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A Simple Model of Anxiety in Students

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Section 1

About the Model

Motivation and modelling goal

- Theories of anxiety in the psychological literature are often ill-defined, overlap and are difficult to distinguish in many situations
- Here we make precise versions of 3 of these
- RQ: *what is the impact of these approaches for modelling anxiety on the behaviours of the agents and on global system dynamics?*
- This is a theoretical exploration to see what the consequences of *these + a particular model structure* are

3 paradigms for anxiety

(In the context of uncertainty about outcomes that matter to the individual) the literature includes 3 kinds of hypothesised anxiety mechanisms:

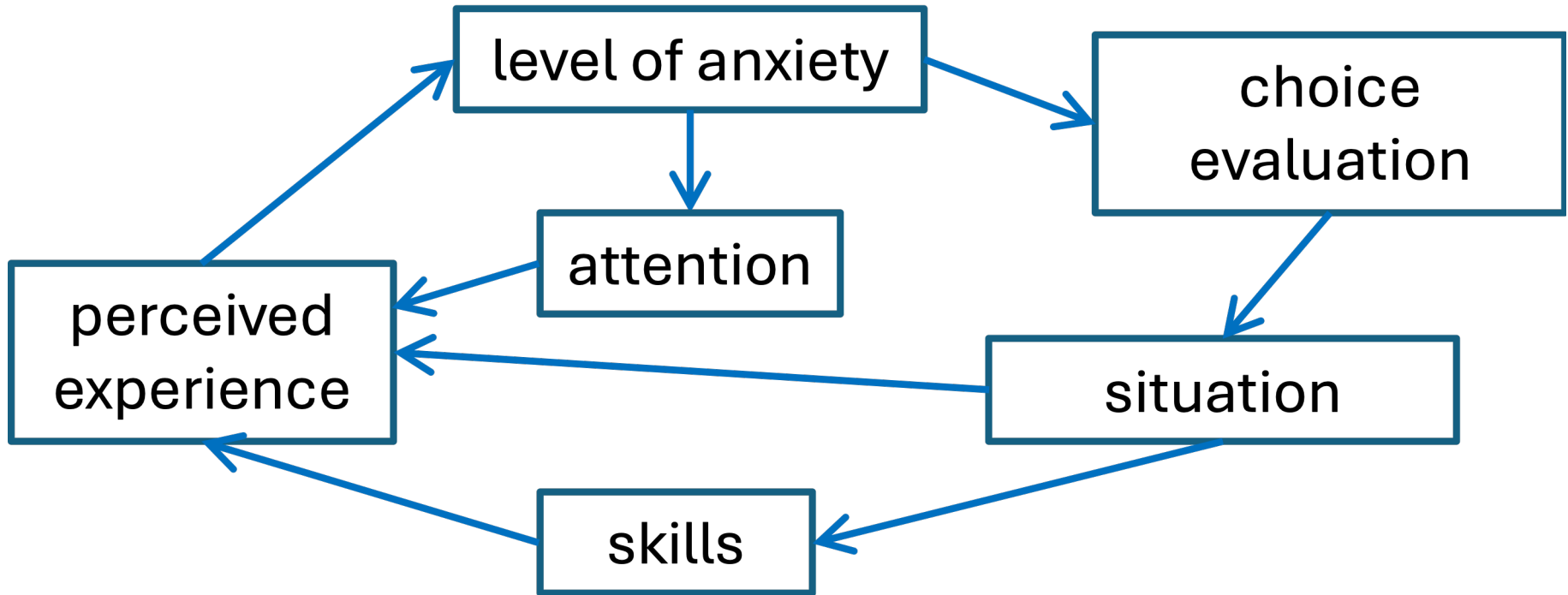
1. **Risk-focused / pessimistic paradigm** – *expect the worst outcome*
2. **Functional/problem-focused mechanism** – *avoid uncertainty*
3. **Emotion-focused coping mechanism** – *avoid anxiety itself*

(see also the UAMA model and Carvalho & Vanhée 2025)

In the model...

- Each agent has a level of anxiety represented as a number between 0 (none) and 1 (very high)
- This level affects the chances of interpreting their experiences in a normal or anxious manner...
- ..when they look back at the (finite) memory of their experiences that resulted from past actions
- Which can result in making different decisions
- The only (*non-randomised*) difference between agents is in how much this level increases as the result of a bad experience (their fixed: *anx-inc*)

Causation within agents



Crucially, this allows for causal loops for an agent:

low anxiety → engage socially

→ develop social skills

→ do not experience 'bad' outcomes → low anxiety

The model environment/structure

- Very simplified! 🤪
- Only two decisions made each day:
 - *Go to school* or not (on days when there is school)
 - *Socialise* or avoid others
- Resulting in 4 kinds of situation
- Plus: school term temporal structure

