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A. Scalco, J. Macdiarmid, T. Craig,
S. Whybrow, & G. W Horgan

Modelling the impact of interventions aimed at reducing meat consumption using agent-based modelling

RESAS Scottish Government Funding - Theme 3 RD 3.2.4

The team

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Jennie Macdiarmid
Stephen Whybrow
Andrea Scalco

Tony Craig

Graham W Horgan

Agenda

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- Research background and objectives
- The methodology
    - Agent-based modelling
    - MeatNet model
- Results and discussion
- Conclusions and future research
- Q&A

The problem with meat consumption

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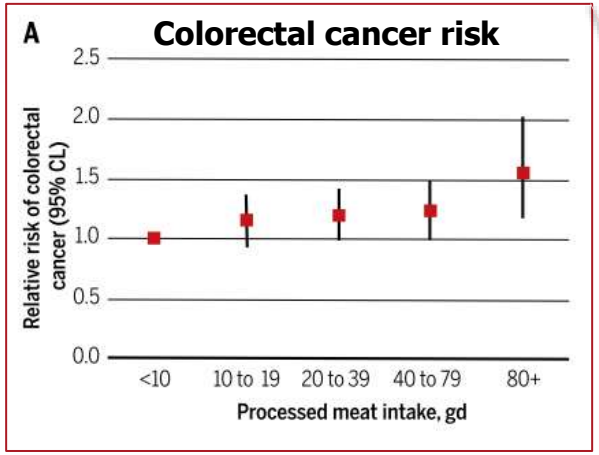
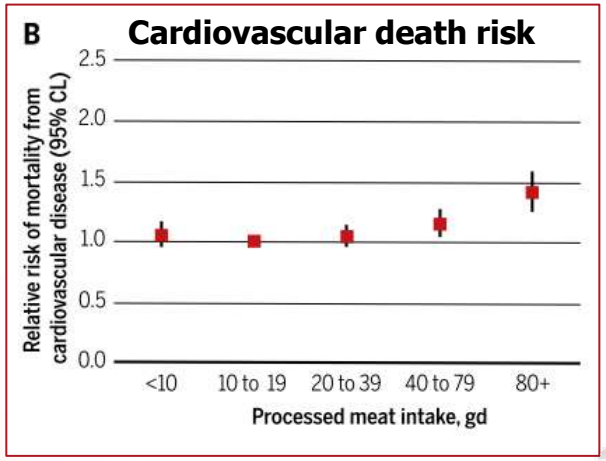


[1]



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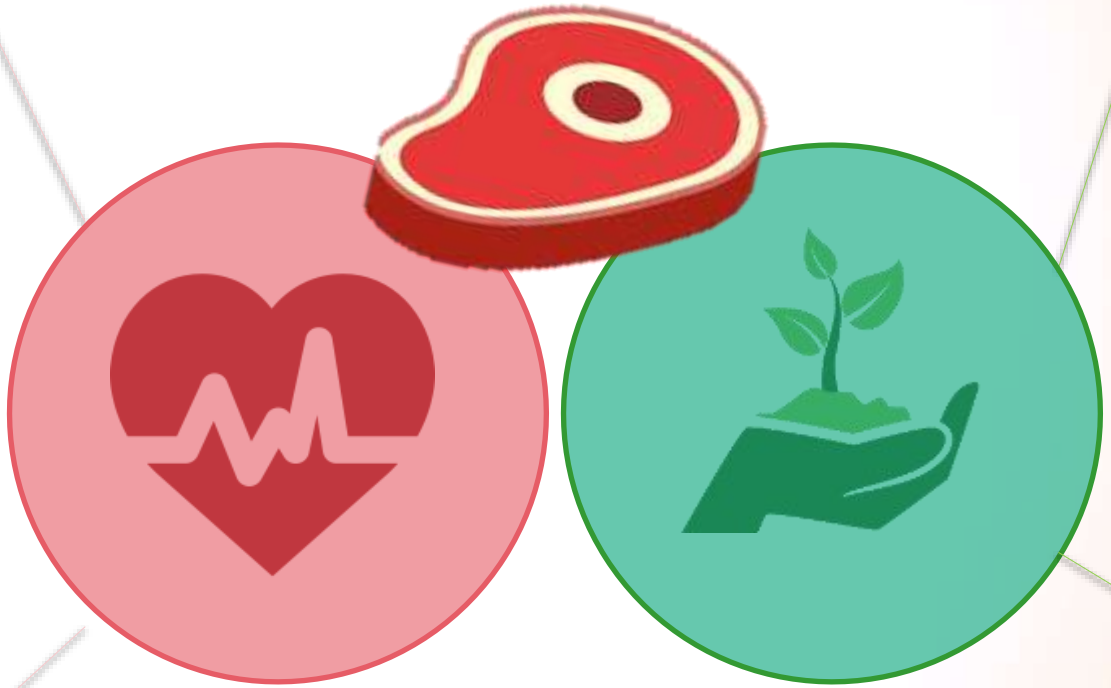

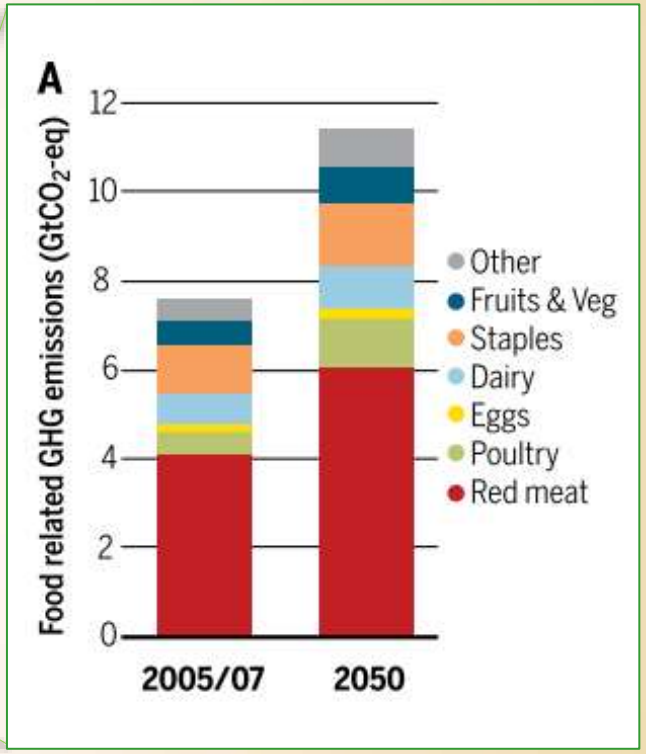

[3]

Figures elaborated by Godfray, Aveyard, Garnett, …, & Jebb (2018) based on [1] Norat, Bingham, Ferrai, …, & Riboli (2005), [3] Rohrmann, Overvad, Bueno-de-Mesquita, …, & Linseisen (2013), and [3] Springmann, Godfray, Rayner, & Scarborough (2016)

Aim of the research and methodology

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To investigate if meat consumption could be changed through **social influence** within personal networks.

We considered two daily contexts:

- meals consumed at **home** with household members
- meals consumed at the **workplace** with co-workers

The effects at the society level of different **social marketing interventions** applied in the **workplace environment** were investigated by developing an an agent-based model.

Social marketing interventions in real-life

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Norm-based message

"A lot of people aren't aware that the typical student eats their five servings of fruits and vegetables each day. Students eat more fruit and vegetables than you'd expect" [1]

[1] Robinson, Fleming, & Higgs (2014)

Agent-based modelling

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Agent-based modelling (ABM) is a computational method that simulates **individuals** making decisions according to programmable rules (Badham et al., 2018).

[1] Badham, Chattoe-Brown, Gilbert, Chalabi, Kee, & Hunter (2018).

Some reasons for using agent-based models

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- Account for **non-linear mechanisms** (e.g. thresholds)
- ABMs are dynamic and can incorporate **feedback**
- Agents can include a variety of characteristics (i.e. **heterogeneity**)
- Agents can **react/adapt** to changes in the environments
- They can help studying **complex systems** (like public health) because system-level phenomena emerges from the interaction of the individuals

[1] Tracy, Cerda, & Keyes (2018)

Complex systems

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Complexity is the property of a real world system that is manifest in the inability of any one formalism being adequate to capture all its properties.

