# An Experiment on Social Learning with Information Sequencing

Pëllumb Reshidi

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## The Theme

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**How does the timing of information arrival affect final beliefs formed within a social network?**

- Does the sequence of information arrival affect the final beliefs formed in a social network?
- Do different network structures affect beliefs?
- What are the predominant heuristics that guide belief dynamics?

# Experimental Design

- Groups of 4 participants
- 8 games, 40 rounds each

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- Two treatments: *Ring Network* & *Fully Connected Network*

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- 2/8 games information arrives all at once in round $\{5\}$

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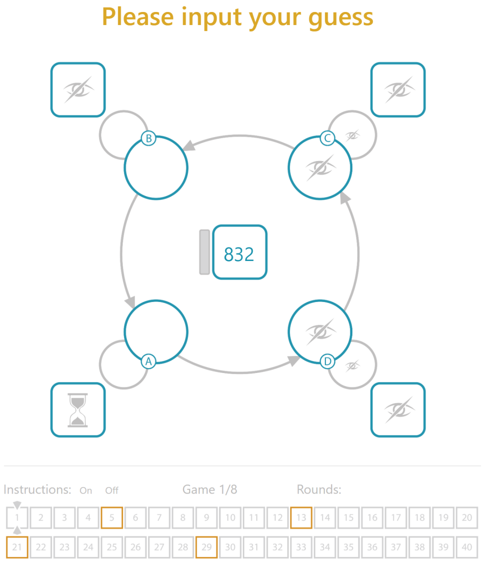
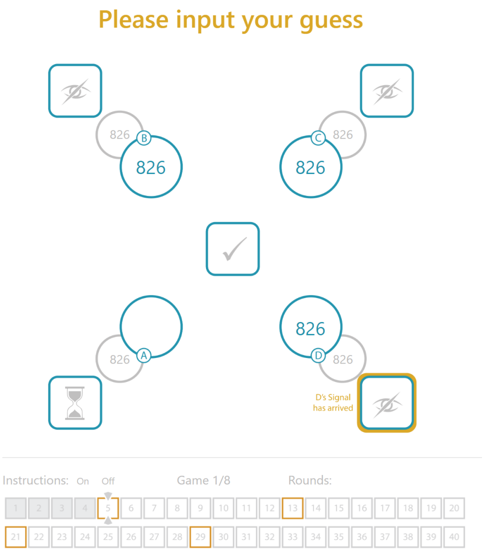
- $payoff = \$10 - \frac{1}{4}|guess - truth|$ for (3 out of 8) games randomly selected and (1 out of 40) rounds randomly selected

# Interface: Ring Network (*Low Information Treatment*)




Please input your guess
826
B
826
C
826
826
826
A
826
826
D
826
D's Signal has arrived
Instructions: On Off
Game 1/8
Rounds:
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

- DeGroot model + sequential information arrival $\Longrightarrow$ **the sequence affects final beliefs**
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- **Releasing a signal in a later round increases the impact it has on the final beliefs**
- **Relevant specification: Releasing all signals jointly maximizes the weight of the prior (common signal)**

# Types of sequences

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$\bigtriangleup$ Sequentially release low $\rightarrow$ high

$\bigtriangleup$ $S_C > S_i \ \forall \ i$ release all in $\{5\}$

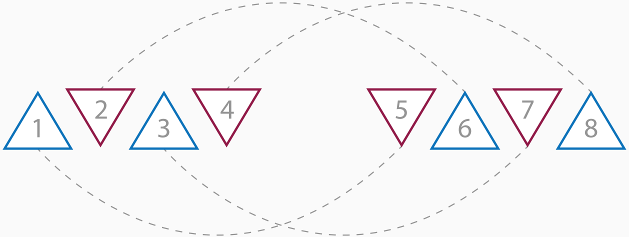
$\bigtriangledown$ Sequentially release high $\rightarrow$ low

