

Integrating human behaviour and epidemiological modelling: Unlocking the remaining challenges

ECMTB 2026 minisymposium:
Epidemiological-behavioural modelling to
address health challenges



Ed Hill & Matt Ryan



JUNIPER

Schedule

15:00–15:20

- ☐ **MS67-02** Edward Hill, Matthew Ryan
Integrating human behaviour and epidemiological modelling: unlocking the remaining challenges

15:20–15:40

- ☐ **MS67-01** David Haw
Epidemics Don't Just Spread - People React: Modelling Behaviour in Real Time

15:40–16:00

- ☐ **MS67-03** Elisabetta Colosi
Modelling social influence through discussion-based contacts in coupled behaviour-epidemic models

16:00–16:20

- ☐ **MS67-05** Joel Winterton
Feedback loops in multi-season influenza vaccinations strategies

17:00–17:20

- ☐ **MS67-04** Elliot Vincent
Modelling the adoption of Integrated Pest Management (IPM) by UK crop growers

17:20–17:40

- ☐ **MS67-06** Rob Deardon
Memory mechanisms in Bayesian behavioural change epidemic models

17:40–18:00

- ☐ **MS67-07** Ryosuke Omori
Oscillatory epidemic dynamics driven by non-linear behavioural feedback

18:00–18:20

- ☐ **MS67-08** Willem Frederiks
Predicting contact rates in response to control measures: a validated protocol for generating contact matrices relevant to transmission modelling of respiratory diseases

Talk outline

1. Our involvement in epidemiological-behavioural modelling related events.
2. Perspective paper – ‘Integrating human behaviour and epidemiological modelling: Unlocking the remaining challenges’.
3. BaD modelling.

Talk outline

- 1. Our involvement in epidemiological-behavioural modelling related events.**
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University of Warwick/JUNIPER workshop

When?

- Monday 10th June 2024

Where?

- Warwick Mathematics Institute, University of Warwick, Coventry

Organising committee



[Ed Hill](#) (Warwick)

[Kirsty Bolton](#) (Nottingham)



[Emily Nixon](#) (Liverpool)



[Stephen Parnell](#) (Warwick)



[Martine Barons](#) (Warwick)



University of Warwick/JUNIPER workshop

Invited speakers

- [David Haw](#) (Lecturer in Mathematics for Health, University of Liverpool) - Linking epidemiological and behavioural models in public health.
- [Anne Kandler](#) (Senior Scientist, Department of Human Behavior, Ecology and Culture, Max Planck Institute for Evolutionary Anthropology) - Applied mathematician interested in the underlying principles of cultural change especially in changing environmental conditions.
- [Ruth McCabe](#) (Postdoctoral Researcher, Imperial College London) - Communication of modelling results to non-technical audiences.
- [Alice Milne](#) (Senior Research Scientist - Agricultural Systems Modeller, Rothamsted Research) - Linking epidemiological and behavioural models in plant health.
- [Suzy Moat](#) & [Tobias Preis](#) (Professors of Behavioural Science & Co-directors of the Data Science Lab, Warwick Business School, University of Warwick) - Measuring real world actions and events with online data.
- [Kavita Vedhara](#) (Professor of Health Psychology, Cardiff University) - Health psychologist with expertise in the inter-relationships between psychological factors and health and disease outcomes.

Contributed talks presenters

- [Elaine Ferguson](#) (Research Associate, School of Biodiversity, One Health and Veterinary Medicine, University of Glasgow) - Infectious disease ecologist working on modelling approaches to study the infectious disease dynamics of rabies.
- [Mark Lynch](#) (PhD student, Mathematics for Real-World Systems Centre for Doctoral Training, University of Warwick) - Research interests in applications of machine learning and neural networks to epidemiological models.
- [Luisa Fernanda Estrada Plata](#) (MSc student, Mathematics for Real-World Systems Centre for Doctoral Training, University of Warwick) - Applied mathematician with research interests in behavioural science.
- [Matt Ryan](#) (CERC Postdoctoral Fellow, Commonwealth Scientific and Industrial Research Organisation - CSIRO) - Applied mathematician exploring the interface of infectious disease modelling and behavioural science to define better "business-as-usual" forecasting models.
- [Fanqi Zeng](#) (Postdoctoral Researcher, Department of Sociology, University of Oxford) - Sociologist working on projects related to the study of global fake medicines trading and organised crime.

Slides and talk recordings that can be shared are available on the event webpage



<https://warwick.ac.uk/fac/sci/math/research/miraw/days/modellingbehaviour>

Special issue on Behavioural Epidemiology

Mathematics in Medical and Life Sciences

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Behavioural Epidemiology

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This Article Collection welcomed contributions that brought together novel data science, mathematical modelling and statistical analysis to improve behavioural realism in methods addressing problems in epidemiology that are impacted by behavioural dynamics.

Edited by

Dr Edward Hill (*Civic Health Innovation Labs (CHIL) and Institute of Population Health, University of Liverpool, UK*)

Dr Stephen Beckett (*Department of Biology, University of Maryland & University of Maryland Institute for Health Computing, USA*)

Professor Calistus Ngonghala (*Department of Mathematics & Emerging Pathogens Institute, University of Florida, USA*)

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MATHS OF HUMAN BEHAVIOUR: MODELLING SOCIALITY, MOBILITY AND PROTECTIONISM

20 July to 14 August 2026

UNIVERSITY OF NOTTINGHAM

The SARS-CoV-2 pandemic showed the deficiencies of epidemic models to incorporate data-driven and theoretical knowledge of the behavioural response to the pandemic, including social contact, mobility and adherence to non-pharmacological interventions. This deficiency is in part driven by the lack of quantitative models that can be translated across disciplines and used to predict the evolving adoption of behaviours across individuals and populations, particularly in new social contexts. Other model systems are also sensitive to human behaviour, in particular energy systems, with onward implications for tackling climate change.

This programme will connect researchers in such fields with an interest in improving behavioural realism in their models. By bringing mathematicians, modellers, statisticians and data-scientists together with social scientists with expertise on drivers and determinants of behaviours and behavioural change, this programme will facilitate the development of mathematical and statistical frameworks for capturing realistic behaviour in modelling approaches.

The programme will focus on advancing mathematical methodologies to consider the behavioural attributes of sociality, mobility and protectionism. These themes will be explored through three cross-cutting challenges in epidemiological and energy system modelling:

1. abstraction of real-world systems into mathematical models;
2. heterogeneity in societal response to policy;
3. understanding the relationship between the information available and behavioural response.

The programme will have an in-built focus on community- and capacity-building, to foster new collaborations between diverse disciplines, with internationalism, interdisciplinarity and impact at the forefront.

Programme Organisers



KIRSTY BOLTON
UNIVERSITY OF
NOTTINGHAM



EDWARD HILL
UNIVERSITY OF
LIVERPOOL



MATTHEW RYAN
CSIRO



JONATHAN WARD
UNIVERSITY OF
LEEDS



ELLEN
ZAPATA-WEBBORN
UNIVERSITY COLLEGE
LONDON

W01

The Mathematics of Behaviour: an interdisciplinary school

20 - 24 JUL 2026

University of Nottingham

W02

Modelling Behaviour for Global Challenges: Epidemics and Energy Systems

10 - 14 AUG 2026

University of Nottingham

Seminars for this satellite
programme will be **broadcast**
live with speakers' consent.