Mikulecky (2011)

[*] Source: J.V. Ijken – The Art of Flying (www.janvanijken.com)

Modelling from the bottom-up

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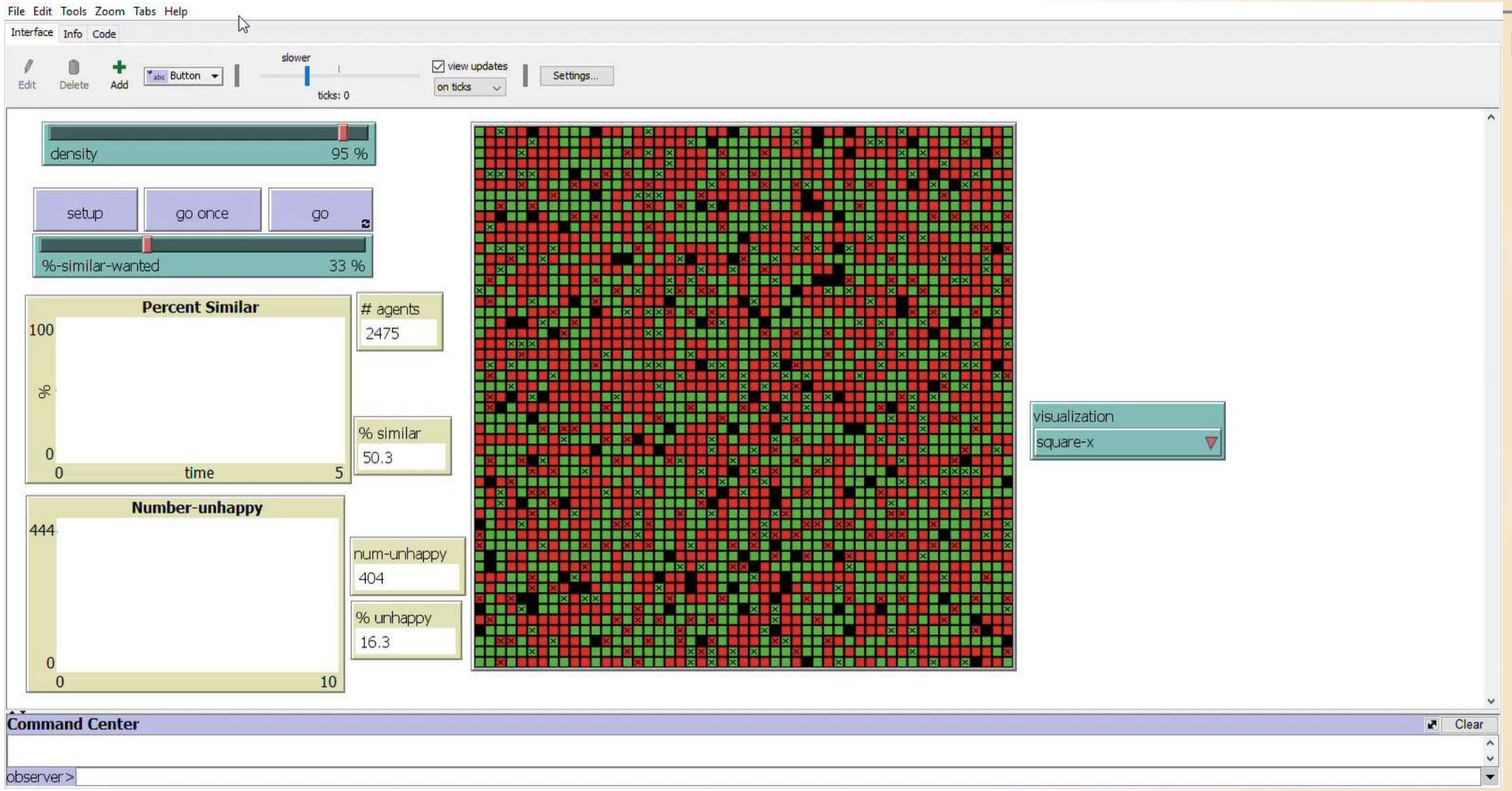

[*] Source: Wilensky, U. (1997). NetLogo implementation of Schelling segregation model (1978).

Complex social systems

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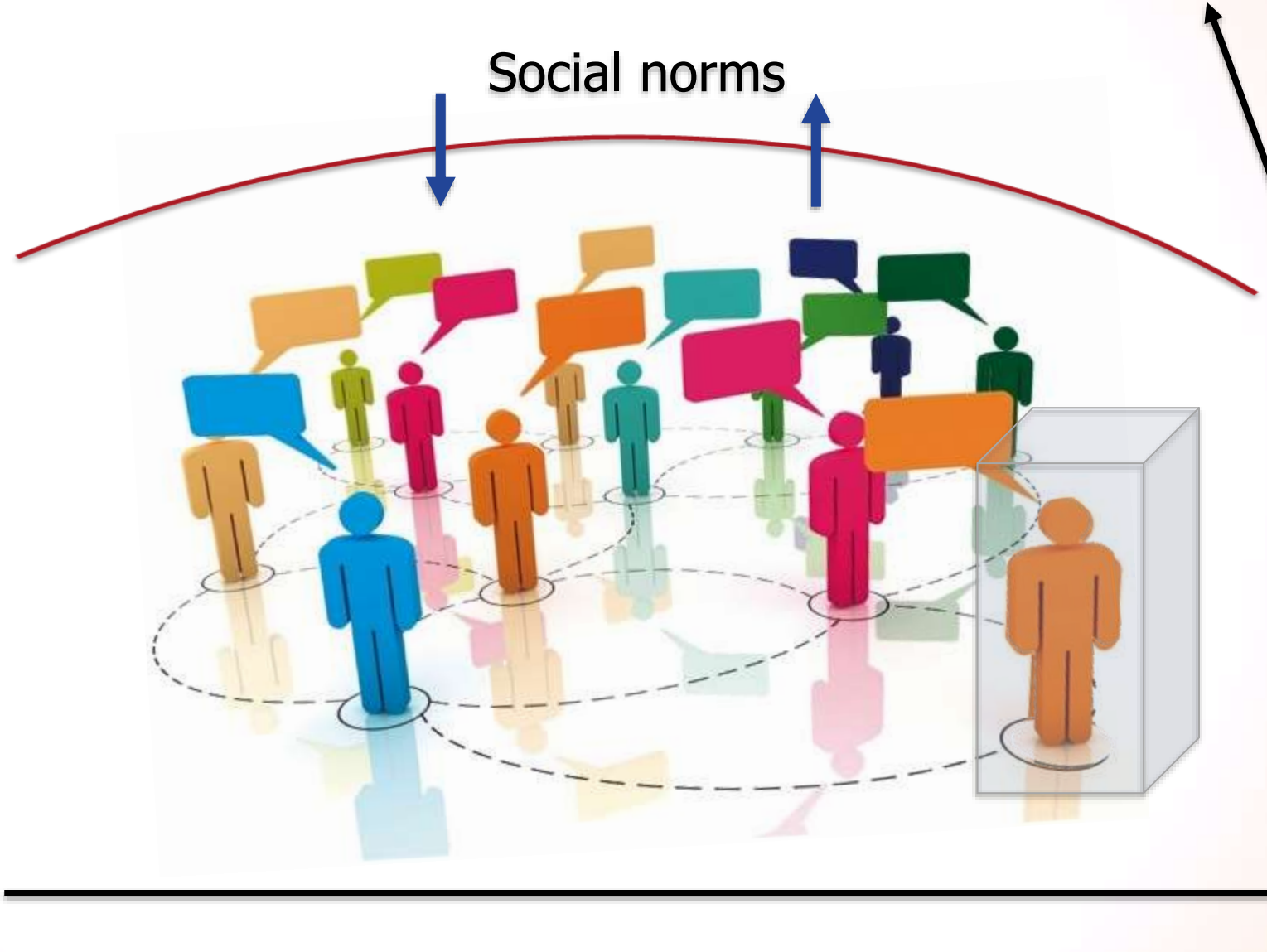

