BOUNCING BACK FROM ADVERSITY:
A NOVEL OUTLOOK ON PSYCHOLOGICAL RESILIENCE AND ITS INDICATORS FROM A COMPLEX SYSTEMS PERSPECTIVE

Gabriela Lunansky, Denny Borsboom Claudia van Borkulo, Laura Bringmann, Sanne Gijzel, Jessica Hartmann, Marieke Wichers & Angelique Cramer

Introduction

The question of why some people develop psychopathology following adversity, while others do not, has been extensively investigated in the psychological literature. An important question is what makes the latter group of people resilient, in that they are seemingly able to withstand 'attacks' that adverse events launch on their health and well-being. A new modeling approach conceptualizes mental disorders as dynamical systems that are driven by networks of interacting symptoms (Cramer et al., 2016). In an important subclass of networks, the way these symptoms are connected to each other (i.e., the *network structure*) determines the resilience of the mental health state. In this project, we study this question in the context of *Major Depressive Episode* (MDE).

Research question:
Can we evaluate the *resilience* of the network to MDE from the *structure* of the MDE symptom network?

Theoretical background: Studying resilience

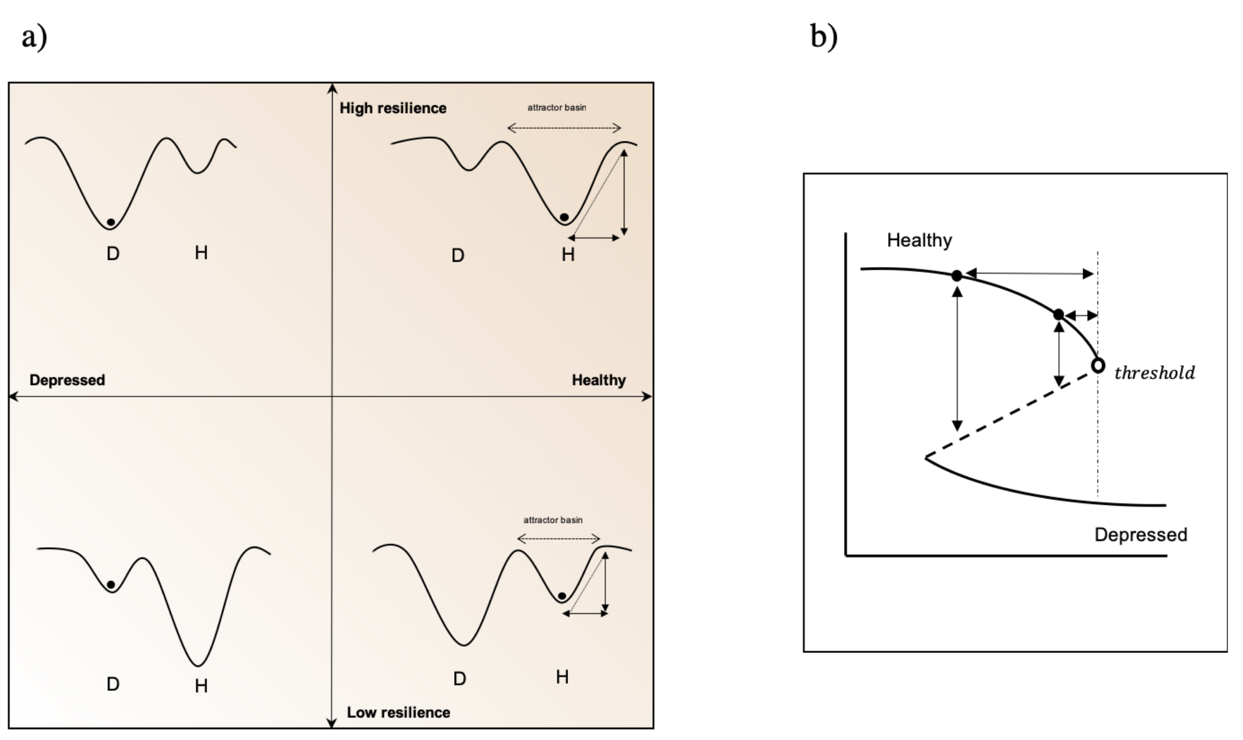

Figure 1: *The Resilience Quadrant.*
Graph (a) shows the Resilience Quadrant of a system representing mental health with two alternative stable states: healthy and depressed. Graph (b) shows the phase transition of the system, from the healthy state (upper trajectory) to the depressed state (lower trajectory).