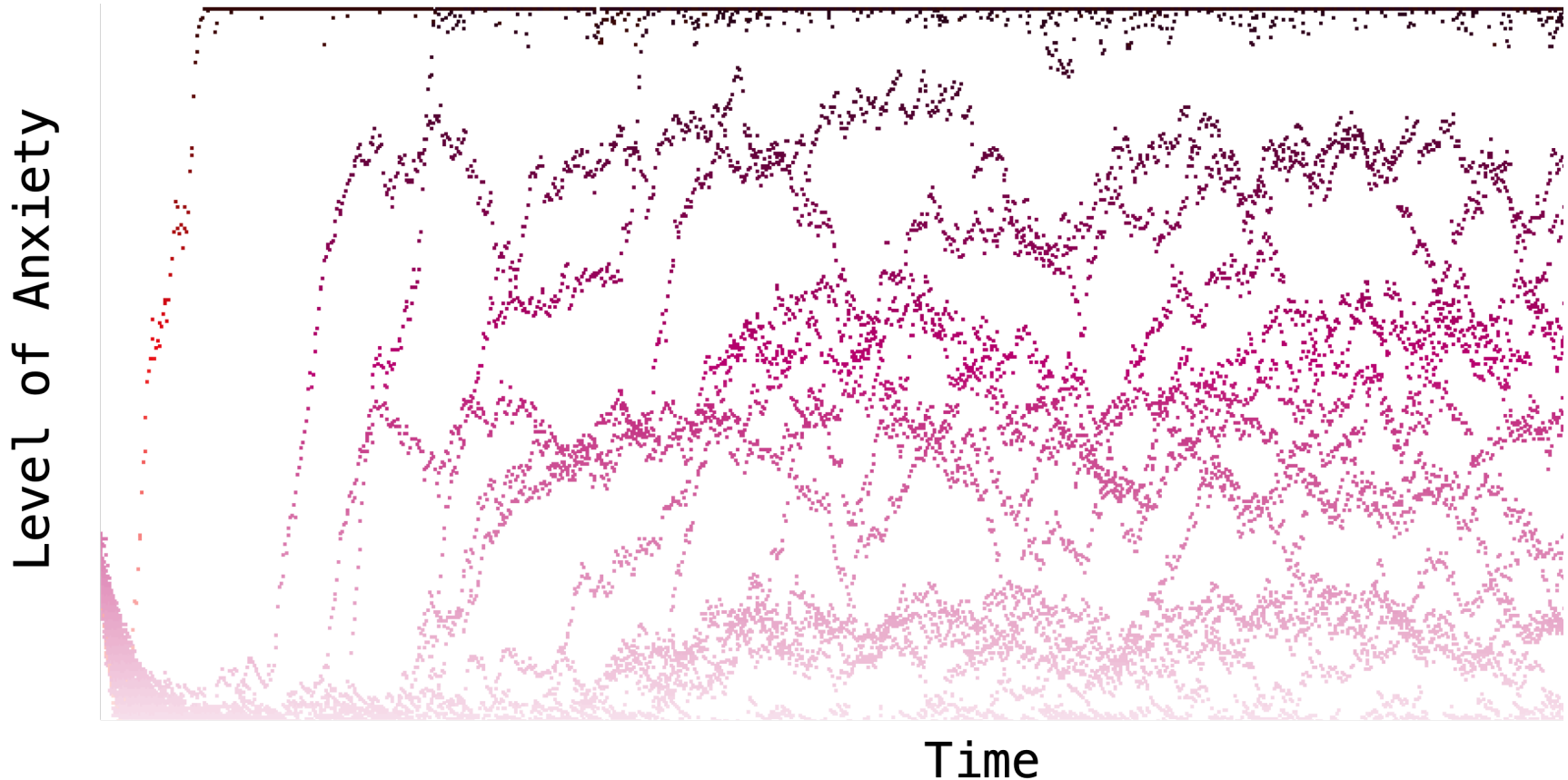


Light-dark is level of anxiety
Colour is anx-inc

Section 2

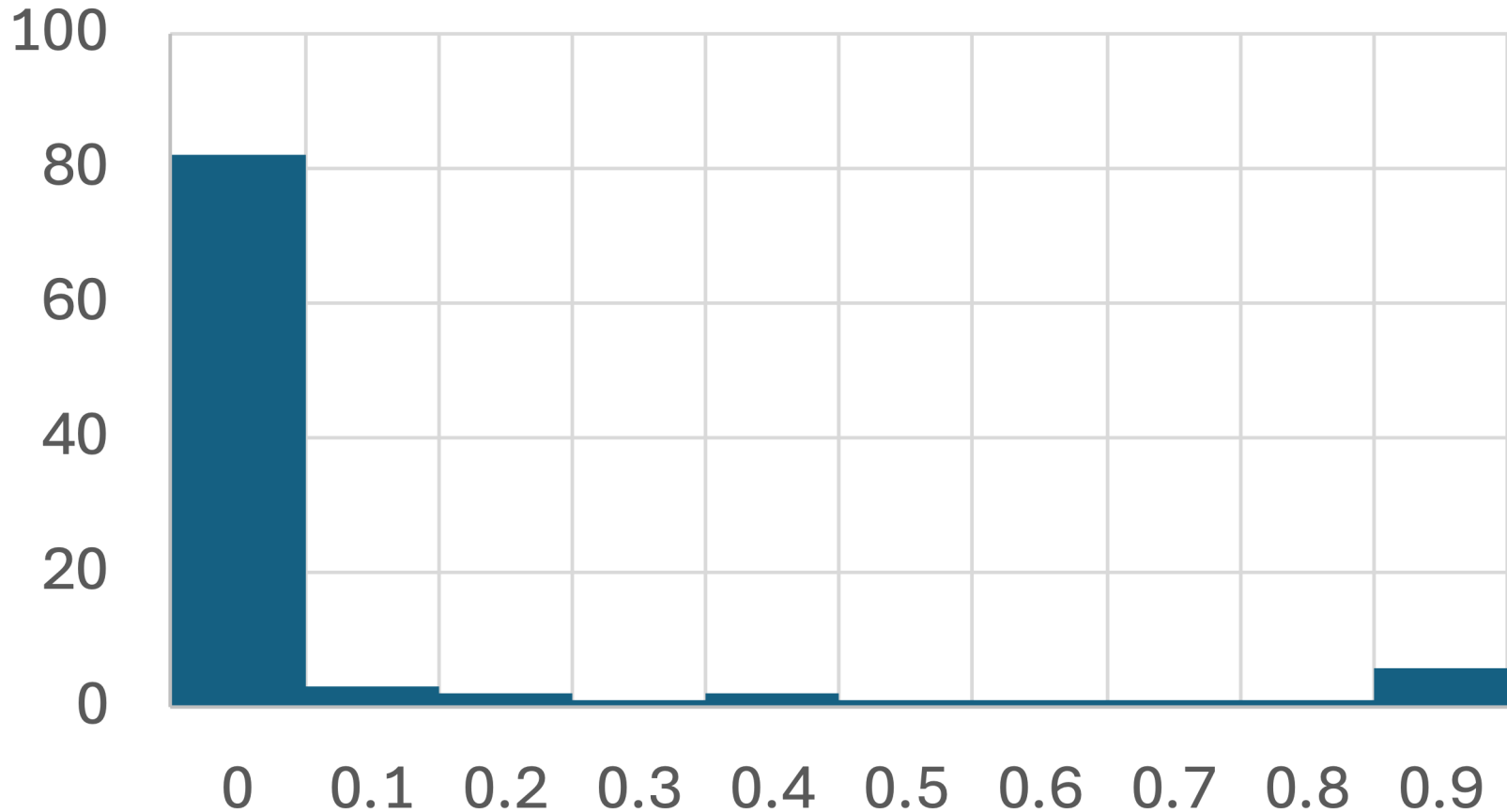
An single illustrative run

Example run – level of anxiety in each student over time



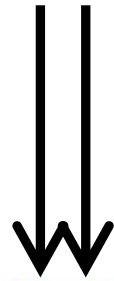
Whilst anxiety level in most agents drops down to low levels, some students become and stay anxious