For more information on the
programme and its workshops:
www.newton.ac.uk/events/mhb
or scan the QR code

INI Isaac Newton Institute
for Mathematical Sciences

#NewtonMHB2026



Talk outline

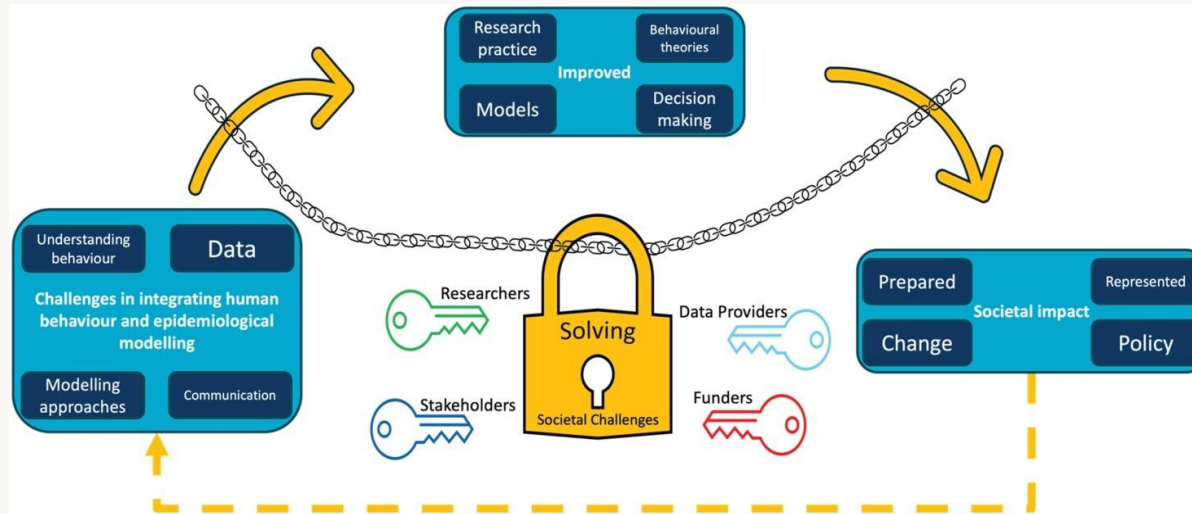
1. Our involvement in epidemiological-behavioural modelling related events.
2. **Perspective paper – ‘Integrating human behaviour and epidemiological modelling: Unlocking the remaining challenges’.**
3. BaD modelling.

Integrating human behaviour and epidemiological modelling: unlocking the remaining challenges

Edward M. Hill ^{a,b}, Matthew Ryan ^c, David Haw ^d, Mark P. Lynch ^e, Ruth McCabe ^f,
Alice E. Milne ^g, Matthew S. Turner ^h, Kavita Vedhara ⁱ, Fanqi Zeng ^j, Martine J. Barons ^k,
Emily J. Nixon ^d, Stephen Parnell ^l and Kirsty J. Bolton ^m

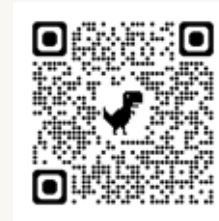


<https://doi.org/10.1080/29937574.2024.2429479>



Challenge area: Understanding behaviour

- Limitations of existing behavioural science theory and models
- Generalisability of existing behavioural science evidence
- Appropriateness of behavioural science research methodologies for the quantification of human behaviour



<https://doi.org/10.1080/29937574.2024.2429479>

Challenge area: Data

- “Striking a balance” – Ethical considerations for data collection, processing & storage. data
- Pipelines to synthesise a range of data sources.
- Identifying the relevant data for use in appropriate models.
- What already exists that could be used/repurposed/tweaked that would be informative?



<https://doi.org/10.1080/29937574.2024.2429479>

Challenge area: Modelling approaches

- Balancing model complexity and interpretability - Should behaviour always be included in models?
- A checklist for constructing an interdisciplinary model?
- Ability to select appropriate models, calibrate them and validate them.
- Useability of developed modelling tools for non-experts.



<https://doi.org/10.1080/29937574.2024.2429479>

Challenge area: Communication & informing policy

- Objective matters, Perspective matters
- What is the end game in the face of uncertainty?
- Role of the public in the research process – Public Involvement.
- Ethical implications of epidemiological-behavioural modelling affecting behaviour.



<https://doi.org/10.1080/29937574.2024.2429479>

Table 1. Recommended action points by challenge area and issue within each challenge area. We group the recommendations according to those that are “short-term actionable” (i.e. what can plausibly be usefully done now) and those that are “long-term thinking” (i.e. steps unlock a long-term vision of how in an idealised setting we envisage studies being conducted).

Challenge area	Issue	Recommendation		Examples / references
		Actionable	Long term thinking	
Interdisciplinarity	Constructing a team with required blend of expertise	Apply for small-scale funding to create networking opportunities through joint seminars and workshops, with emphasis on building a common language and goal set.	Funding bodies to support longer term cross disciplinary collaborations. Develop training opportunities to support new researchers in this interdisciplinary field.	Bottom-up models for generation of interdisciplinary science common language [104]. Seed funding from universities can quickly respond to promising interdisciplinary ideas [104,105]. Top-down approaches sometimes successful, e.g. funding for Human Genome Project largely drove the emergence of bioinformatics [106].
	Establishing a common language	Medical practitioners, epidemiologists and the mathematical modelling community to identify and define relevant behaviours for infectious disease modelling (perhaps differentiated by pathogen type), publishing and advertising them to encourage discussion, refinement and use of these definitions.	Promote use of this common language and use it to develop common methodologies that will address agreed aims via long-term collaborations with regular meetings, cross-disciplinary placements, development of dedicated interdisciplinary journals.	Importance of developing a common understanding often recognised, e.g. through analyses of joint field work [107]. Neuroscience “rapidly evolved as a consequence of a series of symposia, conferences, publications,...” (from Sabbatini & Cardoso [108]).
	Standardisation of interdisciplinary methods	Behavioural science and infectious disease modelling communities to collaborate to test existing behavioural science models on existing data sets (e.g. large-scale data sets on behaviour during the COVID-19 pandemic) – establishing the utility of existing theory in the context of infectious disease modelling.	Support cross-sector collaboration – e.g. with policy makers to ensure models inform current policy questions, with the business and technology sectors to support new methods of data collection.	Emulating methodology of successful fields can accelerate progress in interdisciplinary research and can lend emerging disciplines legitimacy [109]. Potential to expand forecasting hubs for COVID-19 modelling (e.g. Loo et al. [110]) to incorporate behavioural data and behavioural predictions.



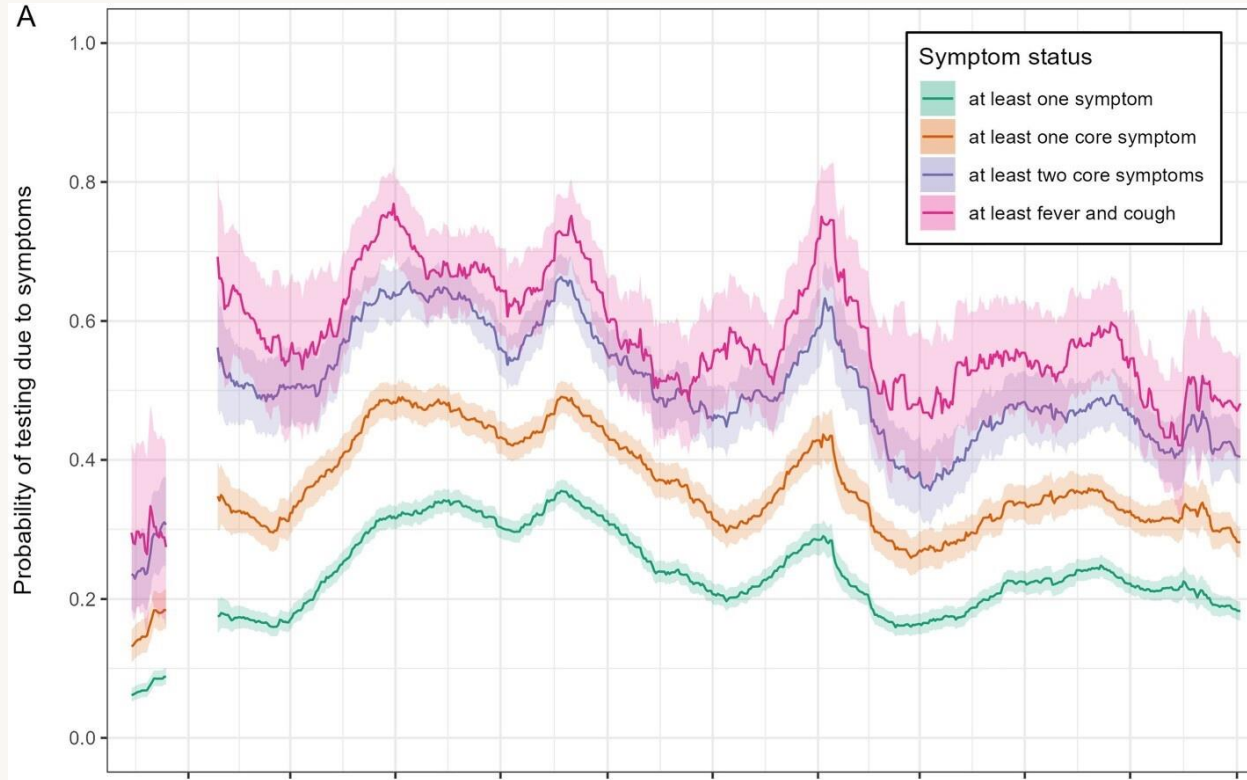
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Talk outline