Modelling consumers like virtual agents

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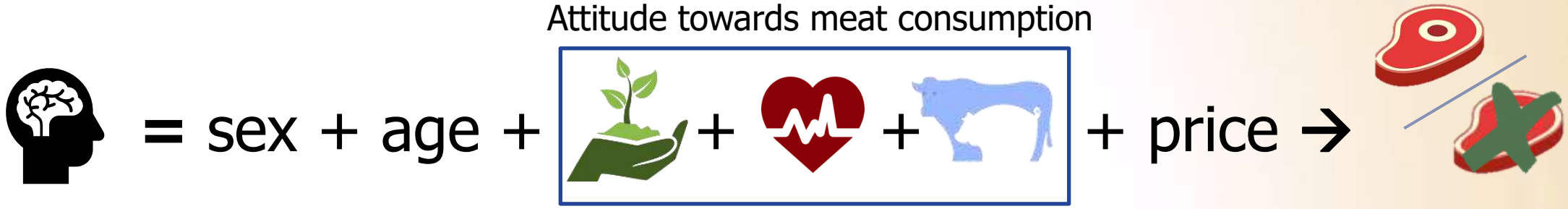
Attitude towards meat consumption



Agent

Food choice

For the decision - Data from the **British Social Attitude Survey** (2014)

- 2759 consumers – 18 y.o. or over
- There are a number of predictors of meat consumption

For the amount - Data from **National Diet Nutrition Survey** (2008/9 - 2013/14)

- Meat intake depends on respondent's sex, time of the day, and context

Social ties and time framework

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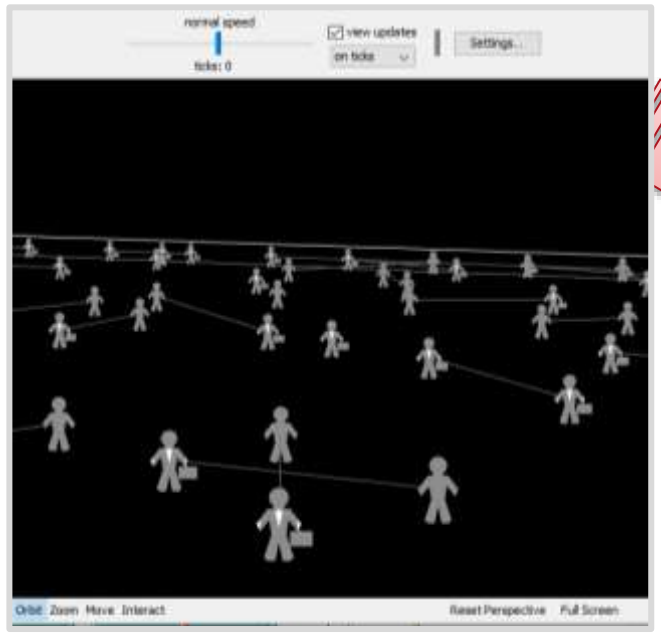
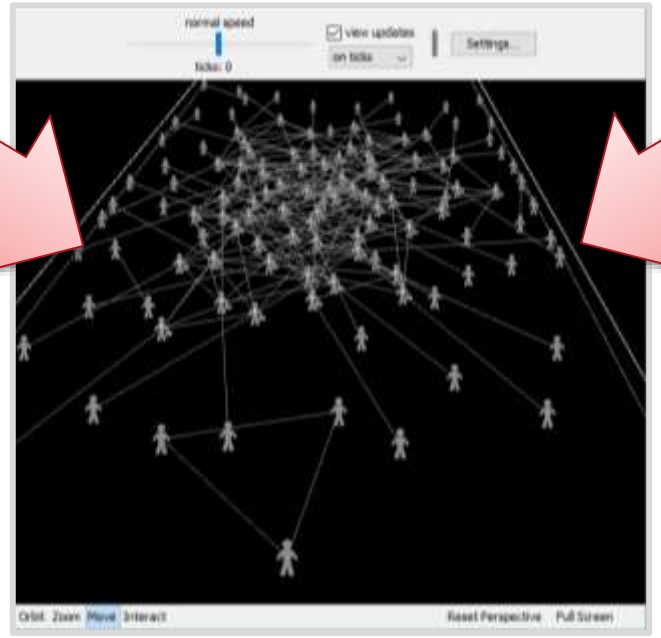
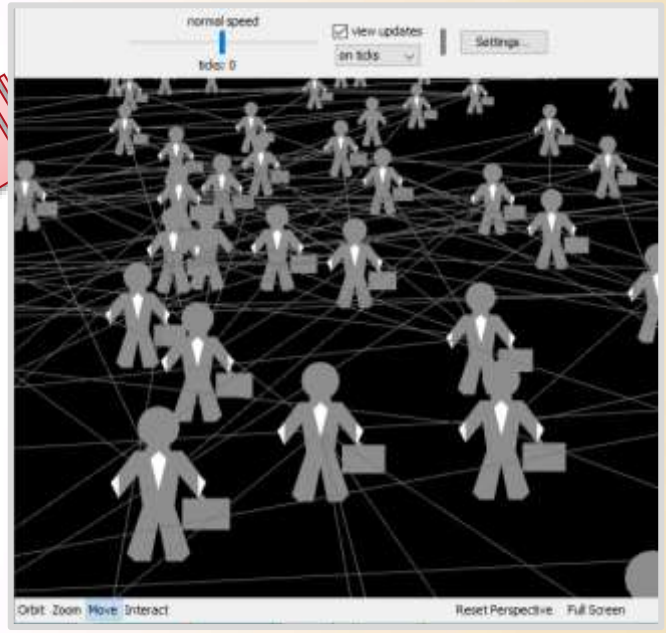
Household members



Combined networks



Co-workers



The main “rules” of social influence

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- An agent can perceive the concerns of others
  (i.e. agents talk about their concerns from time to time)

- An agent is affected only by those agents its network

- An intervention will shift agent’s attention towards those agents that owns higher concerns than itself

- Susceptibility is normally distributed among agents… however, household members tend to have greater influence than co-workers

- Agents’ re-evaluate its concerns after interacting with others

Putting together social influence rules

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Weighted mean of the agent's concern (C)

- **Alpha (α)**
  Individual susceptibility to household members/co-workers
- **Gamma (γ)**
  Effect derived from social marketing intervention

$$C_{i,t} = (1-\alpha_i)C_{i,t-1} + \alpha_i \frac{\sum_{\substack{j\in peers(i) \\ C_{j,t-1}>C_{i,t-1}}} (1+\gamma)C_{j,t-1} + \sum_{\substack{j\in peers(i) \\ C_{j,t-1}\leq C_{i,t-1}}} (1-\gamma)C_{j,t-1}}{\sum_{\substack{j\in peers(i) \\ C_{j,t-1}>C_{i,t-1}}} (1+\gamma) + \sum_{\substack{j\in peers(i) \\ C_{j,t-1}\leq C_{i,t-1}}} (1-\gamma)}$$

(*) Based on the work by Zhang, Giabbanelli, Arah, & Zimmerman (2014)

Intervention options

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Target agents by:
- age
- sex
- concerns