Example run – levels of anxiety at end of simulation

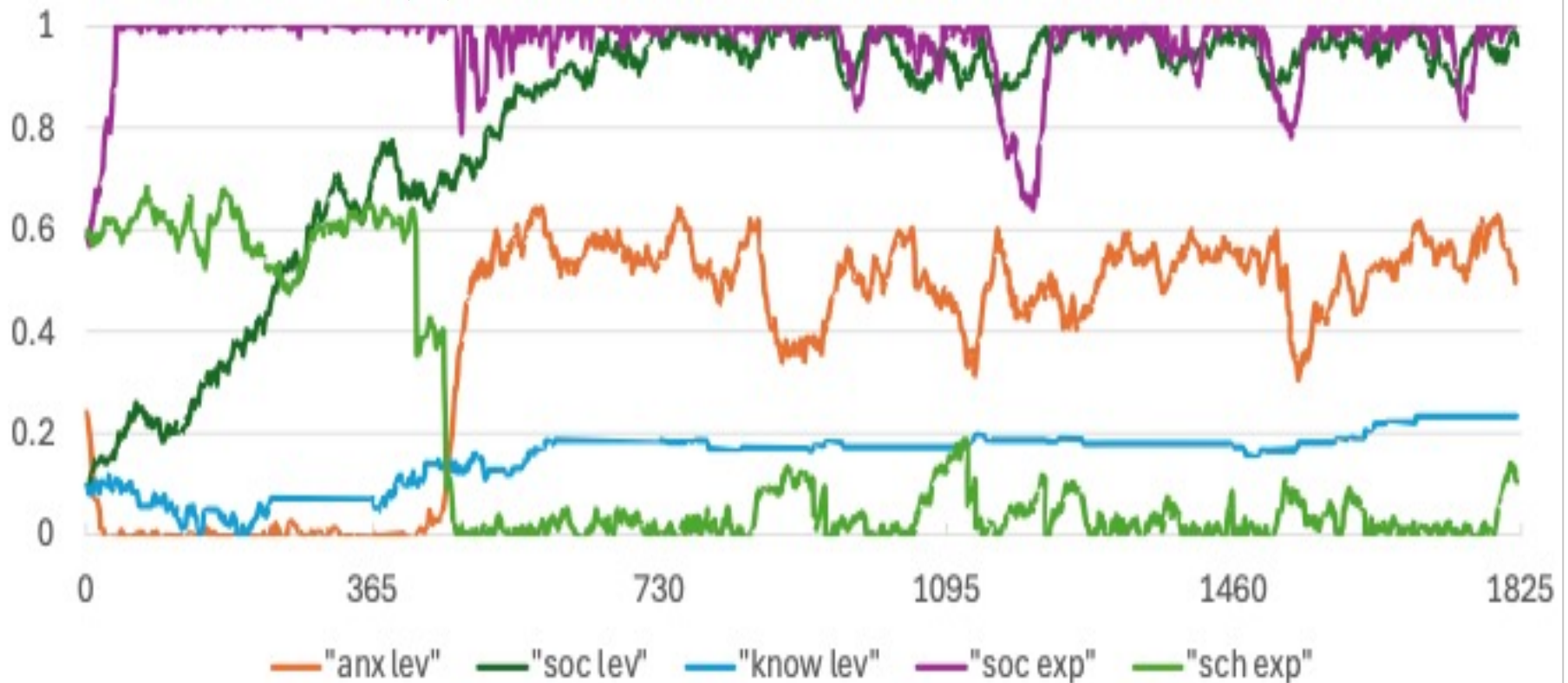


Result: most students develop to not be anxious, but a few get 'stuck' in high anxiety states

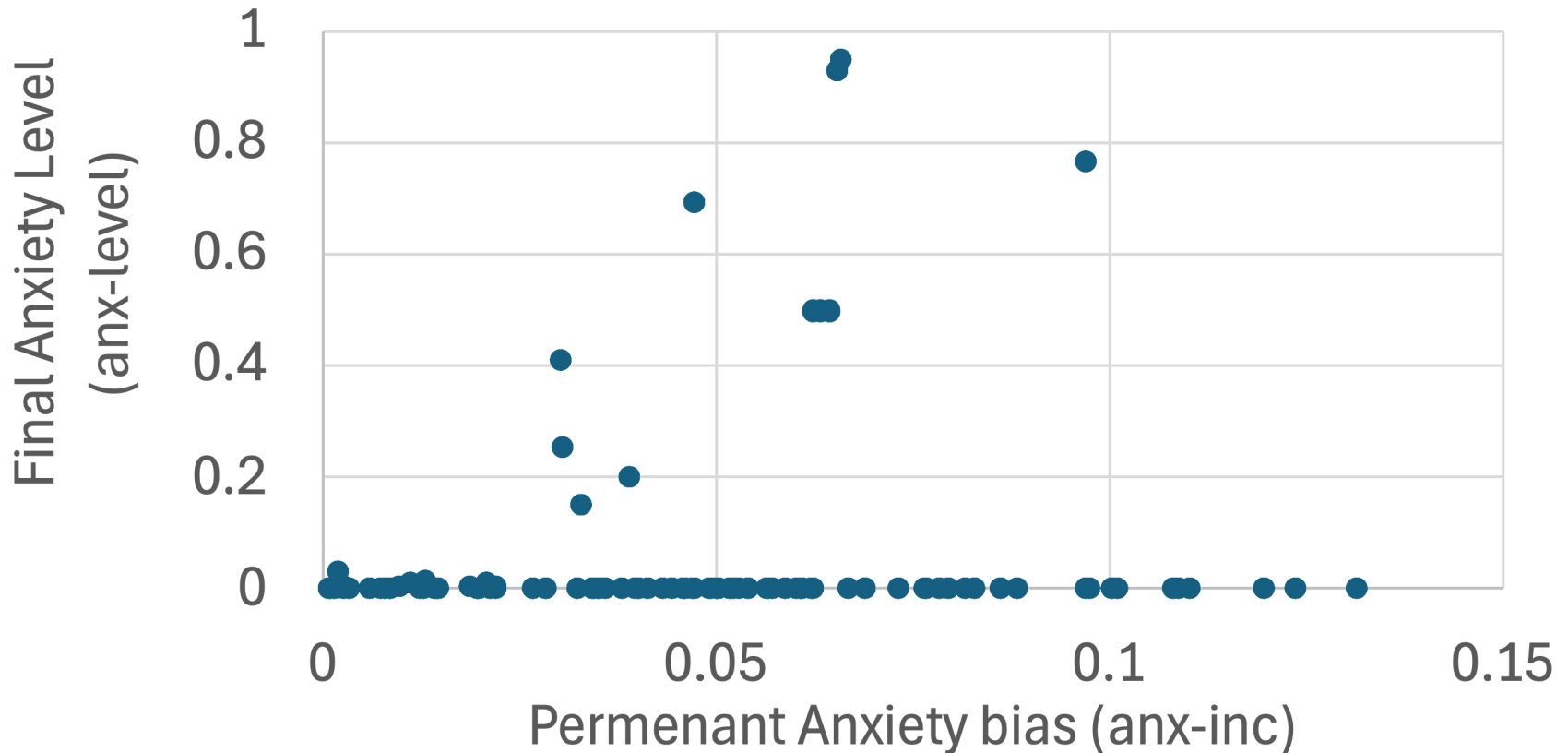
Example run, single agent – various levels over time



Bullying incidents



Example Run: But final anxiety level is not rigidly linked to their inbuilt anxiety bias