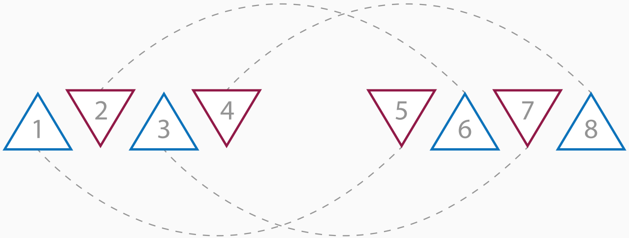
$\bigtriangledown$ $S_C < S_i \ \forall \ i$ release all in $\{5\}$

1 2 3 4 5 6 7 8

1 2 3 4 5 6 7 8

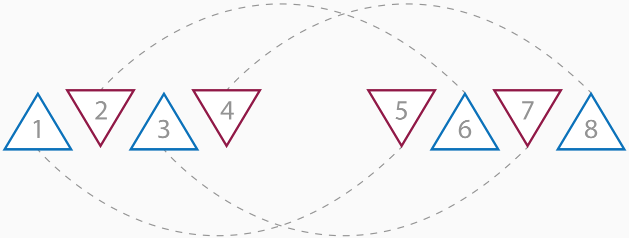

1
2
3
4
5
6
7
8


1
2
3
4
5
6
7
8




$S_c^1 = 375$ $S_A^1 = 353$ $S_B^1 = 416$ $S_C^1 = 341$ $S_D^1 = 493$

$S_c^5 = 789$ $S_A^5 = 767$ $S_B^5 = 830$ $S_C^5 = 755$ $S_D^1 = 907$




$S_c^1 = 375$ $S_A^1 = 353$ $S_B^1 = 416$ $S_C^1 = 341$ $S_D^1 = 493$

$S_c^5 = 375 + c$ $S_A^5 = 353 + c$ $S_B^5 = 416 + c$ $S_C^5 = 341 + c$ $S_D^1 = 493 + c$

- Identical Network

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- Identical Players

# Identification Strategy

- Identical Network
- Identical Players
- Identical Signals

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- Identical Network
- Identical Players
- Identical Signals
- Different Signal Arrival Sequence

# Experiment Summary

- Experiments run at Princeton Experimental Laboratory for the Social Sciences (PExL)
- Total 136 participants
- Ring Network: 64 participants, leading to a total of 128 games (512 individual paths)
- Full Network: 72 participants, leading to a total of 144 games (576 individual paths)

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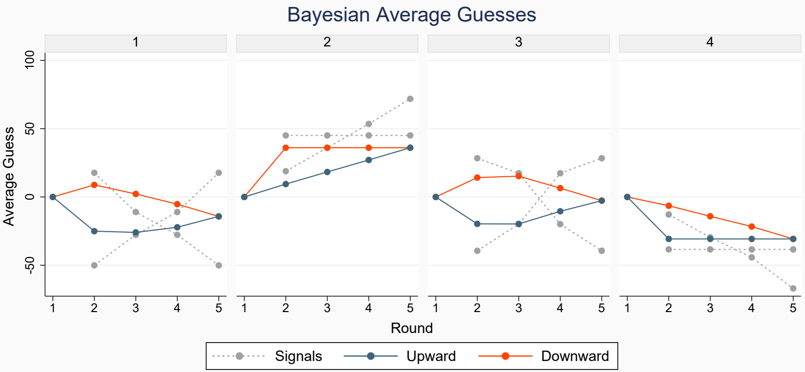
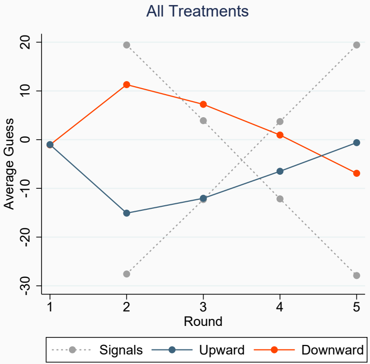
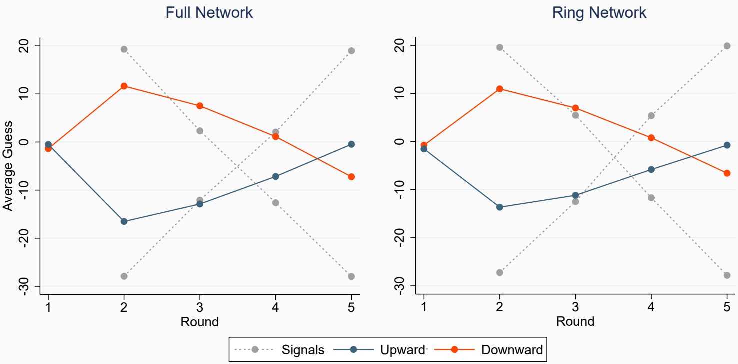
- Planning to collect more data once the lab reopens