Messages focus on:
- environmental costs
- health consequences
- animal welfare

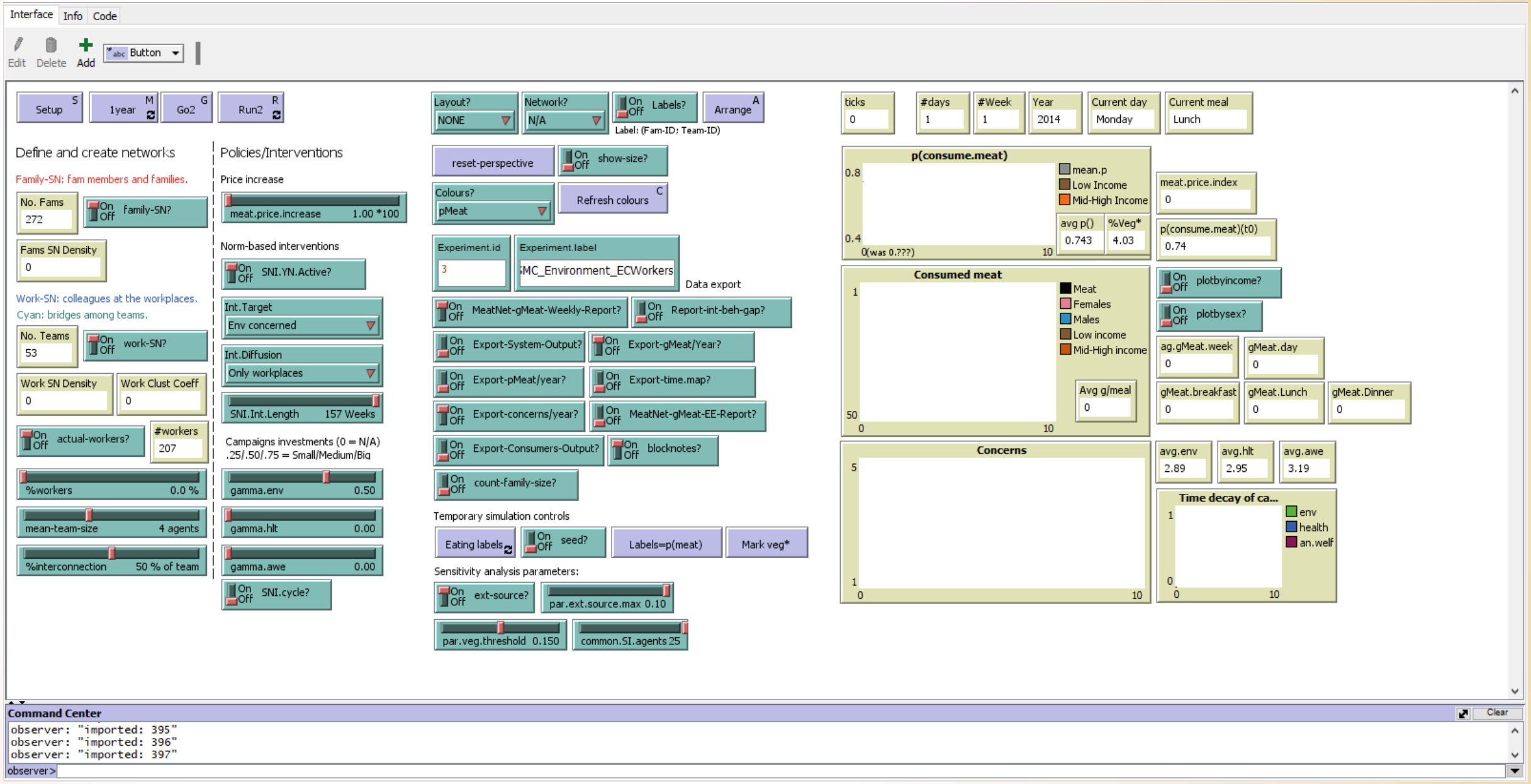
Contexts:
- workplace
- households

Other options:
- length of time
- one-off/recurrent

g/week per agent

Likelihood of eating meat

Original interface



Original interface

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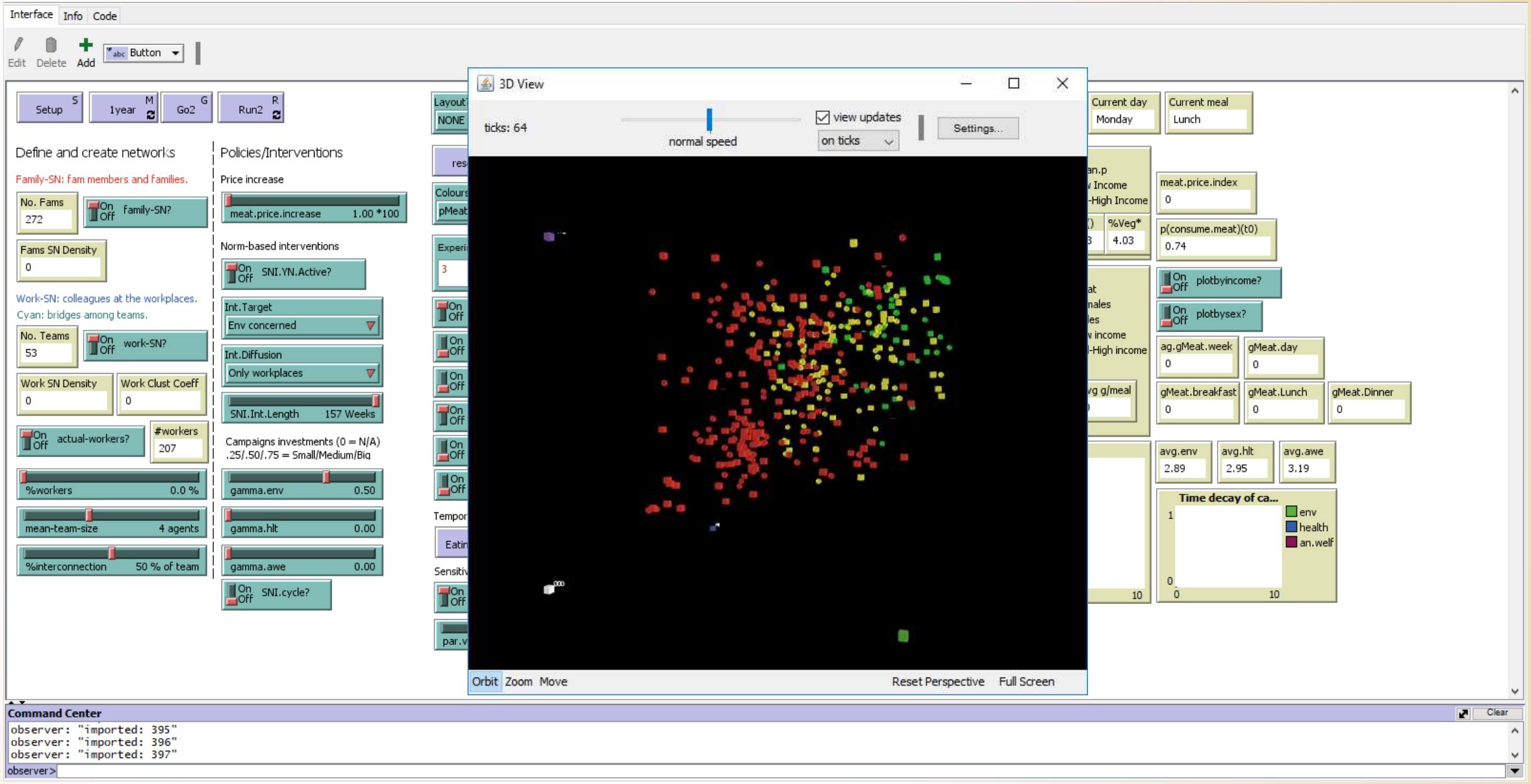

