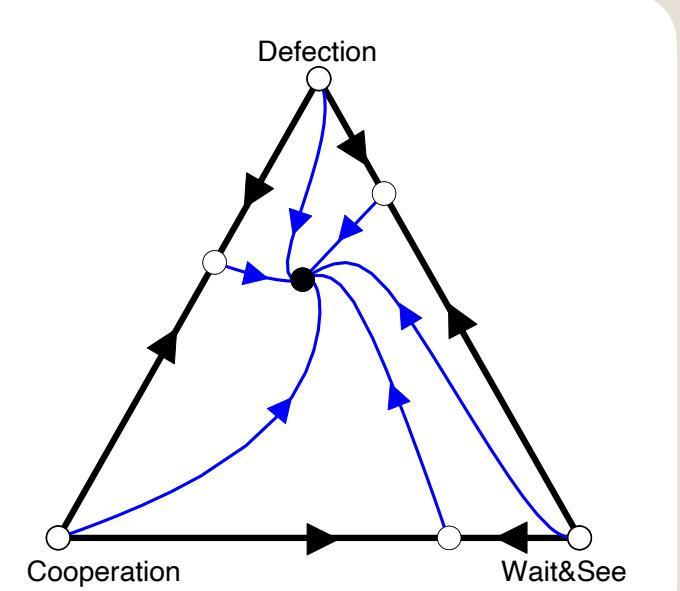


An overview

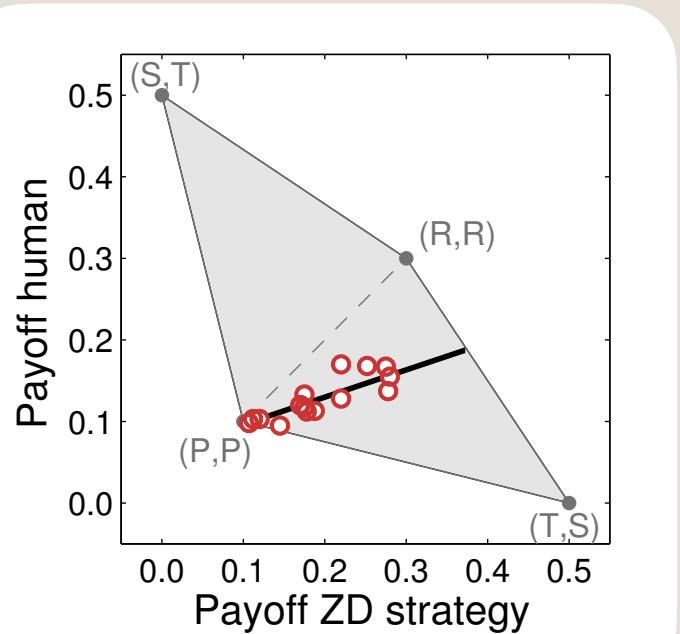
Yesterday's class (March 11, 2025)

- An introduction to evolutionary game theory
(Replicator dynamics, games in finite populations)



Today's classes (March 12, 2025)

- Evolution of cooperation & direct reciprocity
- Social norms & indirect reciprocity



Tomorrow's class (March 13, 2025)

- Some current research: Reciprocity in complex environments

Evolution of cooperation: A Review

Remark 3.1. Evolution of cooperation

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Editorial

Under Review

Editorial

Peer-reviewed

by

Friederike Hartenberger

in

Wiley

on

bioRxiv

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Most scientists regarded the new streamlined peer-review process as "quite an improvement."

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Image: NIKO HIRSCH

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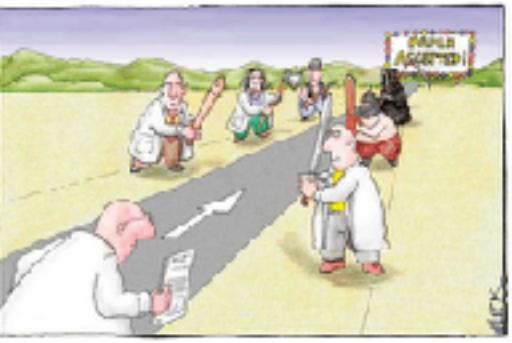
இரண்டு நேரங்களில்

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Under Review

All Partnership

Why do review journals like *Arby* do they, in a sentence summary, spend several hours long, evaluating, and summarizing readings on a manuscript from a group of authors they might not know? The reasons are many, of course, and all should be seen as the summa that reviewers provide on a single paper, on a system based on **curriculum vitae**, from which they are. Among the more frequently mentioned are civic duty (good will citizenship), loyalty to a particular journal, probably need to publish and critique one paper a year, it is a published work, and a desire to expand influence, the presentation of one's work, for noble or ignoble motives.



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can also help journal decisions on a paper that is safer than the 10 others in the set. However, new reviews were the best review type. Quite obviously, we have to refine our scope for the scope of empirical research the article technically example, insufficiently often written closed to the journal, or another review, which, despite its debilities, is frequently identified in surveys as one of the most important sources of the traditional process of scholarly publishing (per., for example, the recent report from LIBER's "New Journal Publishing Models: An International Survey of Scholar Research Libraries" [<http://www.dlib.nl/studs/agents/Biblio000002.pdf>]). Nevertheless, it behoves us all to explore ways to make the process more

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Editorial

Under Review

E-mail notifications

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hile the review cycle in scholarly journals is open, several issues relating to the process and communication between authors and reviewers are often unknown. The reasons are many, often expressed and often asserted as the common, that review provides an useful service to science and to the human mind, from which derive the most frequent cited reasons are civic duty (good scientific citizenship), analysis is part of the job, it is a good way to read and critique the paper, authors can publish their work, and it's a chance to exert and influence the promotion of science. In noble or noble cause.

Increasingly, however, one hears that the system is overloaded. The last reviewer—the ones who can provide perspectives on a field, attention to detail, and a critical eye—have timely responses can require as many as ten requests per week. Equally, reviewers are forced to make choices about which papers to review and others to decline. In some cases, a paper within only a fairly narrow scope that is relevant fails to receive attention. This limits the pool of qualified reviewers for particular papers and for emerging fields or interdisciplinary topics. Therefore, if a paper has been reviewed and rejected from one journal, chances are that an editor from a different journal

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- Such norms consist of rules that determine what people ought to do in certain situations, and what consequences misbehaviour should have.
- Social norms change in time. Beneficial norms, and norms that are easily enforced tend to stay. Others go.
⇒ We can explore the evolution of norms with evolutionary game theory.

Evolution of Indirect reciprocity: Image Scoring

Remark 3.3. Image scoring (Nowak & Sigmund 1998)