# Predicted Bayesian Behavior



# Results


All Treatments
Average Guess
20
10
0
-10
-20
-30
1
2
3
4
5
Round
Signals
Upward
Downward


Full Network
Ring Network
Average Guess
20
10
0
-10
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1
2
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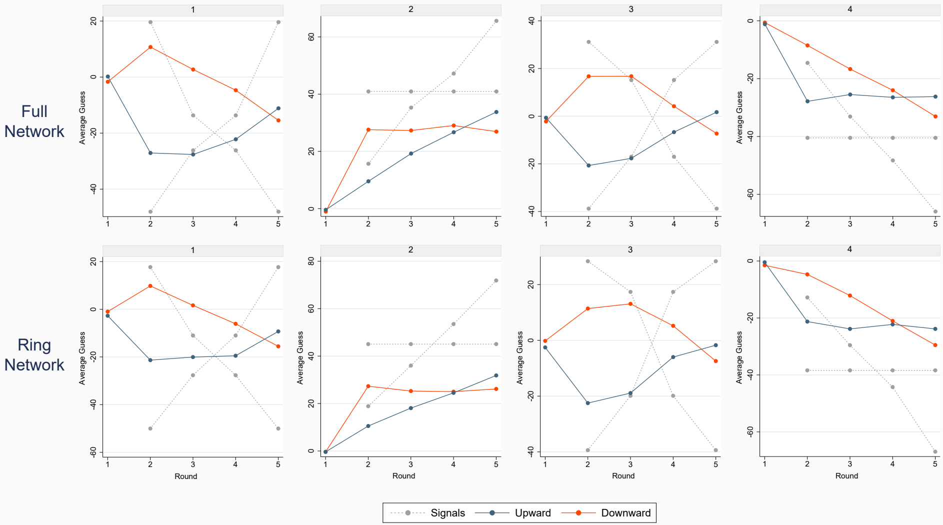
Downward

# Cross Plots



Full Network
Ring Network
1
2
3
4
Average Guess
Round
Signals
Upward
Downward

| Sequence Impact - Fixed Effects Regression: Round 32-36 | |
|---|---|
| | $\triangle$ *Guess* |
| *Constant* | 8.298*** |
| | (0.000) |
| *Sequential* | 0.151 |
| | (0.899) |
| *Low Info* | -0.180 |
| | (0.916) |
| *Sequential* $\times$ *Low Info* | -1.952 |
| | (0.366) |
| *N* | 2720 |

Individual level clustering

*p*-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

$\triangle$ *Guess* $\in [6.17, 8.45]$ corresponds to $0.34 - 0.60$ of ex-post s.d.

