Modelling Individual Protective Decisions within an Influenza Epidemic

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The TELL ME Project

The European funded TELL ME project (Transparent communication in Epidemics: Learning Lessons from experience, delivering effective Messages, providing Evidence) is intended to provide advice about communication in response to influenza pandemics. Outputs from the project focus on effective communication, include a communications guide and online training to assist health authorities and health professionals to effectively provide information and advice. This is based on work already conducted by the project to collect evidence on attitudes concerning vaccination and non-vaccination behaviours, communication needs of health professionals, the role of social media, and other relevant issues.

The output presented here is the **simulation model**, which is to assist health agencies to compare the effect of different communication plans. It is currently under development and is expected to be released in January 2015.

Further information: **www.tellmeproject.eu**

Two Connected Submodels

Agent based model of behaviour: Simulated individuals make decisions to vaccinate or to adopt (or cease) protective behaviour such as hand hygiene or social distancing.

System dynamics model of epidemic: The country map is divided into grid cells, each of which tracks the number of people in different epidemic states (susceptible, exposed, infectious, removed).

Individuals → epidemic: Each grid cell is home to several (or many) simulated individuals. Their behaviour is considered representative of the population in the grid, and the force of infection (in the system dynamics model) is reduced according to the proportion adopting protective behaviour and the efficacy of that behaviour.

Epidemic → individuals: Simulated individuals consider the number of new nearby epidemic cases when making decisions about protective behaviour.

