma^*(\bar{\omega}))\mathbb{E}(\theta|\bar{\omega}')$ for all $\bar{\omega} \notin C$

The equilibrium is **Neologism Proof** if no neologism is credible.

Equilibrium: Uniqueness

Proposition

The equilibrium with maximal selective disclosure is Neologism Proof.

Neologism Proofness delivers outcome uniqueness

An equilibrium (σ, μ) induces an outcome $x : \Omega^N \to A$,

$$x(\bar{\omega}) = \sum_{\bar{\omega}'} \mu(\bar{\omega}' | \sigma(\bar{\omega})) \mathbb{E}(\theta | \bar{\omega}') \qquad \forall \, \bar{\omega}.$$

Equilibrium: Uniqueness

Proposition

The equilibrium with maximal selective disclosure is Neologism Proof.

Proposition

Let (σ^*, μ^*) be the equilibrium with maximal selective disclosure and (σ, μ) be any other Neologism Proof equilibrium. Let x^* and x their respective outcomes. Then, $x^* = x$.

Back to the Example

θ	$\bar{\omega}$	$M(\bar{\omega})$	$\sigma^*(\bar{\omega})$
1	(A, A)	$\{\varnothing, A\}$	$\varnothing$
0	(A, B)	$\{\varnothing, A, B\}$	$\varnothing$
	(B, B)	$\{\varnothing, B\}$	$\varnothing$

$$m = A \text{ and } C = \{(A, A), (A, B)\} \implies$$

$$\mathbb{E}[\theta | m = A] = \tfrac{4}{7} > \mathbb{E}[\theta | m = \varnothing] = \tfrac{1}{2}$$

Credible neologism $\implies$ no Neologism Proof equilibrium

Experimental Design: Sender Interface

Round 7 of 30: Communication Stage **You are the Sender**

Reminder:

If the secret Urn is **Yellow**, this is the probability of each ball being drawn:

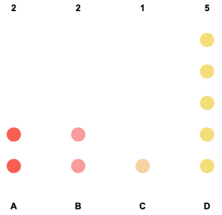
A	B	C	D
10 %	20 %	25 %	45 %

If the secret Urn is **Red**, this is the probability of each ball being drawn:

A	B	C	D
45 %	25 %	20 %	10 %

The secret Urn is Yellow

Available Balls



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Your message to the Receiver is:

Send

Experimental Design: Sender Interface

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The secret Urn is Yellow

Available Balls

A	B	C	D
0	1	1	5

\+ + + +

\- - - -

Your message to the Receiver is:

A A B

Send

Experimental Design: Receiver Interface

Round 7 of 30: Guessing Stage | **You are the Receiver**

Reminder:

If the secret Urn is **Yellow**, this is the probability of each ball being drawn:

A	B	C	D
10 %	20 %	25 %	45 %

If the secret Urn is **Red**, this is the probability of each ball being drawn:

A	B	C	D
45 %	25 %	20 %	10 %

The Sender had 10 available balls and they could disclose 3 or less. This is the Sender's message:

A A B

Use the slider below to indicate your Guess of how likely it is that the secret Urn is Red.

Your Guess: 10

Submit

Back

Experimental Design: Summary

Round 7 of 30: Payoff	You are the Receiver

The secret Urn was **Yellow**

In this Round you earned 100 points.

Continue

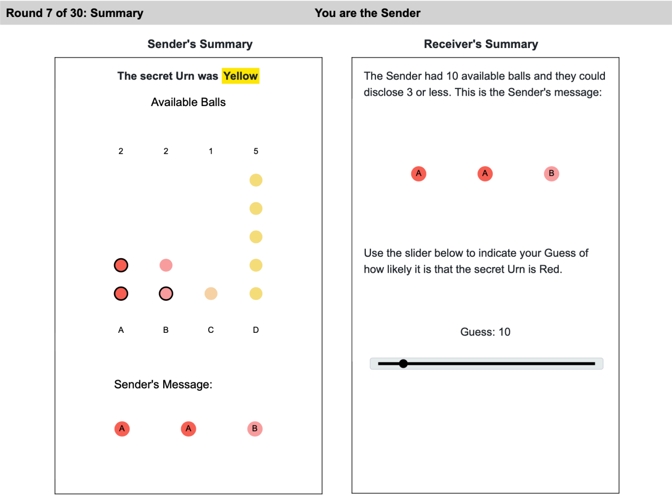
How were your points determined?

The secret Urn was Yellow. Your Guess was 10.