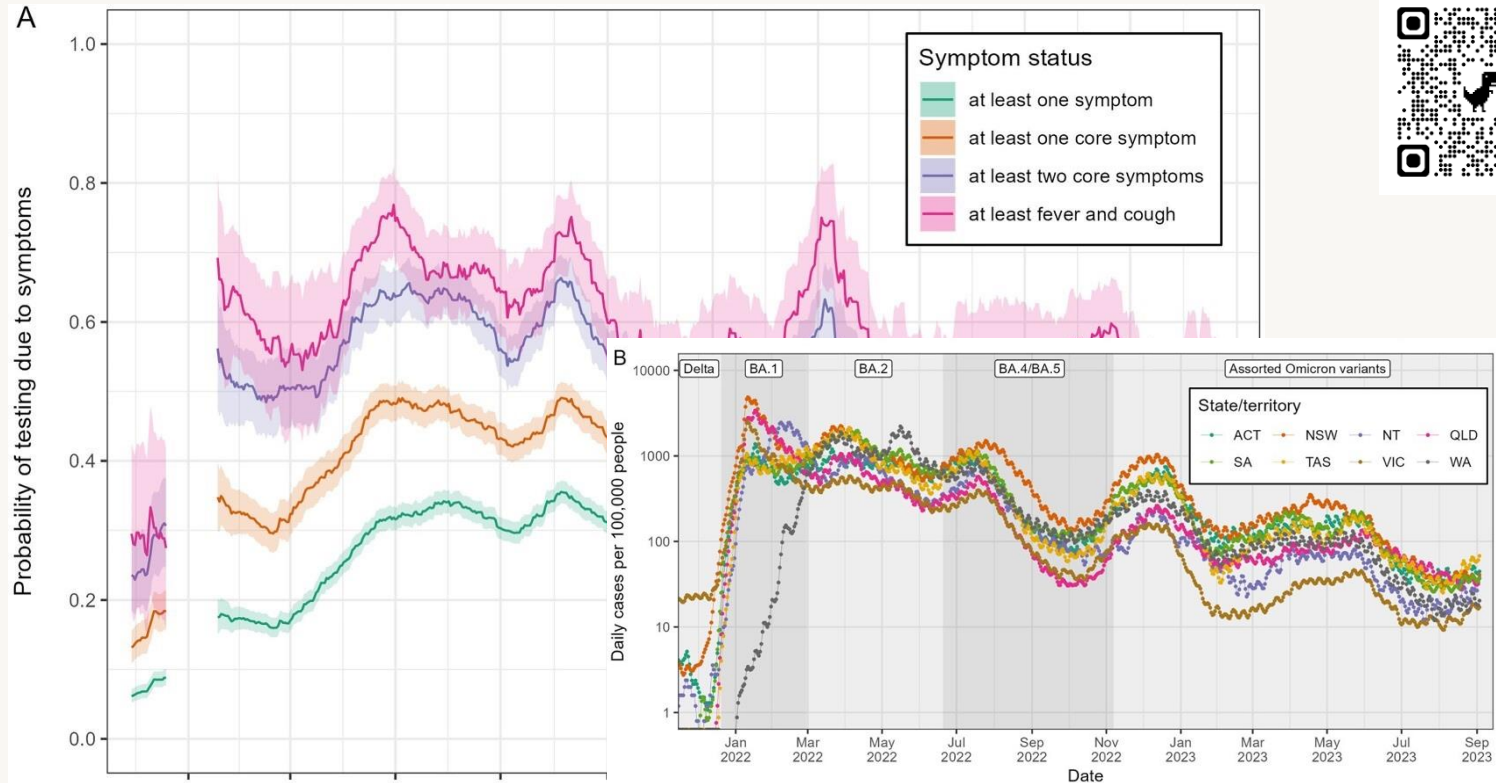
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3. **BaD modelling.**
 - **Work with** Thomas House, Valerie Isham, Dongni Zhang, Mick Roberts, Roslyn Hickson

Informative data

Eales et al. (<https://doi.org/10.1080/29937574.2025.2521858>)



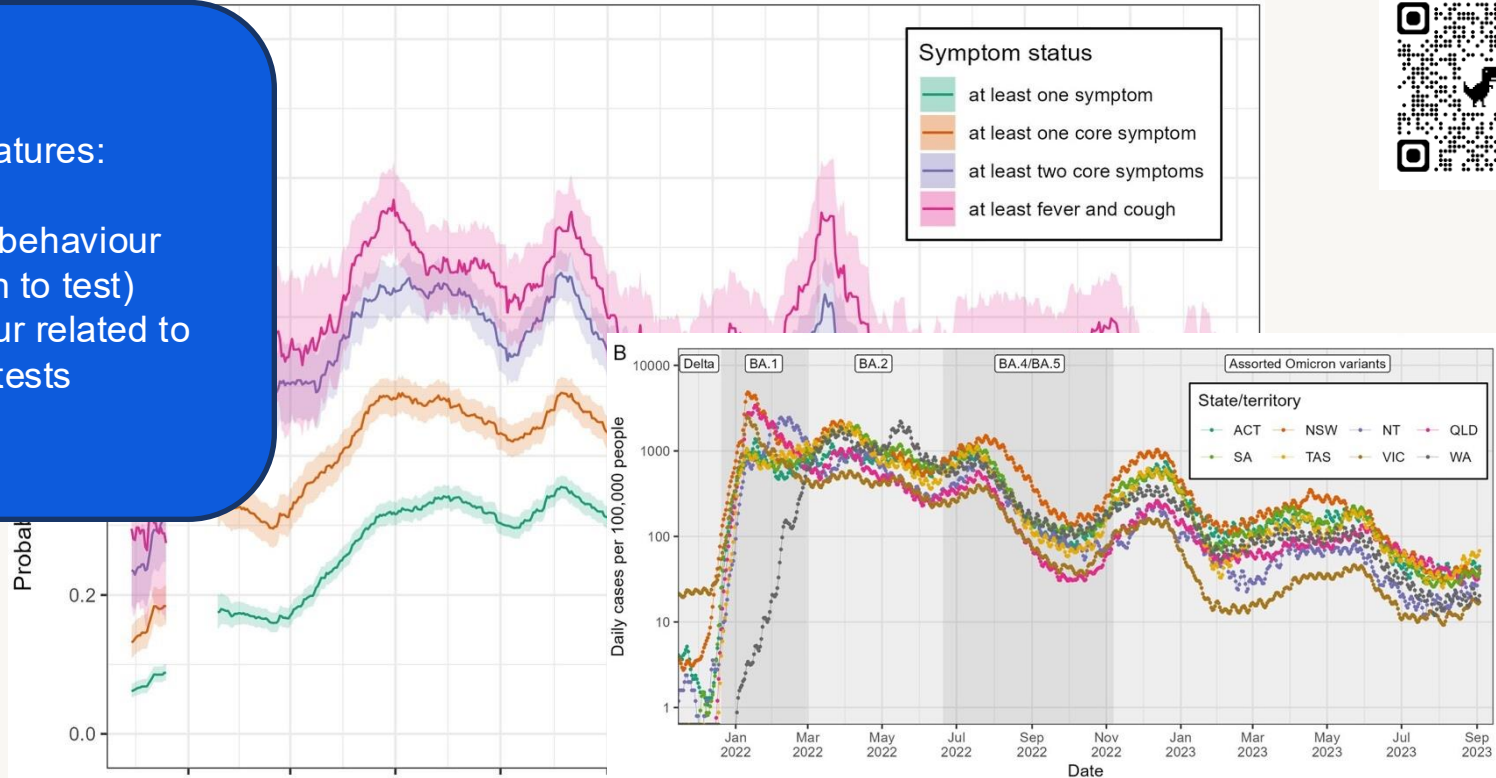
Informative data *Eales et al. (https://doi.org/10.1080/29937574.2025.2521858)*