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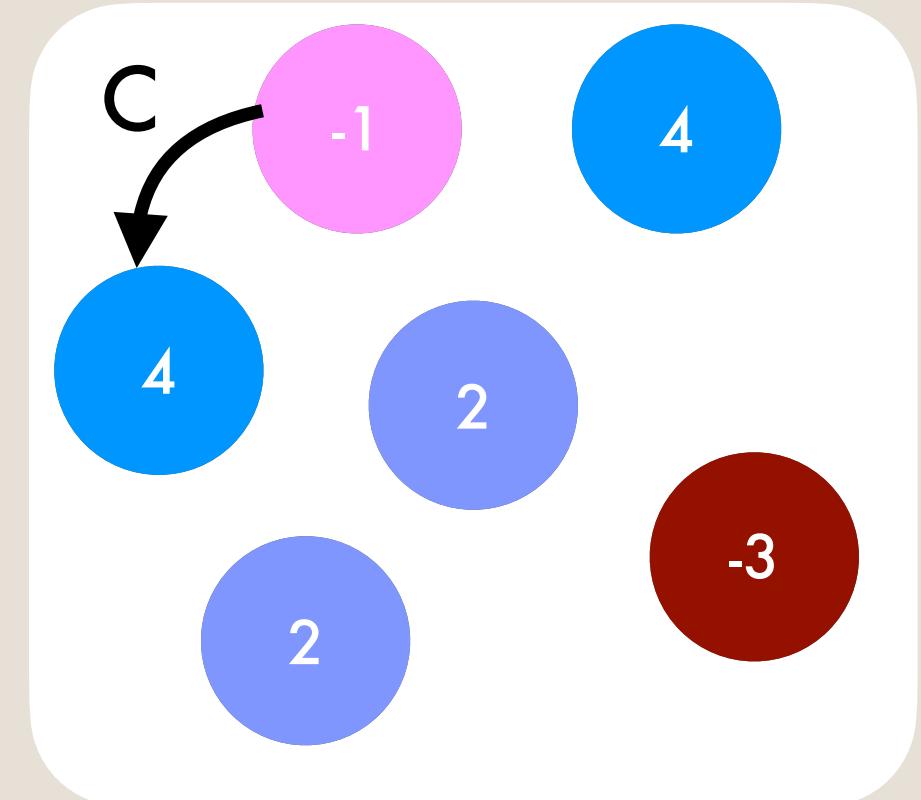
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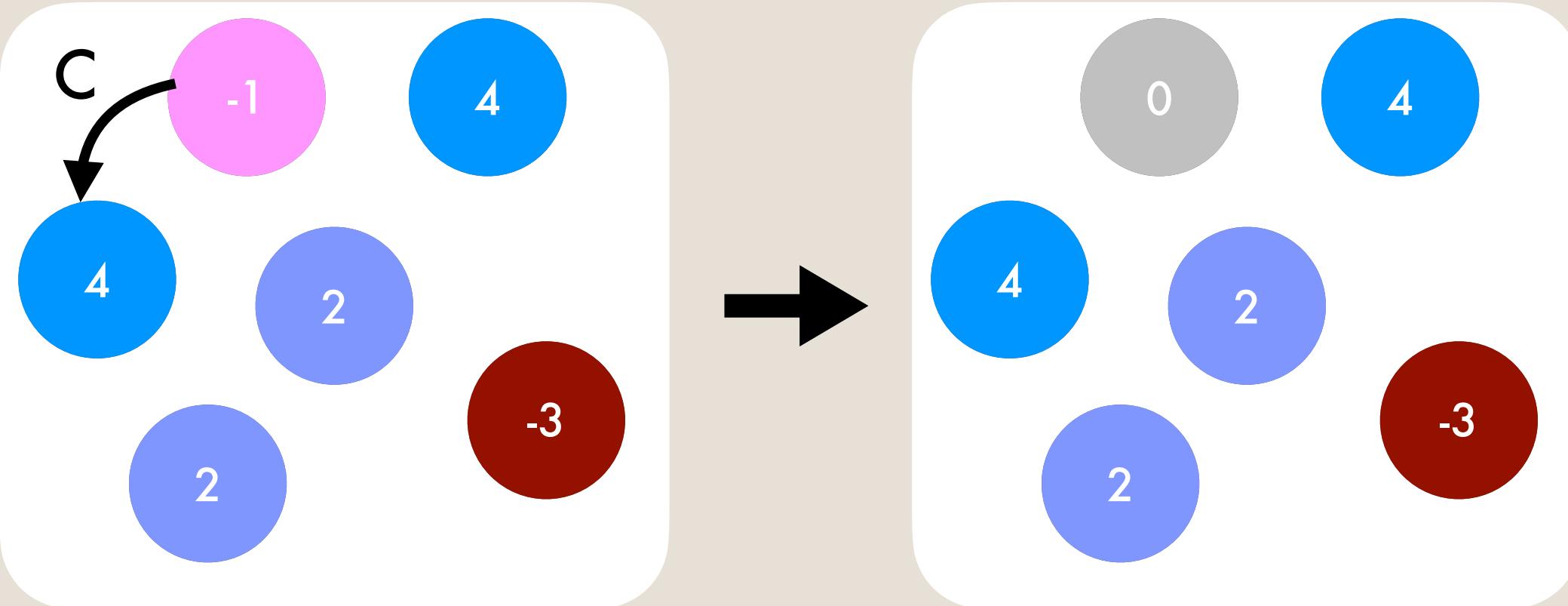
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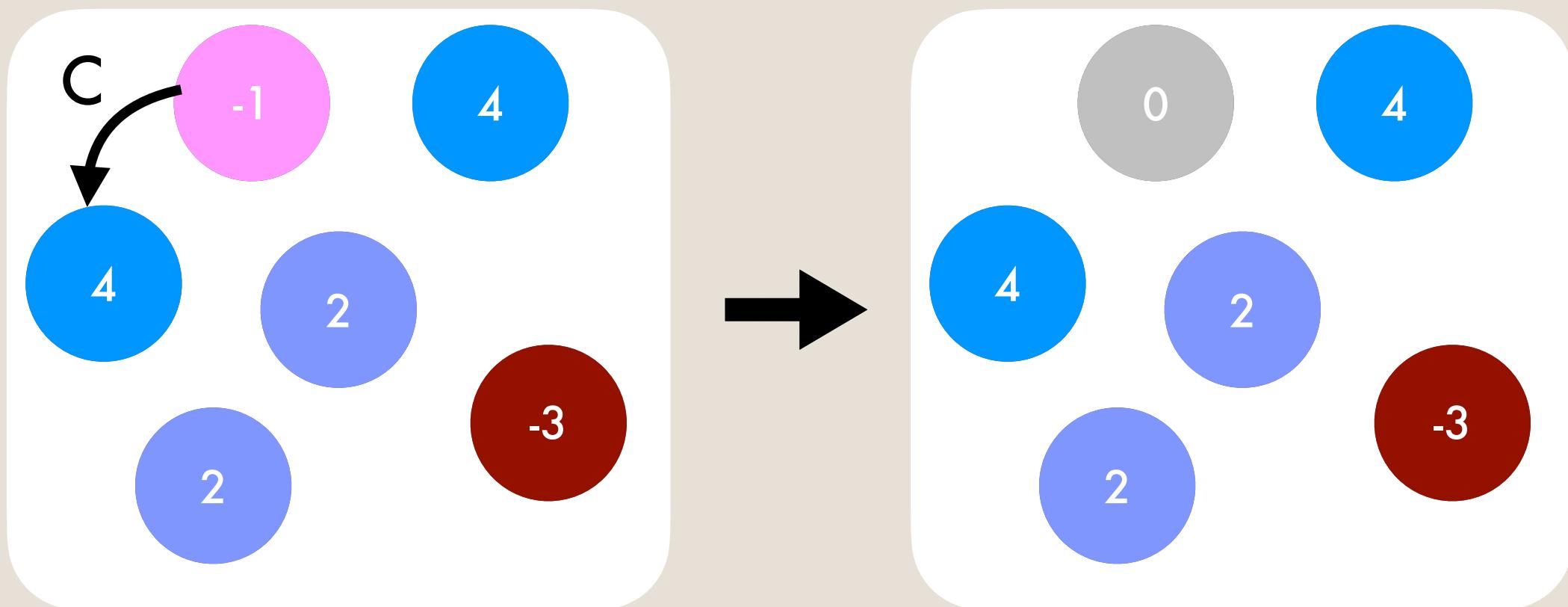
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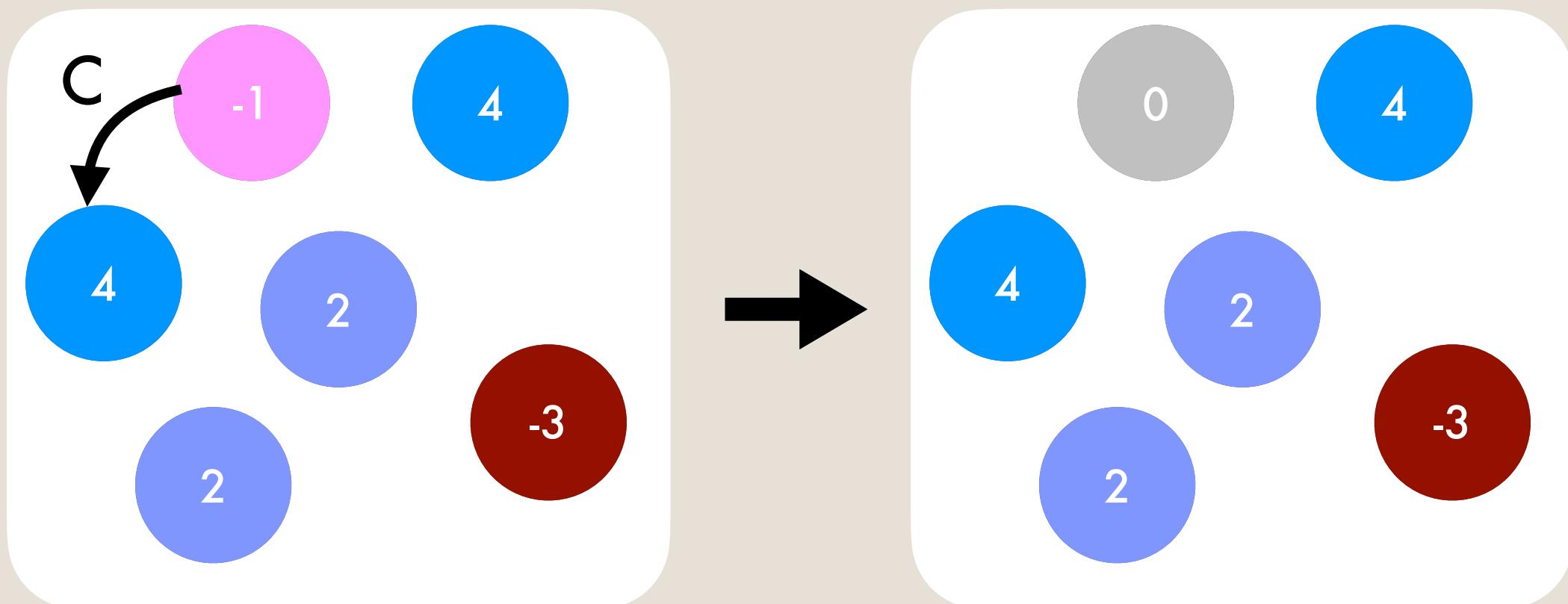
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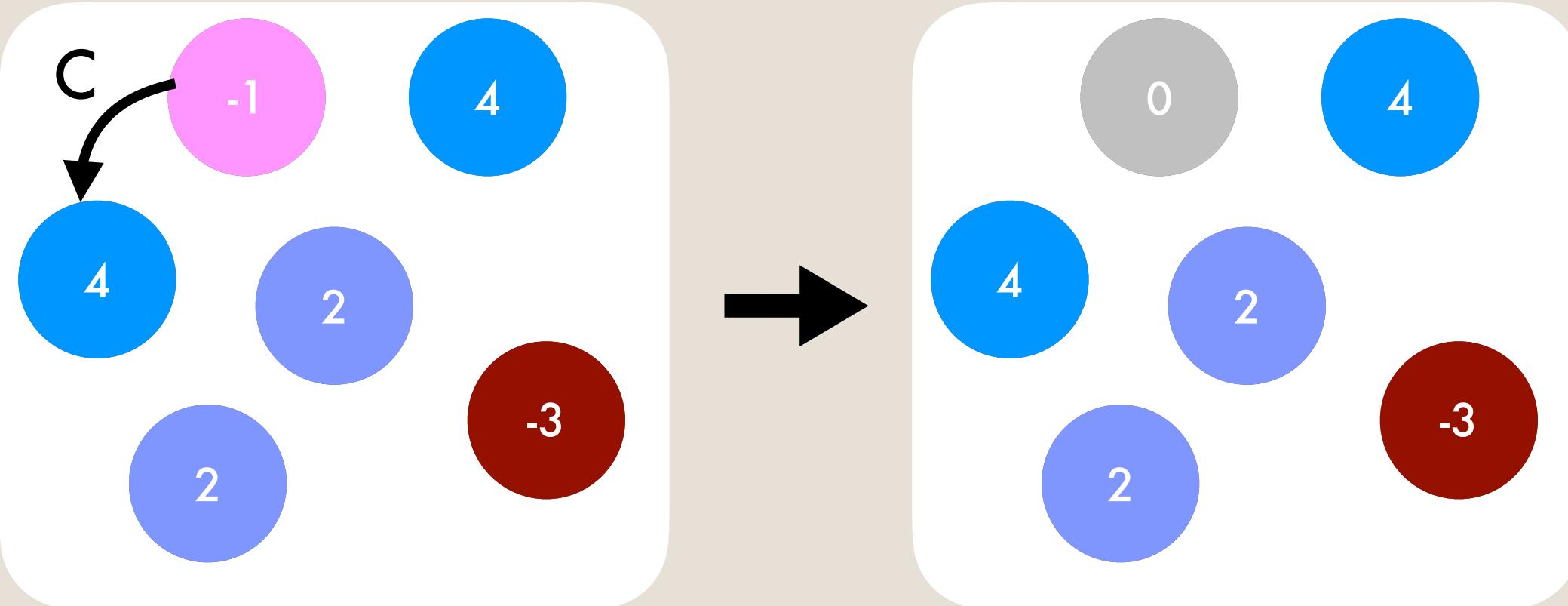
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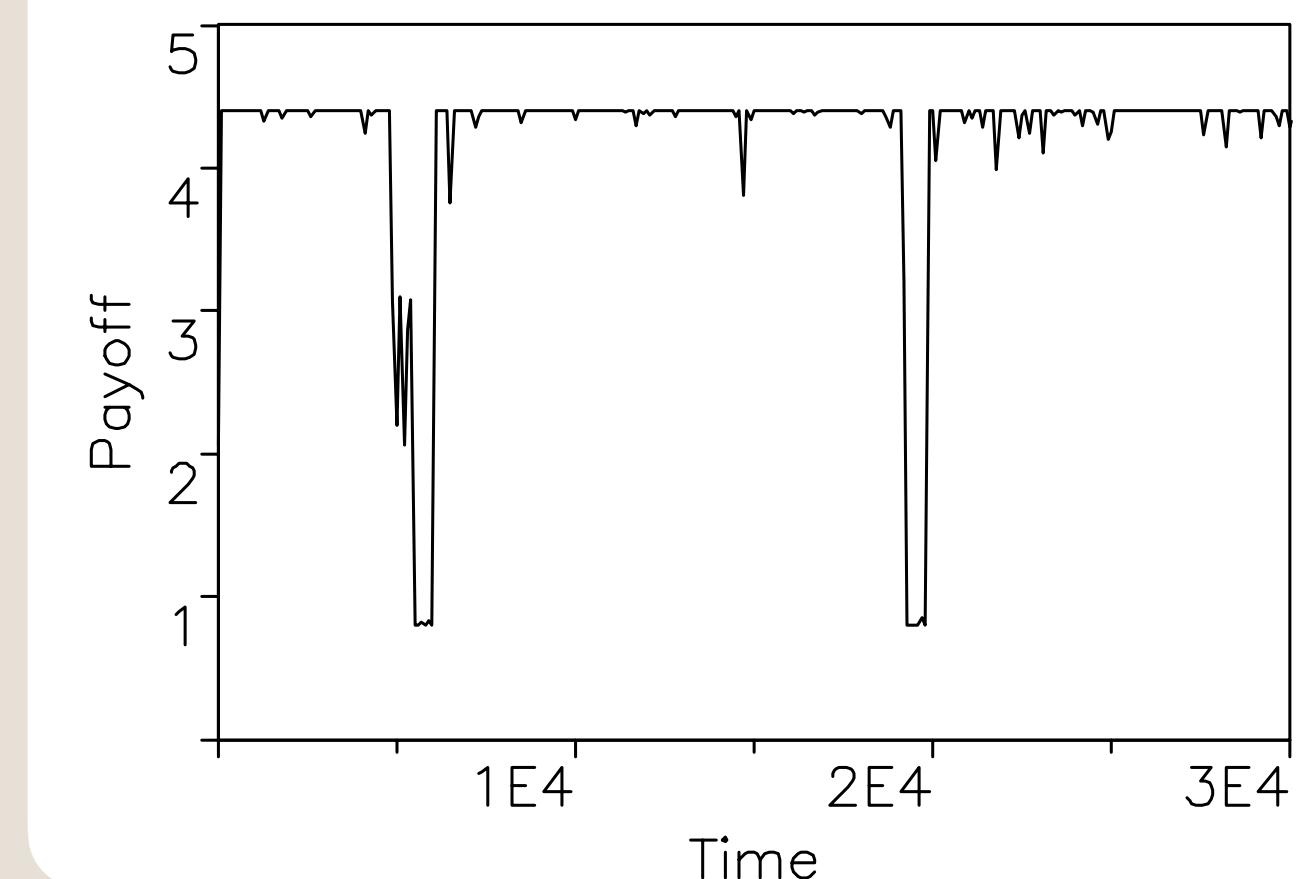
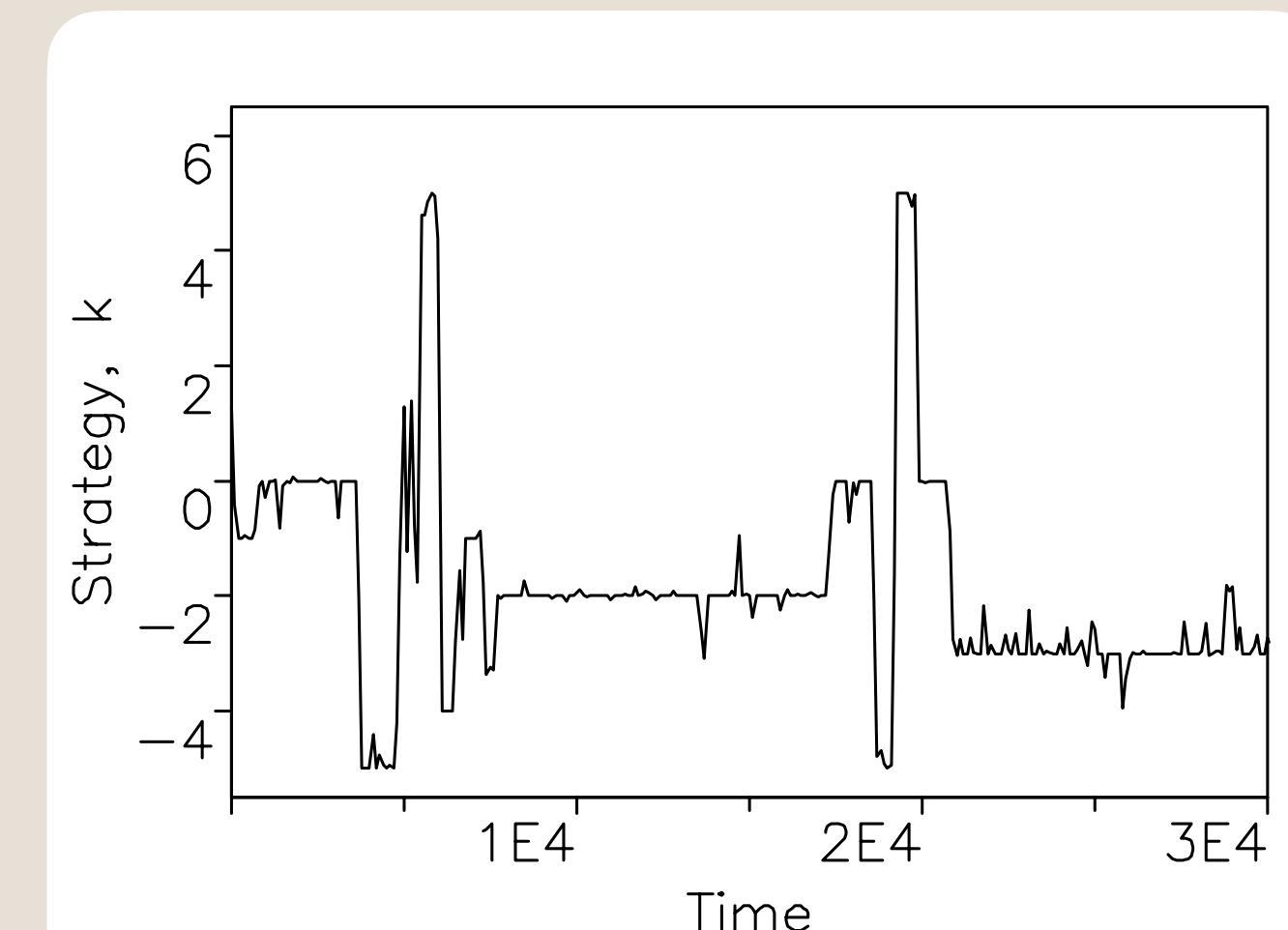
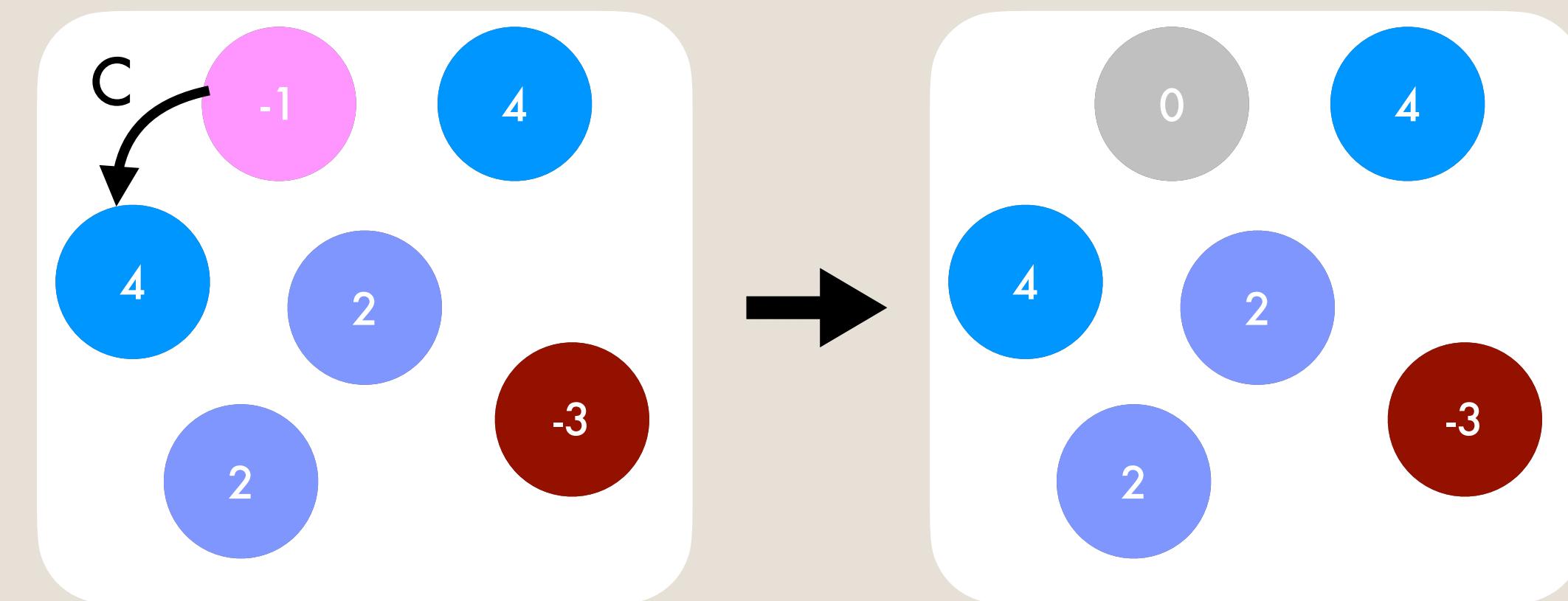
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Evolution of cooperation through indirect reciprocity

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- In principle, this gives rise to $2^{12} = 4,096$ possible social norms to consider.

Evolution of indirect reciprocity: Ohtsuki & Iwasa (2004)

How should we define goodness?—reputation dynamics in
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Remark 3.6. Examples of third-order norms

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- Unconditional cooperators (ALLC)

$$(\alpha_{gCg}, \alpha_{gCb}, \alpha_{bCg}, \alpha_{bCb}, \alpha_{gDg}, \alpha_{gDb}, \alpha_{bDg}, \alpha_{bDb}) = (1,1,1,1,1,1,1,1)$$

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- Simple Scoring (SCO)

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$$(\alpha_{gCg}, \alpha_{gCb}, \alpha_{bCg}, \alpha_{bCb}, \alpha_{gDg}, \alpha_{gDb}, \alpha_{bDg}, \alpha_{bDb}) = (1,1,1,1,1,1,1,1)$$
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- Simple Scoring (SCO)

$$(\alpha_{gCg}, \alpha_{gCb}, \alpha_{bCg}, \alpha_{bCb}, \alpha_{gDg}, \alpha_{gDb}, \alpha_{bDg}, \alpha_{bDb}) = (1,1,1,1,0,0,0,0)$$
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Remark 3.7. Searching for stable cooperative social norms

Question: Among all these pairs (α, β) , can we identify all social norms with the following two properties:

Evolution of indirect reciprocity: Ohtsuki & Iwasa (2004)

How should we define goodness?—reputation dynamics in
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Remark 3.6. Examples of third-order norms

- Unconditional cooperators (ALLD)

$$(\alpha_{gCg}, \alpha_{gCb}, \alpha_{bCg}, \alpha_{bCb}, \alpha_{gDg}, \alpha_{gDb}, \alpha_{bDg}, \alpha_{bDb}) = (0,0,0,0,0,0,0,0)$$
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Question: Among all these pairs (α, β) , can we identify all social norms with the following two properties:

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- The norm is self-enforcing (no population member can gain a higher payoff by deviating from the social norm).

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- The norm is self-enforcing (no population member can gain a higher payoff by deviating from the social norm).

If these norms exist, how do they look like?

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Remark 3.8. The “Leading eight”

- Using analytical methods and numerical computations, Ohtsuki and Iwasa identified eight social norms that satisfy both properties.