The two Computer's Random Numbers were 59 and 44.

Your Guess was smaller than or equal to the largest of the two Computer's Random Numbers, so you earned 100 points.

Experimental Design: Summary



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Experimental Design: History

Round 7 of 30: History **You are the Sender**

Round	Secret Urn	Message	Guess
7	Yellow	A A B	10
6	Red	A A ○	77
5	Red	A B B	77
4	Red	A A A	97
3	Red	A A ○	87
2	Yellow	C C ○	52
1	Red	○ ○ ○	0

Next

Heterogeneity: Senders

Challenge

- Large number of urn / balls / message combinations
- Specific behavior of interest varies across treatments
  - Number of balls sent ($K = 1$ vs $K = 3$)
  - Balls sent vs balls available ($N = K$ vs $N > K$)

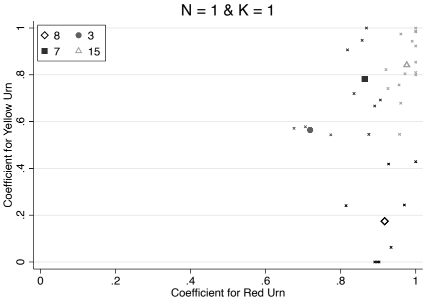
$\rightarrow$ Precludes a unified approach using those variables

Heterogeneity: Senders

Solution

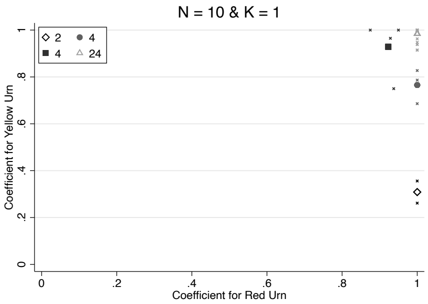
- Transform balls and messages to numbers ($B^{\#}$ and $M^{\#}$)
- Regress $M^{\#}$ on $B^{\#}|$yellow urn and $B^{\#}|$red urn
- Cluster the coefficient estimates
- Describe behavior along key dimensions of interest

Heterogeneity: Senders



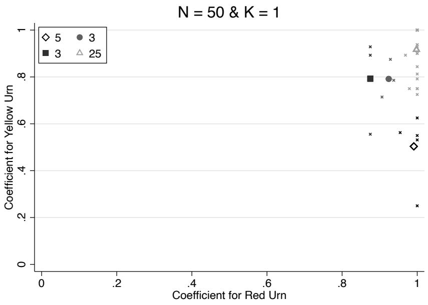
Cluster	Obs (33)	Urn	K	A	D
Triangle	15				
		Red	0.91	1	0.38
		Yellow	0.64	1	0.27
Square	7				
		Red	0.73	1	0.25
		Yellow	0.51	1	0.21
Circle	3				
		Red	0.5	0.92	n/a
		Yellow	0.54	0.67	0.49
Diamond	8				
		Red	0.71	1	0.20
		Yellow	0.30	0	0.46

Heterogeneity: Senders



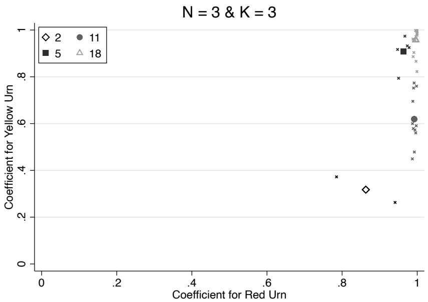
Cluster	Obs (34)	Urn	K	A	D
Triangle	24				
		Red	1	1	0
		Yellow	1	0.97	0.02
Square	4				
		Red	1	0.81	0.08
		Yellow	1	0.88	0.07
Circle	4				
		Red	1	1	0
		Yellow	1	0.46	0.14
Diamond	2				
		Red	1	1	0
		Yellow	1	0	0.89

Heterogeneity: Senders



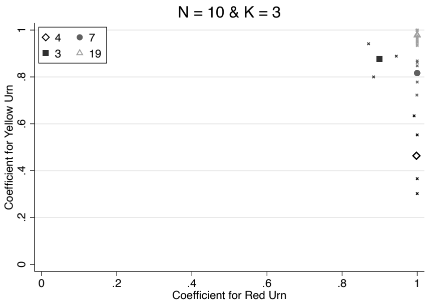
Cluster	Obs (36)	Urn	K	A	D
Triangle	25				
		Red	1	0.99	0
		Yellow	1	0.74	0.03
Square	3				
		Red	0.96	0.82	0.1
		Yellow	1	0.51	0.15
Circle	3				
		Red	1	0.78	0
		Yellow	1	0.63	0.18
Diamond	5				
		Red	1	0.96	0
		Yellow	0.95	0.26	0.46