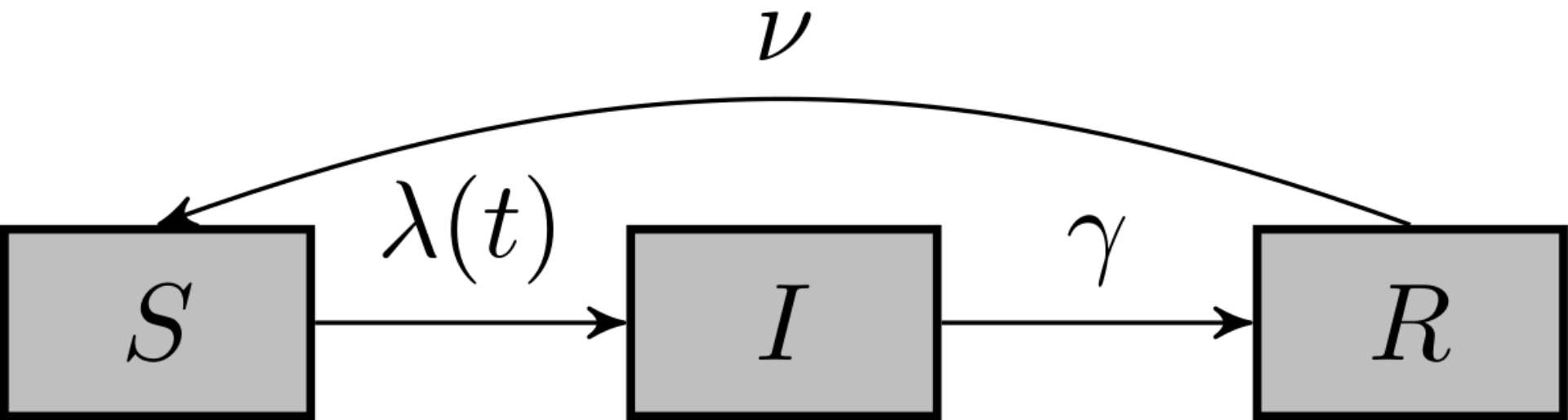
Informative data *Eales et al. (https://doi.org/10.1080/29937574.2025.2521858)*

Some key features:

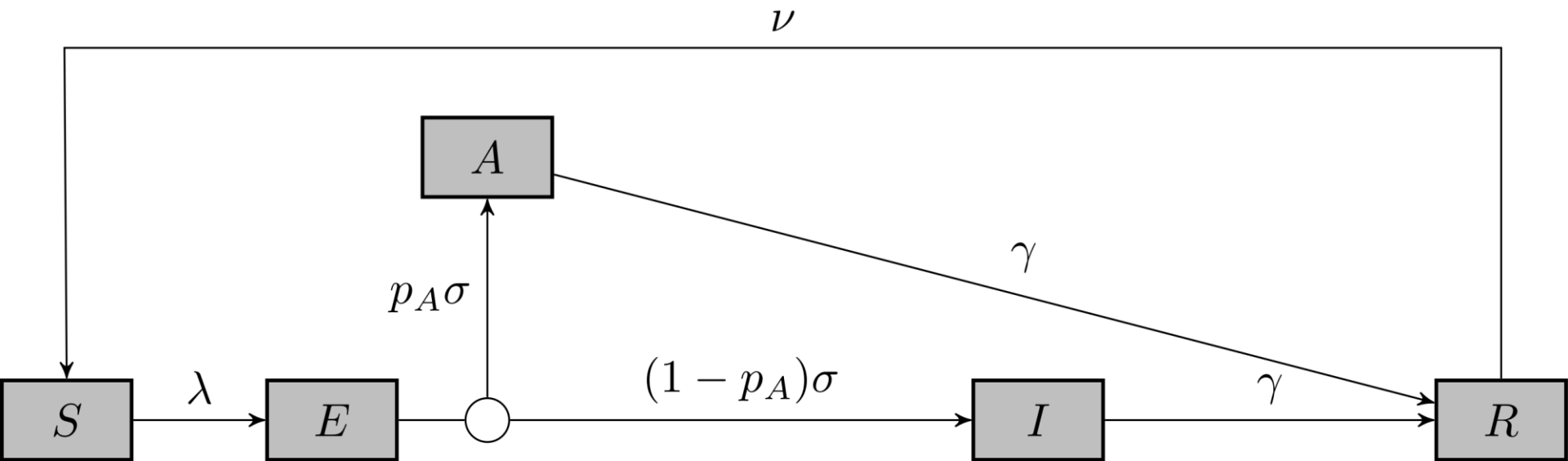
1. COVID
2. Specific behaviour (intention to test)
3. Behaviour related to positive tests