Assessment rule	* L1	Consistent Standing	Simple Standing	* L4	* L5	Stern Judging	Staying	Judging
	L2	L3	L6	L7	L8			
Good cooperates with Good	g	g	g	g	g	g	g	g
Good cooperates with Bad	g	b	g	g	b	b	g	b
Bad cooperates with Good	g	g	g	g	g	g	g	g
Bad cooperates with Bad	g	g	g	b	g	b	b	b
Good defects against Good	b	b	b	b	b	b	b	b
Good defects against Bad	g	g	g	g	g	g	g	g
Bad defects against Good	b	b	b	b	b	b	b	b
Bad defects against Bad	b	b	g	g	g	g	b	b
Action rule	L1	L2	L3	L4	L5	L6	L7	L8
Good meets Good	C	C	C	C	C	C	C	C
Good meets Bad	D	D	D	D	D	D	D	D
Bad meets Good	C	C	C	C	C	C	C	C
Bad meets Bad	C	C	D	D	D	D	D	D

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Bad meets Good	C	C	C	C	C	C	C	C
Bad meets Bad	C	C	D	D	D	D	D	D

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Good meets Bad	D	D	D	D	D	D	D	D
Bad meets Good	C	C	C	C	C	C	C	C
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 - A good donor who defects against a bad recipient should keep his/her good reputation (“justified punishment”)

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 - Cooperating with a good recipient should always yield a good reputation.
 - Defecting against a good recipient should always yield a bad reputation.
 - A good donor who defects against a bad recipient should keep his/her good reputation ("justified punishment")
 - The norms disagree on how one should assess
 - Good donors who cooperate with bad recipients
 - Bad donors who cooperate with bad recipients
 - Bad donors who defect with bad recipients

Evolution of indirect reciprocity: The leading eight

Remark 3.9. Stern Judging

- One important rule among the leading eight is called “Stern Judging” (L6):

The only behaviors that should yield a good reputation are cooperating with good people and defecting with bad people.

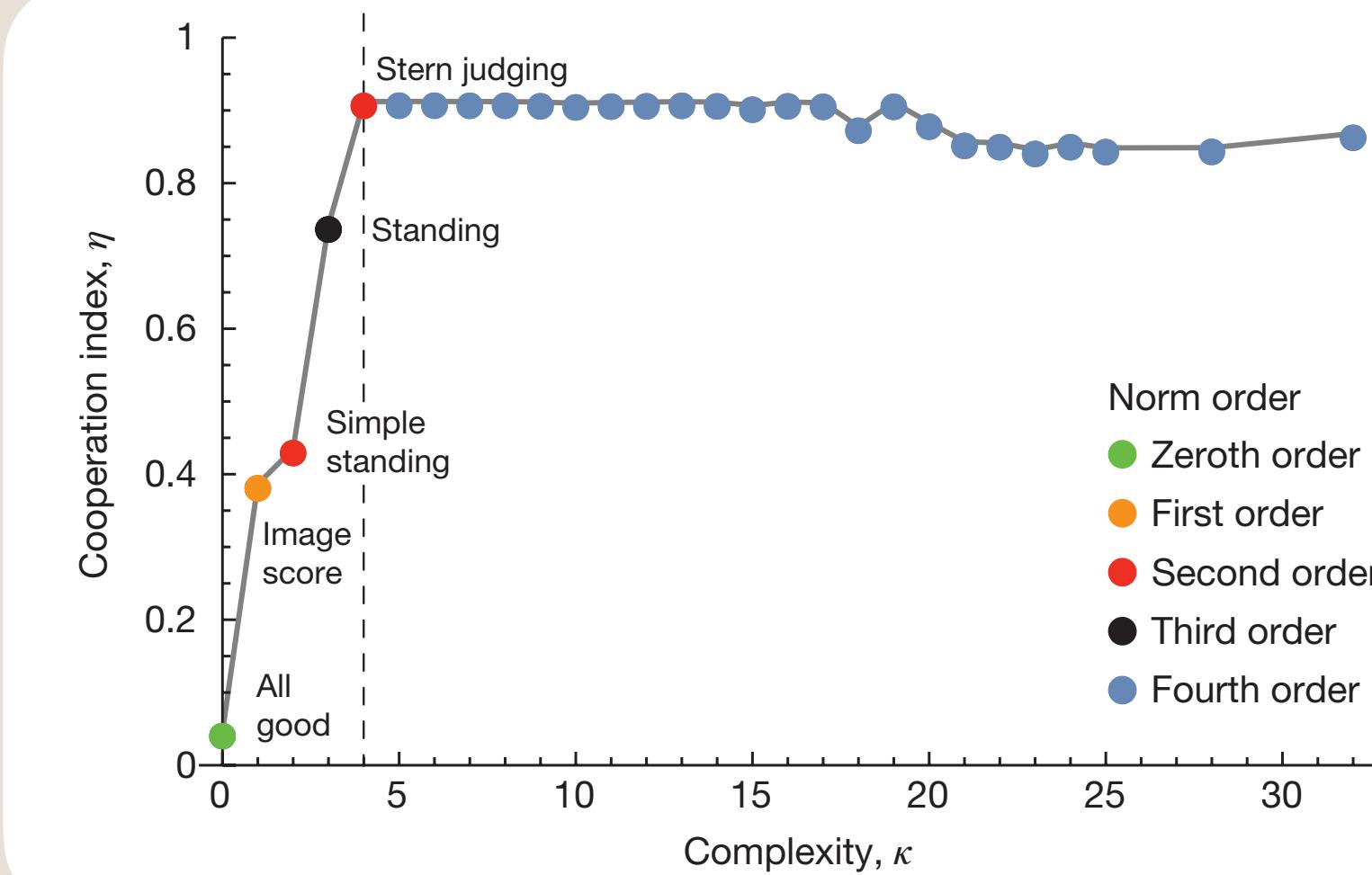
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Social norm complexity and past reputations in the evolution of cooperation

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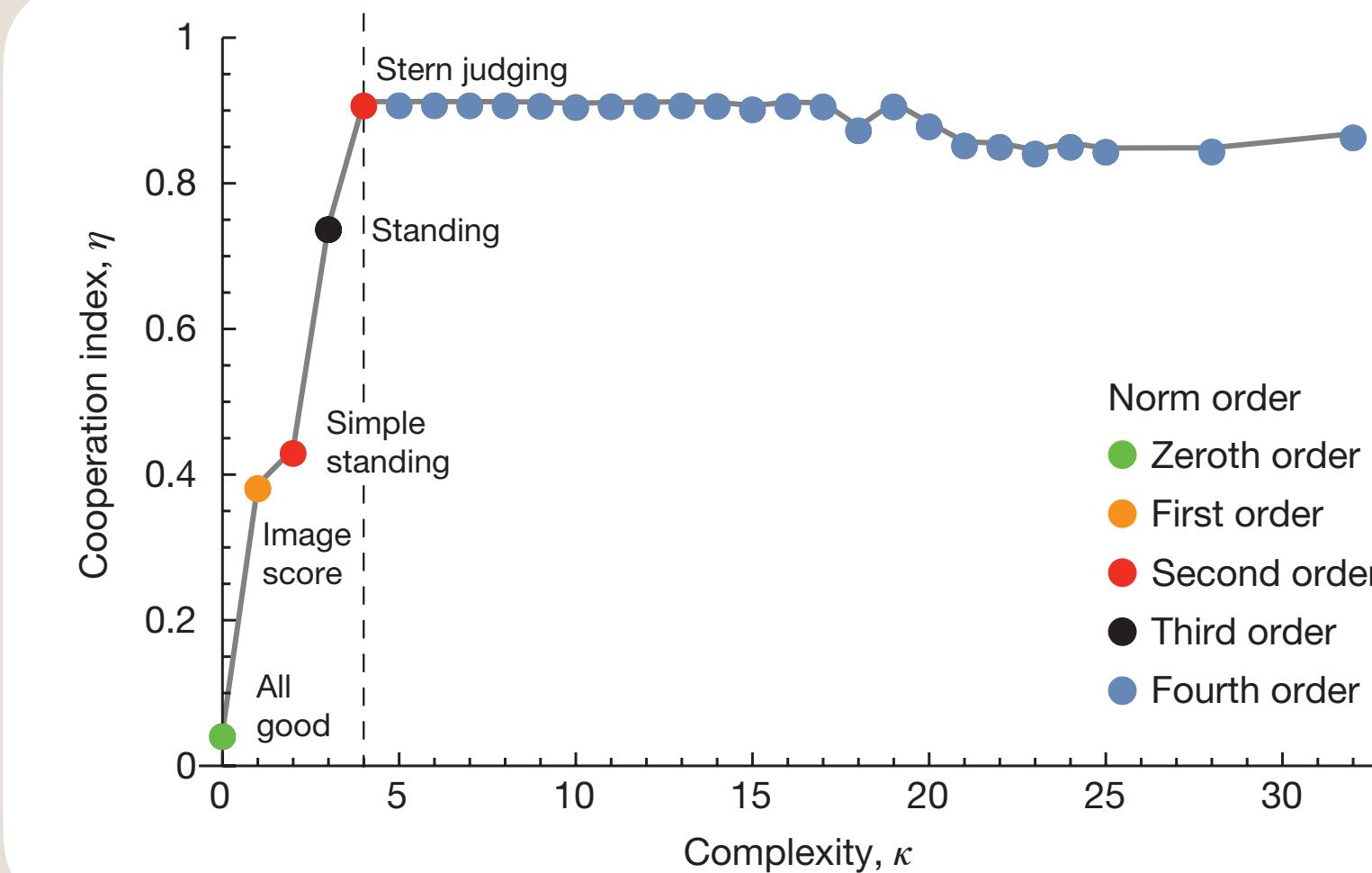
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How infants and toddlers react to antisocial others

J. Kiley Hamlin^{a,1}, Karen Wynn^b, Paul Bloom^b, and Neha Mahajan^b

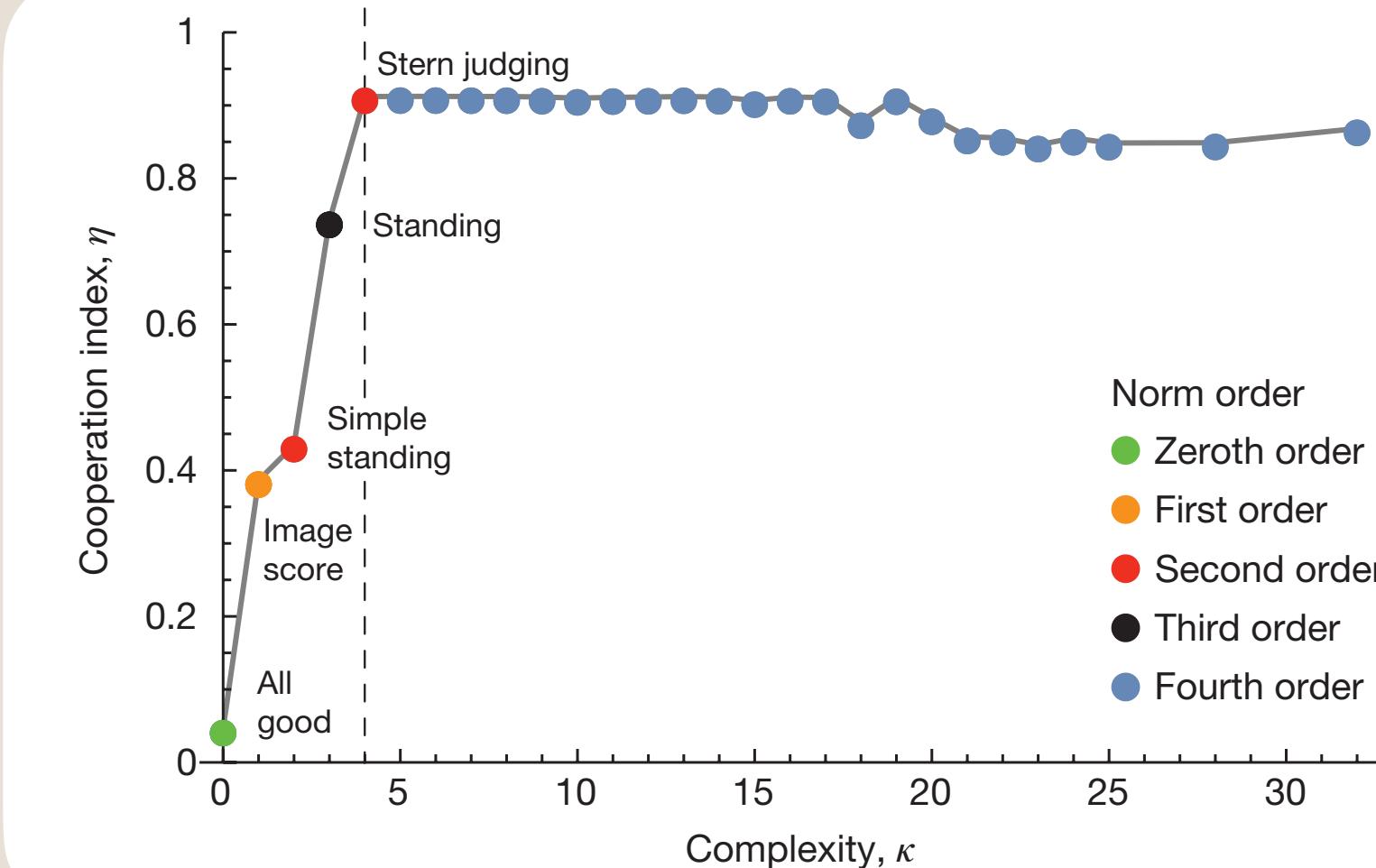
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Infants prefer a nasty moose if it punishes an unhelpful elephant

Evolution of indirect reciprocity: The impact of noise

Remark 3.10. Indirect reciprocity with noise

- One strong assumption in the model on the leading-eight: All relevant information is public and there are no perception errors.

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- Under public information and no noise these image matrices only depend on the column index j .

	1	2	3	4
1	1	0	0	0
2	0	1	0	0
3	0	0	1	0
4	0	0	0	1

Under public
information

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- When there is private information, or some individuals misinterpret a donor's action, there can be disagreements.

	1	2	3	4
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2	1	0	0	0
3	1	0	0	0
4	1	0	0	0

Under public
information

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1	1	0	0	0
2	0	1	0	0
3	0	0	1	0
4	0	0	0	1

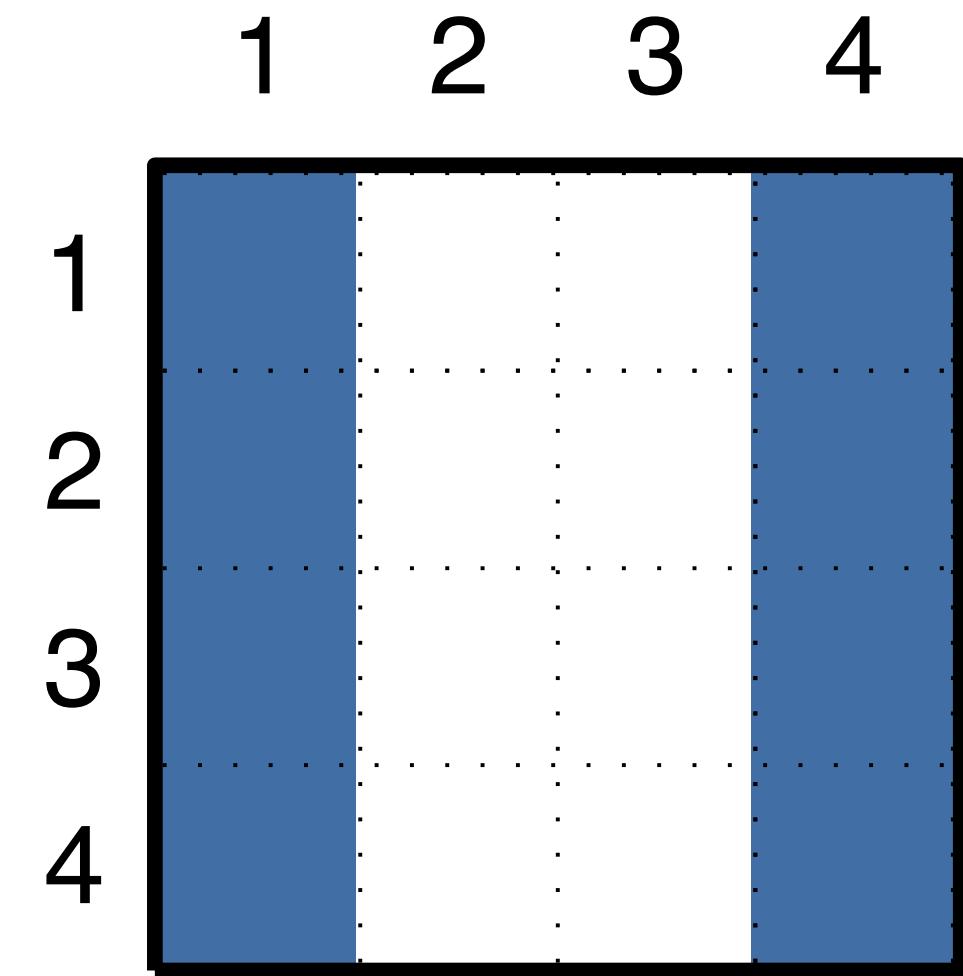
Under private
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Evolution of indirect reciprocity: The impact of noise