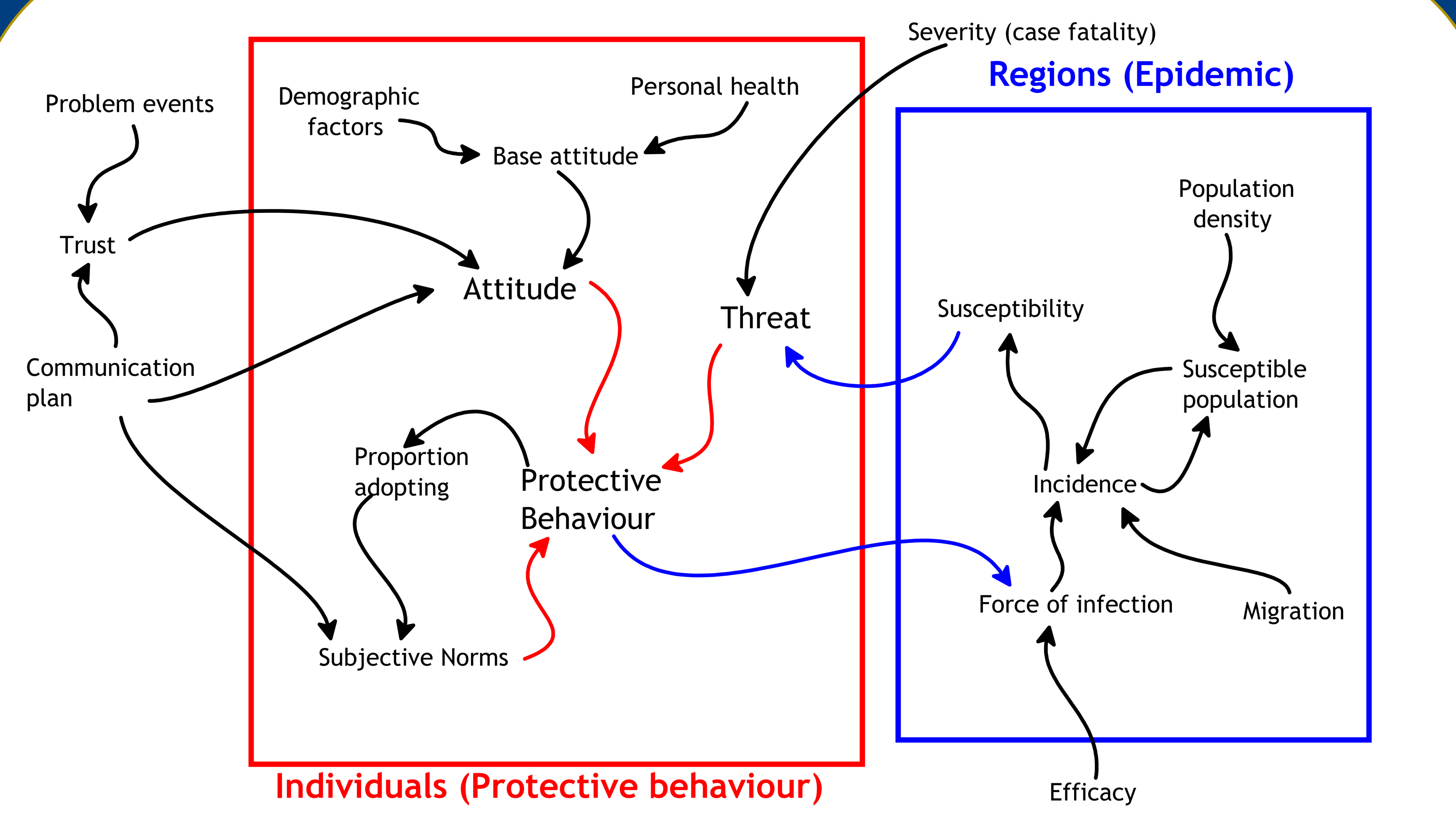
Model Logic

Agent based model: behaviour

At the start of the simulation, attitude scores (in [0,1]) are randomly allocated, recognising that attitude depends on demographic, perceived health, and other factors.

The individual adopts protective behaviour if the weighted average of attitude, perceived norms and perceived risk is higher than the threshold. Norms is the proportion of nearby individuals who have adopted protective behaviour. Risk is the cumulative nearby incidence, discounting older cases.

Communication plans are entered as sets of messages. Each message is described with a simplified language that details the media channel, target group, and other properties. These messages change attitude or other behaviour influences for simulated in-target individuals exposed to the message.



Major influences in the model behaviour rules. The red box contains the agent based model of individuals and their protective behaviour, and the blue box contains the spatial difference equations model of epidemic spread.