- The fundamental idea of dynamical systems theory is that the functioning of a system over time can be mathematically formalized and represented in dynamical models.
- Dynamical systems often feature attractor states, which the system converges to. The stability of these attractor states indicates the resilience of the system.
  - If an attractor basin is wide, deep, and steep, the corresponding state is resilient. In contrast, an attractor basin which is narrow, shallow, and flat, features low resilience.
- We represent MDE in terms of a dynamical system with two alternative stable states: *healthy* and *depressed*. Both these states can be high or low in resilience, as represented in the *Resilience Quadrant* (Figure 1a).

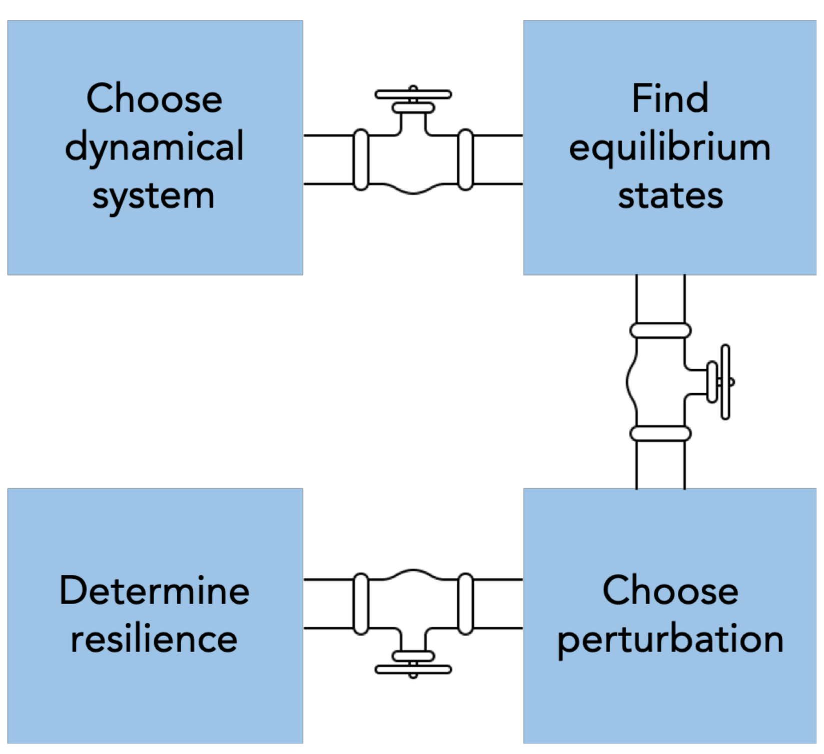

Figure 2: Generic interface for studying resilience
We propose a generic interface for studying resilience: once a dynamical system of interest is chosen, one can study its resilience by finding the equilibrium states the system converges to, do a perturbation analysis and determine an resilience indicator for this system.
In this way, one can study the resilience of the system as a function of its structure.

Equilibrium states

We use the Ising network model as dynamical system. To study the stable states of the network, 10 000 timepoints are simulated using Glauber dynamics (Glauber, 1963) for networks with varying connectivity levels:

- Networks with low connectivity are mostly in a non-depressed state (0 or 1 activated nodes).
- Networks with medium connectivity display higher variance in their dynamics: these networks are typically in a non-depressed state but sometimes spike to a fully depressed state
- Networks with strong connectivity are typically in a fully depressed state (8 or 9 activated nodes).