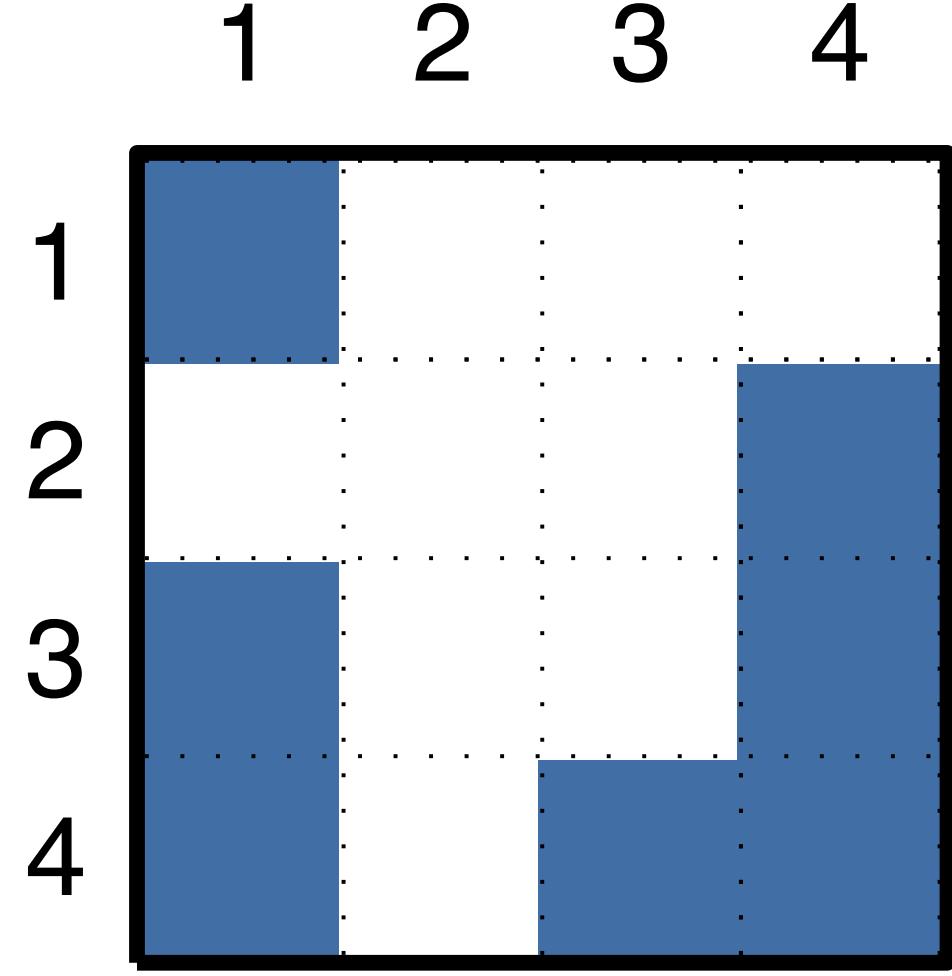
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Question: Assume there are a few initial disagreements between the members of a population. Over time, do these disagreements disappear or do they proliferate? And how does this depend on the population's social norm?



Under public
information



Under private
information

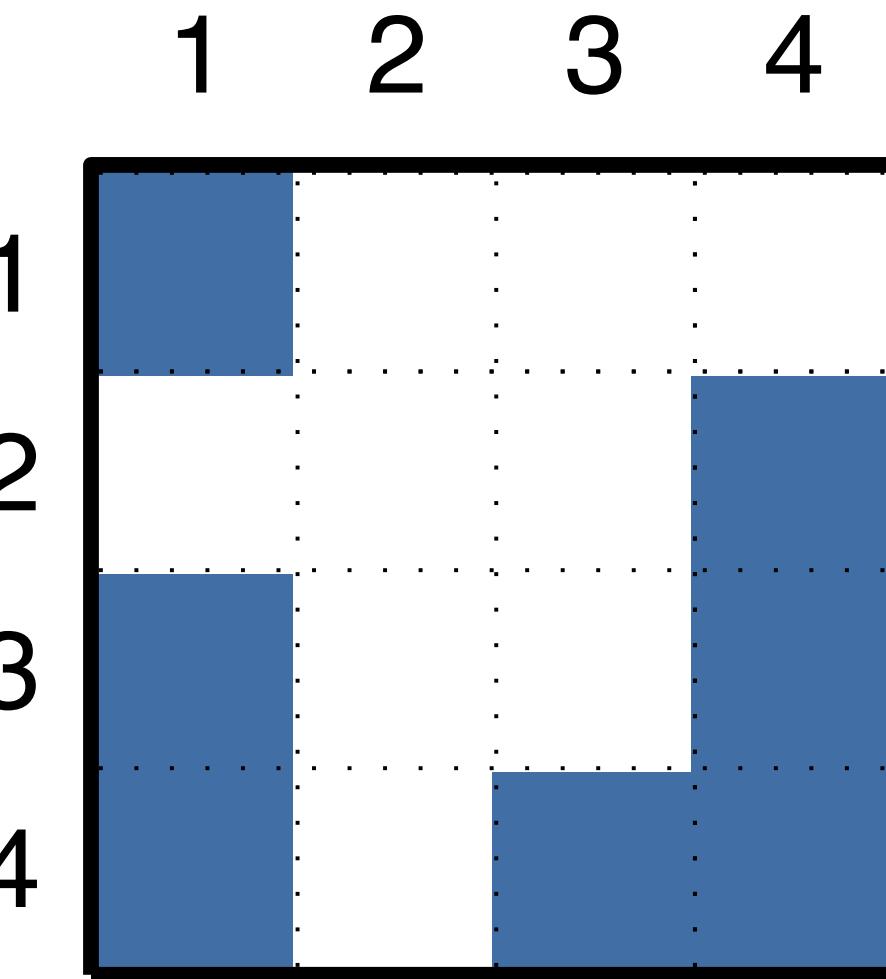
Evolution of indirect reciprocity: The impact of noise

Indirect reciprocity with private, noisy, and incomplete information

Christian Hilbe^{a,1}, Laura Schmid^a, Josef Tkadlec^a, Krishnendu Chatterjee^a, and Martin A. Nowak^{b,c,d}

Remark 3.10. Indirect reciprocity with noise (continued)

- Consider a population in which players assign reputations based on private and noisy information



Under private
information

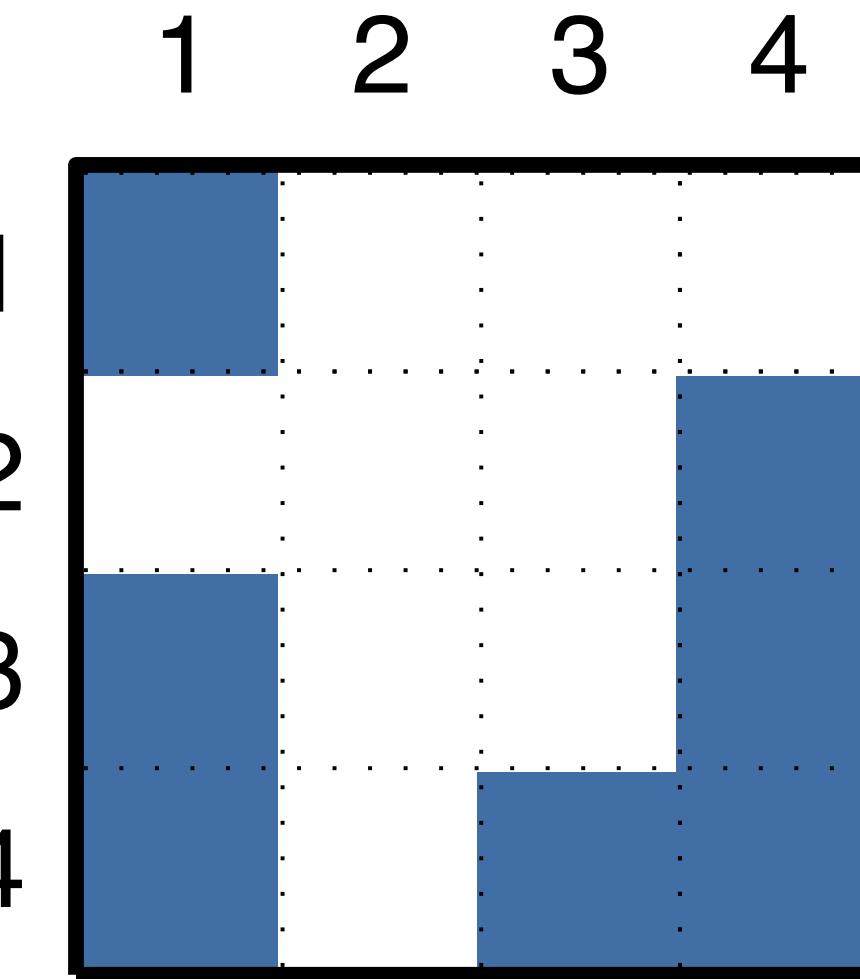
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- Consider a population in which players assign reputations based on private and noisy information
- Moreover, suppose people in the population follow different social norms; one third uses ALLC, one third uses ALLD, and one third uses some leading-eight social norm.



Under private
information

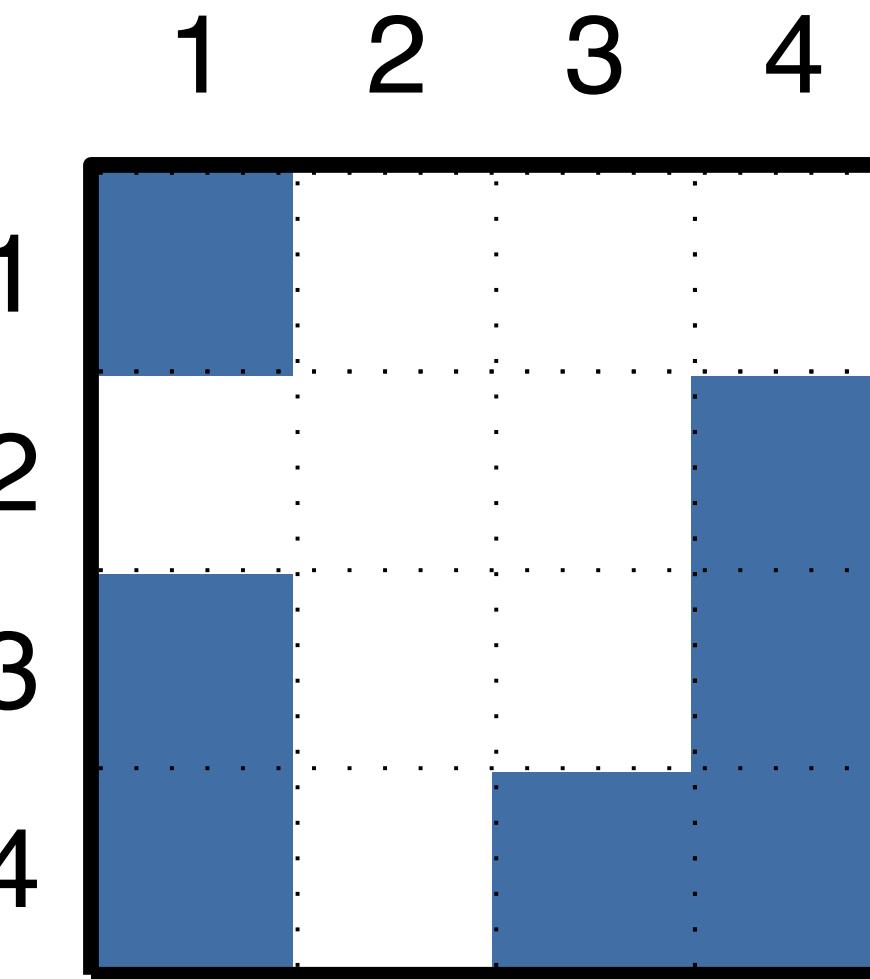
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Under private
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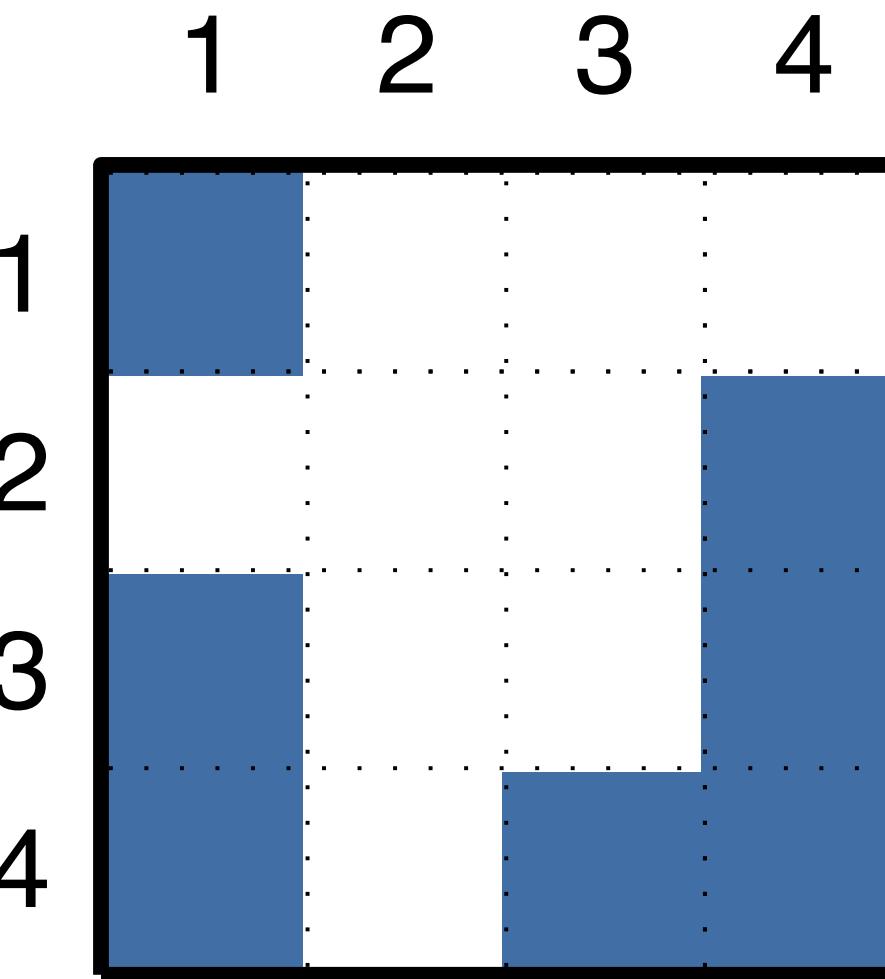
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- How do the population's image matrices evolve in time?



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Reputation dynamics with private information

We assume the population consists in equal parts of a leading-eight strategy, of ALLC, and ALLD.

Snapshot after 10^6 interactions:

Evolution of indirect reciprocity: The impact of noise

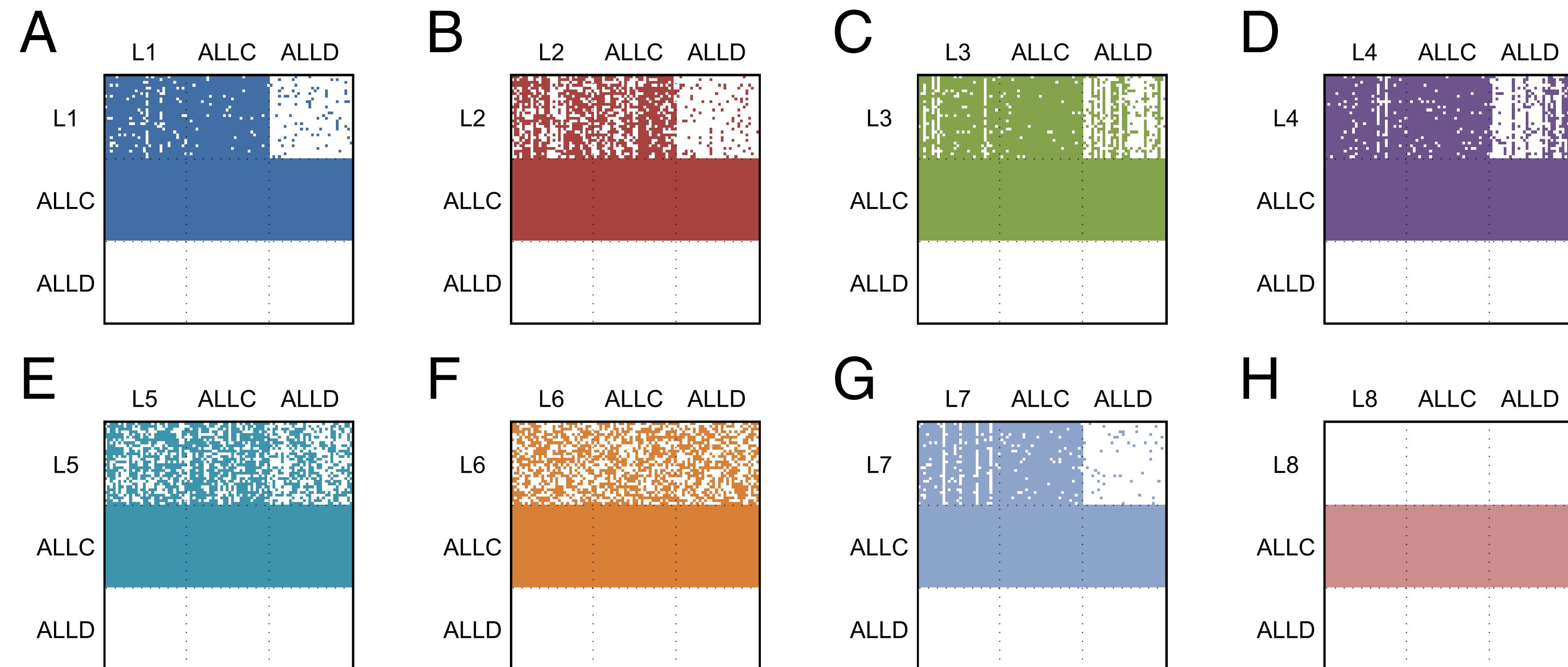
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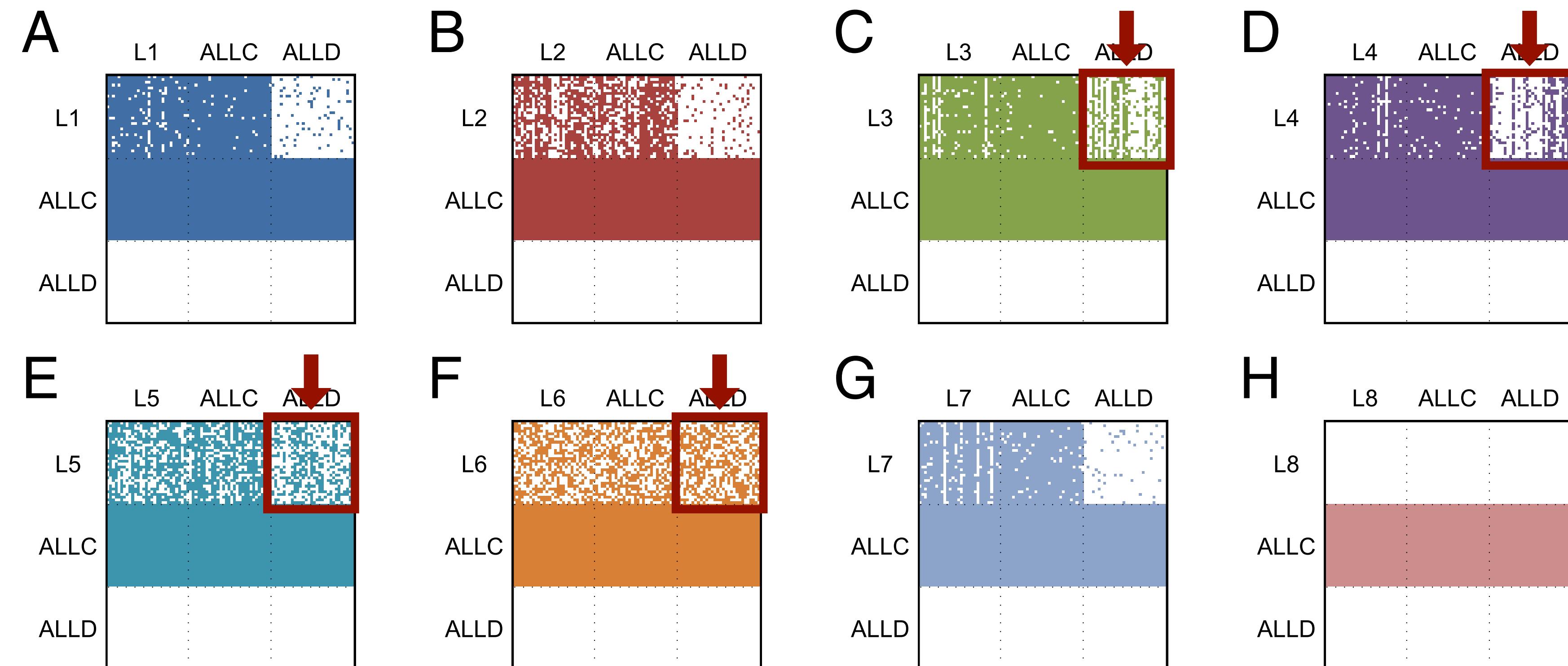
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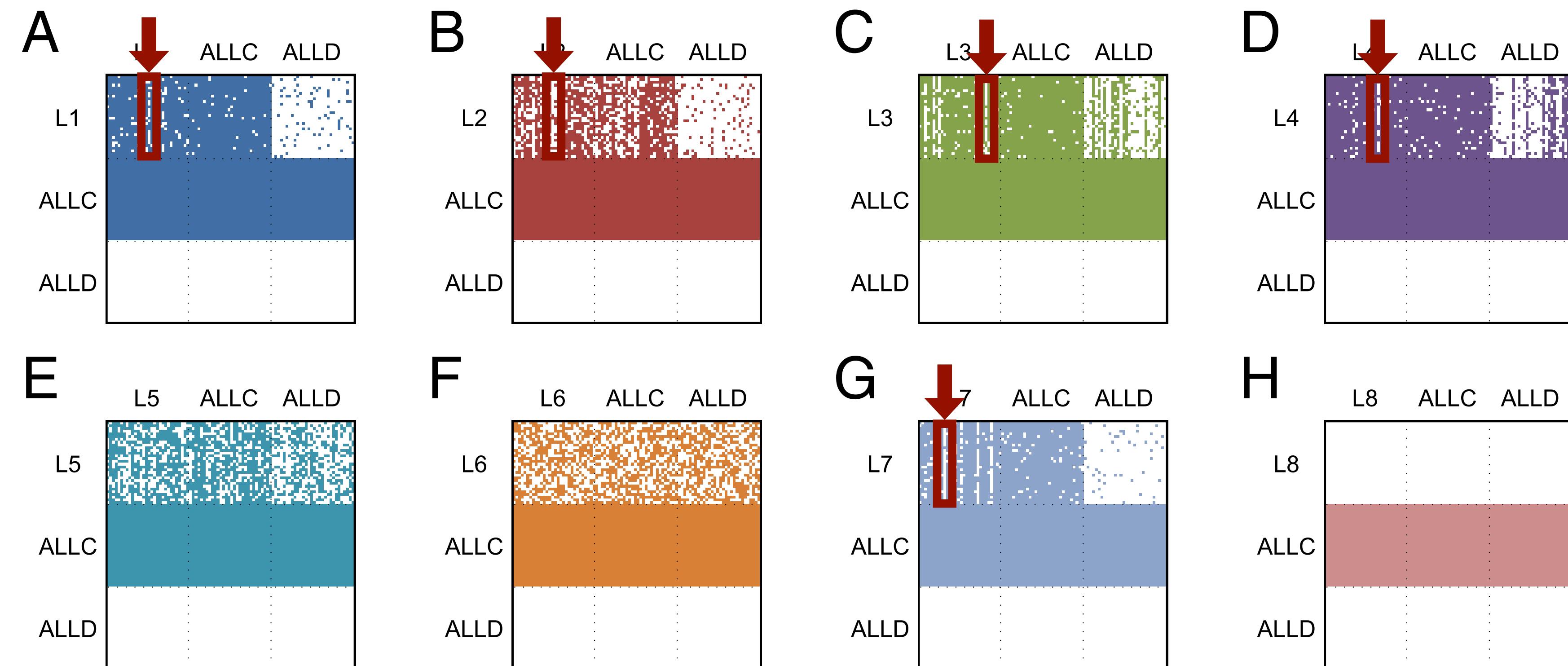
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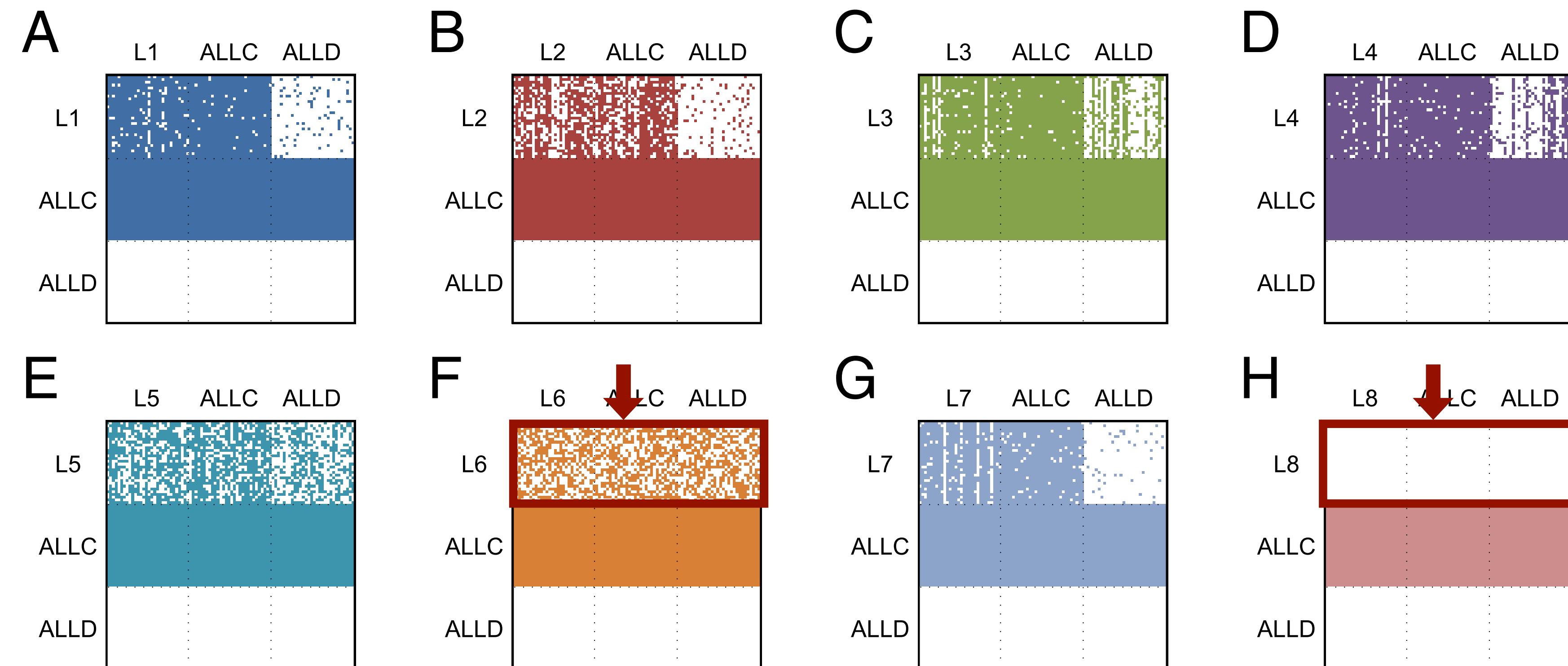
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Evolution of indirect reciprocity: The impact of noise

Remark 3.10. Indirect reciprocity with noise (continued)

- Overall, noise seems to make it harder for the leading-eight to be stable.

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Evolution of indirect reciprocity: The impact of noise

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- Overall, noise seems to make it harder for the leading-eight to be stable.
- Once there are errors, players may think of each other as bad, although they apply exactly the same norm
- These disagreements can spread

Evolution of indirect reciprocity: The impact of noise

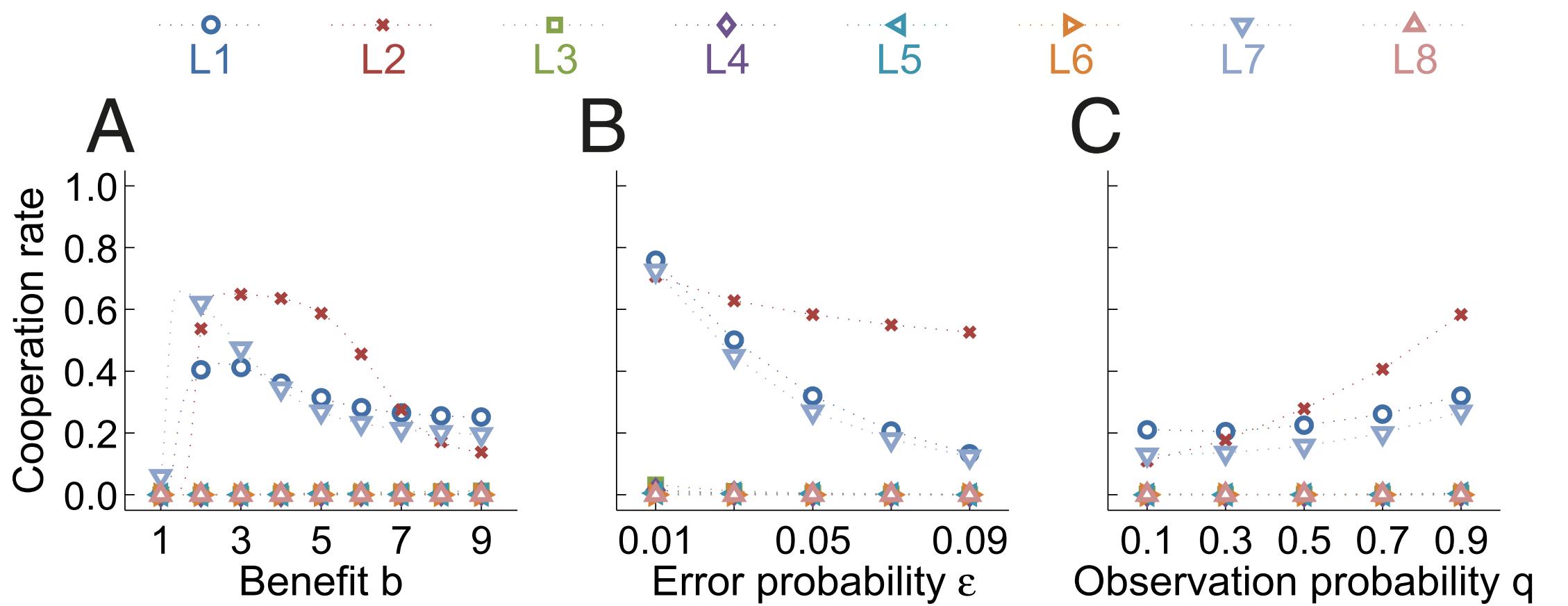
Remark 3.10. Indirect reciprocity with noise (continued)

- Overall, noise seems to make it harder for the leading-eight to be stable.
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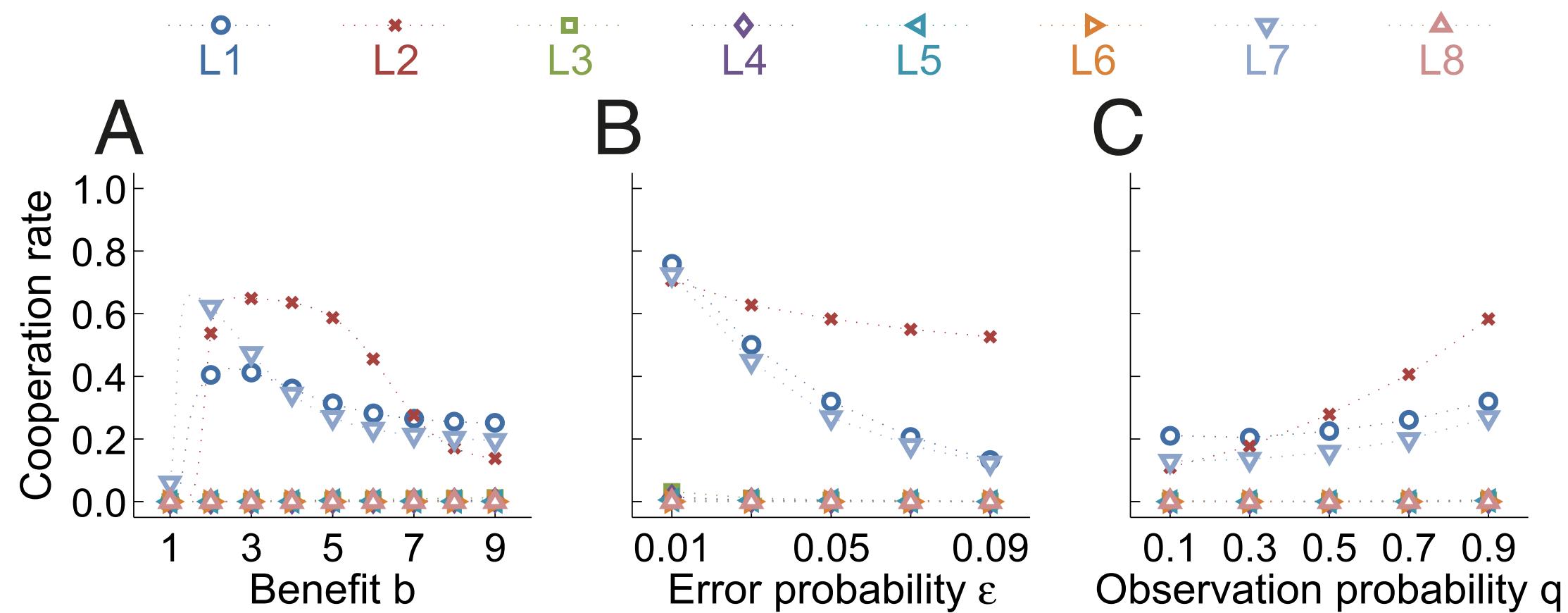
Possible solutions