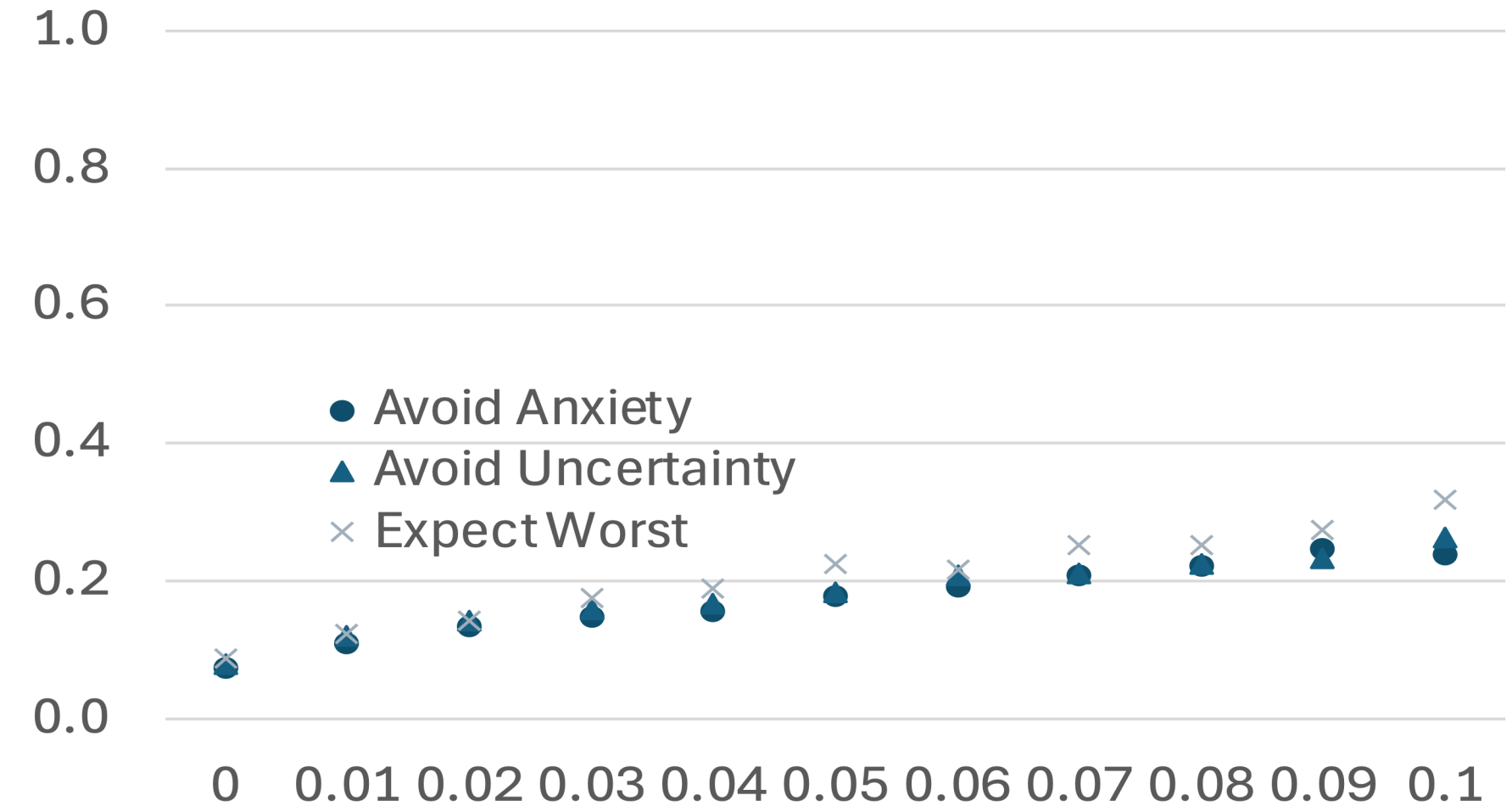


Some agents with a high anxiety bias do not get 'stuck' in a high anxiety state, but a low anx-inc makes this unlikely to happen

Section 3

Comparing the 3 mechanisms over many runs

3 versions of anxiety – *final average anxiety levels (y-axis) on levels of bullying (x-axis)*