Heterogeneity: Senders



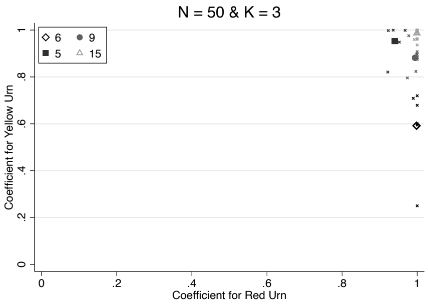
Cluster	Obs (36)	Urn	K	A	D
Triangle	18				
		Red	0.58	1	0.15
		Yellow	0.18	1	0.12
Square	5				
		Red	0.29	1	0
		Yellow	0.10	0.88	0.05
Circle	11				
		Red	0.26	1	0.06
		Yellow	0.15	0.23	0.60
Diamond	2				
		Red	0	1	0
		Yellow	0.06	0.25	0.50

Heterogeneity: Senders



Cluster	Obs (33)	Urn	K	A	D
Triangle	19				
		Red	0.99	0.99	0
		Yellow	0.88	0.96	0.01
Square	3				
		Red	1	0.46	0.17
		Yellow	1	0.43	0.04
Circle	7				
		Red	1	0.94	0
		Yellow	0.74	0.66	0.10
Diamond	4				
		Red	0.92	0.83	0
		Yellow	0.76	0.28	0.43

Heterogeneity: Senders



Cluster	Obs (35)	Urn	K	A	D
Triangle	15				
		Red	1	0.88	0
		Yellow	0.94	0.80	0
Square	5				
		Red	0.89	0.17	0
		Yellow	0.87	0.32	0
Circle	9				
		Red	0.97	0.70	0
		Yellow	0.94	0.31	0.04
Diamond	6				
		Red	1	0.86	0.03
		Yellow	0.95	0.31	0.41

Heterogeneity: Senders

Equilibrium type (56%)

- Most common
- $N > K$: Mostly report best balls independently of the state
- $N = K$: Disclose fewer than K balls

Deception Averse Type (17%)

- A's reported more often when the state is high
- D's reported more often when the state is low
- $N = K$: Disclose fewer than K balls

Others (27%)

- Similar to equilibrium types when the state is high
- Report A's less but do not report D's when the state is low
- Some low rates of A's when the state is high [confusion]

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Heterogeneity: Receivers

Challenge

- Large number of messages
- Different messages across treatments
- Some messages have very few observations

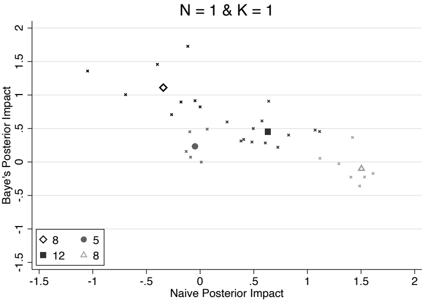
→ Precludes a unified approach using that variable

Heterogeneity: Receivers

Solution

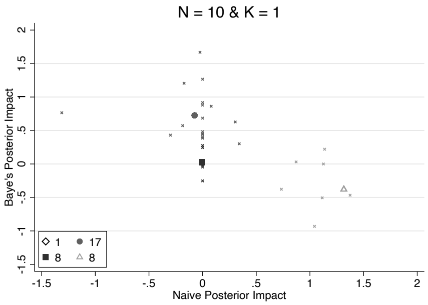
- Compute equilibrium update following each message
- Compute the update of someone who ignores selection: naive update
- Regress guesses on a constant (α) and the equilibrium and naive updates
- Cluster the coefficient estimates
- Describe behavior along key dimensions of interest

Heterogeneity: Receivers



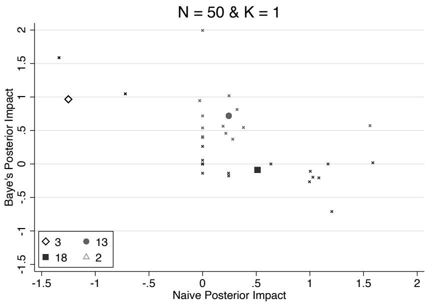
Cluster	Obs (33)	A	B	∅	C
Diamond	8				
$\alpha = 0.23$		0.87	0.67	0.23	0.47
Circle	5				
$\alpha = 0.39$		0.56	0.49	0.41	0.37
Square	12				
$\alpha = 0.02$		0.86	0.73	0.41	0.38
Triangle	8				
$\alpha = -0.23$		0.90	0.67	0.51	0.23