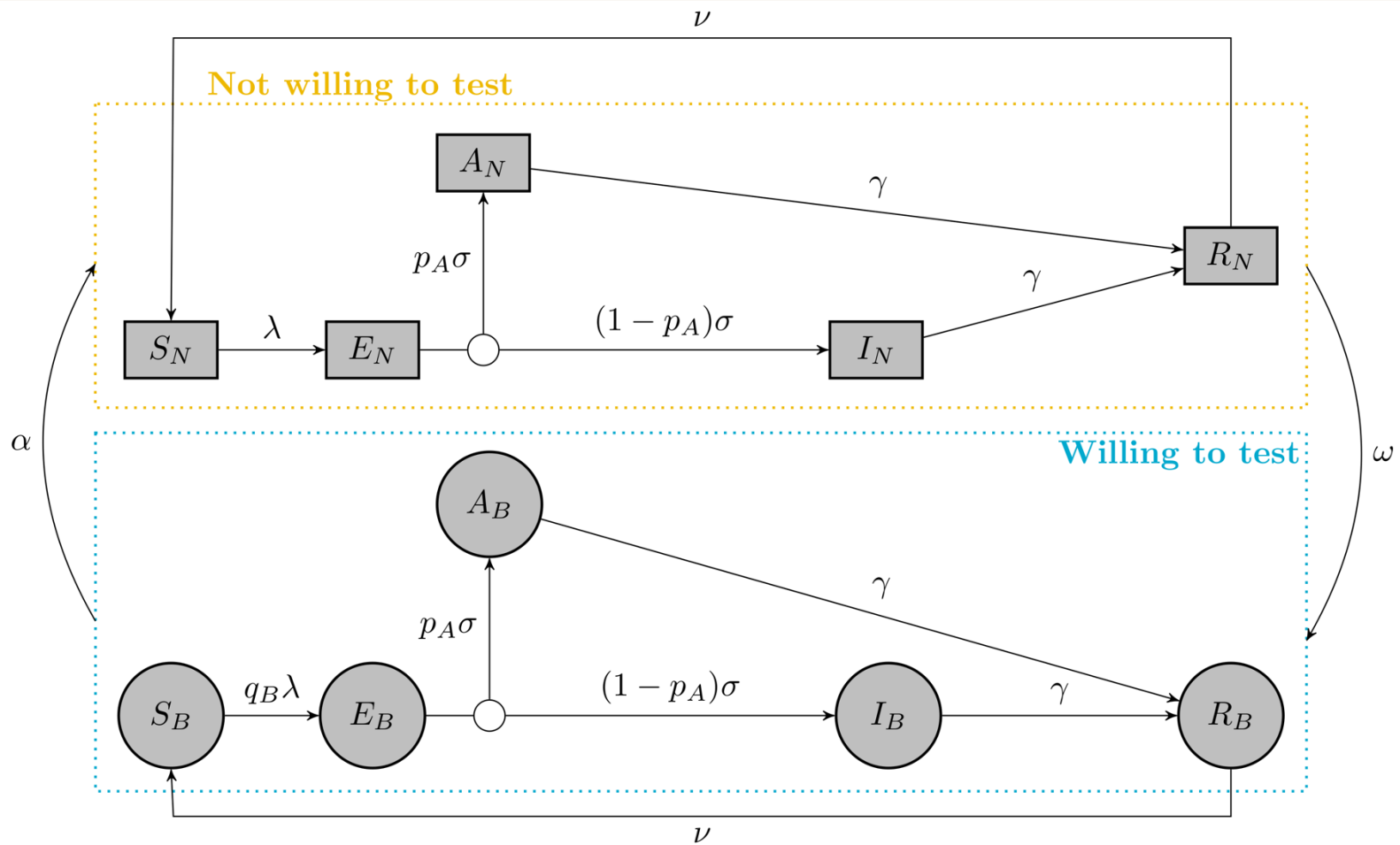


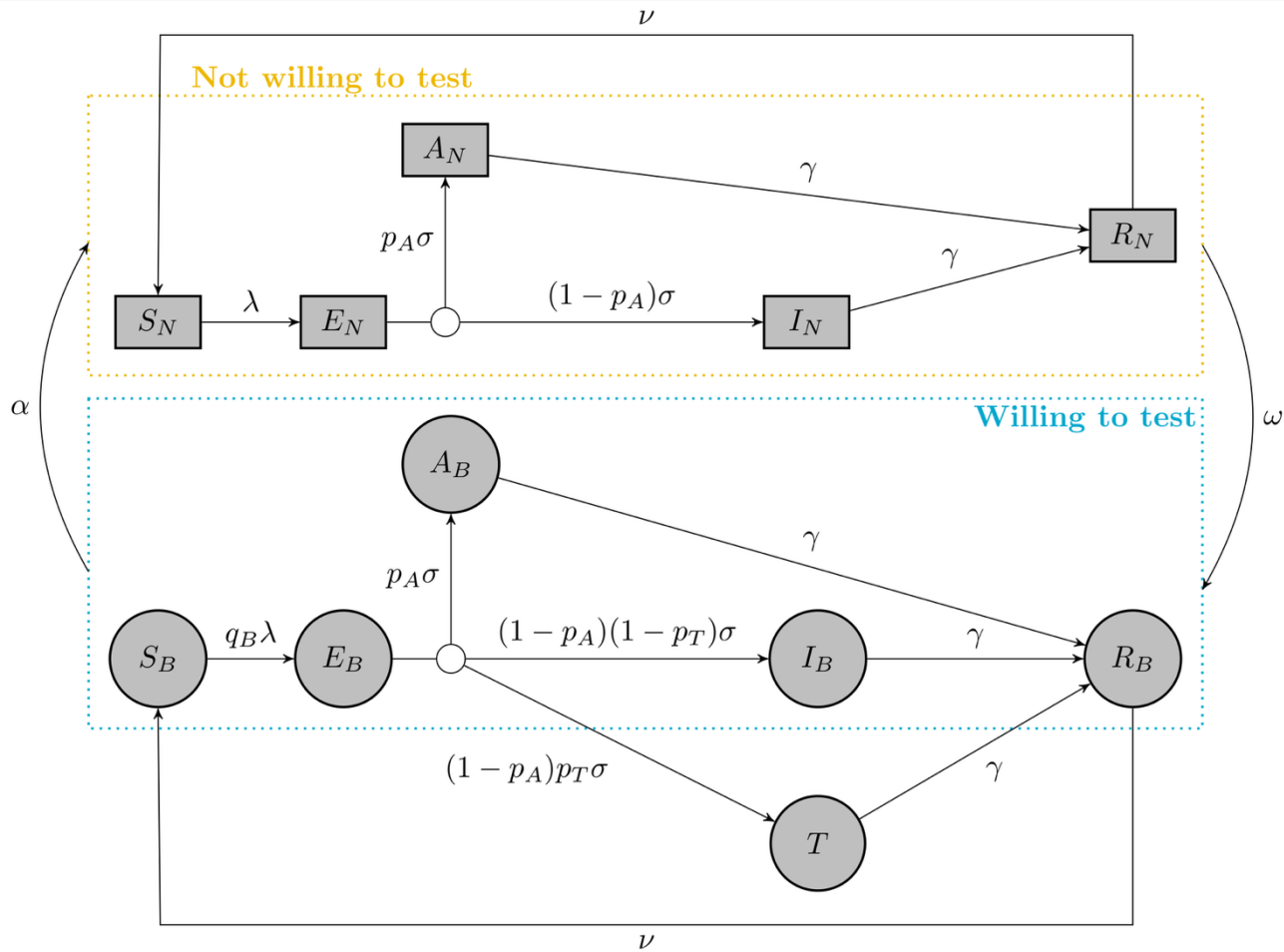
Compartmental structure



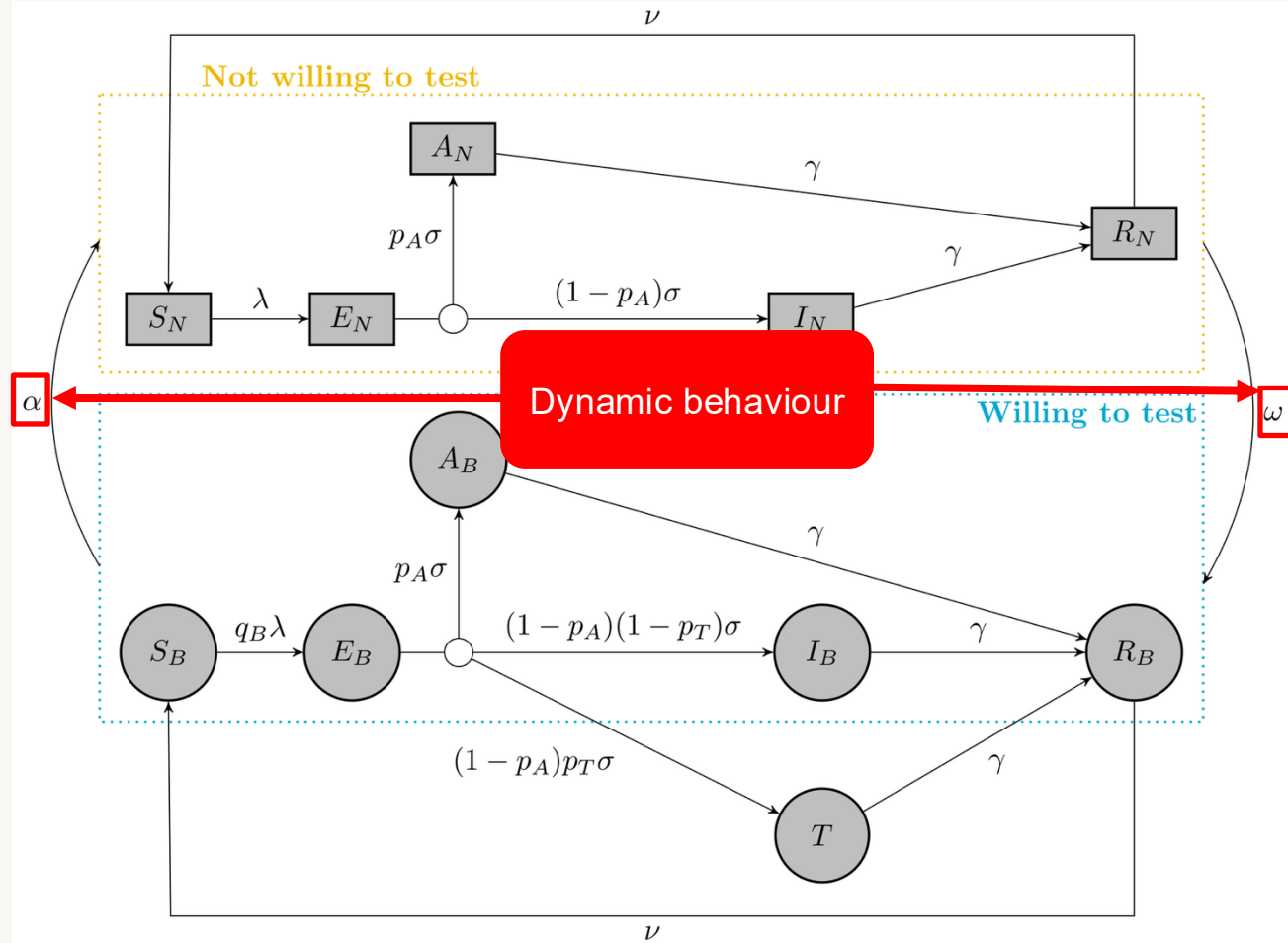
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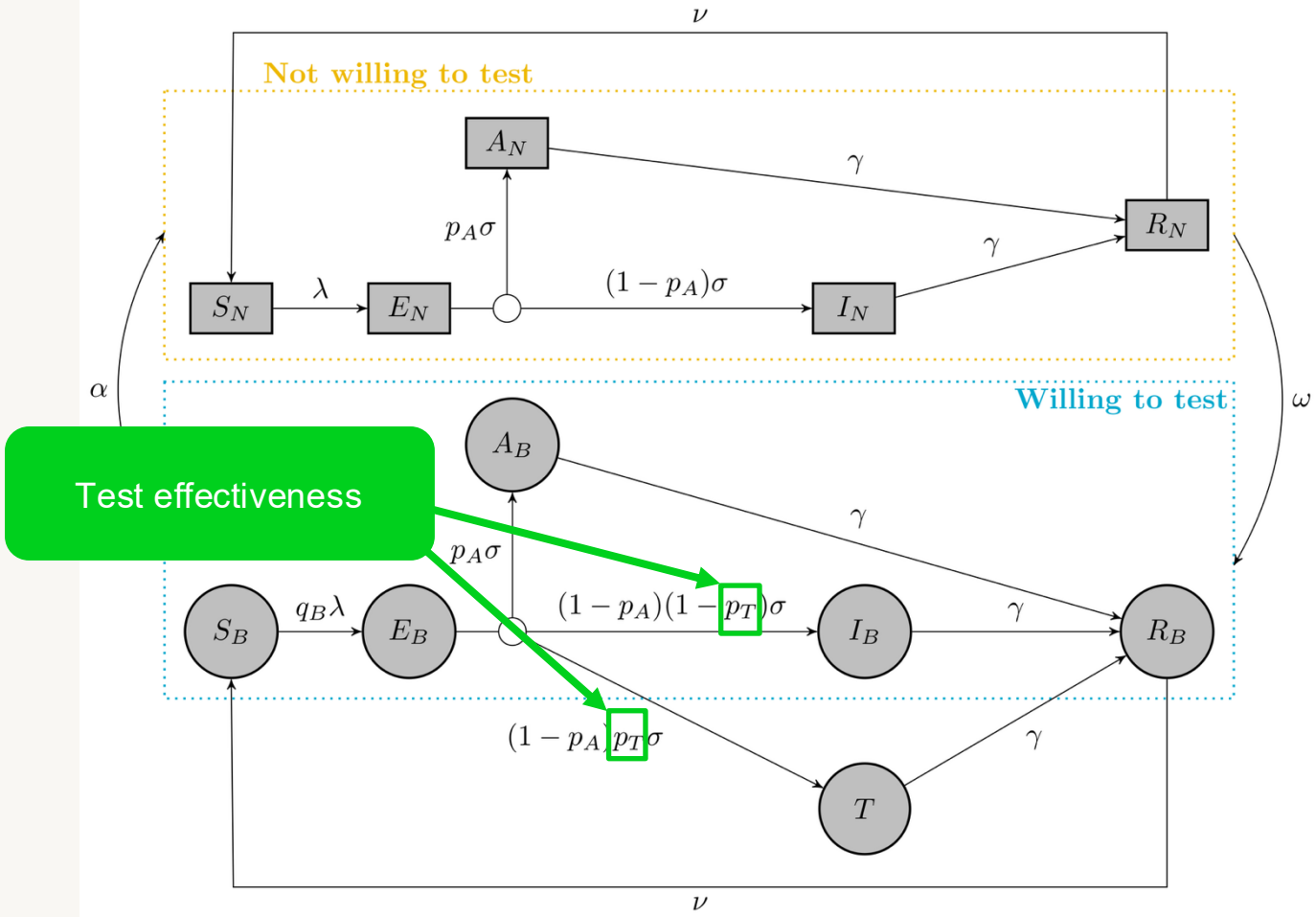