Empathy

Evolution of empathetic moral evaluation

Arunas L Radzvilavicius^{1*}, Alexander J Stewart², Joshua B Plotkin^{1*}

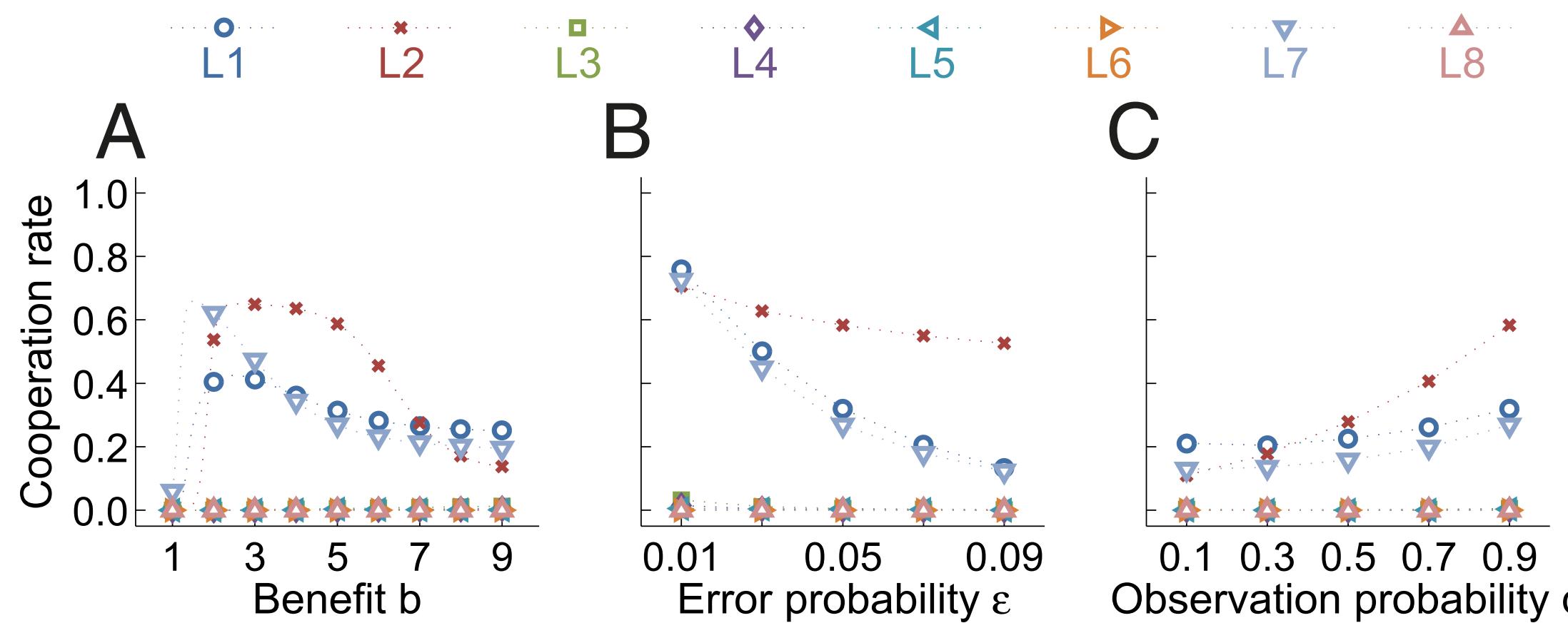
eLife, 2019



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Adherence to public institutions that foster cooperation

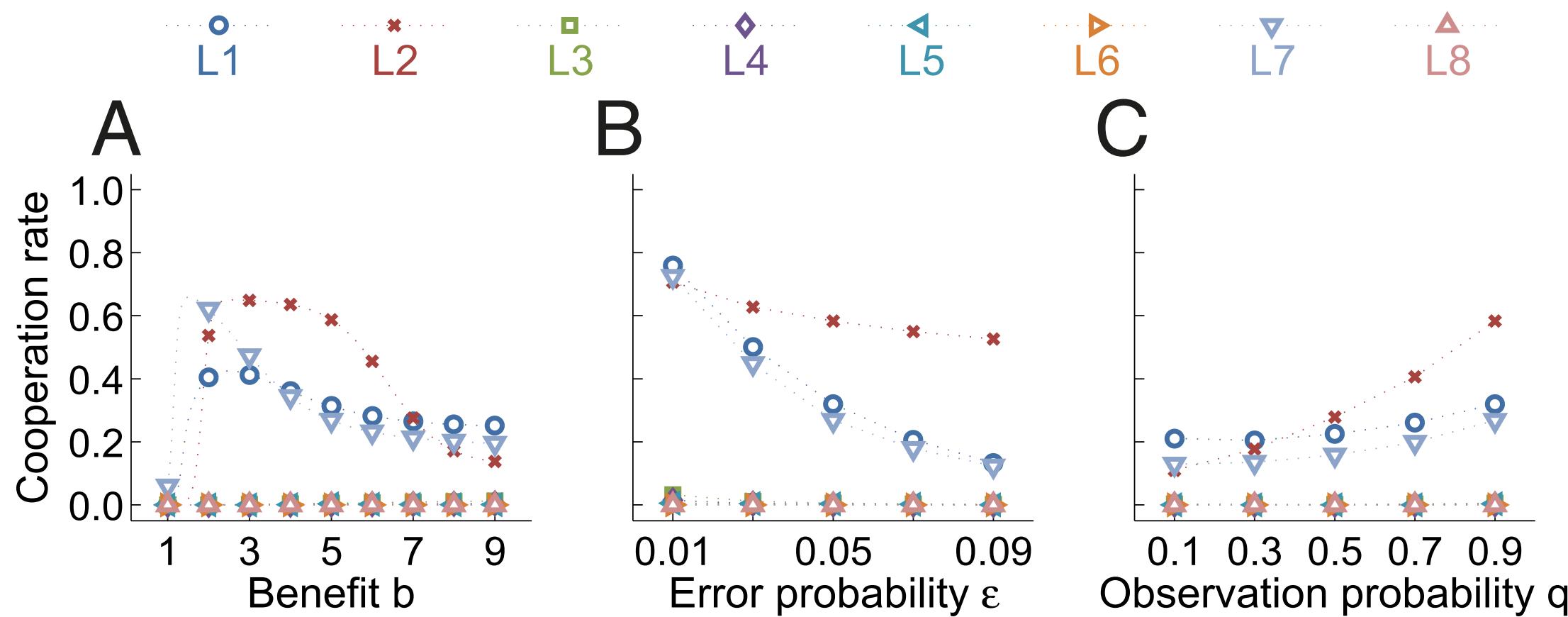
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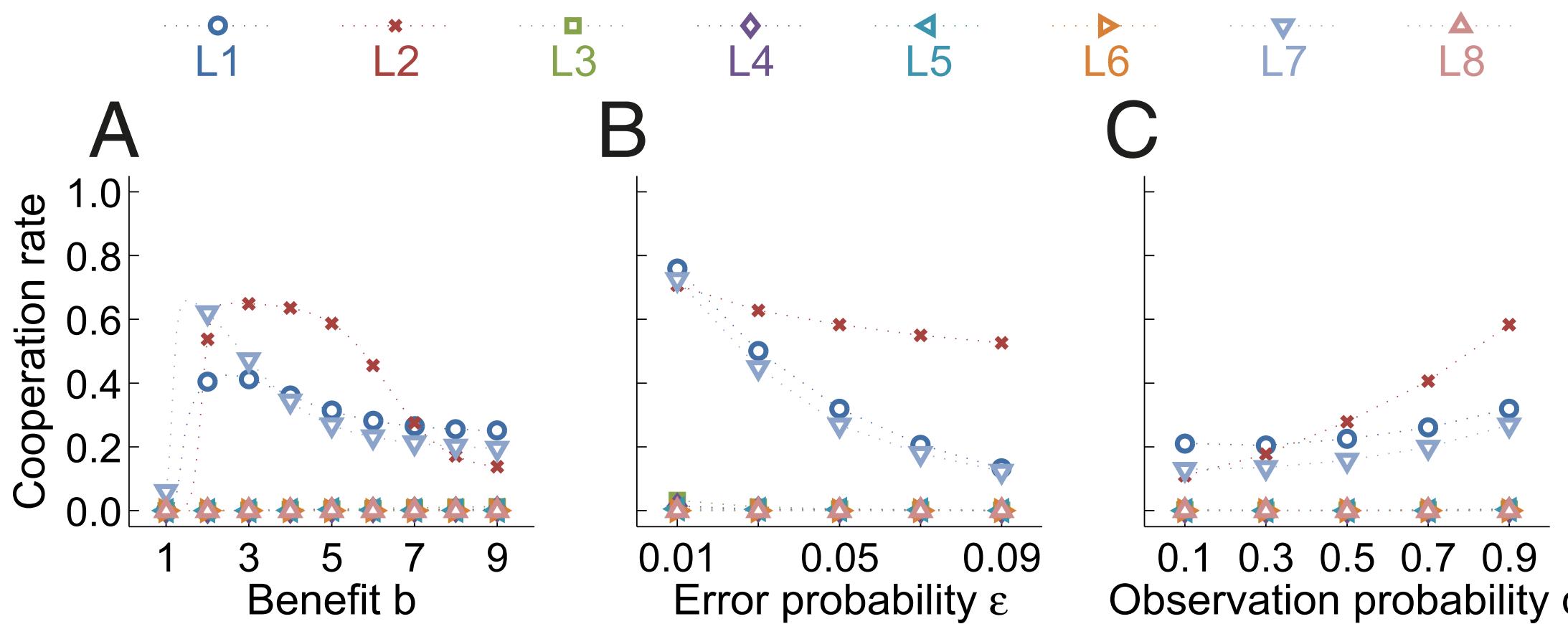
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PNAS, 2024

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PNAS, 2024

Opinion synchronization

Indirect reciprocity under opinion synchronization

Yohsuke Murase^{a,1} and Christian Hilbe^b

PNAS, 2024

Evolution of social norms: Humility

Remark 3.11. Why being humble?

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Donor Cause Recipient Where Recipient Is Based

Anonymous - all - + all + GO RESET

Donor's Source of Wealth Where Donor Lives Year Gift Made

Year Gift Value

Showing 1-50 of 75

Year	Donor	Where Donor Lives	Donor's Source of Wealth	Recipient	Recipient Location	Cause	Gift type	Value
2015	+ Anonymous			Wellesley College (Mass.)	Massachusetts	Colleges and universities		\$50,000,000
2015	+ Anonymous			College of William & Mary (Williamsburg, Va.)	Virginia	Colleges and universities		\$50,000,000
2015	+ Anonymous			U. of California at San Francisco	California	Colleges and universities		\$50,000,000
2015	+ Anonymous			Methodist Le Bonheur Healthcare (Memphis)	Tennessee	Health		\$40,000,000

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Anonymous - all - - all - - all - GO RESET

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Showing 1-50 of 75

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 - Why pay a cost to do something good, or purchase something valuable, and then hiding the cost?