A more friendly interface

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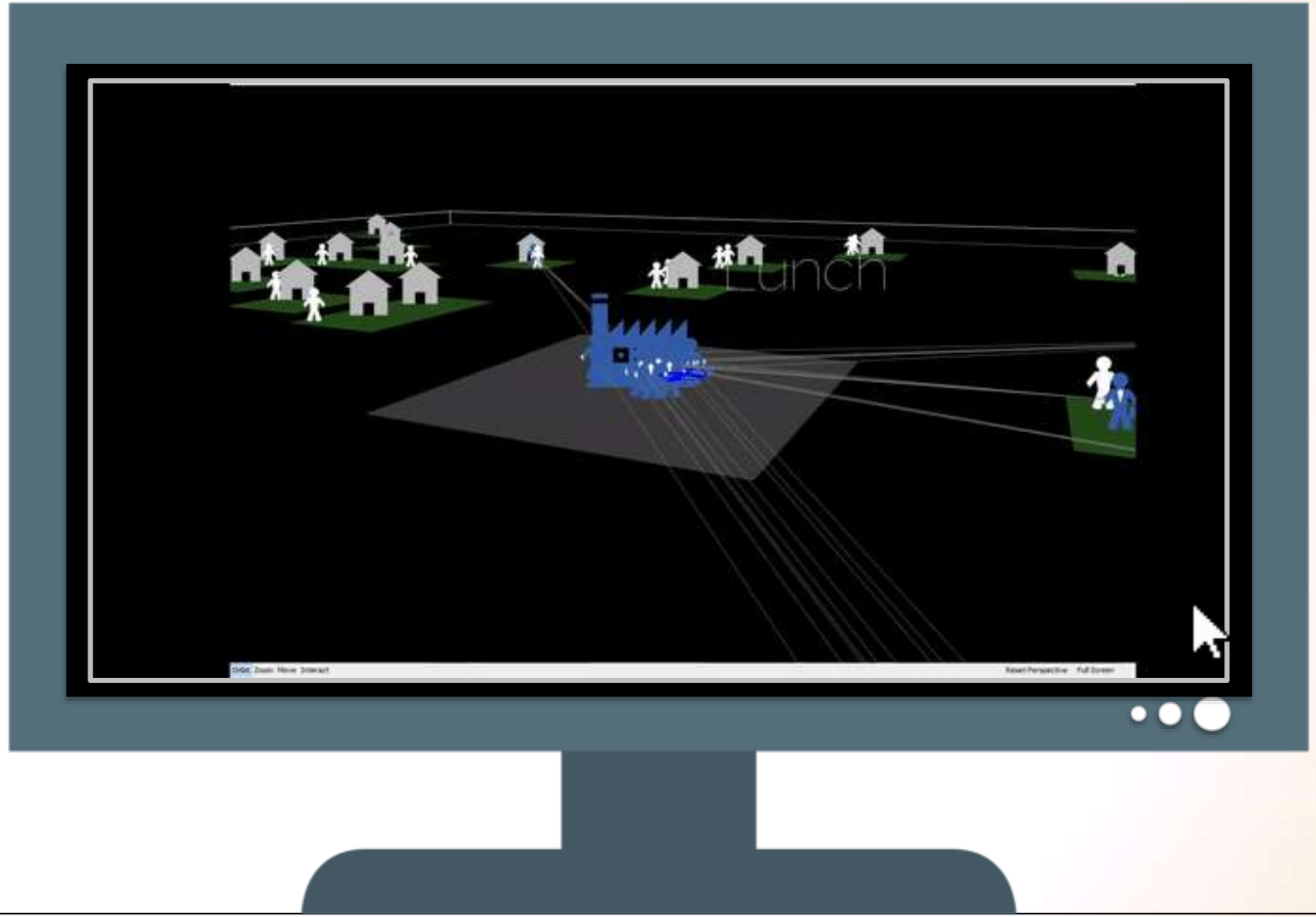
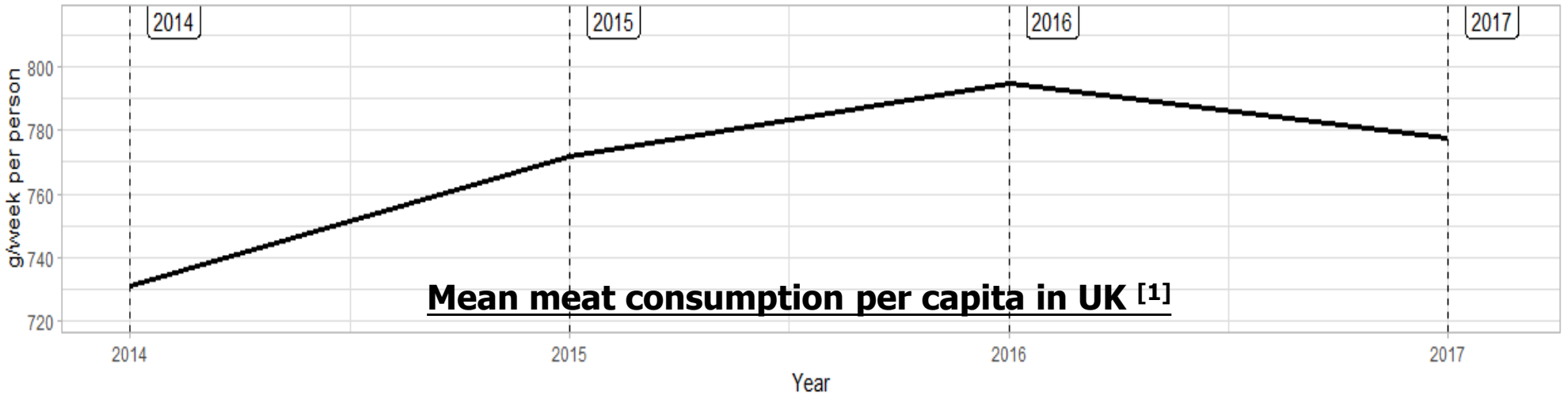
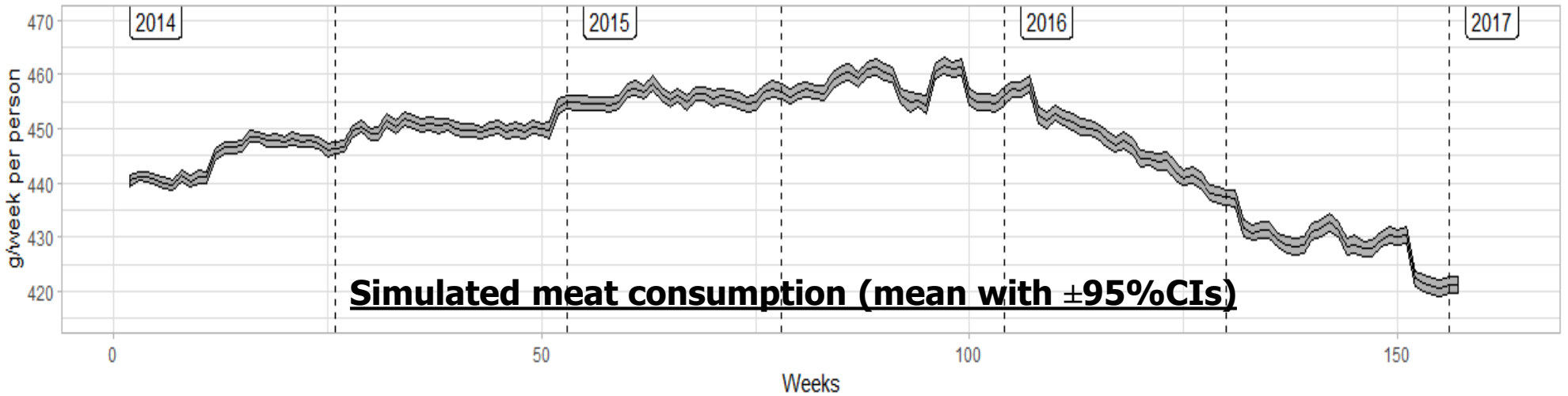


Snapshots from a user-friendly version of the simulation model.

External validation

Comparison of reported meat consumption with the simulated meat consumption





[1] Data elaborated by the Agriculture and Horticulture Development Board (2018).

What works best? (1)

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A comparison between messaging about (A) environment, (B) health, or (C) animal welfare associated with meat consumption

For instance, "*most people think that eating meat is bad for the environment*"

What works best? (1)

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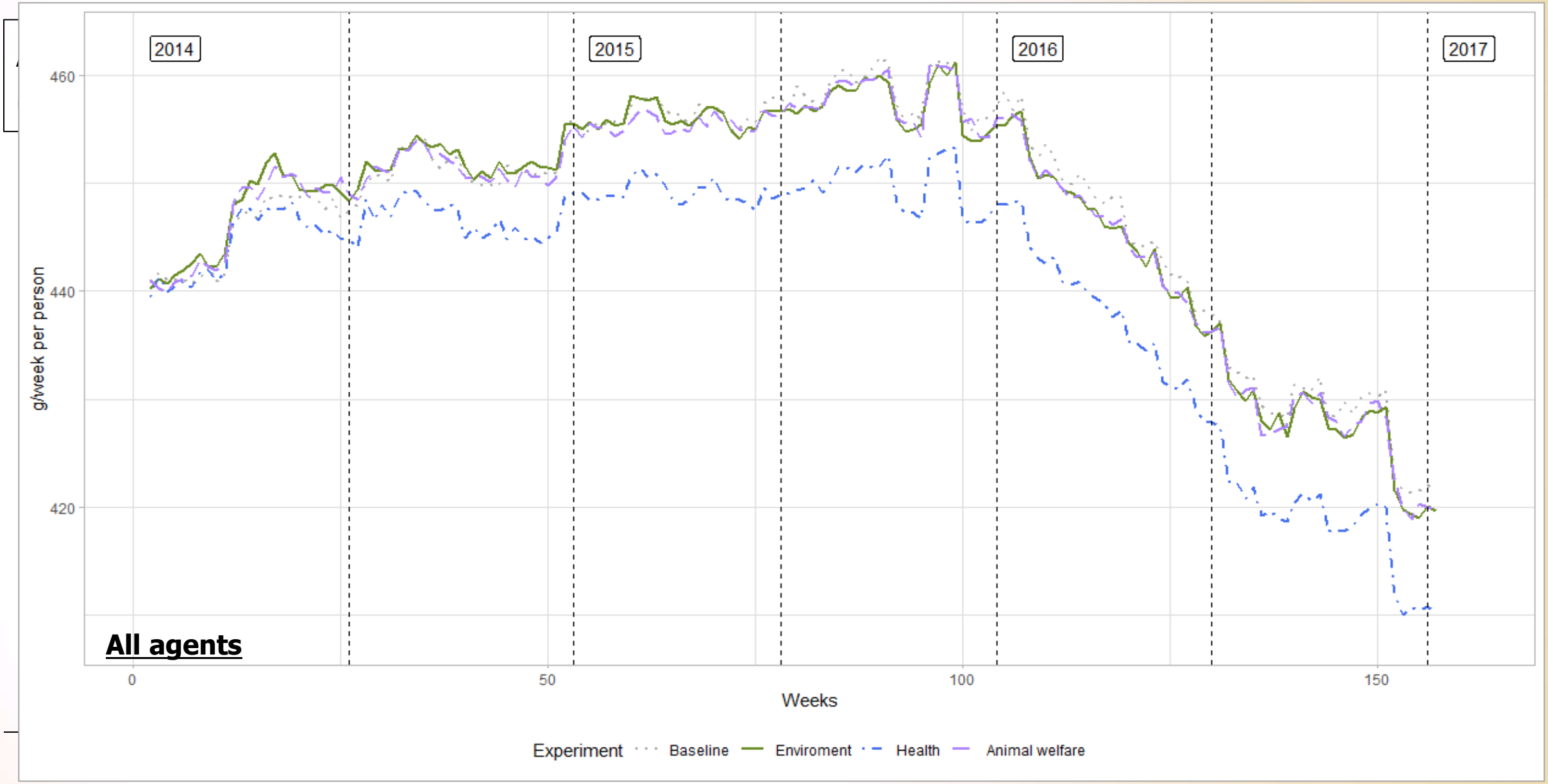