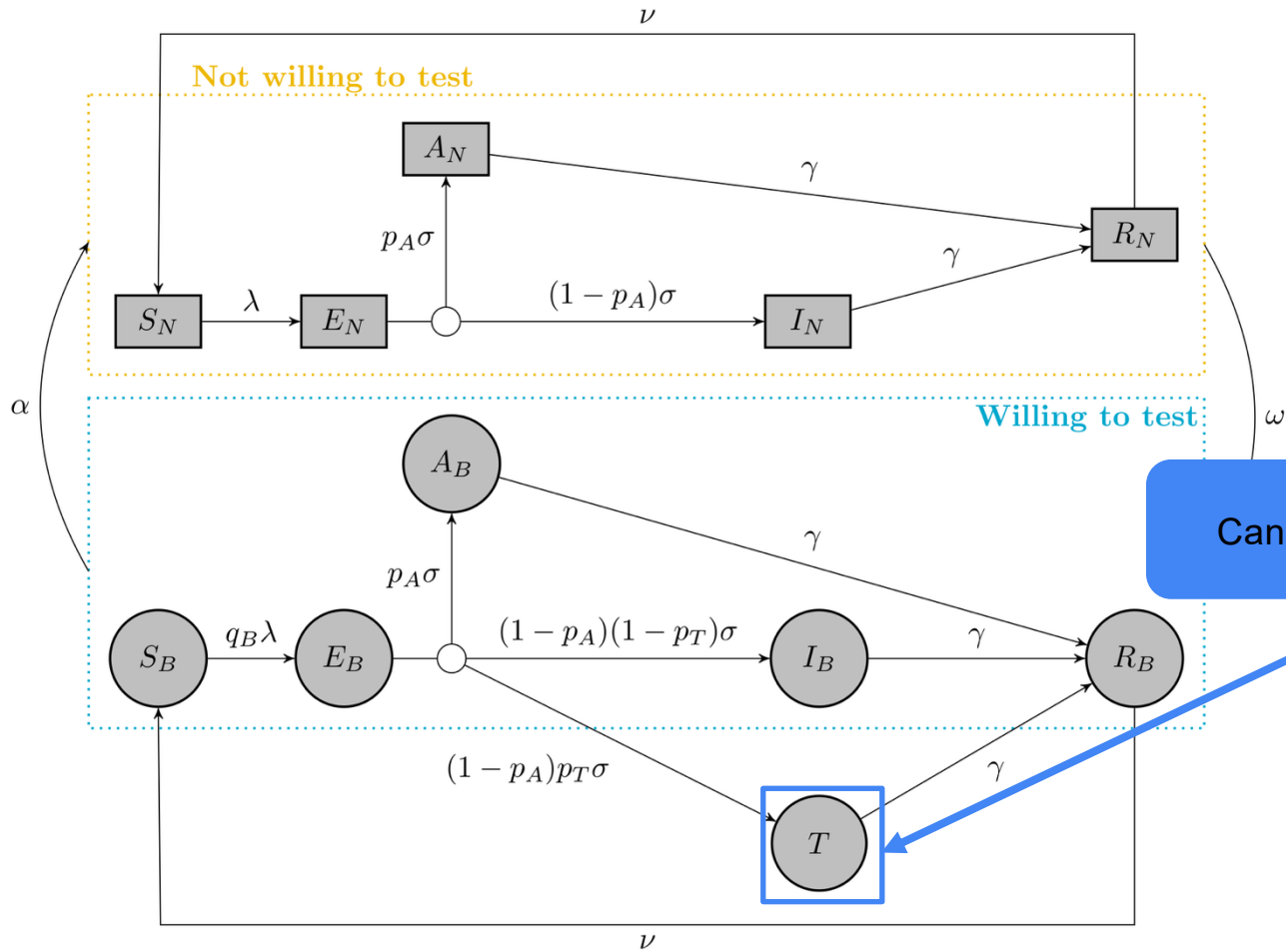
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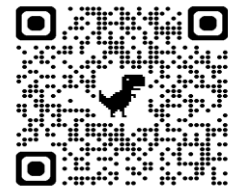