Evolution of social norms: Humility

Remark 3.12. The signal-burying game

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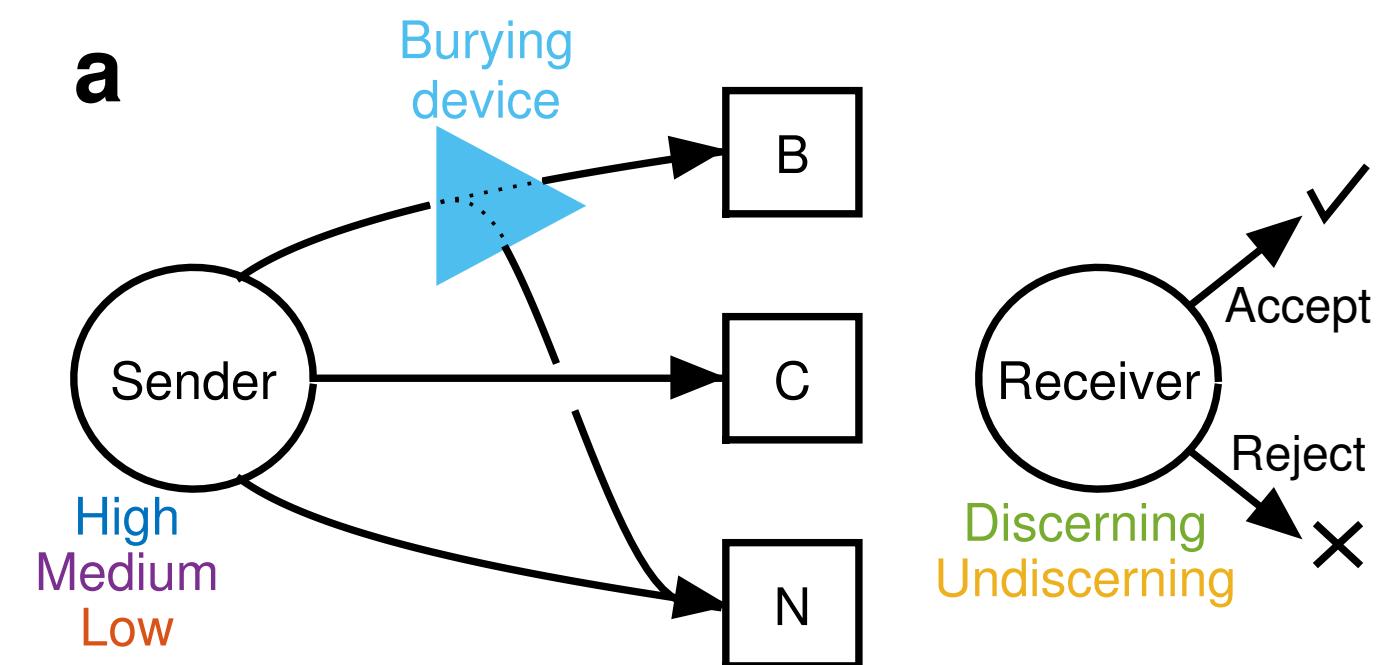
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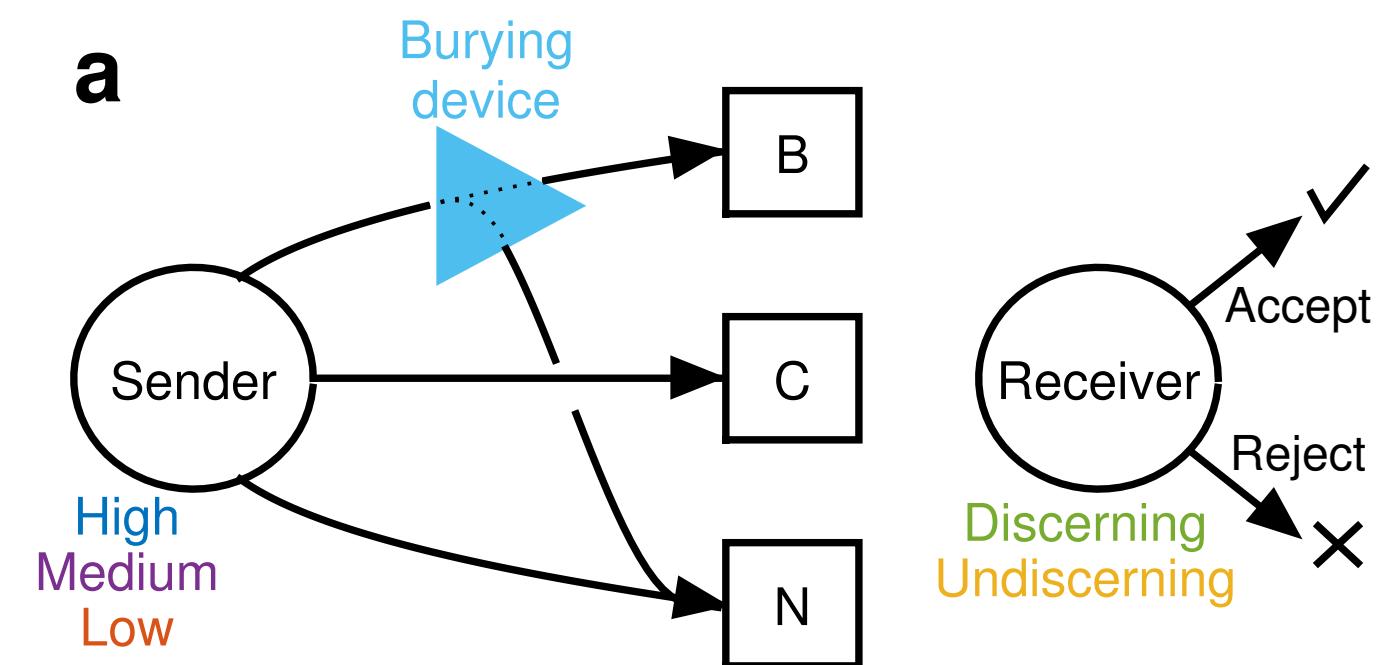
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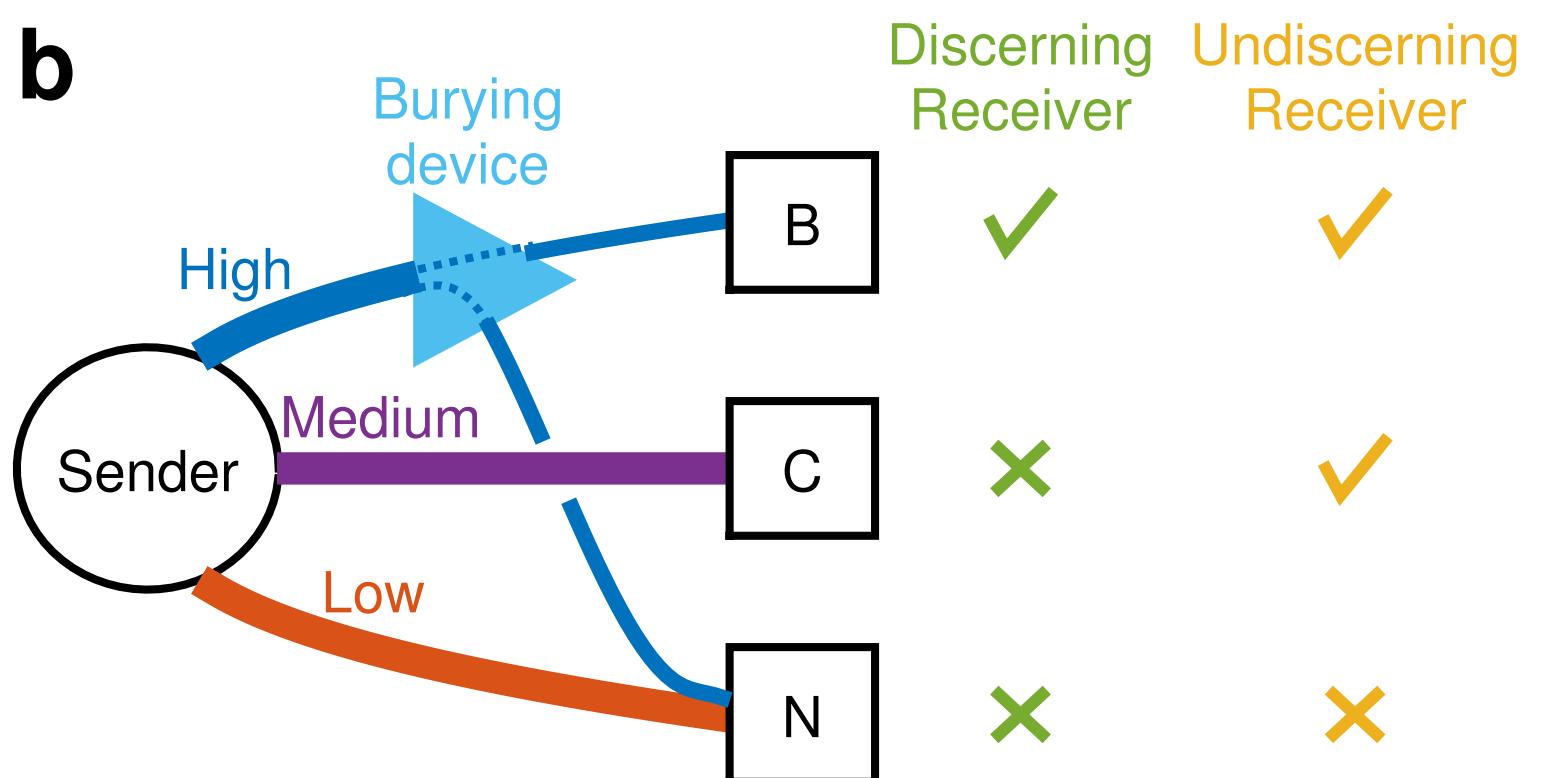
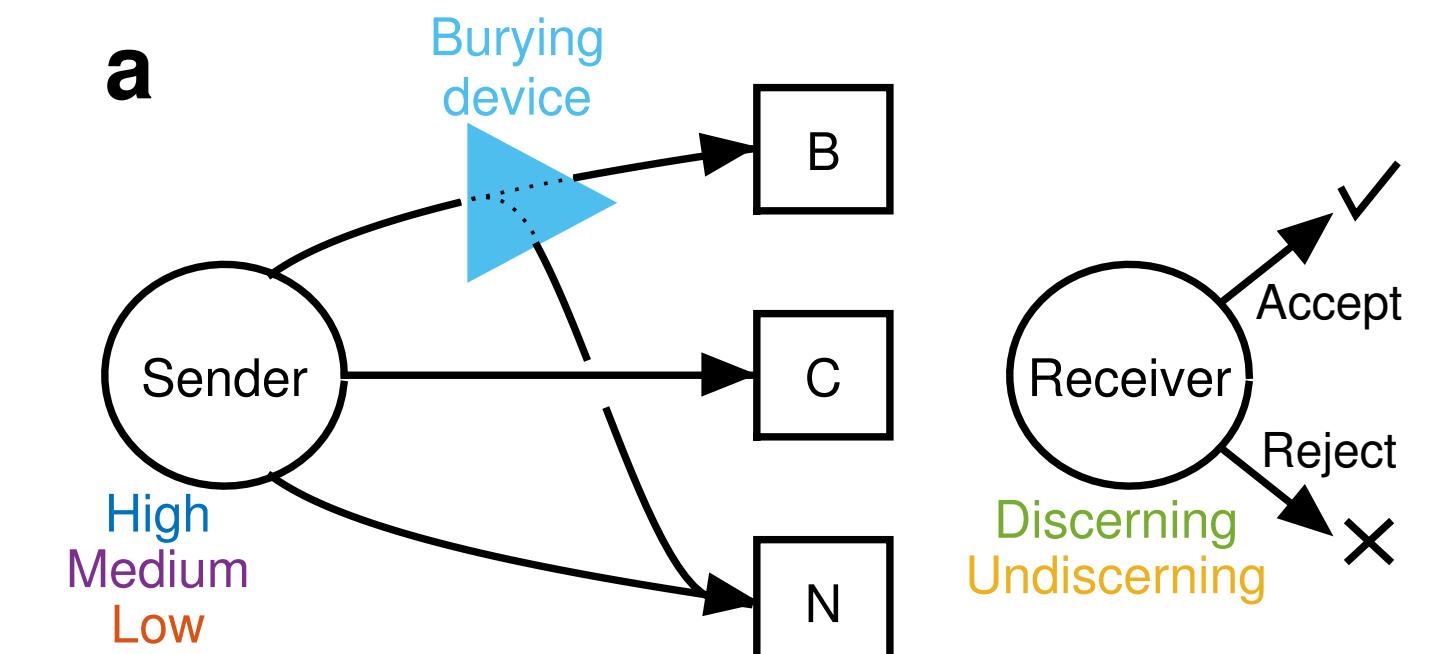
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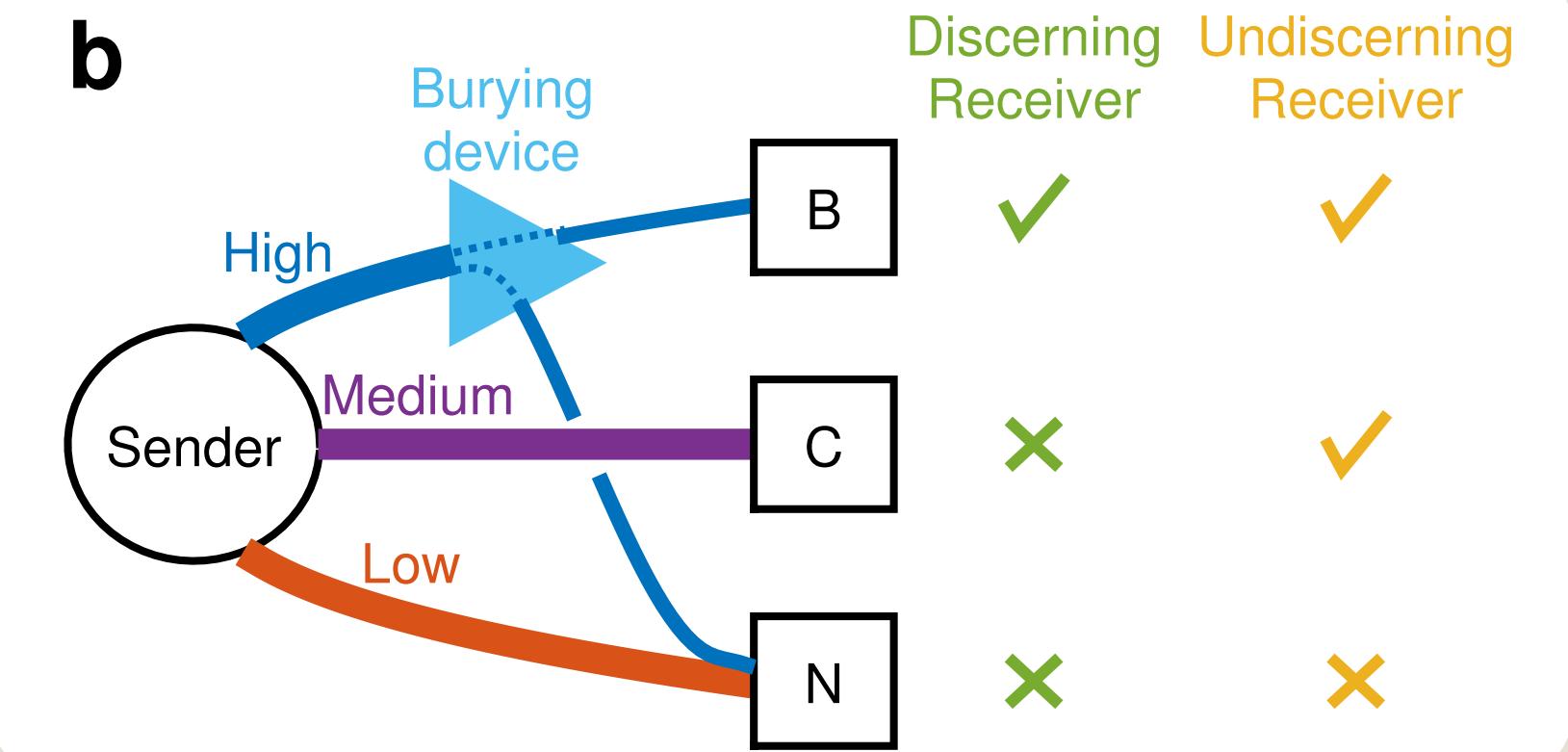