What works best? (2)

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A comparison between messaging about (A) environment, (B) health, or (C) animal welfare associated with meat consumption

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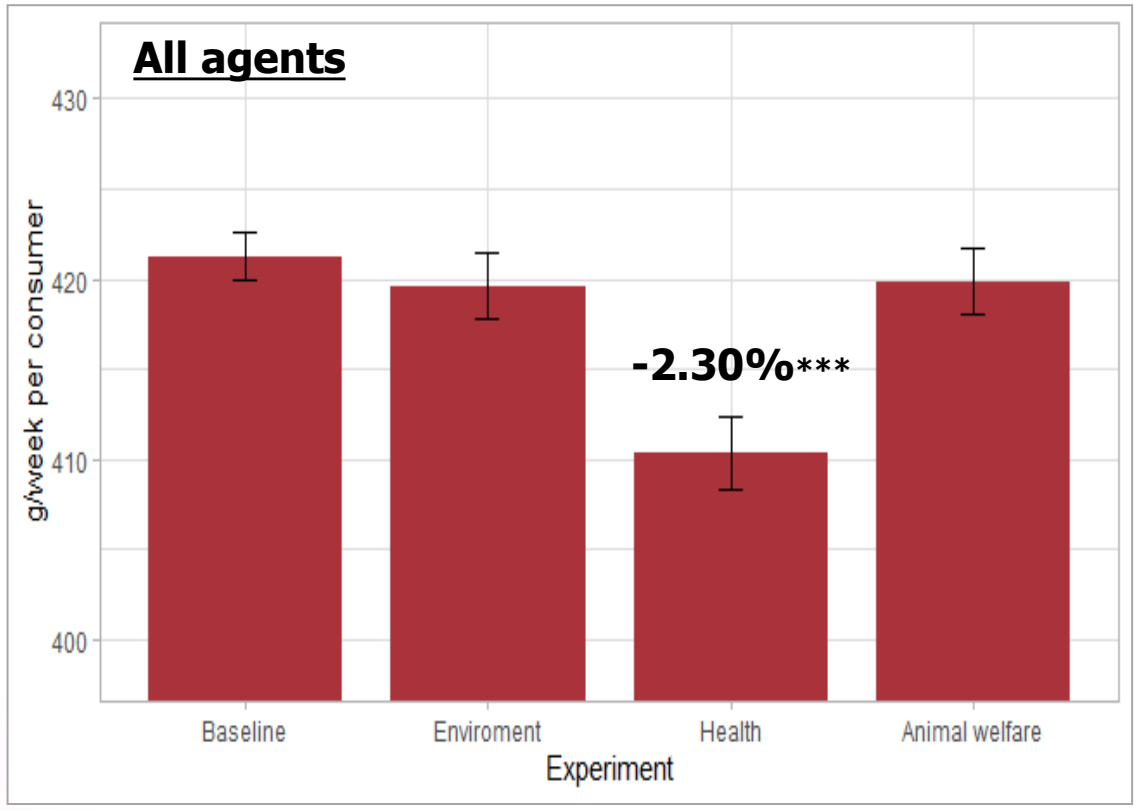

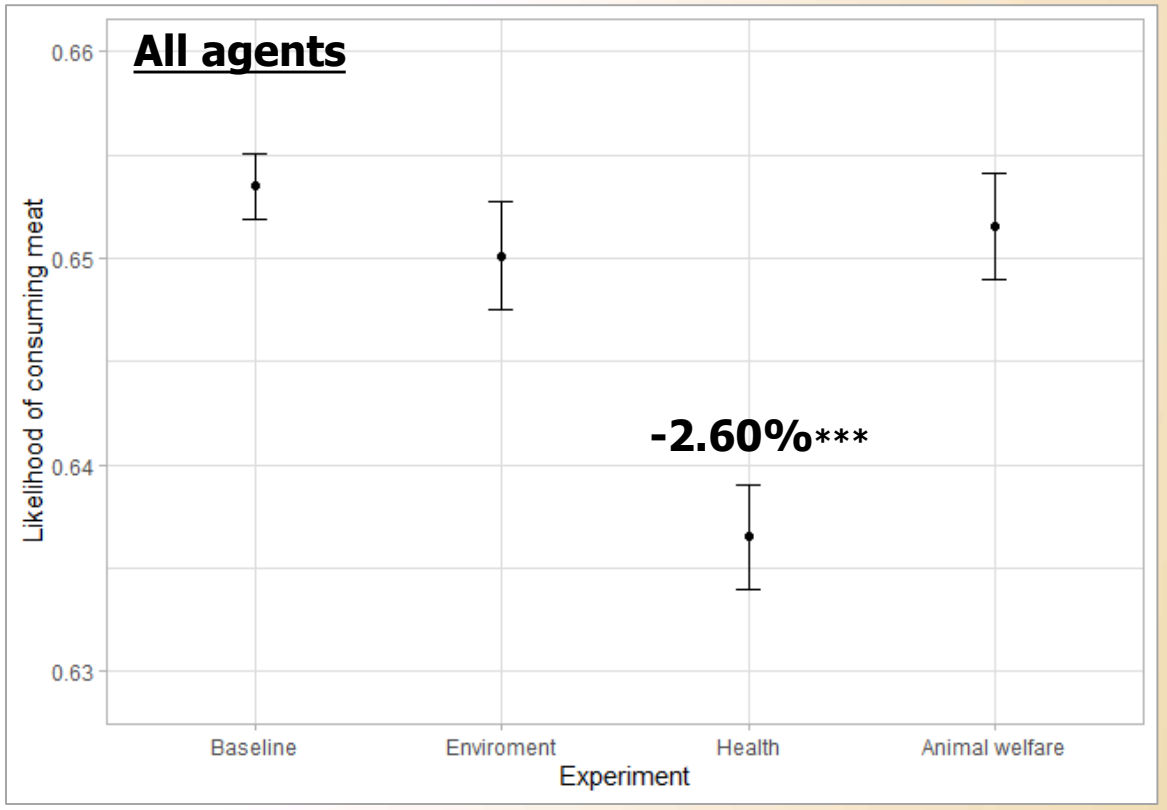

What works best? (3)