# Weight on Signals

| | *Weight on Signals: Round 32-36* | |
|---|---|---|
| | *Guess* | |
| | *Low Information Treatment* | *High Information Treatment* |
| ⋮ | ⋮ | ⋮ |
| $S_i$ | 0.186*** | 0.150*** |
| | (0.000) | (0.021) |
| *Bonus* | 0.0553*** | 0.0863*** |
| | (0.003) | (0.012) |
| $N$ | 1024 | 1152 |

Individual level clustering

$p$-values in parentheses

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**Table 1:** Weight on Common Signal

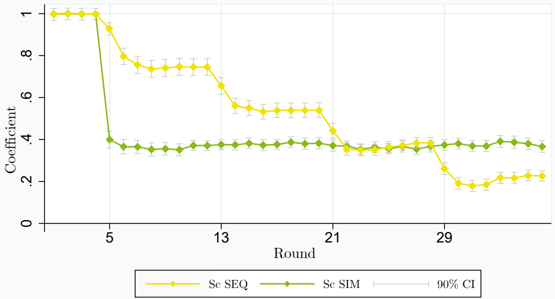
| | Guess on Round 36 |
|---|---|
| $S_c$ | 0.385*** |
| | (0.000) |
| $S_c \times SIM \times HIT$ | -0.0409 |
| | (0.235) |
| $S_c \times SEQ$ | -0.122*** |
| | (0.001) |
| $S_c \times SEQ \times HIT$ | -0.0716** |
| | (0.012) |
| $N$ | 1088 |

$p$-values in parentheses

Individual-levle clustering

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Figure 1:** The Weight on the Common Signal: *SEQ VS SIM*



# Model Parameter Estimation

Estimate a **Hybrid Model**, that nests the **Bayesian Model**, the **Sequential DeGroot Model**, and intermediate levels of sophistication.

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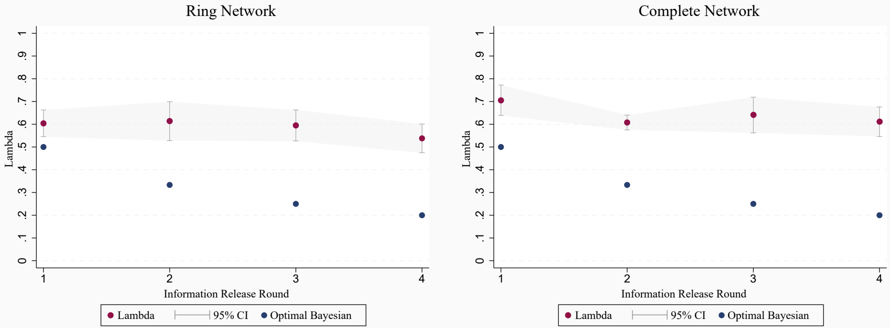
| | Weights on own previous guesses | | | | |
|---|---|---|---|---|---|
| | Regular rounds | | Information rounds | | |
| | $m_{i,i}$ | $m_{i,j}$ | $\underline{m}_{i,i}$ | $\underline{m}_{i,j}$ | $\overline{m}_{i,j}$ |
| *Value* | 0.55 | 0.14 | 0.33 | 0.07 | 0.51 |
| 95% *CI* | (0.54-0.57) | (0.13-0.15) | (0.27-0.39) | (0.04-0.10) | (0.48-0.53) |

| | Anchoring parameters | |
|---|---|---|
| | $\delta_c$ | $\delta_s$ |
| *Value* | 0.02 | 0.07 |
| 95% *CI* | (0.01-0.03) | (0.06-0.08) |

| | Weights on own signals | | | |
|---|---|---|---|---|
| | $\lambda_5$ | $\lambda_{13}$ | $\lambda_{21}$ | $\lambda_{29}$ |
| *Value* | 0.70 | 0.57 | 0.64 | 0.61 |
| 95% *CI* | (0.64-0.77) | (0.51-0.64) | (0.56-0.72) | (0.55-0.68) |

# Weight on Own Signal



- The timing of information arrival affects beliefs (in a predictable manner).
- The network structure and information sequencing the can be utilized to improve outcomes.
- Participants are not fully mechanical, but not Bayesian either.
- Main heuristic: over-weighting own signals + lack of adjusting over time.