Buried signals equilibrium

Evolution of social norms: Humility

Remark 3.13. Interpretation

- Why make anonymous donations?
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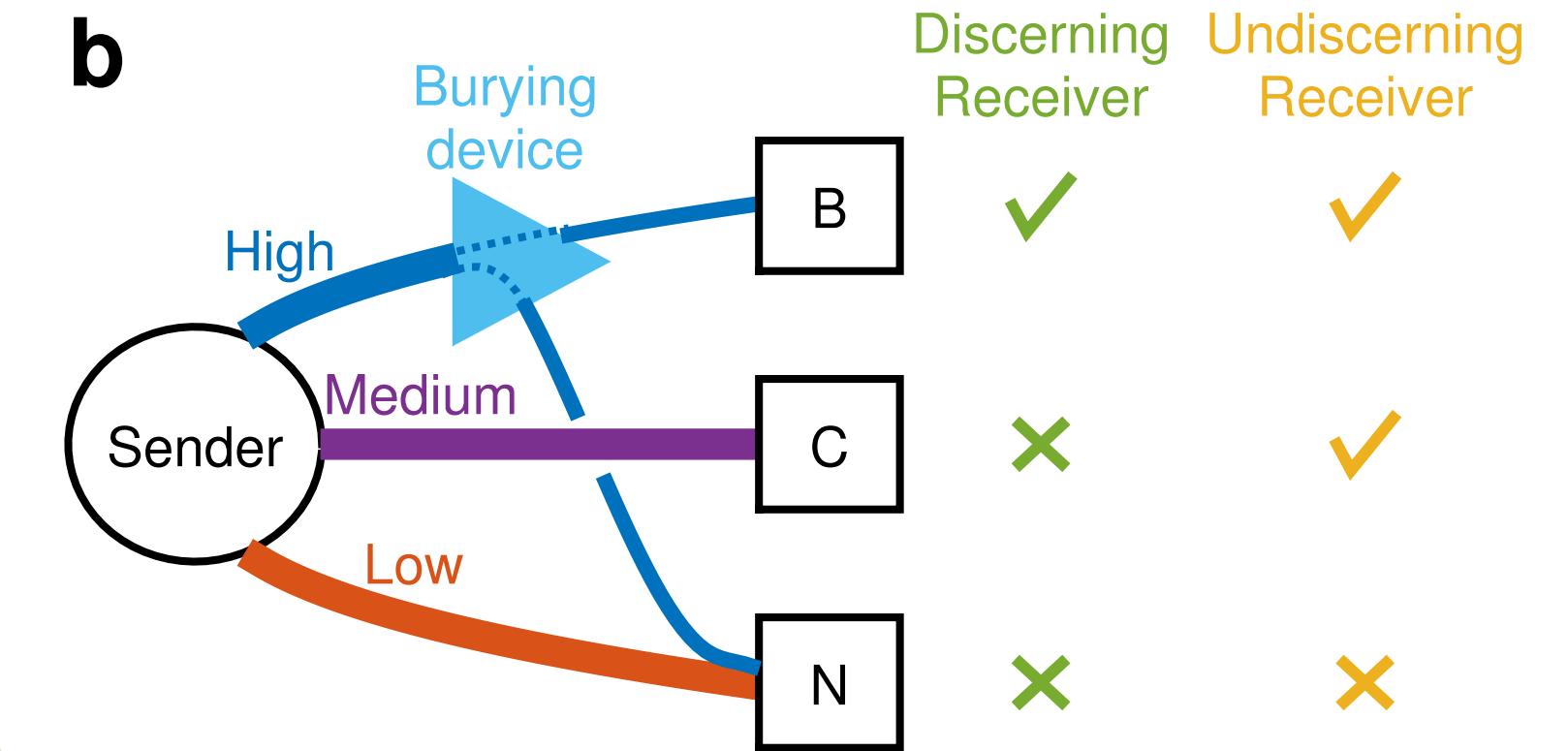
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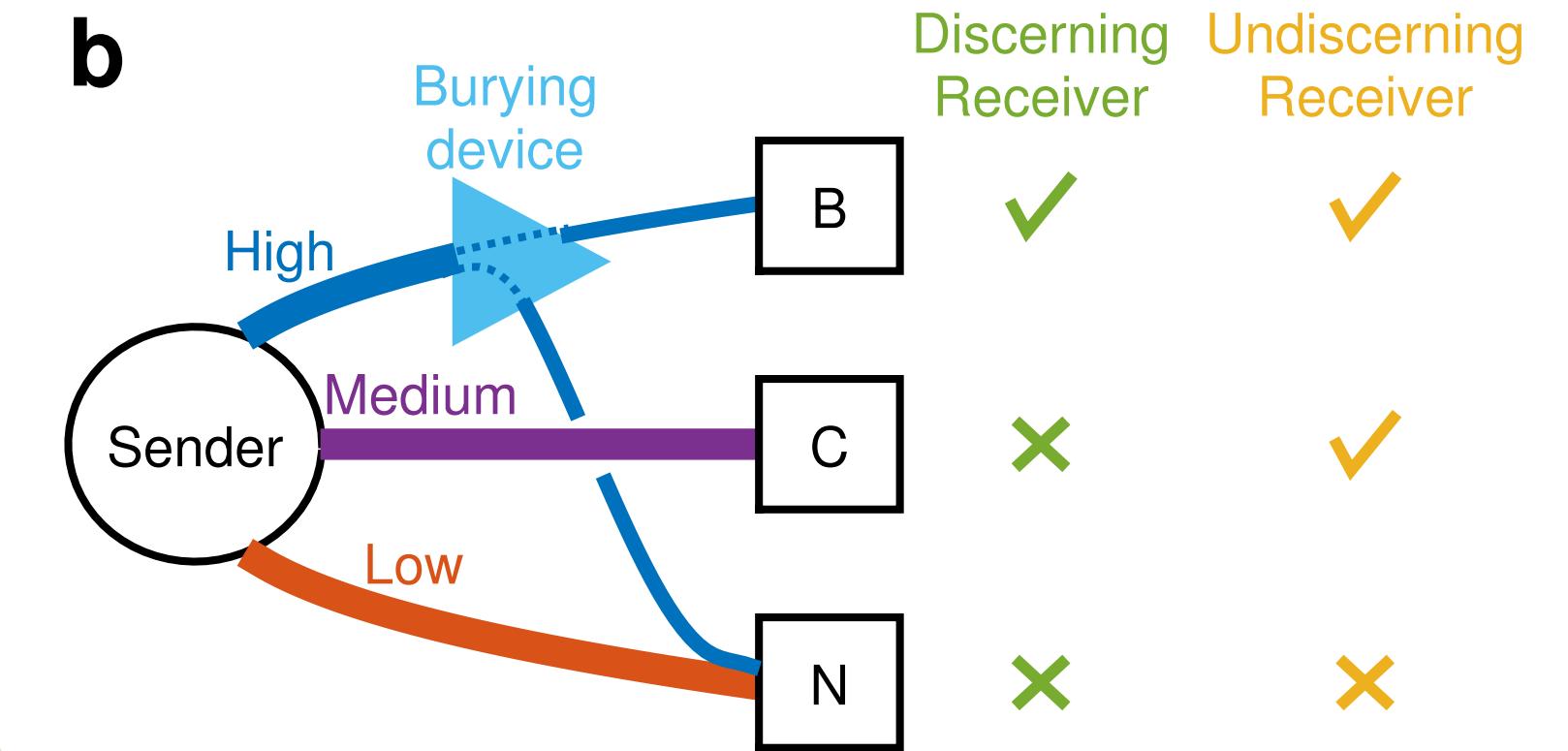
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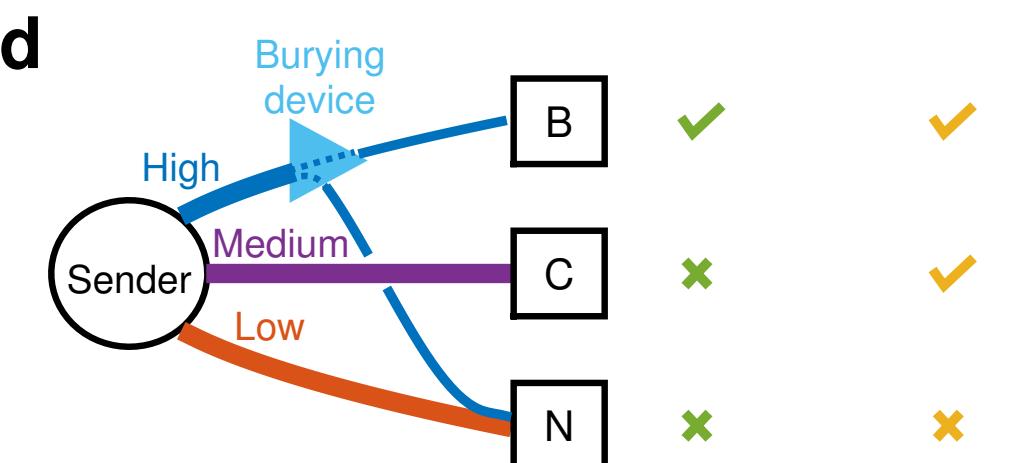
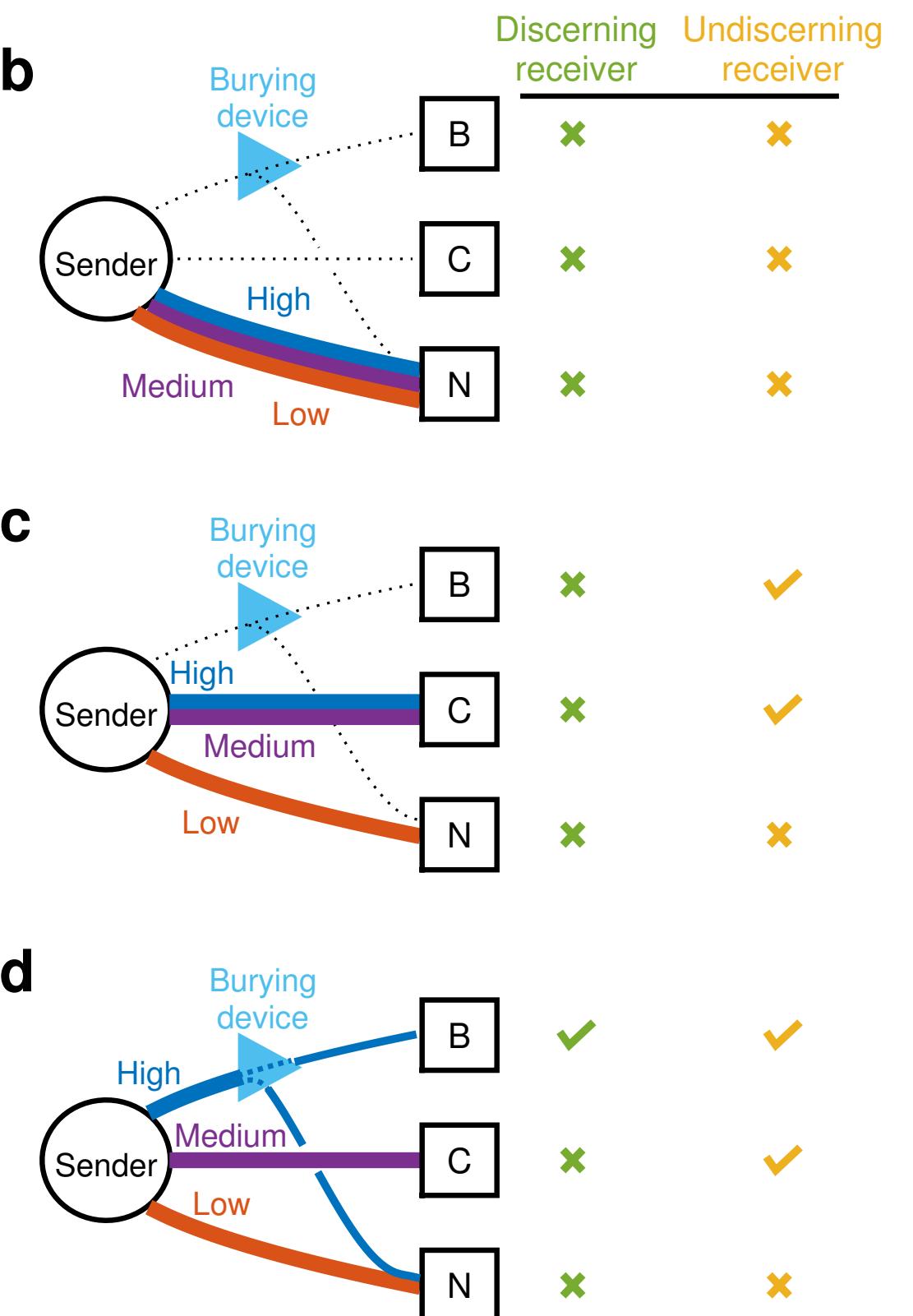
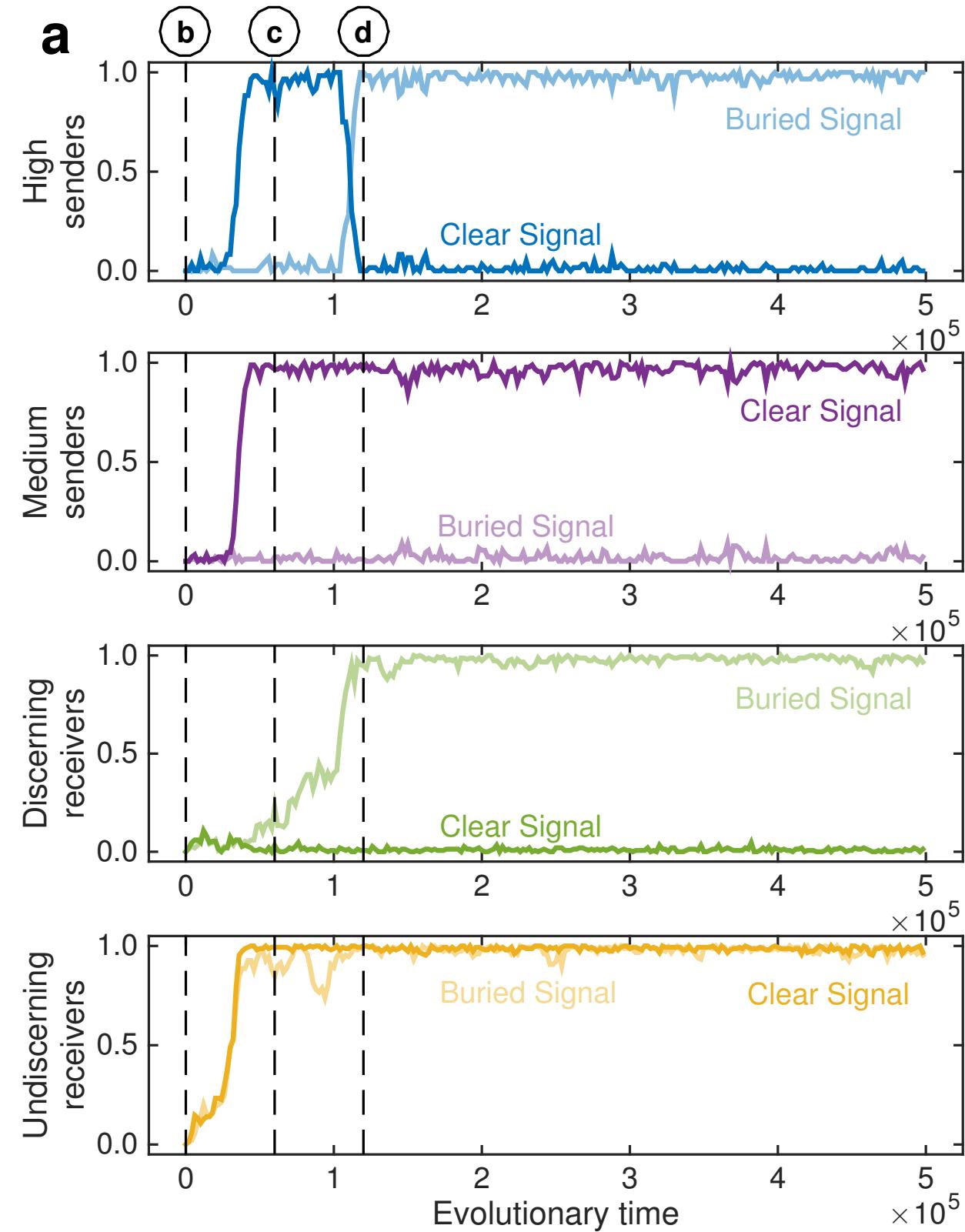
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- Why being subtle in your fashion choices?
Wearing a brand handbag may signal wealth, but it also signals that you really want everyone to know it, instead of only those people who are sophisticated enough to know the subtle signals of expense.
- Burying such signals is a great way of showing that you are only interested in a particular group of receivers.



Buried signals equilibrium



Evolution of social norms: Humility

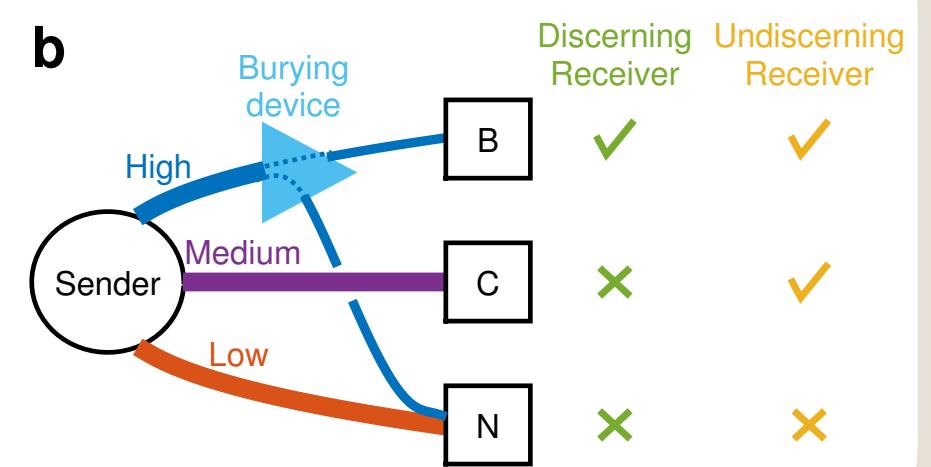
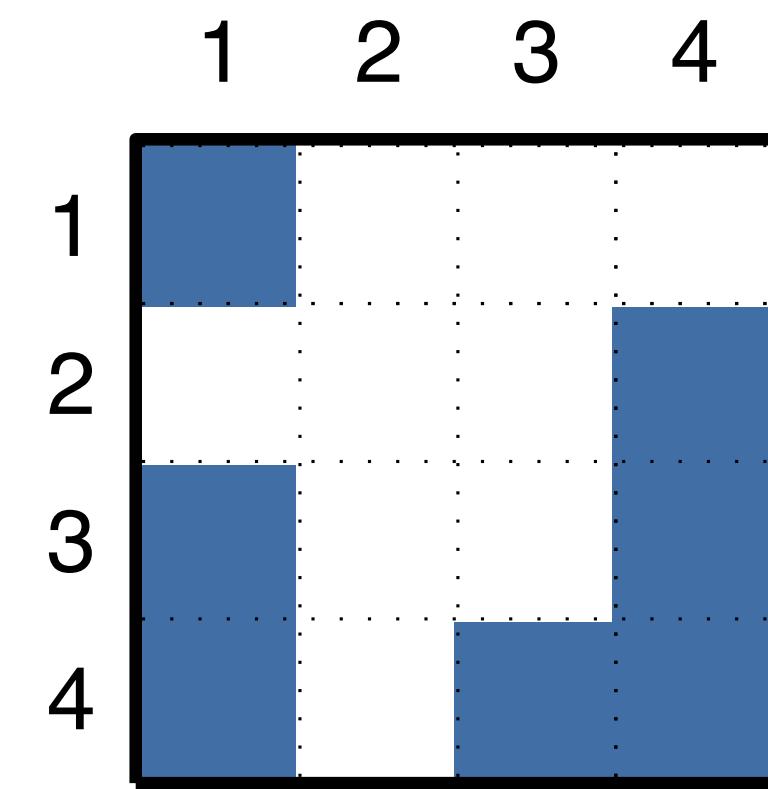


Evolution of the Buried signals equilibrium

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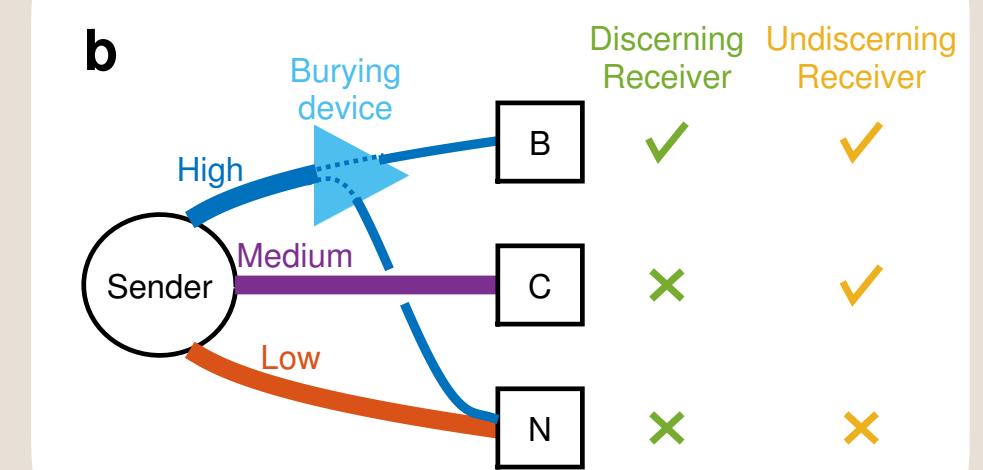
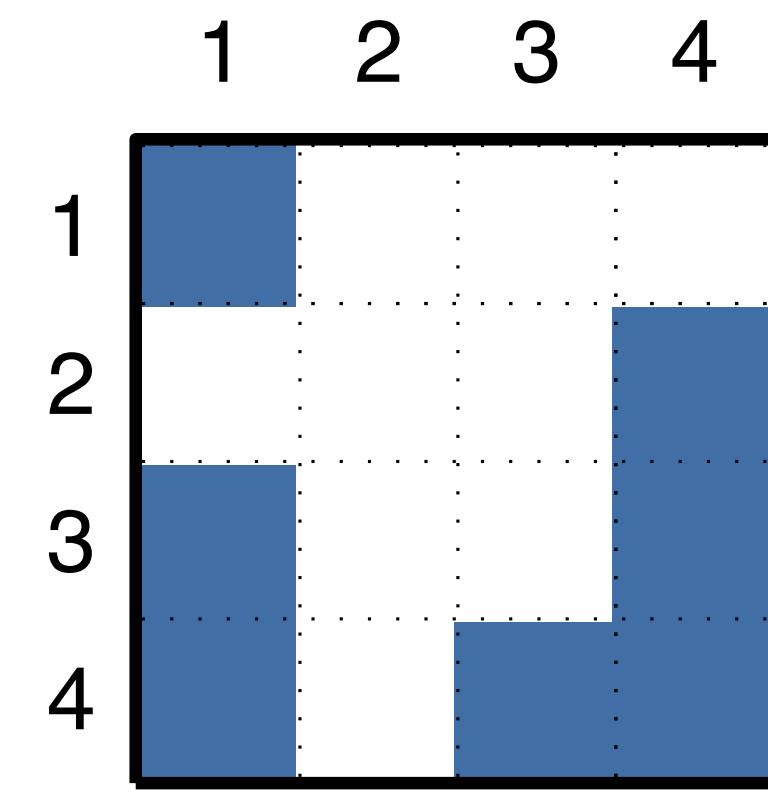
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3. Social norms can also be rather nuanced; as an example, we discussed why people might value modesty. Also such norms can be explained with game theory (in this case: with a signaling model).