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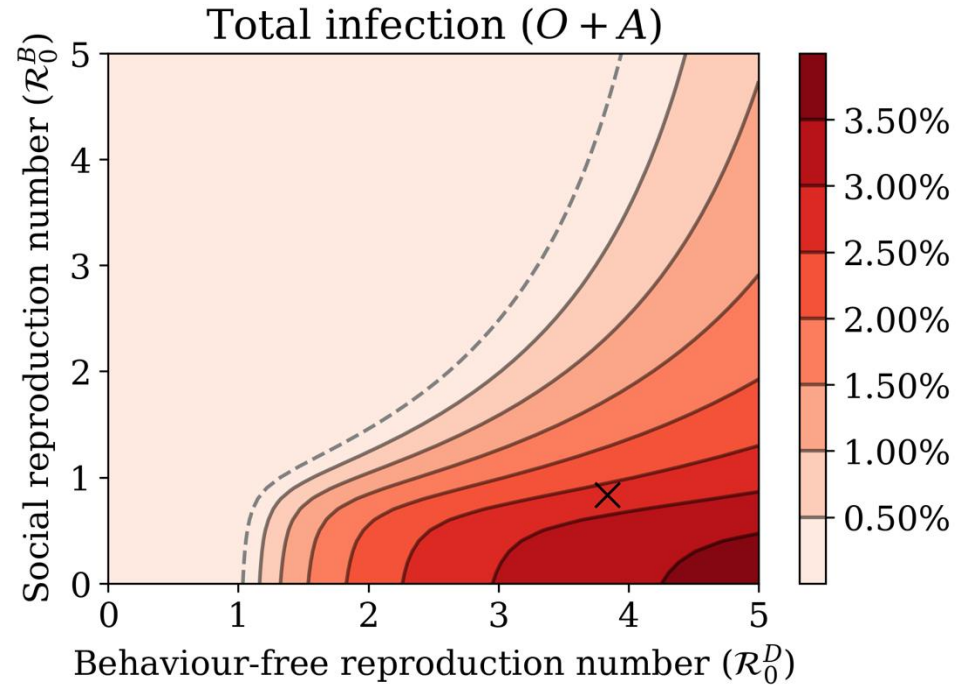
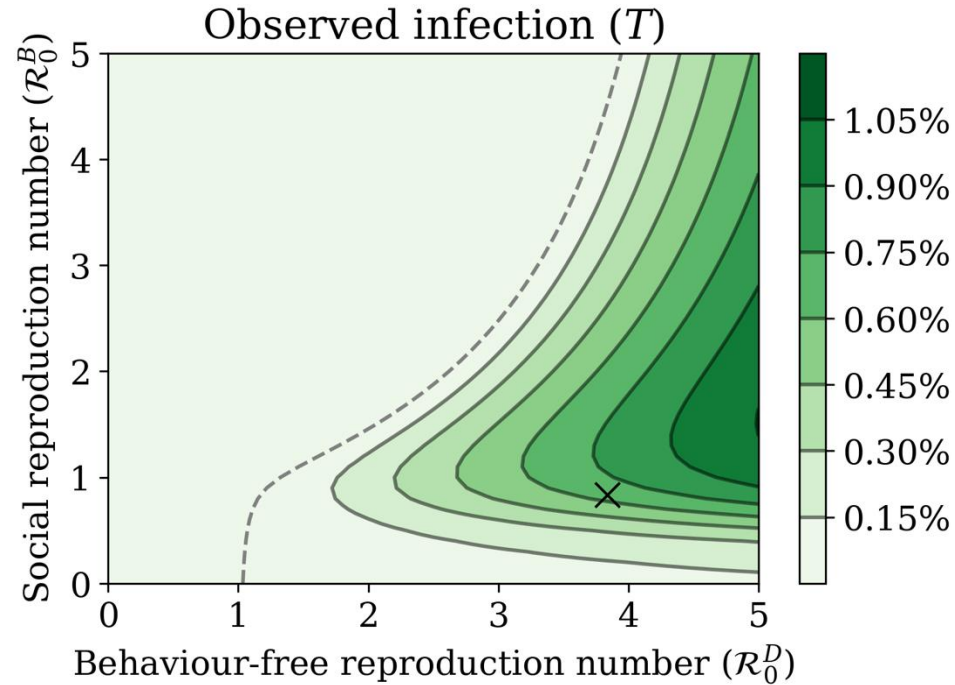


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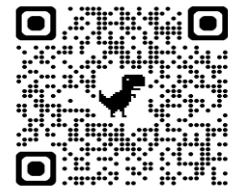
Observed vs true prevalence