System dynamics model: epidemic

Standard SEIR difference equations

$$\frac{dS_r}{dt} = -\beta_r S_r I_r$$

$$\frac{dE_r}{dt} = \beta_r S_r I_r - \lambda E_r$$

$$\frac{dI}{dt} = \lambda E_r - \gamma I_r$$

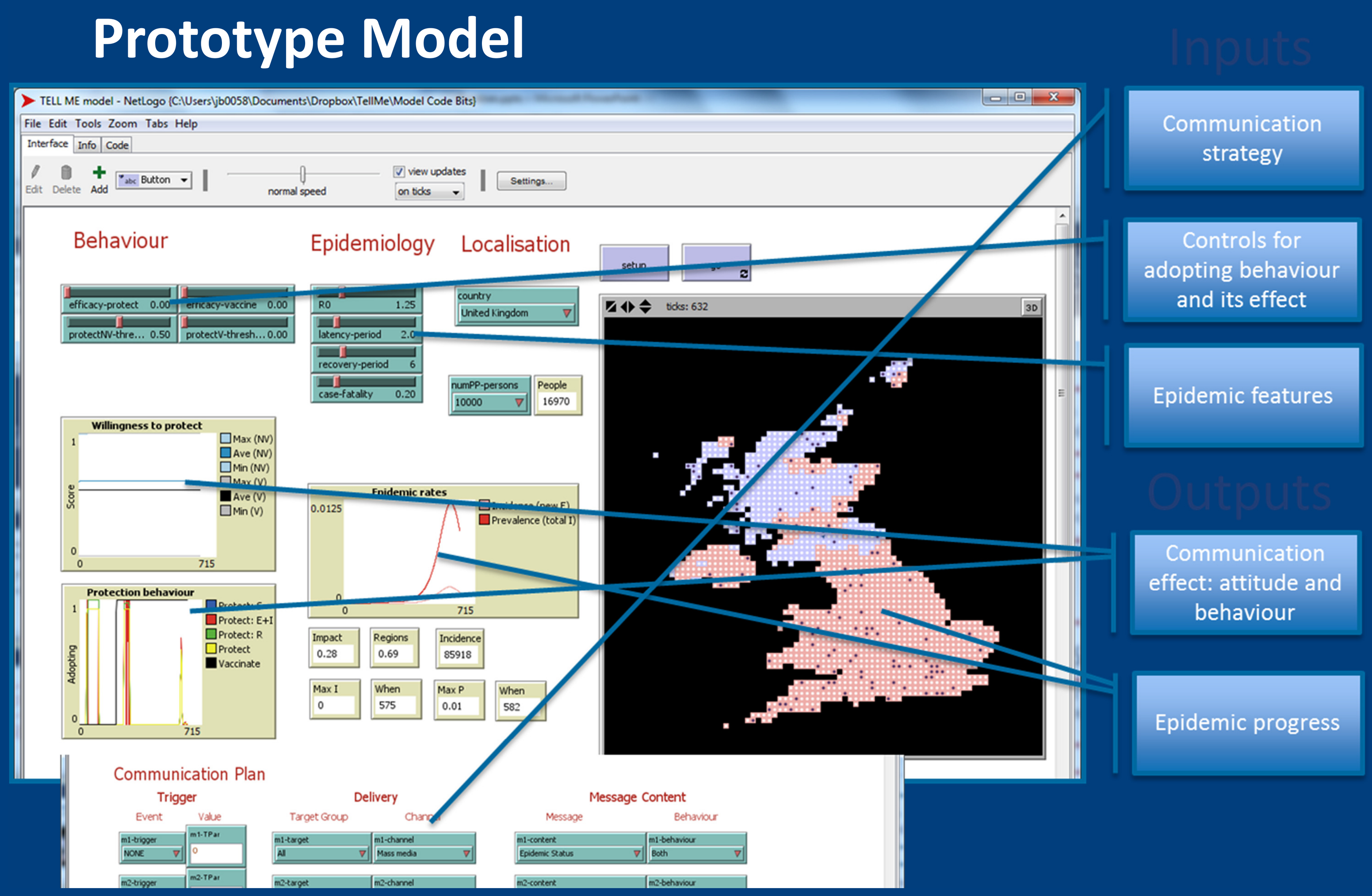
$$\frac{dR}{dt} = \gamma I_r$$

Some proportion of new infections in each grid cell are created at other locations, to represent mobility.

Infectivity is adjusted to reflect the proportion of local agents who have adopted protective behaviour and the efficacy of that behaviour.

$$\beta_r = \beta(1 - P_r e)$$

Prototype Model



In practice, the model **cannot be calibrated** with available datasets.

- Large number of parameters:
  - Communication effect: trust, attitude adjustment, duration, ...
  - Behaviour model: weights, incidence discount, adoption thresholds, ...
- Limited data
  - need longitudinal so behaviour can be related to epidemic progress
  - data specific to infection (SARS, H1N1...), type of behaviour (vaccination, hand hygiene, face masks...) and culture.

Conclusion

There are excellent epidemic models that include detailed movement patterns and other important factors in epidemic progression. Some of these models also allow basic assumptions about behaviour such as social distancing. However, the TELL ME model is the first to link three inherently connected components of the system of an influenza epidemic:

- Communication
- Personal protective behaviour
- Epidemic progress

The TELL ME prototype model will be available January 2015, with user manual, scenarios and other supporting documentation.

The prototype will assist planners to assess the implications of their understanding of effective communication in epidemic management. It implements that understanding in a formalised thought experiment that allows planners to explore scenarios and more deeply understand the complex and dynamic connections between communication and personal behaviour during an epidemic.

In the medium to long term, if predictive models are to be useful for communication planning, more and different data must be collected before, during and after epidemics. This prototype can guide the necessary data collection.

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