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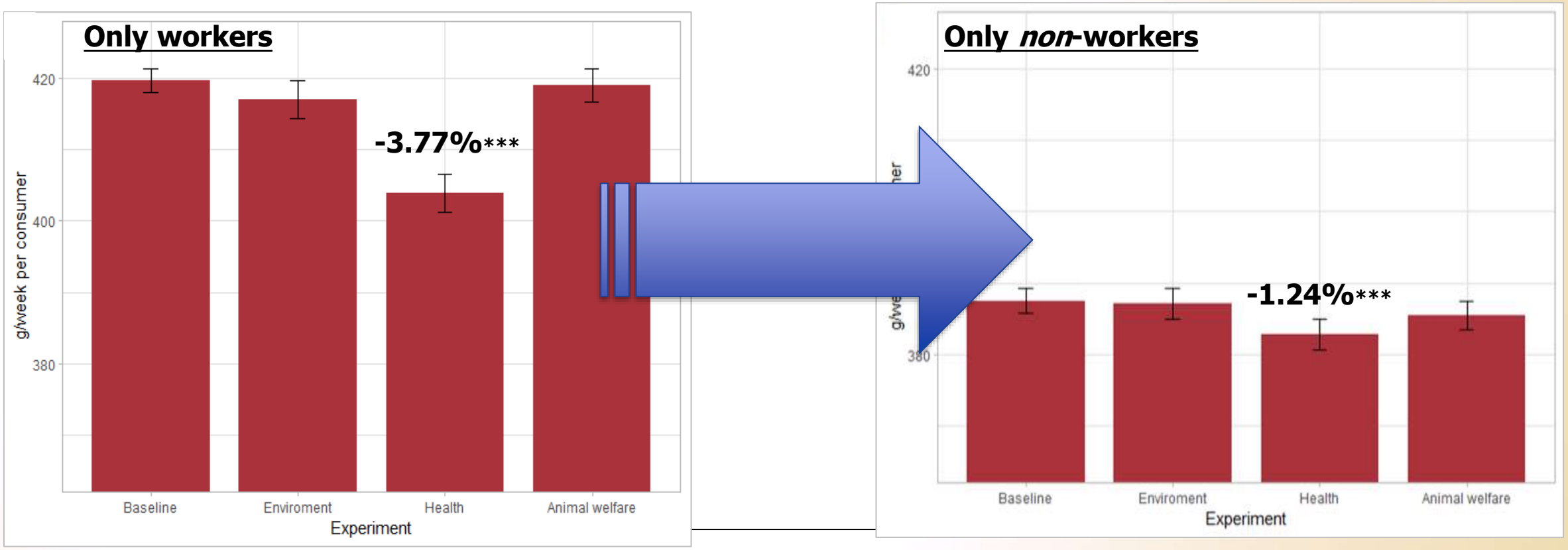
A comparison between messaging about (A) environment, (B) health, or (C) animal welfare associated with meat consumption

For instance, "*most people think that eating meat is bad for the environment*"



Undesired effects (1)

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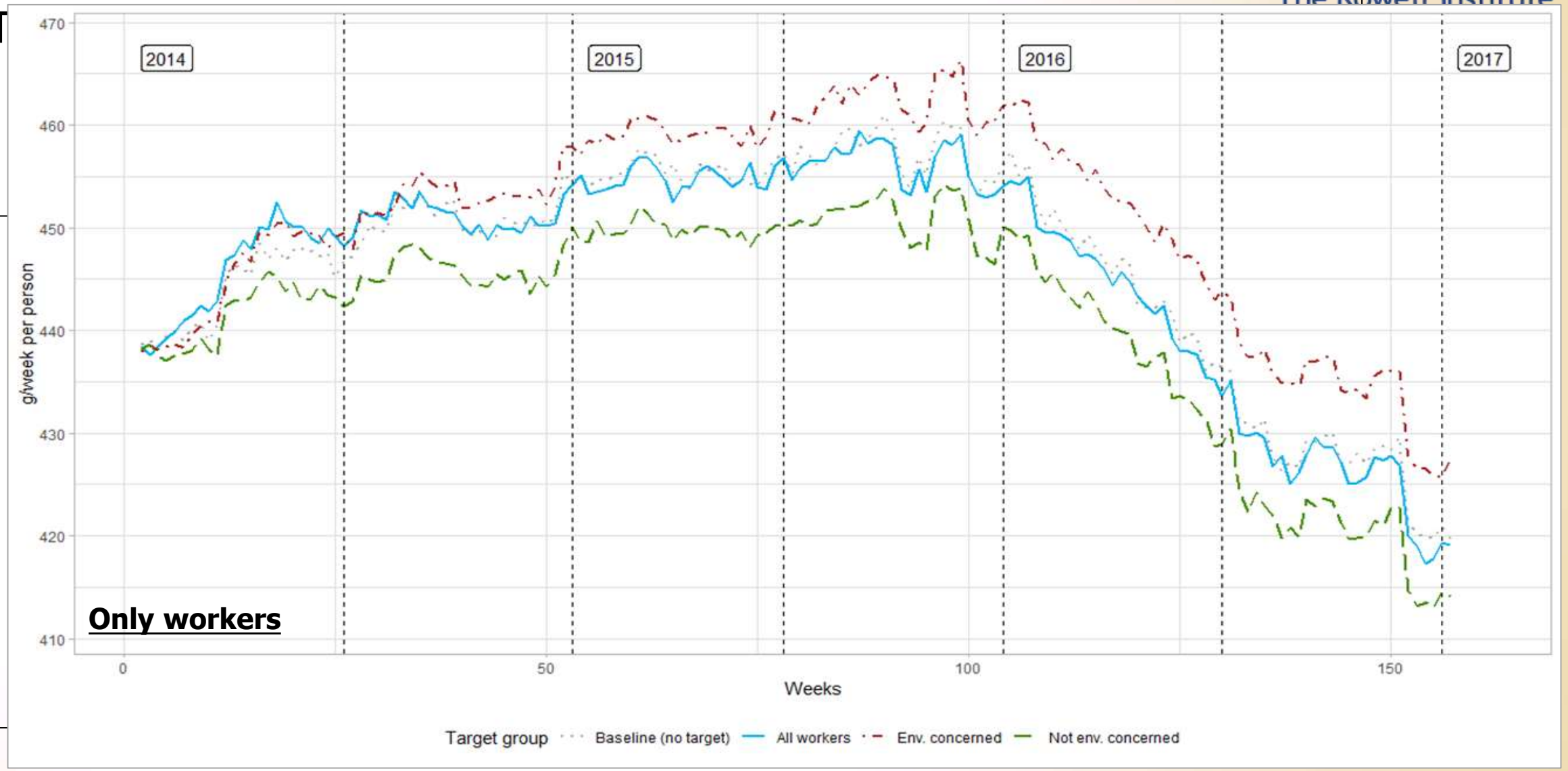
The same (environmental) intervention targeted to different groups:

A. all workers
B. workers with *low* concern for the environment (~7% of workers)
C. workers with *high* concern for the environment (~9% of workers)

Undesired effects (1)



Undesired effects (2)

The same (environmental) intervention targeted to different groups:

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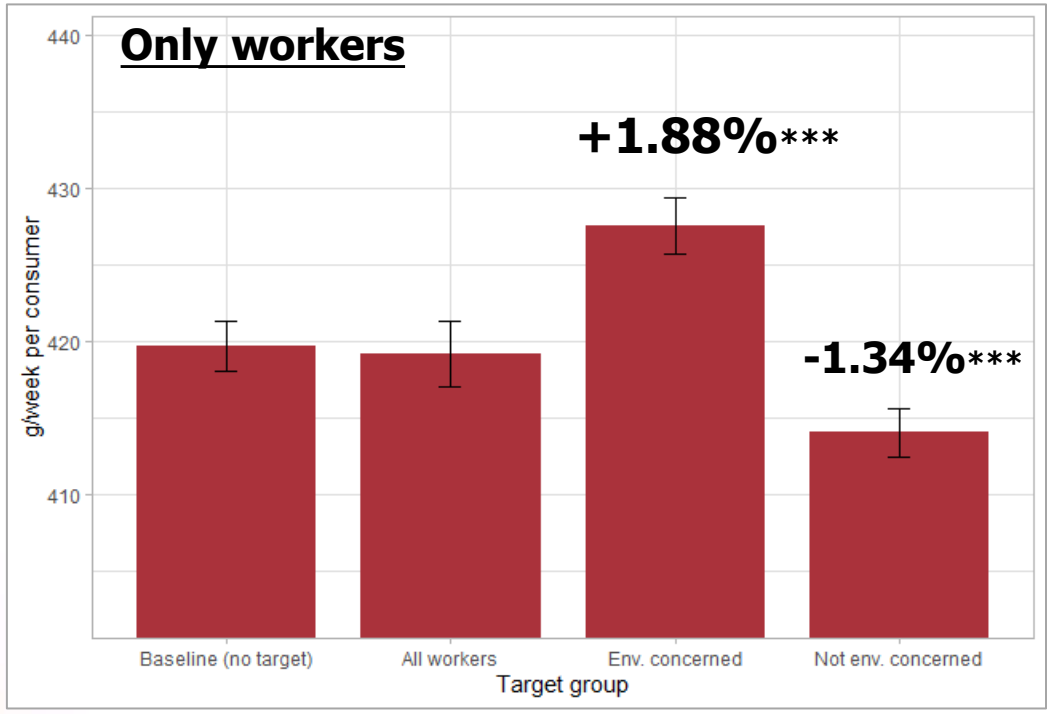
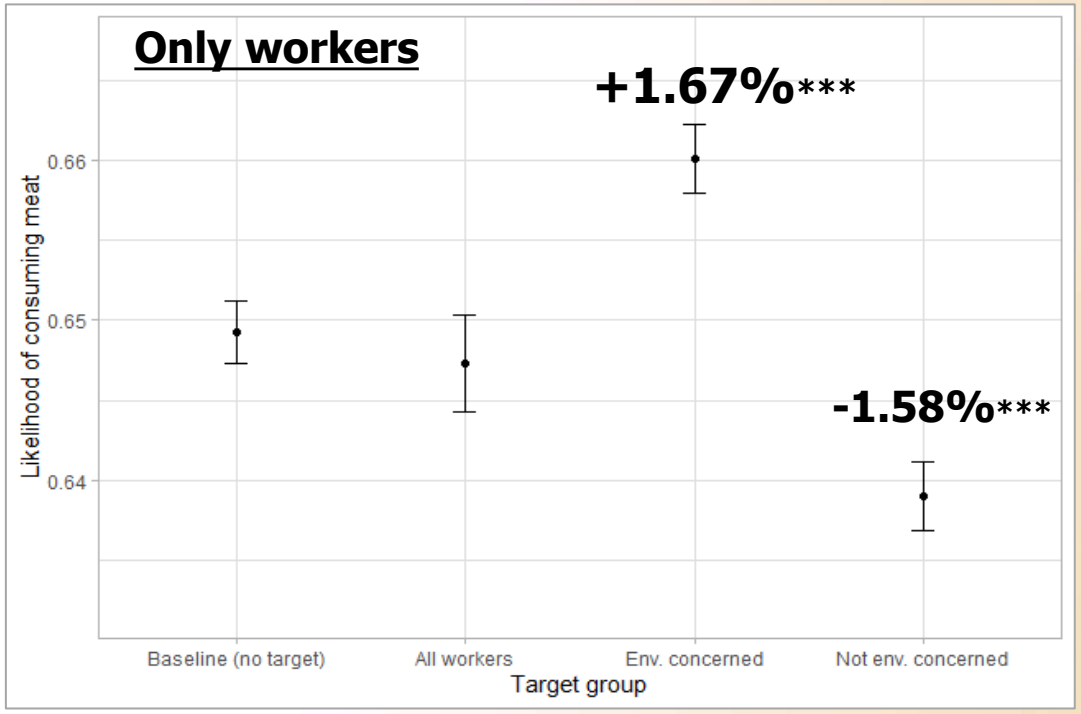
B. workers with *low* concern for the environment (~7% of workers)
C. workers with *high* concern for the environment (~9% of workers)





Conclusions and future research

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- The results suggest that focusing on **health** rather than environment or animal welfare could be the best approach to reduce meat consumption.

- Workers could affect household members in a positive manner.
  The simulation showed has the potential emergence of "**social spillover"**.

- Targeting the wrong groups of workers could result in potential **undesired effects**.

[1]

Conclusions and future research

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Main limitations

- We did not included children influence on adults' food choices.
- The interventions accurately targets all workers within the hypothetical organization with specifics characteristics (e.g. a certain age range): this might be harder to achieve in the real-world.

We expect the results from the simulation will **inform the development of real-world interventions** in the next few years of research.

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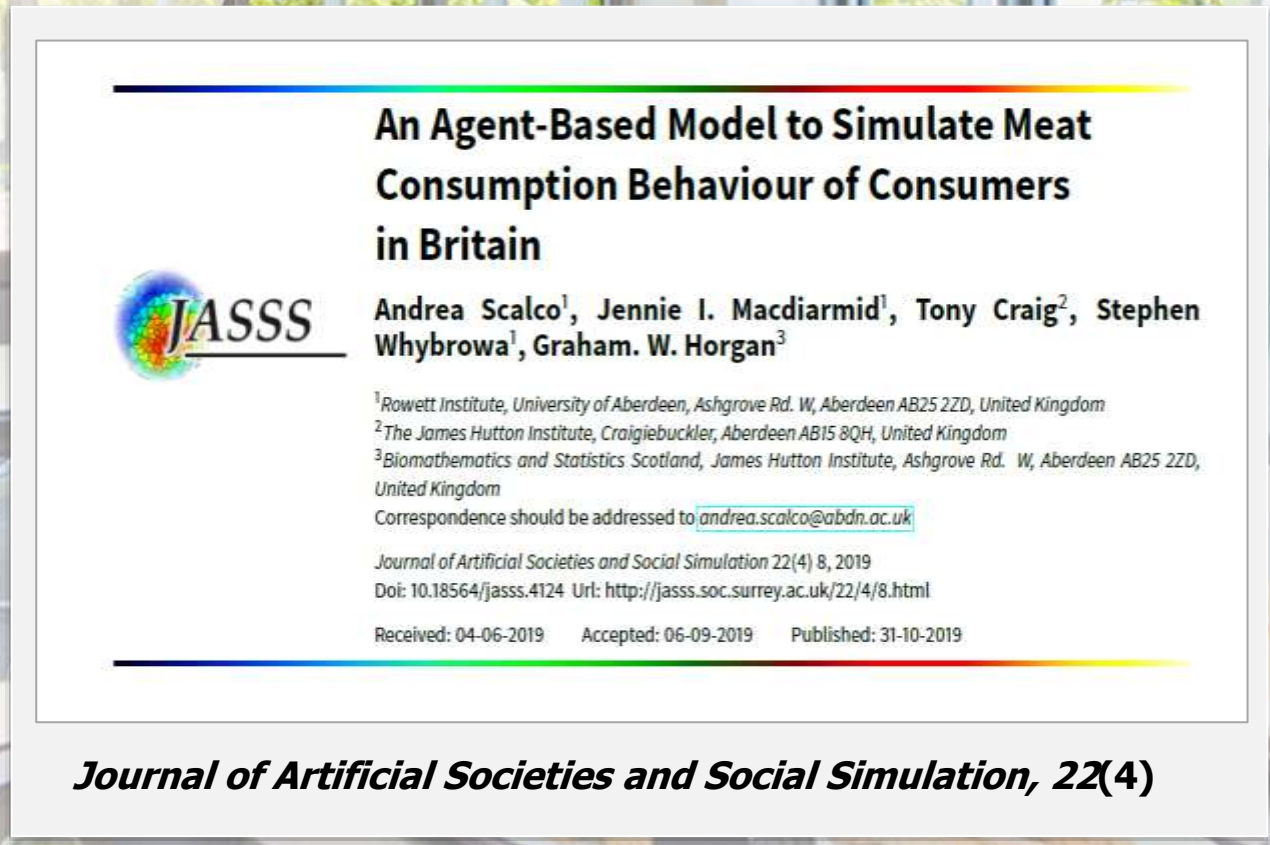
Thank you

Contact: andrea.scalco@abdn.ac.uk

All questions are welcome



An Agent-Based Model to Simulate Meat Consumption Behaviour of Consumers in Britain

JASSS

Andrea Scalco[1], Jennie I. Macdiarmid[1], Tony Craig[2], Stephen Whybrow[1], Graham. W. Horgan[3]

[1]Rowett Institute, University of Aberdeen, Ashgrove Rd. W, Aberdeen AB25 2ZD, United Kingdom
[2]The James Hutton Institute, Craigiebuckler, Aberdeen AB15 8QH, United Kingdom
[3]Biomathematics and Statistics Scotland, James Hutton Institute, Ashgrove Rd. W, Aberdeen AB25 2ZD, United Kingdom
Correspondence should be addressed to andrea.scalco@abdn.ac.uk

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