Heterogeneity: Receivers



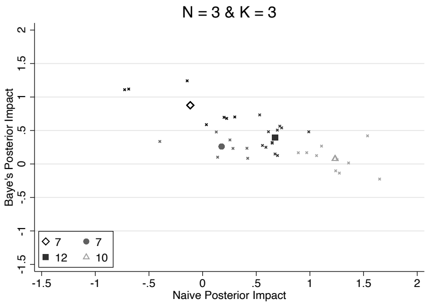
Cluster	Obs (34)	A	B	∅	D
Diamond	1				
$\alpha = 4.20$		0.60*	0.23*	0.60*	n/a
Circle	17				
$\alpha = 0.28$		0.66	0.26	n/a	0.11
Square	8				
$\alpha = 0.56$		0.58	0.60	n/a	0.60
Triangle	8				
$\alpha = -0.23$		0.62	0.52	n/a	0.11

Heterogeneity: Receivers



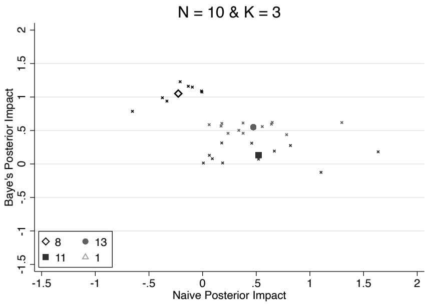
Cluster	Obs (36)	A	B	∅	D
Diamond	3				
$\alpha = 0.89$		0.35	0.17	0.21*	0.75
Circle	13				
$\alpha = 0.15$		0.71	0.29	0.46*	0.11
Square	18				
$\alpha = 0.26$		0.63	0.53	n/a	0.19
Triangle	2				
$\alpha = -1.15$		0.69	0.41	n/a	n/a

Heterogeneity: Receivers



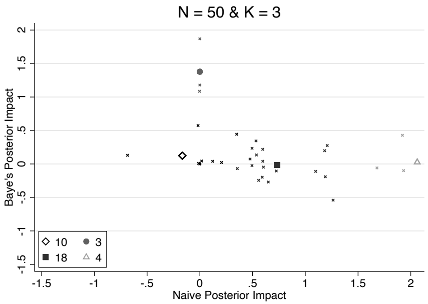
Cluster	Obs (36)	AAA	AAB	AA	AB
Diamond	7				
$\alpha = 0.20$		0.92*	0.86	0.86	0.62
Circle	7				
$\alpha = 0.30$		0.72	0.66	0.63	0.68
Square	12				
$\alpha = -0.04$		0.88	0.92	0.91	0.86
Triangle	10				
$\alpha = -0.24$		1	0.97	0.96	0.90

Heterogeneity: Receivers



Cluster	Obs (33)	AAA	AAB	AA	ABB
Diamond	8				
$\alpha = 0.19$		0.95	0.11	0.02	0.03
Circle	13				
$\alpha = -0.07$		0.89	0.70	0.24	0.26
Square	11				
$\alpha = 0.10$		0.74	0.70	n/a	0.61
Triangle	1				
$\alpha = -3.98$		1^*	0.54^*	n/a	0.02^*

Heterogeneity: Receivers



Cluster	Obs (35)	AAA	AAB	AA	DDD
Diamond $\alpha = 0.64$	10	0.54	0.49	0.33	0.32
Circle $\alpha = 0.11$	3	0.84	0.01*	n/a	0.07
Square $\alpha = -0.04$	18	0.67	0.69	0.57	0.12
Triangle $\alpha = -1.16$	4	0.89	0.80	0.91*	n/a

Heterogeneity: Receivers

- Variation in updating strategies
  - Extent they account for selection
- Being closer to equilibrium $\not\rightarrow$ higher payoffs
- However, in many treatments, groups better at accounting for selection are among the highest
- With $N = 50$, few differences in payoffs

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Summary

Senders

- The majority:
  - Select the better balls to send.
  - Behave similarly for both urns.
- Some convey more information by conditioning on the type.

$\rightarrow$ More information transmitted than predicted.

Receivers

- Many do not fully account for selection.
- Some are not very responsive.

$\rightarrow$ Less information received than predicted.