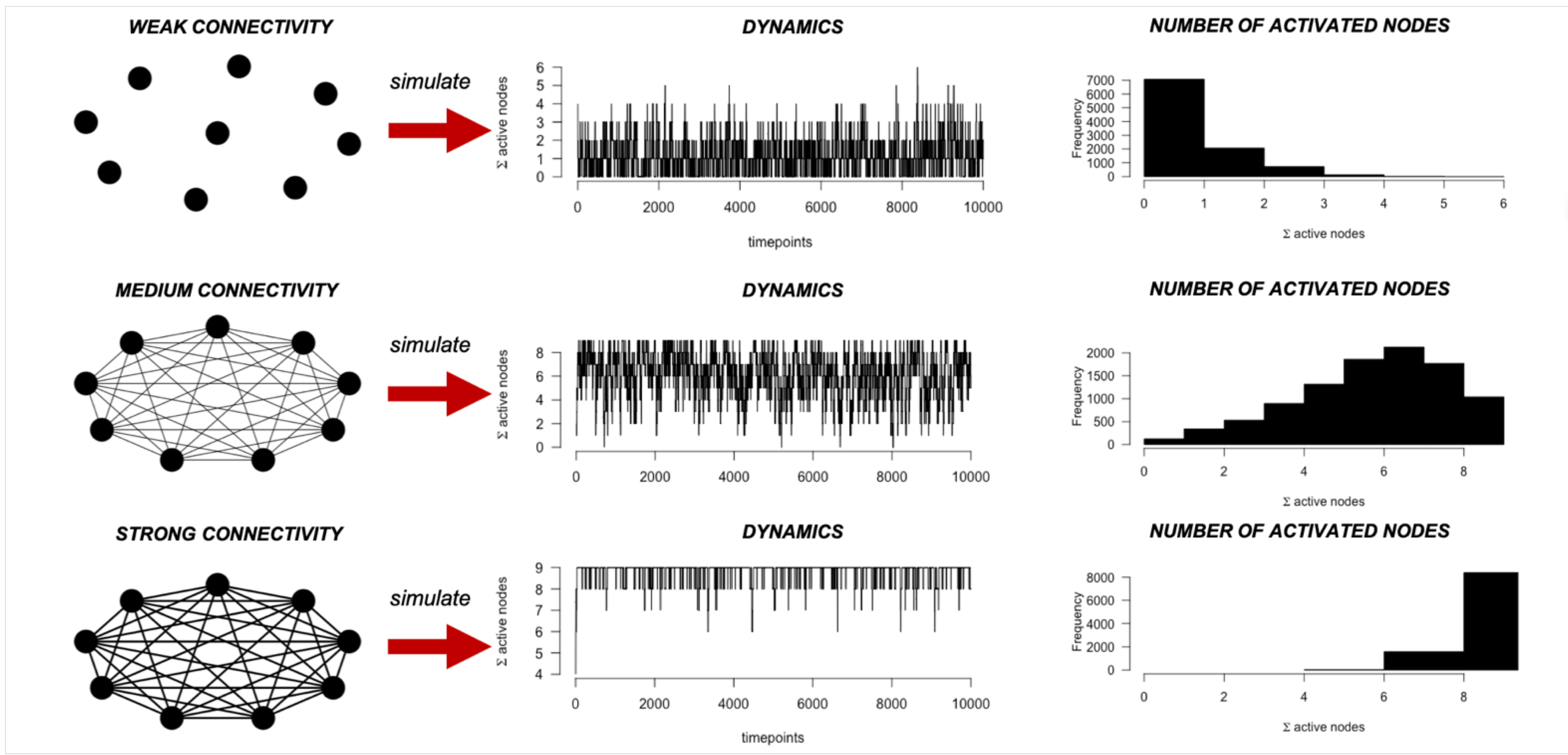

Figure 3: Network equilibrium states as a function of network structure.

Perturbation analysis

To study the resilience of the equilibrium states, we use perturbation analysis. 10 000 timepoints are simulated for the three different network structures. After every 1000 timepoints, the system is perturbed by forcing it into a fully depressed state (all symptoms are activated). Depending on the network structure, the system recovers from this perturbation - or not.