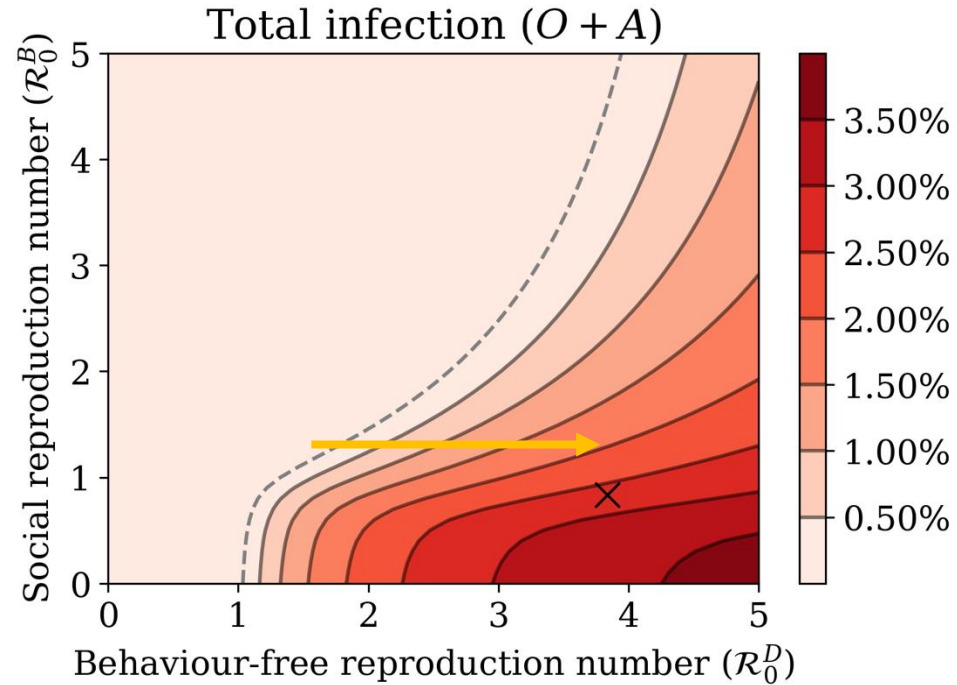
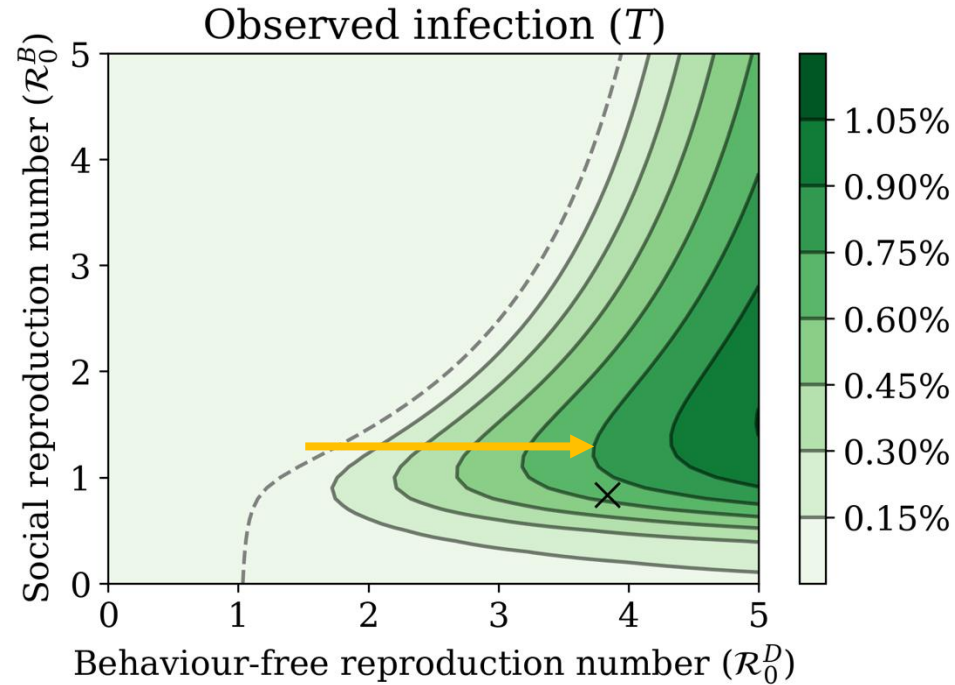
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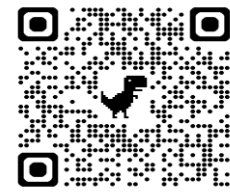
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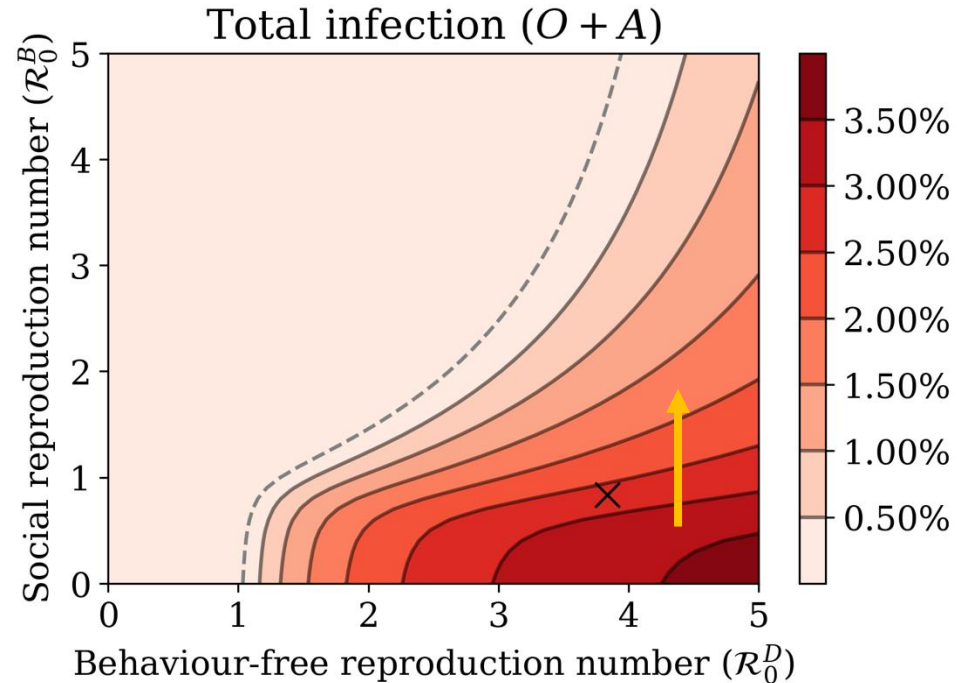
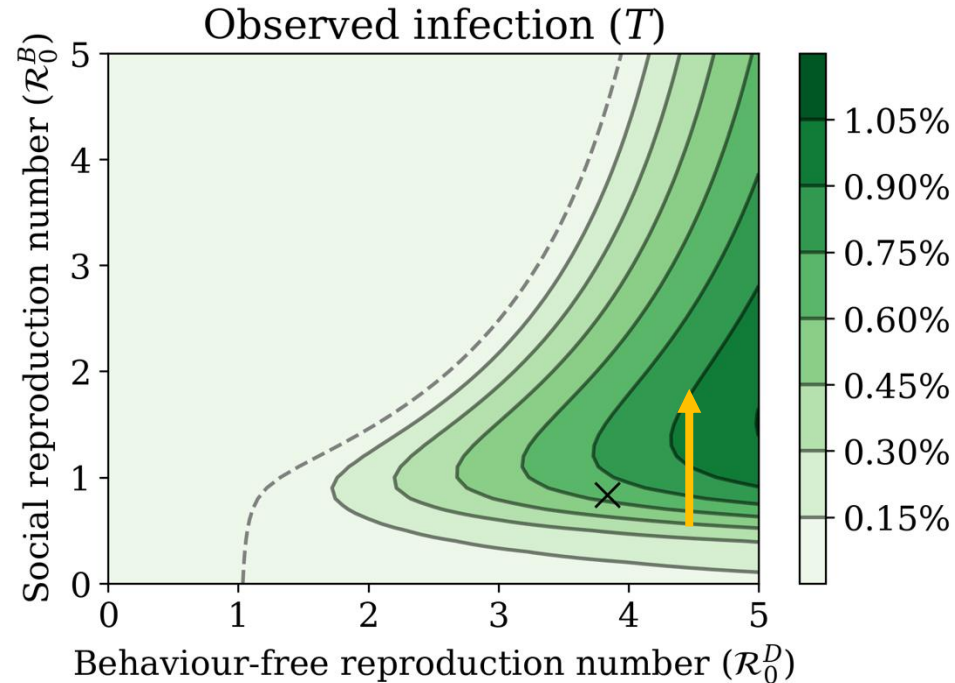
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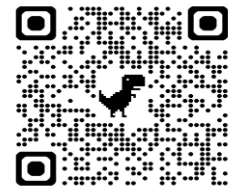
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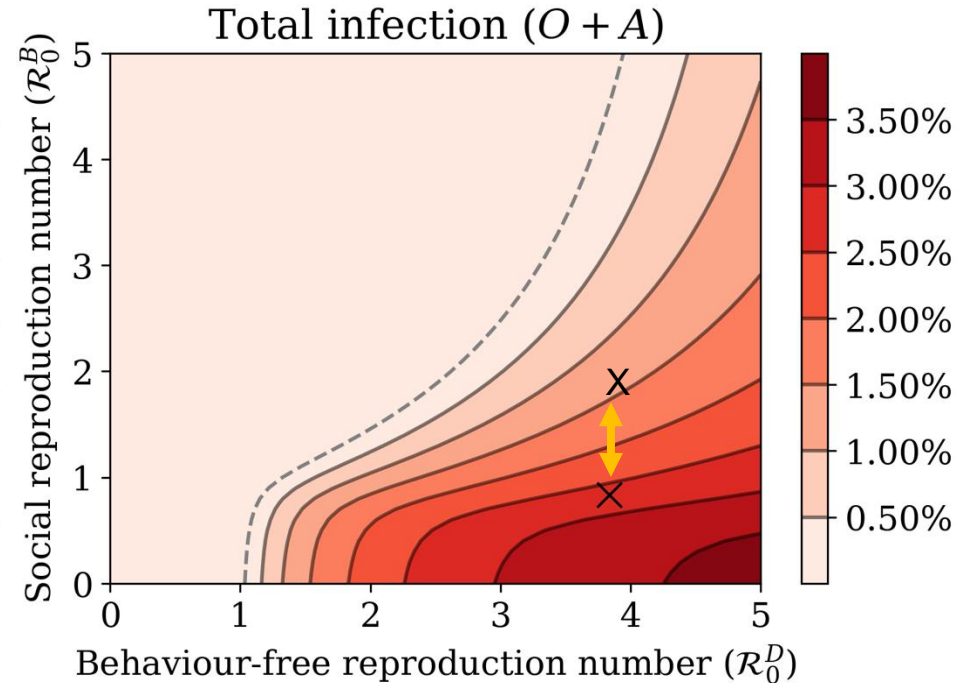
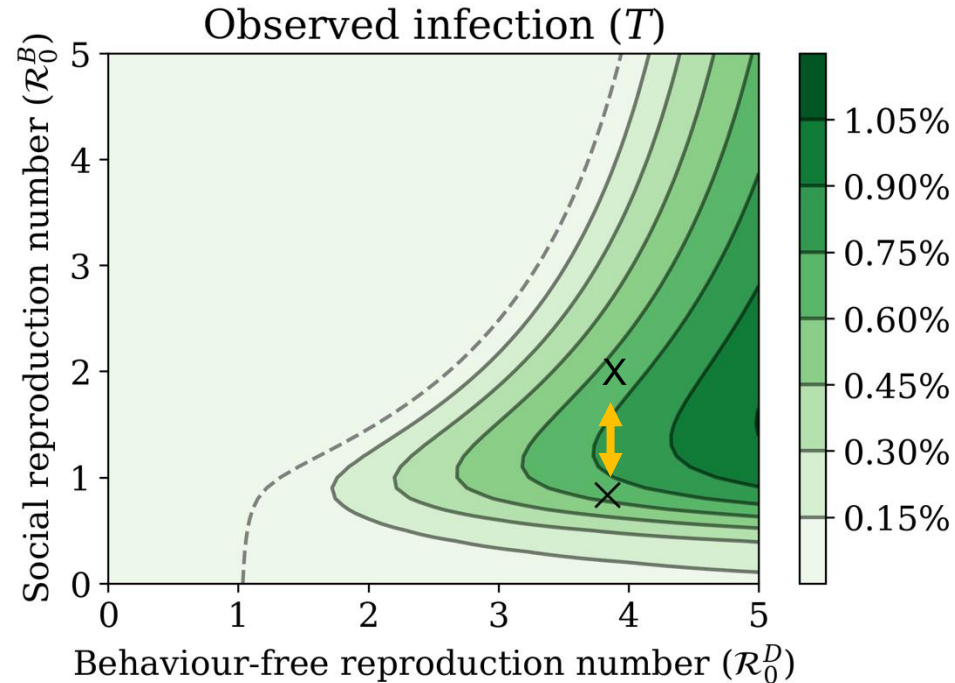
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Observed vs true prevalence



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Summary

Please keep in contact if you would like to discuss ideas related to epidemiological-behavioural modelling!

Contact info



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