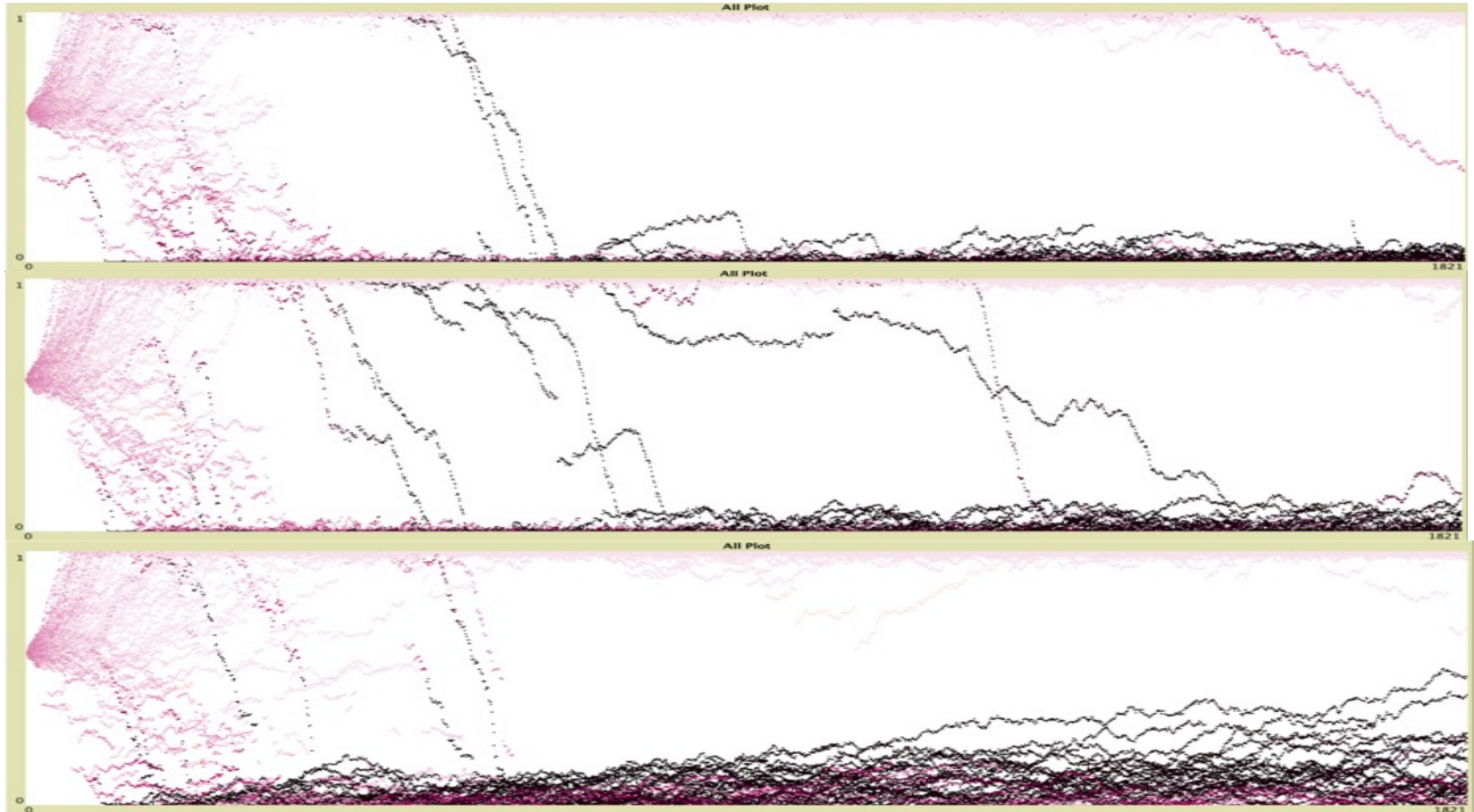
In many settings, it is difficult to distinguish the impact of different anxiety mechanisms

3 versions of anxiety – *final average* *socialising proportions on levels of bullying*