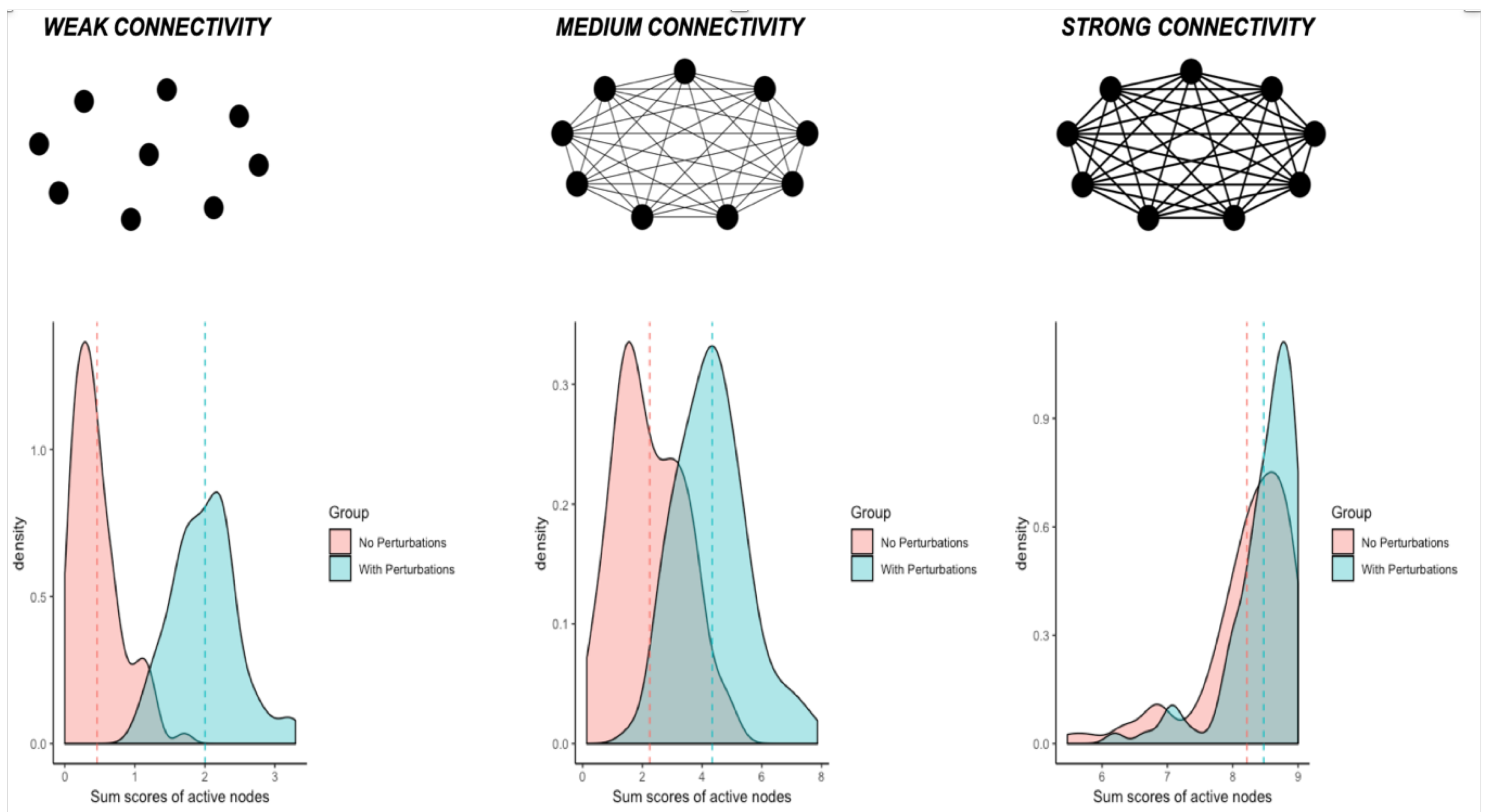

Figure 4: Density distributions of the network dynamics after adding perturbations to the simulation study.

Discussion

- This paper takes the first steps into forming a novel framework regarding psychological resilience using the network perspective on mental disorders.
- Future research should focus on expanding the dynamical systems and network models that can be used for the proposed generic interface.
- With this paper, we have laid out the thinking tools and framework for extending this line of research to other network models.