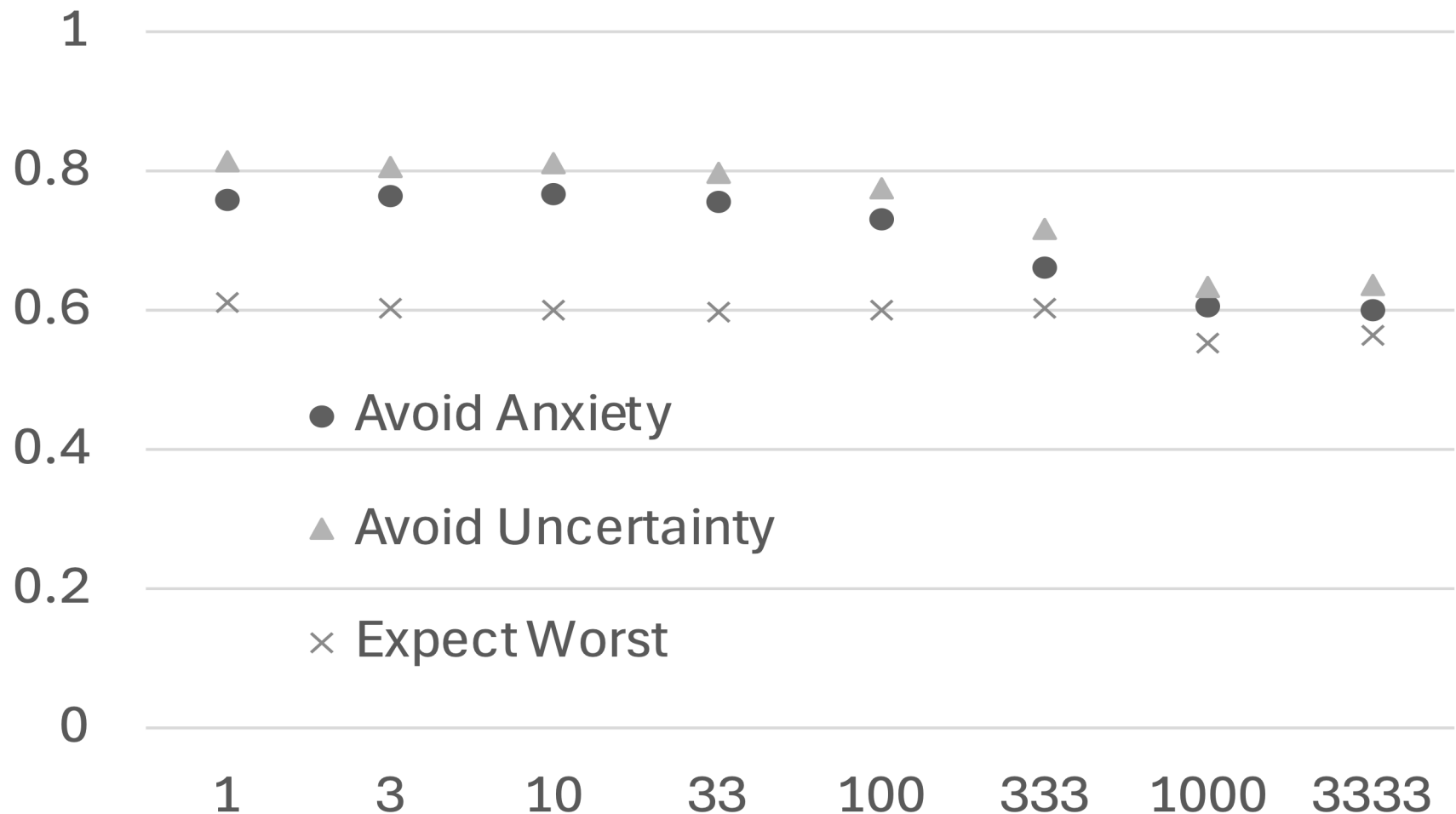
But in some aspects & settings you can

3 versions of anxiety – social experience in 3 example runs (y-axis) – with some bullying



(Top) “Avoid Anxiety”, (Middle) “Avoid Uncertainty”
and (Bottom) “Expect Worst”

3 versions of anxiety – *final average socialising proportions on memory length*



Shorter memory allows agents to sometimes reset back into socialising again

Conclusions

- First simulation that makes different anxiety theories precise and systematically compares them
- Most agents flourish, but some get stuck in a self-reinforcing high-anxiety cycle which can be triggered by bullying in this model
- This necessarily involves both cognitive and social parts – it is a socio-cognitive system (Dignum et al. 2022)
- Having an inherent bias towards anxiety does not predetermine agents to develop high anxiety
- In many settings there is little difference in effect between the 3 mechanisms...
- ...but in some situations that tend to cause anxiety, one can distinguish between them, especially “expect worst”



The End!



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These slides at: <http://cfpm.org/slides>
as 'Anx-Model-SSC2026.pdf'

The model, docs, etc. are at: <https://shorturl.at/LP6yR>
(or find it on CoMSeS.et)

Bruce Edmonds' Publications:
<http://cfpm.org/~bruce/pubs.html>

Loïs Vanhée: <http://umu.se/en/staff/lois-vanhee/>

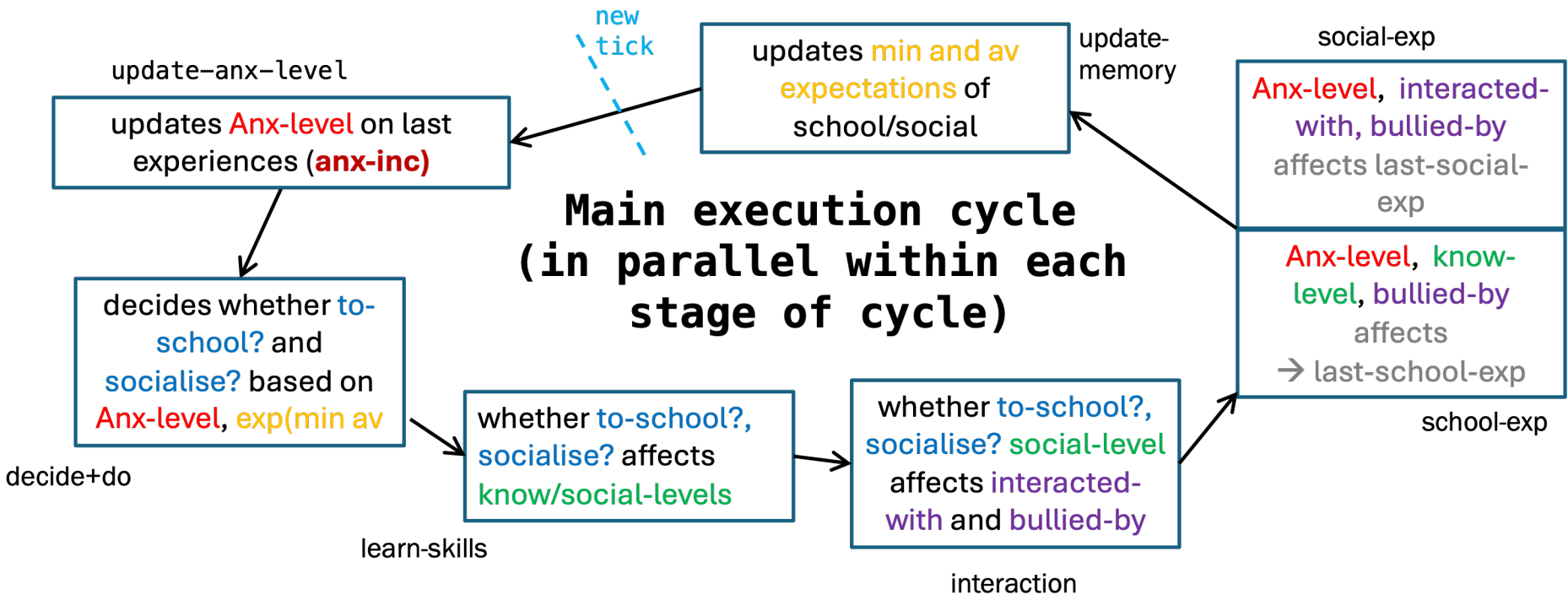
Some Key References

Dignum, F., Edmonds, B. & Carpentras, D. Socio-Cognitive Systems – A Position Statement. Review of Artificial Societies and Social Simulation, 2nd Apr 2022. <https://rofasss.org/2022/04/02/scs>

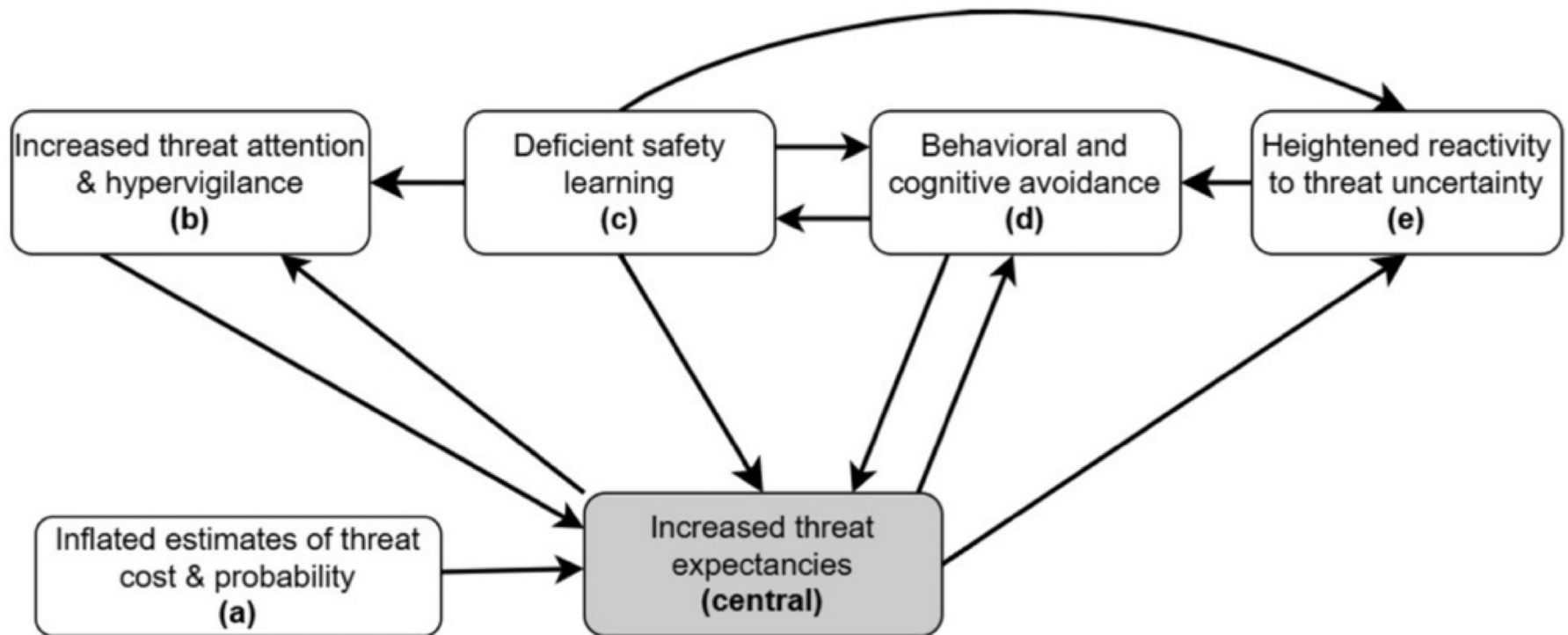
Carvalho, J. & Vanhée, L.. ABM of anticipatory anxiety: Theoretical foundations and application on bullying. Social Simulation Conference 2025, Delft, (2025).

Grupe, D.W., & Nitschke, J.B. Uncertainty and anticipation in anxiety: an integrated neurobiological and psychological perspective. *Nature Reviews Neuroscience*, 14(7), 488–501, (2013).

The main execution cycle and agent variables



The UAMA model



Grupe & Nitschke 2013